HANDBOOK OF ECOLOGICAL ECONOMICS

Handbook of Ecological Economics

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1. Taking stock: the keystones of ecological economics

Joan Martínez-Alier and Roldan Muradian

1. TAKING STOCK

After some decades of existence, ecological economics is a thriving field of knowledge. Our purpose here is not to engage in the normative debate about what it should be, but rather to introduce the *Handbook* we have edited, while also trying to provide some insight into what constitutes the ontological foundations of ecological economics. In the concluding chapter we shall elaborate on the most salient current concerns of the field, as well as on its future. This compilation of chapters aims, on the one hand, to present and stimulate the debate on the scope and methods of the multifaceted transdisciplinary field that was baptized as ecological economics in the late 1980s and, on the other, to comprehensively review the 'state of the art' in several exciting, relevant and rather new subjects dealing with the fluid interface between economic and ecological systems.

The *Handbook* covers a wide range of appealing topics but it would be too ambitious to attempt to review the vast history and current production of ecological economics in a single volume. Moreover, this compendium is the result of combining the tastes of the editors with the generous availability of the invited authors. Therefore, we do not pretend to have made a full overview of all major trends and issues of ecological economics. Our goal is more modest. We have invited some of the leading authors in the field to reflect on the most important developments in the subjects in which they are experts, and in doing so to contribute to disseminate within the ecological economics and other communities what they consider to be the most significant achievements and challenges in specific areas of knowledge. The outcome is stimulating and we hope enjoyable both for junior and experienced readers.

The rest of section 1 contains a historical account of ecological economics, while also describing what we consider to be its foundations. The review is not done in a chronological order, but along main foundational propositions. It is meant to be particularly useful for readers not yet familiar with the field. Section 2 briefly summarizes major organizational

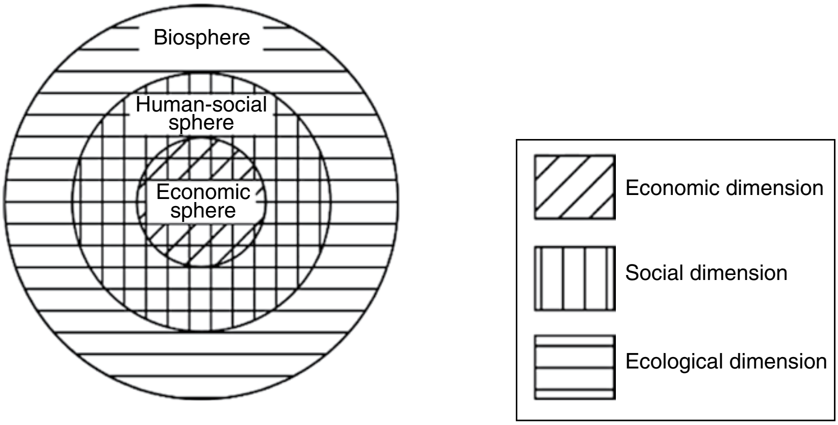

Figure 1.1 The economy embedded in the institutions of human society and in the biosphere

achievements of ecological economics as a community of scholars and introduces the contributions composing this volume.

1.1 The Analytical Lenses of Ecological Economics

René Passet in 1979 in *L'Économique et le Vivant* drew an image of the relations between nature, human society and the human economy (Figure 1.1) that has become a symbol for ecological economics. The drawing shows the obvious reality that there was nature before human society, and human society preceded the generalized market system by many generations. This vision has implications for economics. The teaching of the theory of externalities (that is, the impacts of the economy on the environment which are not measured by market prices) should not wait for the time when students have already grasped the analysis of general market equilibrium. On the contrary, the study of the market (the chrematistics) should come after the study of ecology and social institutions. The 'externalities' come before the 'internalities'. The market economy could not exist without social institutions, and without the unpaid services of ecosystems.

Ecological economists see the economy as an open system. In thermodynamics, systems are classified as 'open' to the entry and exit of energy and materials, 'closed' to the entry and exit of materials though open to the entry and exit of energy, such as the Earth, and 'isolated' systems (without entry or exit of energy and materials). The availability of free energy and the cycling of materials allow life forms to become ever more organized and complex; the same applies to the economy. Dissipated energy and waste are produced in the process. If the scale of the economy is too large and its growth is too rapid, then the natural cycles cannot sustainably produce the resources or absorb or assimilate the waste such as, for instance, heavy metals or carbon dioxide. The economy bumps into 'limits to growth' or 'planetary boundaries'.

In ecological economics the economy is seen as embedded in the ecosystem (or, more accurately, in the historically changing social perception of the ecosystem). The economy is also embedded in a structure of property rights on environmental resources and services, in a social distribution of power and income, in social structures of gender, social class or caste. Instead, in mainstream economics the economy is seen as a self-sufficient system where prices for consumer goods and services, and prices for the services of production factors, are formed.

Ecological economists (Norgaard, 1990) disputed the view expressed in the 1960s by Barnett, Krutilla and other mainstream resource economists, that since natural resources were cheap, they must be abundant. Markets are myopic, they discount the future, and they cannot see future uncertain scarcities of sources or sinks. Ecological economists understand and even sympathize with attempts at 'internalizing' externalities into the price system, they readily concur with proposals to correct prices by taxes (such as 'natural capital depletion taxes' or taxes on pollution) but they deny that there exists a set of 'ecologically correct prices'.

In the late nineteenth and early twentieth centuries the biologist and urban planner Patrick Geddes, the chemist Frederick Soddy and the engineer and social reformer Josef Popper-Lynkeus had unsuccessfully tried to promote a biophysical view of the economy as a subsystem embedded in a larger system subject to the laws of thermodynamics (Martínez-Alier and Schlüpmann, 1987). By 1850 or 1860 the carbon cycle and the cycles of plant nutrients had been discovered, while the first and second laws of thermodynamics (conservation and transformation of energy, but also dissipation of energy and increase in entropy) had been established.

The contrived conflict between the 'optimistic' theory of evolution which explained the diversity of life and the 'pessimistic' second law of thermodynamics was a staple of the cultural diet of the early 1900s. Praising the energy accounts of agricultural systems published in 1880 by the 'narodnik' revolutionary and physician S.A. Podolinsky, the ecologist Vernadsky wrote in 1924 (Vernadsky, 1924, pp. 334–5) that Podolinsky had analysed the energetics of life (life systems being open to the entry of energy), and had applied these ideas to the analysis of the economy. Podolinsky wrote that, for an economy to be sustainable, the energy productivity of human work (that is, how much energy is made available by one day of human work) must be higher (or equal, if everybody is working) than the efficiency of the transformation of the energy intake into human work. The energy productivity of a coal miner (wrote Podolinsky) was much larger than an agriculturalist could attain but this energy surplus from fossil fuels was transitory (Podolinsky, 1880, 1883).

Therefore, the main ingredients for an ecological view of the economy were present much before the birth of a self-conscious ecological economics in the 1980s, which was delayed by the strict boundaries between the natural and the social sciences. The biologist and systems ecologist Alfred Lotka, born in 1880, had introduced in the 1910s and early 1920s the fundamental distinction between the endosomatic use and the exosomatic use of energy by humans. While we have genetic instructions on the amount of food energy to be consumed (about 7 to 10 MJ per day for an adult), our exosomatic use of energy depends on culture and income, and reaches 1 GJ or more per day for rich people.

Much later, four well-known economists, who did not yet form a school, are seen in retrospect as ecological economists: Nicholas Georgescu-Roegen (1906–94), the author of *The Entropy Law and the Economic Process* (1971) (where Lotka was often quoted), Kenneth Boulding (1910–93), who worked mainly on general systems analysis, K.W. Kapp (1910–76) and S. von Ciriacy-Wantrup (1906–80), who were both institutionalist economists. The systems ecologist H.T. Odum (1924–2002) studied the use of energy in the economy and some of his former students were among the first ecological economists in the 1980s. Other sources of ecological economics are in Environmental and Resource Economics (microeconomics applied to environmental pollution and the depletion of natural resources), in Human Ecology, Ecological Anthropology, Agroecology and Urban Ecology, and in the study of 'industrial metabolism' as developed by Robert Ayres (born in 1932), now known as Industrial Ecology.

The first books or special issues of journals with the title 'Ecological Economics' appeared in 1987. After meetings in Stockholm and Barcelona, Robert Costanza and Herman Daly set up the International Society for Ecological Economics (ISEE) and convened the first world conference in Washington DC in 1990. The book that came out of this first conference (Costanza, 1991) ambitiously defined the field as 'the science and management of sustainability'. The successful academic journal *Ecological Economics* started in 1989, edited first by Robert Costanza, and later by Cutler Cleveland (who also edits the Encyclopedia of the Earth) and by Richard Howarth.

Some environmental economists of neoclassical persuasion were also present in those early efforts. David Pearce became one of the main editors of the new journal, *Ecological Economics*, but he left the journal after 1994 because of internal disputes on what is now called 'weak sustainability vs. strong sustainability'. Pearce had influenced the World Bank to do macroeconomic accounts in which 'human-made capital' could in theory be a substitute for so-called 'natural capital'. This was 'weak sustainability', that is, sustainability in the weak sense of the term. Herman Daly, Peter Victor and other ecological economists objected to 'weak sustainability'. One could not sustainably substitute the increased horsepower of the fishing fleet for a declining availability of fish. Moreover, measurement of stocks of capital depended on the rate of profit (as discussed in the controversies on capital theory of the 1970s) (Victor, 1991).

However, the International Society for Ecologial Economics (ISEE) is a scientific society encouraging internal controversy and also a product of the environmental movement of the 1960s and 1970s in its different varieties. Internal pluralism and perhaps some confusion of ideas were present in the volume produced after a second ISEE conference in Stockholm in 1992, 'Investing in natural capital: the ecological economics approach to sustainability'. While some ecological economists even today feel that the metaphor of 'natural capital' is useful, others strongly reject it because it suggests that we can use 'units of capital' as a common measuring rod that would make commensurable the losses of biodiversity and the increases in manufactured capital stocks. The notion of 'natural capital' supports policies such as 'habitat trading' (one habitat is destroyed and another one, far away, is effectively protected) or the Rio Tinto mining company's doctrine of 'net positive impact' (a new location is destroyed while another is preserved and enhanced, going round the world until no natural spaces will be left).

While H.T. Odum (and his disciples working on human ecological energetics: A.M. Jansson, Robert Costanza, Charles Hall and Cutler Cleveland), David Pimentel (agricultural energetics) and C.S. Holling ('resilience') were the ecologist grandfathers, mothers and fathers of ecological economics, Boulding and Georgescu-Roegen were the economist grandfathers. (K.W. Kapp had died early, missing the birth of ecological economics.) Herman Daly's influence was also decisive. Daly (born in 1938) published his first article in what we now call ecological economics in 1968 in *The Journal of Political Ecology*. In the early 1990s (Daly and Cobb, 1989) Daly promoted an index of sustainable economic welfare (ISEW) expressed in money terms that showed results very different from GDP (because of the different assumptions in the calculations). It seemed at the time that ISEW was a good way to attack GDP accounting but an index in money terms was not congruent with the critique against 'weak sustainability'. Daly maintained his stature in the field and recently increased it as his early defence of a Steady State economy (Daly, 1973) is now seen as having announced the new ecological macroeconomics without growth (Victor, 2008; Jackson, 2009).

Daly was explicitly inspired in his work by Boulding and Georgescu-Roegen. Boulding had published a famous article on *The Economics of the Coming Spaceship Earth* (a spaceship where materials would have to be recycled) (Boulding, 1966). He became a card-carrying member of the ISEE and an author in the collective book edited by Costanza (1991). Georgescu-Roegen refused to be drawn into the ISEE; he preferred to call the field 'Bioeconomics' (Mayumi, 2001; Bonaiuti, 2011) and announced the publication of a book with this title that never appeared. He disliked Costanza's article in *Science* in 1980 (Costanza, 1980) proposing an energy theory of value, he disliked also H.T. Odum's 'emergy' (embodied energy) accounts to which he answered with an irritated reply: 'matter matters too' (Georgescu-Roegen, 1977), against what he called the 'energetic dogma'. On the other hand, Boulding, more concerned with scarcity of materials than with energy dissipation, wrote a less than enthusiastic review of Georgescu-Roegen's magnum opus. In due course the edition of the collected works and correspondence of such major intellectual figures and pioneers of ecological economics will clarify the real substance, if any, in such disagreements and quarrels.

Georgescu-Roegen's point on the importance of entropy for the economy is as follows. Life is 'negentropic': Georgescu very often cited Schrödinger's *What is Life* (1944). The evolution of species, the complexity of living structures, was achieved by 'capturing' energy through photosynthesis, and by dissipating energy to outside systems. The industrial economy, however, after the thermo-industrial revolution (Grinevald, 1976) did not work only by using current photosynthesis or hydraulic energy. It was burning stocks of fossil fuels. Even a non-growing industrial economy would not be sustainable because energy cannot be used twice (except in minor cases of 'co-generation'). In any day in 2014 we take 90 million of barrels of oil from the 'subterranean forest' (Sieferle, 2001), and tomorrow we have to do the same again, a little more or a little less, whether from the bottom of the sea or from fields in Iraq or Saudi Arabia, the rainforest of Ecuador or the Orinoco Delta in Venezuela. Perhaps the EROI is declining (the energy return on the energy input) or perhaps not yet. Georgescu was also aware of Hubbert's approaching 'peak oil'.

Although we could claim that Darwin won against Sadi Carnot (Prigogine and Stengers, 1984), in the industrial economy the sources of low-entropy become scarcer. Moreover, materials cannot (in practice) be recycled to the full extent (an observation that Georgescu tried to glorify into a Fourth Law of Thermodynamics, without success; Mayumi, 2001). Georgescu saw the economy as a system open not only to the entry of energy and materials but also to the unavoidable exit of inconvenient and unrecyclable 'garbojunk' (a word formed by garbage + junk).

Georgescu's fundamental contribution to ecological economics was then that, because of the Second Law of Thermodynamics or Entropy Law, even a non-growing industrial economy is not sustainable. Therefore, in the rich economies, a steady state (as proposed by Daly, drawing on Stuart Mill) would not be enough. A steady state economy aims for mildly fluctuating levels in population and consumption of energy and materials. Birth rates equal death rates, and (in economic terms) saving/investment equals depreciation. Georgescu said that in rich countries a degrowth in the inputs of fossil fuels and other materials was required. Hence Georgescu's agreement to the French title to a selection of his articles edited by Grinevald in 1979, *Demain la Décroissance*. In retrospect, this book became 25 years later one main inspiration for the European 'degrowth' movement (Martínez-Alier et al., 2010). Nobody ever preached a 100 per cent degrowth of the economy. Georgescu's lower limit would be that of an economy fuelled by the current inflow of solar power. There is therefore a confluence of ideas between Georgescu's degrowth, Daly's steady-state (Kerschner, 2010) and the new ecological macroeconomics without growth which is presented in this volume.

The winner of the Nobel Prize in Chemistry and expert on radioactivity, Frederick Soddy, had written on energy and the economy from 1910 onwards. He compared 'real wealth', which grows at the rhythms of nature and which, if turned into manufactured capital, is worn down, with 'virtual wealth' in the form of debts that apparently could grow forever. Private property in a capitalist system guarantees (for a while) the increasing private debt while the public debt could apparently grow based on the guarantees provided by the State. But this was a flimsy building. Soddy has been quoted by Daly and other ecological economists since the 1980s, much before the financial crisis of 2008. Debt-fuelled growth was not viable. The real fuel of economic growth was coal, oil and gas. The amount of real wealth that an economy could create is limited by the amount of low-entropy energy and materials that it can sustainably take from the external environment, and by the amount of effluents such as greenhouse gases that the environment could sustainably absorb. Soddy's book of 1926 was called *Debt, Wealth and Virtual Wealth*. He drew on John Ruskin. He meant that debt was not real wealth, it was virtual wealth. Real wealth was the current inputs of solar energy. Although ecological economists have not developed a consensual monetary reform plan, they follow Soddy on the need for 'financial prudence' against increasing indebtedness and recommending for instance a large increase in the cash reserve requirements of banks (Daly and Cobb, 1989).

Soddy approvingly quoted Aristotle's distinction between *oikonomia* and *chrematistika*, as Marx had done and Karl Polanyi (1957) was to do later. Ecological economists are fond of this distinction. *Oikonomia* meant the material provisioning of the *oikos* (the extended family), while chrematistics was the art of studying market prices to make money, for instance by becoming a monopolist (a word used by Aristotle). What Aristotle called *oikonomia* would now be called human ecology and economic anthropology, while chrematistics is what students of microeconomics learn.

Apart from the United States and Europe, the Japanese 'entropy school' of economic analysis (Tamanoi et al., 1984) studied the environmental services provided by the water cycle, and also the ancient urban ecosystems of Japan. In India, there was much work after the 1970s by economists but also by ecologists (Madhav Gadgil) on the links between forest or water management and common property rights, nowadays one main focus of interest in ecological economics (Berkes and Folke, 1998; Agarwal, 2010). Other early ecological economists (whose major works were not in English) are, in France, René Passet (1979), and Ignacy Sachs, who proposed in the early 1970s the notion of 'eco-development'; Roefie Hueting (1980) in the Netherlands and Christian Leipert in Germany; Jose-Manuel Naredo in Spain (Naredo, 1987). (For general introductions to the field, see: Costanza et al., 1997; Cleveland et al., 2001; Martínez-Alier and Røpke, 2008; Spash, 2009.)

According to Georgescu-Roegen (1971), economics should see the economy as an open system (and not as a self-sustaining system, a 'merry-go-round' between consumer and producers, as in the textbooks). Economics should study the 'metabolic flows' in the economy. This is today linked to two research schools. The first one centres on Marina Fischer-Kowalski and collaborators at the Institute of Social Ecology in Vienna, drawing on work by Robert Ayres, R.P. Sieferle and other authors.

The second school would be Marxist ecological economics. It has much less influence. It claims with reason that Marx already wrote in the 1860s that the capitalist economy was causing a 'metabolic rift' (Foster, 1999). Marx took the word 'metabolism' (*Stoffwechsel*) from Moleschott and Liebig, pointing to the export of nutrients in the soil by commercial agriculture. Capitalism not only exploited workers, it also exploited the soil. The soil was no longer a 'fund' able to supply crops continuously; it became an exhaustible stock in terms of its fertility and texture. Marx quoted Liebig who feared the day when guano imports would diminish. Marx, as Liebig, hoped for factory-made chemical fertilizers (in a sort of 'weak sustainability' approach) to escape the Malthusian trap of 'diminishing returns'. Despite such intellectual traces, a Marxist ecological economics or environmental history has not existed until the contributions at the end of the twentieth century from Altvater (2007), Bellamy Foster, Hornborg (in his theory of ecologically unequal trade, Hornborg, 1998), and O'Connor's 'second contradiction' (O'Connor, 1988).

1.2 Keystone Concepts: Irreducibility of Needs and Incommensurability of Values

In economic theories of production and consumption, compensation and substitution reign supreme. Not so in ecological economics, where diverse standards of value are deployed 'to take Nature into account' (O'Connor and Spash, 1999). In the ecological economics theory of consumption, some goods are more important and cannot be substituted by other goods (economists call this a 'lexicographic' order of preferences). Thus, sacredness cannot be traded off. And no other good can substitute or compensate for the minimum amount of endosomatic energy or for water necessary for human life. To call the endosomatic consumption or the exosomatic use of energy a 'socially constructed need or want' would ignore the ecological explanations and/or implications of such use of energy, while to call the daily endosomatic consumption a revealed preference would betray the conventional economist's metaphysical viewpoint.

There is another approach which, as pointed out by John Gowdy and Susan Mesner (1998), builds upon the 'principle of irreducibility of needs' (proclaimed by Georgescu-Roegen in the 1968 edition of the *Encyclopedia of the Social Sciences*, article on 'Utility'). According to Max-Neef (1992), all humans have the same needs, described as 'subsistence', 'affection', 'protection', 'understanding', 'participation', 'leisure', 'creation', 'identity', 'freedom' . . . and there is no generalized principle of substitution among them. Such needs can be satisfied by a variety of 'satisfactors'. Instead of taking the economic production as given, we may ask (as in the steady-state and *décroissance* perspectives) why there is so much travel, and why there is so much building of houses with new materials instead of restoration of old ones. Is there a trend to use 'satisfactors' increasingly intensive in energy and materials in order to satisfy predominantly non-material needs?

In part due to the existence of a 'lexicographic' order of preferences, there are also limits to the degree of substitution between different types of values (economic and non-economic). Stressing these constraints, one of the foundations of ecological economics is thus the incommensurability of values. Ecological economics is not committed to a unique type of value expressed in a single numeraire or unit of account. 'The issue is not whether it is only the market place that can determine value, for economists have long debated other means of valuation; our concern is with the assumption that in any dialogue, all valuations or "numeraires" should be reducible to a single one-dimension standard' (Funtowicz and Ravetz, 1994, p. 198). Ecological economics encompasses money-valuation, and also physical appraisals of the environmental impacts of the human economy measured in their own physical numeraires. It also gives importance to social indicators.

However, ecological economists understand and have pushed sometimes for the economic valuation of ecosystem services, with the avowed intention of making them more visible to the general public and to policy makers who are assumed to think mainly in money terms. Nevertheless, the insistence on money valuation clearly makes less visible the biological and ecological importance of Nature, and also livelihood and cultural values. The beauty and sacredness of mountains such as the Niyamgiri Hills in Odisha might seem negligible when compared to the very large money value of their bauxite deposits. The mountains are better defended outside money valuation (Temper and Martínez-Alier, 2013). The debates on when money valuation is appropriate continue in ecological economics (Kumar, 2010). A consensus is perhaps being reached that money valuation is appropriate when trying to make companies accountable in civil litigation for their past environmental liabilities (as in the British Petroleum case in the Gulf of Mexico, Chevron-Texaco in Ecuador or Shell in the Niger Delta) but it is not appropriate when taking decisions for the future (whether on climate change or biodiversity policies or on building an open cast mine or a dam) when money valuation becomes only one of several relevant valuation languages (Rodriguez-Labajos and Martínez-Alier, 2013).

As John O'Neill and Thomas Uebel show in their contribution to this *Handbook*, the current debate on incommensurability of values in an intergenerational context goes back to the 'socialist calculation debate' started by Otto Neurath and Ludwig von Mises in Vienna in the early 1920s. Otto Neurath (1882–1945) favoured a *Naturalrechnung*, accounting in physical terms, while Von Mises wrote that without prices there could not be a rational economy. Max Weber agreed with Von Mises. Otto Neurath disagreed, and asked how we should decide whether to use more coal now and less human labour, or keep coal for the future and use more human labour now. In today's terms, should we use more fossil fuels now, enjoy economic growth and produce more GHG, rely on technological change and invest in new renewable technologies and geoengineering, or should we go into a steady-state economy after a period of slight degrowth in the rich economies? Collectively, these are technical-ethical questions, they are not decisions that real or fictitious market prices can solve. We cannot enter into market-like negotiations with future generations of humans; the methodological individualism of orthodox economic theory breaks down here. Nevertheless, instead of engaging with such arguments, Hayek (1952) in *The Counter-Revolution of Science*, pursuing his thirty-year-old disagreement with Neurath, lumped him and other authors (Soddy, Geddes, Mumford) who supported physical accounting together into the category of 'social engineers', would-be dictators.

1.3 The Institutional Dimension

Many years later, one article by Vatn and Bromley (1994) titled 'Choices without prices without apologies' explained why money valuation is only optional. Choices depend on socially moulded preferences that depend on institutions, that is, the social rules and norms. As Veblen famously put it, the individual consumption of the rich is guided by the social rule of showing off. Bromley and Vatn are institutionalist economists, in Veblen and Kapp's tradition. (Kapp himself was influenced by Otto Neurath's economics.) They see economic behaviour not as being determined by inscrutable individual preferences but as influenced and explained by social rules and norms. Institutions articulate a diversity of values (Vatn, 2005).

In this context, Coase's approach to the internalization of negative externalities or positive environmental services into the price system relies on market transactions between partners. So, if an agent (a peasant community, a factory) pollutes the water in a river, the downstream aggrieved agents may get together either to ask for an indemnity equivalent to the damage suffered or to bribe the polluters to stop the pollution, depending on the property rights on the river. This might work without need for government intervention. However, getting the downstream people together to start a court case implies 'transaction costs' (lawyers' fees, time for meetings) which prevent the simple Coasean solution from operating. Also, when those being polluted are future generations and other species, the market solution does not operate. Regulation (physical norms and fines) or Pigovian taxation are preferable.

Regarding the empirical study of a very popular policy instrument such as Payment for Environmental Services, one main contribution from ecological economists has been to criticize the simple Coasean, market approach, and introduce complexities related to uncertainty, distributional issues, social embeddedness and power relations, acknowledging the variety of contexts and institutional settings in which PES operate (Muradian et al., 2010).

The institutionalist perspective (economic actions are explained by social rules more than by inscrutable individual preferences) is also very relevant for the study of the relation between property rights or property regimes and the management of natural resources. We go back here to the much quoted article by Garrett Hardin (1968), 'The tragedy of the commons', which should have been titled 'The tragedy of open access'. In fact, Hardin attended the inaugural conference of the ISEE in Washington DC and he had a chapter in the seminal book edited by Costanza (1991). One paragraph in Hardin's article starts like this: 'Picture a pasture open to all. . .', and describes how a tragedy of overgrazing will occur because individuals will put more and more sheep or cows on it provided that the marginal benefit (a few litres of milk, a few pounds of wool, a sack full of dung) are larger, individually, than the private marginal cost, disregarding the collective marginal costs in terms of soil degradation.

To the old liberal critique of 'common' property ('the magic of private property (and enclosures) would turn sand into gold' had written Arthur Young) was now added a trendy environmental critique, the Tragedy of the Commons. However, was Hardin not aware of the rules that in the past (brought from England to New England) presumably regulated the amount of horses or cows that a citizen could put to pasture in the Boston Commons? Or in any other commons, whether a Mexican *ejido* or a New Mexican common pasture? Why was the confusion between 'commons' and 'open access' not spotted by the reviewers of Hardin's article in *Science*? There were many well regulated communal systems of management for coastal fisheries or irrigation water, as Bromley and others soon retorted and as Elinor Ostrom was to study in detail (Ostrom, 1990).

Hardin's 1968 article mistook commons for open access. It preached privatization (or State property) against the misnamed 'commons'. It took some time until the confusion was cleared up, provoking much research on the practical functioning of common property regimes, and also on the relations between forms of property and resource management. There are certainly open access resources, for instance some fisheries in the open seas. The atmosphere was also treated as being in open access to dump polluting substances such as CFC that damage the ozone layer until an international treaty banned this practice. The atmosphere is still a dumping ground in open access as regards GHG. Other examples abound. Some scholars did research on the trend to turn natural resources held in common and subject to traditional management rules (like coastal mangroves and fisheries in India or Latin America) into de facto private property, for example for growing shrimp or for fishing for export. This was described not only as a social but also an environmental 'tragedy of enclosures'.

Compared to open access, private property is in principle more conducive to conservation because the costs of today's actions will be felt by the owner or his/her immediate kin. This has been discussed in resource economics at least since Faustmann's rule (1849). The private owner of a forest (or rather, of a tree plantation) will decide to cut the trees not as soon as possible, but when the rate of growth of the trees (net of harvesting costs and multiplied by the market price of wood) falls below the rate of interest in the bank plus the rent to be obtained from the land now empty of trees (potentially used for crops or pastures while the new stand of plantation trees is starting to grow again). Notice here that a high interest rate (or discount rate) will lead to cutting the trees very soon, while payment for ecosystems products or services (like hunting rights, mushroom collection, recreation under the trees, carbon capture) will slow down the rotation period and could even persuade the owner not to cut the trees at all and eventually turn back the plantation into a true forest.

In the case not of trees in a plantation but of metal mining or extraction of fossil fuels, private property linked to the profit motive is certainly not conducive to conservation, nor to the avoidance of negative environmental impacts during operation or after the exhaustion of the resource such as acid drainage from mines. New institutions, that is, rules articulating new values (for instance, civil or criminal legislation on socio-environmental liabilities) would perhaps modify such behaviour.

1.4 The Contested Issue of Population Growth

Ecological economists emphasize both the pressure of population and the pressure of production (and consumption) on resources. How large is humankind's ecological footprint? Has humankind exceeded 'carrying capacity'? This is defined in ecology as the maximum population of a given species, such as frogs in a lake, which can be supported sustainably in a given territory without spoiling its resource base. However, the large differences internal to the human species in the exosomatic use of energy and materials mean that the first question is, maximum population at which level of consumption? Second, human technologies change at a quick pace. Already Boserup's thesis (1965) of endogenous technical change according to which pre-industrial agricultural systems had intensified in response to increases in population density, turned the tables on the Malthusian argument. Third, the territories occupied by humans are not 'given', other species are pushed into corners or into oblivion (as the index Human Net Primary Productivity (HANPP) implies), and, internal to the human species, territoriality is politically constructed through state borders. Fourth, international trade (similar to horizontal transport in ecology, but which humans can regulate consciously) may imply 'ecologically unequal exchange', though if one territory lacks a very necessary item which is abundantly present in another territory, Liebig's law of the minimum would recommend exchange. Then, the joint carrying capacity would be larger than the sum of the carrying capacities of all autarchic territories.

Because of the shortcomings of 'carrying capacity' as an index of (un) sustainability for humans, and because of Barry Commoner's arguments against Paul Ehrlich's fixation on population growth (Ehrlich, 1968) forgetting that overconsumption was the main environmental threat, the formula I = PAT was proposed by Ehrlich himself, where I is environmental impact, P is population, A is affluence per capita, and T stands for the environmental effects of technology. Efforts are being made to operationalize I = PAT. True, population remains one important variable. True also, the demographic transitions are not mere automatic responses to urbanization and education, and their timing does not depend only on social institutions, such as inheritance patterns and family forms. Human demography is anticipatory and self-conscious. Though it also follows Verhulst's curve, it is different from the ecology of a population of frogs in a lake.

There have been three different varieties of Malthusianism. First, Malthus' own view in 1798 that human populations would grow exponentially unless checked by war and pestilence, or by the unlikely restraint of chastity and late marriages. Food would grow less than proportionately to the growth of the labour input, because of decreasing returns. Hence, subsistence crises.

Then there was the Neo-Malthusianism of 1900, with radical activists such as Emma Goldman, Paul Robin (Ronsin, 1980). Human populations could regulate their own growth through contraception. Women's freedom was required for this, and it was desirable for its own sake. This was a feminist Neo-Malthusianism, insisting on what is called today 'reproductive rights'. Abortion and vasectomies should not be criminalized. 'Conscious procreation' was required in order to prevent low wages and pressure on natural resources but the main cause of poverty was social inequality. This was a successful bottom-up movement only in some parts of the world, particularly in Europe and America against states (which wanted more soldiers) and against the Catholic Church.

There is finally top-down Neo-Malthusianism after 1970, reaching extremes like Hardin's 'lifeboat ethics' (Hardin, 1974) against freedom of migration with racist overtones. This top-down doctrine and practice is sponsored by international organizations and some governments. Population growth is seen as one main cause of poverty and environmental degradation. Therefore states must introduce contraceptive methods, even sometimes without the population's (particularly women's) prior consent.

Ecological economists have been divided into top-down and bottom-up Neo-Malthusians with lack of dialogue between them, although they all refuse the doctrines of the anti-Malthusians, who assume that human population growth is no threat to the natural environment, and that it is conducive to desirable economic growth. The divide has been expressed in more recent debates about the relationship between migration and the environment (Muradian et al., 2006). Ecological economists believe that growth of world population (four times in the twentieth century) is certainly a very major issue, but differ in their visions about policies to deal with population growth and migratory flows. It now seems that population might be stabilized and even go into a slow decline after 2050, perhaps at 9 billion people. Fertility is going down in many regions and countries. The demographic transition is being completed. This is a good thing, although local depopulation (not only rural, also urban) may create new social and environmental problems.

2. THE SOCIETY FOR ECOLOGICAL ECONOMICS

Could the ISEE (born in the late 1980s) be seen in future as remotely similar in influence (though very different in intention) to the Mont Pelerin Society founded by Hayek in 1947 to defend the market economy and Karl Popper's 'open society' against Marxist doctrines and Keynesian social-democratic planning? Should we have a political objective, are we already politically motivated? Is the pluralism in ecological economics undermining such a prospect, or rather, is the radicalism of ecological economics preventing or delaying its social acceptance? Should we relent a bit and accept 'weak sustainability' and the promises of ecological modernization, or should we denounce UNEP's 'green growth' of 2013 as an oxymoron even more blatant than Brundtland's 'sustainable development' of 1987? In fact, should 'we' (ecological economists) have any collective position at all?

The ISEE has lived up to its promise of promoting a transdisciplinary academic field at the intersection of ecology and economics. Both economists and ecologists coming from different schools have been active in the field. This chapter has briefly explained the origins of ecological economics going back to the late nineteenth century. Therefore it is not true that 'ecological economics is simply what ecological economists do'. They do many different things but within a common tradition which is a bit shaky and not clearly delimited because it is at the interface of related fields.

While the journal *Ecological Economics* and the biennial conferences are the main focus of activities of the ISEE, there are active regional societies in the United States, Europe, India, Latin America and Russia. The European Society for Ecological Economics edits a journal, *Environmental Policy and Governance*. The Latin American ecological economists publish the journal *Revibec*. Other well-known ISEE members have edited related journals: Charles Perrings, *Environment and Development*; Clive Spash edits *Environmental Values*; Robert Costanza, *Solutions*; Jeroen van den Bergh, *Environmental Innovation and Societal Transitions*. The Indian Society (INSEE) regularly publishes proceedings of well attended conferences. Its past-president, Kanchan Chopra, gave her name to a famous committee named in 2002 by the Supreme Court, giving Net Present Values to non-market forest products and services that companies have to pay for when carrying out mining or hydroelectric projects.

Among all this variety, there is a common thread. A sample of first university degrees and main scientific interests of the (older) ecological economists can easily be constructed by listing the names of the ISEE presidents since 1989, as follows.

- Robert Costanza, ecologist and landscape architect, energy in the economy, valuation of ecosystem services;
- R.B. Norgaard, economist, post-development studies, co-evolution, biodiversity conservation;
- John Proops, physicist, energy and the economy, capital theory, economic-ecological modelling;
- Charles Perrings, economist, development studies, economics of biodiversity;
- Joan Martínez-Alier, economist, energy and society, environmental history, political ecology;
- Peter May, resource and environmental economist, development, Amazon deforestation;
- John Gowdy, economist, economic anthropology, economics of consumption;
- Bina Agarwal, economist, development and feminist economics, common property, India;
- Marina Fischer-Kowalski, sociologist, industrial ecology, social metabolism, transition societies.

This list can be complemented by the list of recipients of the ISEE Boulding Award: Herman Daly (economist); Robert Goodland (biologist); A.M. Jansson (ecologist); Robert Costanza (ecologist); C.S. Holling (ecologist); Robert U. Ayres (physicist, industrial ecologist); Partha

Dasgupta (economist); K.G. Mäler (economist); R.B. Norgaard (economist); Charles Perrings (economist); Manfred Max-Neef (economist); Ignacy Sachs (economist); Joan Martínez-Alier (economist); Bill Rees (ecologist); Mathis Wackernagel (ecologist); and Peter Victor (economist), roughly divided as half ecologists (biologists, physicists) and half economists in their original training. Their names often appear in the present *Handbook*.

Ecological economics is then a new transdisciplinary field which develops topics and methods such as:

- new indicators and indices of (un)sustainability of the economy;
- ecological macroeconomics without growth, the debate between 'weak' and 'strong' notions of sustainability;
- the application of ecological notions of carrying capacity and resilience to human ecosystems;
- the valuation and payment for environmental services, monetary valuation of externalities but also the discussion on incommensurability of values;
- risk assessment, uncertainty, complexity and 'post-normal' science; integrated environmental assessment, including building of scenarios, dynamic modelling, participatory multi-criteria methods of decision making;
- the allocation of property rights and its relation to natural resource management, old and new communal institutions for environmental management;
- environmental causes and consequences of technological change, relations between ecological economics and evolutionary economics;
- theories of consumption (needs, satisfactors), as they relate to environmental impacts;
- relations to industrial ecology; applications to business administration; corporate liability and accountability;
- relations to fields such as industrial ecology, urban ecology, feminist economics; environmental and economic history; political ecology, peasant studies;
- instruments of environmental policy, often centred on the 'precautionary principle' (or 'safe minimum standards', as introduced by Ciriacy-Wantrup).

As stated above, in this *Handbook*, however, we do not attempt to cover all these issues. The book cannot therefore be considered as a comprehensive map of all the topics addressed by ecological economists. It should rather be seen as a stimulating exploration of some of the most critical contemporary matters in the field. After this introduction, the chapter written by Clive Spash tackles one of the recurrent and fundamental subjects in the modern history of ecological economics. Namely, what ecological economics is or should be, and how it could be differentiated from other fields of knowledge. This constitutes the topic of an ongoing debate. The frontiers of ecological economics are by definition difficult to set, and its call for pluralism often falls in contradiction to some core tenets of the field, including a critical vision about the assumptions and methods of mainstream neoclassical economics. Furthermore, some of the internal contradictions of ecological economics arise from 'epistemological tensions'. For example, between the need of pragmatism (to have influence on contemporary policy making) and the aim of conceptual rigour, or between the adoption of the notion of biophysical constraints to the economy (implying a sort of 'objective' vision on human societies) and acknowledging that reality is socially constructed (social constructivism), which implies adopting the vision that biophysical limits are dependent on social preferences.

The emphasis on incommensurability of values is one of the main issues of dispute between ecological economics and mainstream economics, and John O'Neill and Thomas Uebel's contribution traces the roots of such discussion to the 1920s and 1930s. The search for alternative methods to conventional monetary valuation of environmental assets (and ability to acknowledge the plurality of human values) has been a recurrent concern in ecological economics. In his chapter, Christos Zografos draws the state of the art of deliberative methods for policy design in the field of the socio-environmental evaluation. Deliberative methods assume legitimacy as a key element of social decision making. A motivation for the adoption of deliberative methods in ecological economics is the concern for improving the quality of policy assessment and design.

One of the distinctive features of ecological economics has been a shared vision of the economic system as embedded in a biophysical base, which calls for looking at economic processes from a biophysical perspective (instead of solely from a monetary point of view) and thus invoking the notion of metabolism. The chapter written by Fischer-Kowalski and Haberl outlines the concept of social metabolism, and discusses how it has evolved across time. The chapter addresses some key conceptual and methodological issues when studying the socio-metabolic profile of economic processes, as well as showing some empirical findings and patterns, stylized through several decades of research. This contribution constitutes an excellent state of the art of the study of the material and energetic metabolism of human societies.

The relationship between macroeconomic policies and the condition of the environment is a subject that has been often neglected. The chapter by Nadal tackles this complex issue from a post-Keynesian perspective. He argues that sustainability objectives involve the whole economy, and therefore environmental policies cannot be disentangled from macroeconomic policies. Environmental sustainability is hence essentially a macroeconomic problem. In practice, this means that monetary and fiscal policies, for example, must be redesigned and redefined in order to be instrumental in achieving sustainability objectives. This chapter discusses extensively how the priorities of macroeconomic policies (which are assumed to be politically determined and not the result of technical considerations) can be redefined in order to achieve a better environmental performance in contemporary capitalist economies.

Also making use of Keynesian insights, the contribution from Peter Victor deals with a subject studied so far by only a few scholars, namely, the 'macroeconomics of non-growth'. The goal of this approach is to test whether social, economic and environmental goals can be met in a non-growing economy, so less emphasis could be put on economic growth as a societal goal. A model is used to discuss how different components of the economy, such as consumption, investment, employment, technological change, public expenditure and trade, would look in a non-growth advanced economy. The chapter also outlines a possible research agenda around these issues.

The chapter by Petridis, Muraca and Kallis also deals with the current discussion around the concept of 'degrowth'. Activists and scholars gathered in the contemporary 'degrowth' movement criticize the adoption of economic growth as the ultimate goal of human societies since they point out that, after a certain threshold, growth intensifies social inequalities and exacerbates environmental problems. The chapter traces the history of critical ideas composing the core of the degrowth movement, and the parallelism with other contemporary initiatives. It also discusses the links between academia and activist groups around this issue. Ecological economics, as a broad field of knowledge creation and exchange, has traditionally been closer to social bottom-up movements, as compared to other more mainstream approaches in economics. The authors also delineate a research agenda and propose some key lines of action for strengthening a fruitful exchange between academicians and activists over societal goals, particularly in advanced economies. The tenets of the contemporary degrowth movement are not shared by the whole community of ecological economists. However, what is a common concern is the biophysical limits to the economy.

The flow of resources into the economy is not only a relevant issue because of the threats of depletion or over-exploitation, but it is also relevant due to the multiple conflicts that arise between social groups about access and the distribution of benefits and costs derived from the use of natural resources. Ecological economics has always had a fluid exchange with political ecology, the field that studies socio-environmental conflicts. The contribution of Rodríguez-Labajos and Martínez-Alier discusses the relationship between water social metabolism ('the hydro-social cycle') and water conflicts. The authors outline a classification of contemporary conflicts over water resources and elaborate on what type of responses from social movements and new management institutions have emerged from conflicts, showing that disputes over water can also be a creative source of institutional changes.

The contribution by De Groot and Braat deals with one of the currently most influential concepts in the environmental field, namely the notion of ecosystem services. This approach is based on the proposition that lack of information about the benefits humans derive from ecosystems and wrong incentives remain as the key sources of the persistent degradation of the natural environment. The authors give an overview of the history of the ecosystem services paradigm and elaborate on the typology of those services. They also discuss the ongoing debate and existing methods to estimate the values (quantify the importance) of ecosystem services. Furthermore, the chapter addresses a critical issue, namely how to incorporate the notion of ecosystem services into decision making in order to improve socio-environmental governance. In this field, they pinpoint three key issues currently hotly debated: how to estimate and aggregate monetary values; how to undertake trade-off analysis and to incorporate it into decision processes; and how to raise awareness and create positive incentives to change practices.

In their chapter, Gómez-Baggethun and Martín-López also tackle the issue of how to incorporate the benefits humans derive from the natural environment into decision making by means of allocating values to ecosystem services. Instead of taking a monist (monetary) approach for value assessment, they plead for 'value pluralism'. That is, they consider different social values allocated to the natural environment, and they assess them by using a broad set of units and scales. This calls for integrated valuation and methodological pluralism, which can, however, be very challenging (due to the problem of aggregation and a higher complexity of communication). Such an approach would need openness to different knowledge systems and the will to negotiate values along different social groups and organizations. This constitutes an appealing research and policy agenda, which is still under construction among ecological economists, despite the progress made during past decades, particularly in the development of integrated methodologies for socio-environmental valuation.

Adopting a plural vision about knowledge systems involves, among other things, taking into consideration traditional environmental knowledge. In her chapter, bridging a gap between anthropology and ecological economics, Reyes-Garcia describes how the relative importance allocated to traditional ecological knowledge has been reconsidered and revalued in recent times in academic and policy arenas. Despite being threatened by modernity, this knowledge system, which is embedded in local institutions, organizations and culture, has shown a remarkable capacity for dynamism and adaptation, as well as contributing to local livelihoods, the conservation of biodiversity and ecosystem functions, and the resilience of social-ecological systems. The chapter includes a comprehensive literature review about the relationship between traditional environmental knowledge and these three dimensions, and discusses how the dynamism of these knowledge systems can contribute to enhancing the contemporary 'knowledge society'.

One of the exciting areas of recent innovation in economics has been the growing field of experimental economics. Empirical results have been noteworthy since many of them have challenged basic assumption of mainstream neoclassical models. The contribution of J.C. Cardenas analyses how the progress made by behavioural sciences over the last decades and the tools provided by experimental economics have helped to enhance our understanding of the decision-making process of individuals in collective action situations, including the management of common pool resources. These methodological approaches have been able to simulate some of the complexities involved in the management of common pool resources in real-life situations. The chapter identifies some behavioural patterns in such situations, and it delineates a possible future research agenda.

Another behavioural concern in ecological economics has been the issue of consumption. The chapter by Røpke outlines trends in consumption patterns during the past twenty years. She also discusses major trends in consumption patterns among affluent and middle-class citizens of rich countries, a key matter since these patterns reflect the aspiration of billions of people in less wealthy parts of the world. In this chapter, the phenomenon of consumption is understood from a comprehensive perspective, taking into consideration not only behavioural aspects (such as practices and habits), but also the role of economic cycles, and the structure of socio-technical systems of provision. The author conceives consumption as a key element in enabling a sustainability transition towards lifestyles more compatible with the existence of planetary biophysical constraints.

Complementing the previous chapter, the contribution of Guarín and Scholz deals with the environmental and social consequences of the consumptions patterns of the emerging middle classes at the global level. It addresses the interesting issue of whether consumer behaviour is converging or diverging among the new middle class in emerging countries. Generalizations around this topic are difficult to elaborate, since the relationship between culture, income and consumption patterns is very complex. The authors acknowledge cognitive biases and the variety of values and motivations underlying consumption, which creates flexibility and diversity among consumers from different cultural and social backgrounds. Four broad emerging trends are identified, and their implications for environmental sustainability discussed. The authors point out that there is scope for being both pessimist and optimist about the prospects for sustainable lifestyles in the future, depending on the aspects considered.

The chapter written by Vatn is based on two basic premises: environmental problems increasingly have a global scope, with regard to both causes and solutions; and in general there is a misfit between the governance systems and the type of problems faced, which creates a 'governance gap'. From an institutional perspective, first the chapter clarifies what governance is about. Then it characterizes the main global governance challenges and discusses the variety of governance structures, as well as the configuration of the most important international agreements. The chapter ends pleading for a look beyond technological fixes (which have dominated the search for solutions to environmental problems) and necessary attention to be paid to changing the multi-level institutions governing economic and political processes.

The contribution of Ring and Barton also addresses governance issues, and more specifically it analyses the challenges involved in disentangling the role of economic instruments in policy mixes for biodiversity conservation and the provision of ecosystem services. A policy mix is understood as a particular combination of policy instruments with a common goal. After systematizing evaluation criteria for evaluating policy instruments, the authors elaborate on the possible frameworks for the analysis of policy mixes and the types of policy interactions. The chapter ends taking examples of policy mixes from two relatively novel governance approaches: payments for ecosystem services and ecological fiscal transfers.

In their contribution to this book, Coudel and co-authors examine the evolution of a novel environmental policy instrument (again, payments for ecosystem services) in one of the countries where it has been adopted swiftly and at different scales: Brazil. The authors describe the ongoing process of policy experimentation and how payments schemes have been inserted in policy mixes. They show that the success of payments for ecosystem services in Brazil has been driven by diverse policy agendas. These schemes have raised the interest of different social groups about how to reward efforts to protect natural ecosystems and thus create incentives to adopt more environmentally-friendly practices and prevent deforestation. The authors conclude that there is yet insufficient empirical evidence about the impacts of these schemes. Much additional research is therefore needed in order to feed future decision-making processes.

In the last chapter of the book we, the editors, delineate what we consider to be the most salient concerns in contemporary ecological economics and discuss possible ways forward, while also recapitulating the main contributions made in this comprehensive volume. Overall, the contributions composing this book show a very complete picture not only of the foundation of the field but also of some of the most appealing areas of knowledge where ecological economists work nowadays.

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2. The content, direction and philosophy of ecological economics

Clive L. Spash

1. INTRODUCTION

This chapter borrows, and provides some key points, from a series of articles where I have explored the divisions in environmental research in economics (Spash, 1999; 2013; Spash and Ryan, 2012), the need to raise the profile of social and political research in ecological economics (Spash, 2011a) and the necessity of developing a clear understanding of the philosophy of science upon which to base the whole research agenda (Spash, 2012a). My position can be set out briefly as being that ecological economics has lost its direction and the mass of 'stuff' calling itself by this name needs to be disentangled. More specifically what is superficial and shallow should be clearly separated from what is progressive and deep. Much of the work being presented in the journal *Ecological Economics* and at conferences run by the international and regional societies is mainstream resource and environmental economics, *not* ecological economics. This reveals the betrayal of the original aims of challenging and changing society and economy as opposed to pursuing the mainstream economic goals of efficiency and growth reinforced by spreading market institutions to all aspects of life.

In contrast to the economic orthodoxy, the aim of societal transformation to a more just, equitable and environmentally benign system involves a realization of the need for deconstructing the current capital accumulating, energy-intensive, materialist, hedonic system and the academic economics that provides it with supporting rhetoric. In order to clarify the distinction, the progressive area of the field is termed 'social ecological economics'. The basis for this designation is that the only meaningful way ahead for humanity is to institute a radically different form of social and economic organization than currently exists. The failure of ecological economics today is then merely a reflection of the failure of society at large to face up to the complex of structural problems created by the existing system of political economy. The pretence is that we can continue doing much of what we have been doing both in science and society. Yet challenging that assumption of business as usual was exactly why ecological economics came into existence in the first place – that is, in order to explain the reality of human-Nature interactions and the implications of taking biophysical reality into account. The goals were to critically analyse the inadequacies of the existing socio-economic approaches and, more importantly, to develop far better alternatives.

Instead of a path-breaking interdisciplinary field for critical social science, ecological economics has then become an academic forum for presenting anything socio-economic falling under the broad topic of environmental sciences. This is what Rich Howarth (2008), as Editor-in-Chief of the journal *Ecological Economics*, has termed the 'big tent', and advocates as a pluralist approach. This is meant to be an all-inclusive talking shop for all ideas. However, instead of a progressive social ecological economic understanding of the world around us, which could offer well-founded alternative policy recommendations, the result has been the persistence of an 'anything goes' philosophy that presents all sorts of contradictory approaches and information as equally valid and relevant. There is no talking shop and cross-disciplinary engagement, let alone interdisciplinary understanding, and alternative ideas are pushed aside by the mass of orthodox conformity. There is no attempt to sort the wheat from the chaff or indeed to discuss the necessity of doing so.

After a quarter of a century of its modern existence, in the form that Inge Røpke (2005) has referred to as a reputational organization, ecological economics is in danger of becoming a meaningless agglomeration of anything and everything. On the one hand, ecological economics provides neoclassically trained mathematical formalists, and their emulators, with an outlet for their abstract theoretical ramblings that pose as being rigorous and scientific. These new resource economists emphasize deductive modelling and trust in their models to predict the efficient future path for resource use (Spash, 2013). On the other hand ecological economics promotes theoretically ungrounded, but equally unrealistic, methods claiming to have empirically proven the value of Nature, the world and/or aspects thereof, either as money amounts (for example, natural capital, ecosystem services) or land-based equivalents (that is, footprints). Here we find researchers justifying themselves as engaged in being practical rather than theoretical. Their approach is framed in terms of providing a useful means for communication to the policy community and possibly the public. They see themselves as addressing the information needs of politicians and business. This group I term new environmental pragmatists (Spash, 2009).

In this chapter I will not devote much time to the new resource economists, who are best regarded as unreconstituted neoclassical economists who believe in, or are apologists for, most tenets of the orthodoxy in economics (for example, markets as efficient allocators of resources, prices as reflecting resource scarcity, power and ethics as irrelevant and indeed damaging to their scientific objectivity, choice being equivalent to trade-offs, technology as providing the ultimate world-saving substitutes for everything). Despite my lack of attention and summary dismissal of this group, as the antithesis of social ecological economics, readers of this *Handbook* will undoubtedly find representatives of this position within its pages. This inclusiveness of incoherent positions by ecological economists is something I discuss within this chapter as the problem of indiscriminate (methodological) pluralism and eclecticism.

Instead of giving space to explaining the imperialism of mainstream economics, as evident in the spread of new resource economics, I will open by considering the new environmental pragmatists. This is a commonly expressed position which many seemingly feel is totally justified and some adopt as compatible with the more radical approach of social ecological economics. The new environmental pragmatists, who have been dominant in ecological economics, view the world as being run by market systems and prices. They may be for or against this but either way accept as a necessity the communication of their environmental concerns via the concepts of economics, accountancy, banking and finance. These approaches they regard as using the language of power, while themselves actually having no explicit theory of power. Indeed, as pragmatists of a simple sort (and by definition anti-theoretical) they are not concerned with detailing the basis for their knowledge claims. Theory, contradicting their own understanding and claims, they can readily dismiss as some form of undesirable and unnecessary fundamentalism. This derision of theoretical foundations is highly problematic as will be explored in what follows.

2. THE DAMAGING INFLUENCE OF NEW ENVIRONMENTAL PRAGMATISM

Elsewhere, I have made clear the distinction between new environmental pragmatists and the philosophical school of American Pragmatism (Spash, 2013), and I will not repeat this here; the reader should just be aware that the two should be differentiated. Those who fall under my category of new environmental pragmatism are focused on pushing methods and concepts because they are deemed to be effective under current political conditions and economic institutions (that is, those of neoliberalism and capitalism). These pragmatists want to sell their environmental message in an appropriately marketable form acceptable to political, business and financial elites, and in doing so buy into the methodology and ideology of commodifying, quantifying and pricing Nature.

This form of pragmatic drive can be seen in a variety of work and use of concepts such as ecosystems services valuation, natural capital, green accounting, carbon trading, and biodiversity offsets and banking (for further references see Spash, 2009; 2011b). The people who appear to be most strongly in favour of this position are not philosophers of science but rather environmentalists, environmental scientists, conservation biologists and ecologists. That is, a major faction employing such new environmental pragmatic justifications appears to be coming from outside economics and within the natural sciences. They may be motivated by a variety of arguments including: the view that this is necessary to be effective politically, that there are no better alternatives, that this is how things should be done, and that this is the way to produce the best outcomes (Spash, 2008). The distinguishing feature of new environmental pragmatism is the lack of concern for theoretical rigour, especially in the social sciences, and prioritizing of methods to achieve supposed 'solutions' on purely instrumental grounds. Environmentalism is then a practical problem solving activity, not a fundamental critique of the dominant structure of political economy and its treatment of human relationships with Nature.

Typically, as currently being practised, new environmental pragmatism is about recommending monetary valuation and supporting a neoliberal market approach for environmental policy.[1] This may be undertaken with reluctance or be ideologically motivated. Regardless of motivation, a range of work led by non-economists seems to fit, including that of Costanza et al. (1997a) on valuation and natural capital, Daily (1997) on ecosystems services, Balmford et al. (2002) on conservation, and Walker and Pearson (2007) on resilience. Environmental non-governmental organizations also seem to have become strong advocates of new environmental pragmatism (Spash, 2009), and more specifically via their integration with corporations (Anshelm and Hansson, 2011; Van Huijstee et al., 2011). It has also spread to international agencies. For example, this is evident in the United Nations advocacy of a green economy (Spash, 2012c), and sponsorship of work on the economics of ecosystems and biodiversity (Spash, 2011b). These projects have included ecological economists (for example, TEEB, 2010), and/or referenced their indebtedness to ecological economics (UNEP, 2011: 2). Indeed the TEEB project, ecosystem commodification and the conversion of ecological concepts into economistic goods and services are also represented in this *Handbook* as being part of ecological economics.

[1] Some might argue that civil protest and organized social resistance are the best approaches to achieving environmental policy change, and just as pragmatic but with a different political ideology and goal as the motivator.

Research and applications attempting monetary valuation of ecosystems exemplify the role of new environmental pragmatism in ecological economics. The original aim of ecological economists in this area was to seek new ways of conceptualizing and counting the impacts of economic and policy decisions on ecological systems and processes. However, Norton and Noonan (2007: 665, emphasis added) state: 'we hear less and less discussion of these *deep issues* as ecological economists have embraced quantitative analysis of non-market values and ecosystems services as the means to identify, monetize, and count environmental values in virtually every circumstance and context.' Here reference is specifically to the work by such new environmental pragmatists as Costanza et al. (1997a) and Daily (1997) for placing theoretically unjustifiable monistic money numbers on Nature under the concept of ecosystems services. This is seen as resulting from use of a shortcut method for creating dollar values, because ecologists were frustrated by adherence to economic theory and so recommended relaxation of the strict rules of valuation under environmental economics. As Norton and Noonan (2007: 669) summarize: 'Advocates of this approach measure, by whatever means available, the economic impacts of various ecological processes and outcomes on human well-being.'

For new environmental pragmatists, social science methodology and theory are largely irrelevant because the aim is to get communicatively powerful statements of why everyone should be paying more attention to environmental problems. They ignore the possibility that presenting theory as secondary to and disconnected from practice might misconstrue the motives and justifications for action. In criticizing such a philosophy, Proctor (1998: 367) notes that theory is necessary to inform understanding of actual events and in making critical appraisals of what is a workable approach to address environmental problems. Similarly, Sayer (1992a) explains how judging what is practically adequate information cannot avoid theoretical conceptualization. Yet these matters clearly have no relevance for new environmental pragmatists.

There is no pretence within such work to be testing the validity of ideas in accord with any philosophy of science; concepts, methods and results are instead advocated as politically useful and rhetorically justified as such. Rather than seeking scientific understanding or empirical validity, the aim is political validation, that is, success is to be measured by political reaction. Indeed, new environmental pragmatism uses a non-philosophical discourse of self-justification embedded in everyday language. In common usage the word 'pragmatism' refers to dealing with things in a way that is based upon practical as opposed to theoretical considerations (that is, drawing a false dichotomy between what can usefully be done and the need to conceptualize what to do). This easily moves to emphasizing what is most expedient, downplaying process and dismissing anyone expressing concerns which can be classified as too abstract, idealist, romantic, utopian and so on. On these grounds the new environmental pragmatist can justify what they may know lacks any theoretical basis, or scientific validity, by appealing to a claim of something being potentially practically useful in achieving a goal. In rhetorical terms, not being pragmatic is regarded as being impractical, which is a derogatory classification implying that a person or their ideas should be dismissed as politically unrealistic, bad or even stupid. The new environmental pragmatist then employs doublespeak as they claim to be operating in 'the real world', while in fact refusing to address the complexity and meaning of social and political reality.

While I have emphasized the support this has given to neoliberalism, new environmental pragmatism may also exist beyond the straightforward drive towards markets and commodification. Work by Wackernagel and Rees (1997) on ecological footprints might then qualify, because its land theory of value is implicit and its problems seem neglected due to the importance given to achieving political impact regardless of issues such as incommensurability. Then there is the work of Walters and Holling on adaptive management, which also does not plump for monetary valuation. For example, after doing some promotion of objective scientific and Bayesian approaches to the management of uncertainty, Walters and Holling (1990) admit a more political agenda is relevant along with the broader context in which knowledge operates when dealing with policy problems. They state that 'policy is politics' and argue that acceptability amongst scientists, government and the public of explanations for action can occur regardless of whether scientific uncertainty is high. So now they are arguing, contra themselves, that objectifying, reducing and resolving uncertainty is not the only or even the key aspect for management. As they state: 'decisions are not made because of a well-proofed argument in the tradition of experimental science, but because of the accumulation of credible evidence supporting a simple and widely perceived explanation in a political environment that demands action.' (Walters and Holling, 1990: 2067). The message is that, if you want policy impact, then provide simple explanations that have political (not scientific) credibility. Such arguments open the door to adopting any approach that seems useful within a specific context, regardless of whether this is mainstream economics or some radical alternative.

3. FOUNDATIONS IN INDISCRIMINATE PLURALISM AND ECLECTICISM

Transdisciplinarity and methodological pluralism have been taken as core ideas by many in ecological economics. However, rather than providing a meaningful epistemology and methodology, the result has been the creation of confusion and superficiality. A lack of serious attention to the theoretical basis for ecological economics has created an amorphous body of literature, not least in the journal *Ecological Economics*, and much that is totally contradictory and/or bears little relationship to the supposed objects of study, namely society, economy, Nature and their interactions.

Transdisciplinarity has a tendency to be used as a blind for work which fails to seek any depth of disciplinary understanding while deriding those regarded as overly specialized disciplinary experts. This weak transdisciplinarity can be contrasted with a strong form based solidly on serious interdisciplinary understanding that requires as a prerequisite knowledge of the disciplinary fields being brought together and synthesized (Spash, 2012b; 2013). Transdisciplinarity is not then a way around disciplinary engagement, but rather a means for critical reflection upon different understandings that adds to interdisciplinarity through engagement with lay knowledge. Yet, while the rhetoric of transdisciplinarity abounds, the theoretical basis is largely ignored. This is also true more generally of the entire basis for scientific understanding within ecological economics.

Discussions of methodology have not moved much beyond the article by Norgaard (1989) in the first issue of the journal that claimed the necessity of a pluralism that included the naïve objectivism of mainstream economics. His argument for methodological pluralism has at its core the belief that 'a diversity of methodologies is appropriate and pressures to eliminate methodologies for the sake of conformity should be avoided' (1989: 37). However, this is an argument against prescriptive epistemology, not the elimination of some methodologies per se. Intellectual progress requires understanding built on deciding what contributes to knowledge or, as Norgaard (1989: 38) himself admits, 'the intellectual environment we create to sort the good from the bad'. He is highly critical of specific epistemological features – unity of science, universal laws, independence of reality from observer and culture – and he clearly favours their rejection from any epistemology for ecological economics (see also Norgaard, 1994). Furthermore, Norgaard (1989: 38) explicitly criticizes both ecologists and economists for their adherence to such a prescriptive methodology as 'logical positivism', and states that he is in 'opposition to this long-standing belief in a right way of knowing and precise prediction'. Of course in doing so he is unwittingly offering another 'right way of knowing'. In any case, his point does not seem to be that all methodologies can be regarded as equally valid or acceptable.

Yet Norgaard (1989: 44) then claims that: 'In fact, few scientists study methodology or make their beliefs explicit. Individual scientists, and eventually whole disciplines, succeed by being pragmatic'. Later he concludes that 'logical positivism is inappropriate but necessary', and it is necessary 'because modern people perceive science in terms of objective, universal truths' (Norgaard, 1989: 51). So ecological economists must apparently accept arguing on the same naïve objectivist grounds! This amounts to recommending methodology on the basis of presumed popularity and fails to address the critical epistemological concerns and realist arguments he himself has raised.

Despite this poor foundation, the idea of an uncritical pluralism has spread within ecological economics and has been promoted at the highest levels. Ecological economists Costanza, Perrings and Cleveland represent between them two former Editors-in-Chief of the journal and two former international society presidents. In their combined opinion: 'Ecological economics is necessarily eclectic and pluralistic. It is therefore difficult to pin down and summarize.' (Costanza et al., 1997b: xiii). Acceptance of this as the natural order of things seems to condemn ecological economics to ultimate irrelevance.

As Dow (2007: 448) states, 'unstructured pluralism or eclecticism, understood as an absence of selection criteria, or "anything goes", is antithetical to the building up of knowledge'. In addition, a belief in some objective reality (as opposed to a strong social constructivist position) adds further restrictions. As Dow (2007: 455) goes on to remark: 'There is a limit to how far there can be plurality of understandings of the nature of reality, approaches to knowledge, and meaning, when knowledge needs to be developed within groups of researchers and communicated to others. Plurality in practice cannot be infinite.' The conundrum for methodological pluralists is that they must either indiscriminately accept everything, and so lose any meaning for the concept of knowledge, or accept some grounds for rejecting ideas and approaches which they find strongly objectionable.

The need to save ecological economics from an 'arbitrary openness to just everything' is recognized by Baumgartner et al. (2008), although their discussion still claims an epistemological plurality to support plurality in the use of methods. Besides being unnecessary, there is a problem in proposing multiple epistemologies without any synthesis. This is the simple impossibility of simultaneously holding two (or more?) contradictory ways of understanding the meaning of knowledge. Indeed, under epistemology, they actually end up arguing for a social constructivist position, although without making clear if this is strong or weak.[2] They also state the need for a unified methodological basis which needs to be consistent with and systematically directed towards the subject matter and aims of ecological economics (Baumgartner et al., 2008). Some of their suggestions in this area are potentially progressive.[3] However, they seem to fall foul of the epistemic fallacy,[4] never addressing the ontological foundations of ecological economics, and so miss the opportunity to provide some foundational basis for the argument. Yet the thrust of their position is clearly that structuring epistemology and methodology in ecological economics is necessary for progress.

More generally, anyone reflecting on how the integration of knowledge can advance will realize discourse, deliberation and effective criticism are aided if there are some grounds for identifying, understanding and appreciating the principles, perceptions and presuppositions underpinning others' thought. Awareness of epistemological differences is a precondition for engagement with ideas and such engagement cannot proceed with an unlimited range of 'methodologies'. So with whom discourse is going to be best is a necessary criterion for engagement. For example, in order for the old idea of a fully-informed, rational, atomistic agent to be replaced by the complex, fallible, multiply motivated agent requires dropping mathematical formalism, which acts as a constraint and perverts concepts. Expressing all theory in terms of individual behaviour which can be captured in formal mathematics prevents a more realistic model from developing. The decision as to where ecological economics should engage seems rather self-evident when given the choice between discourse with close-minded formalists employing outdated behavioural psychology to defend an unrealistic position, and open-minded social psychologists or sociologists sharing common critiques. Similarly, those who have called for paradigm shifts and revolutions in economics would be better off, and more consistent, looking to heterodox schools of thought rather than pretending there are bridges to be built and fruitful avenues to be walked

[2] Those who view scientific facts as social constructions deny that the goal of science is to find facts. As Steup (2010) explains: 'Such constructivism, if weak, asserts the epistemological claim that scientific theories are laden with social, cultural, and historical presuppositions and biases; if strong, it asserts the metaphysical claim that truth and reality are themselves socially constructed.'

[3] A useful aspect of their discussion is to highlight the role of concepts, which is something Kapp (1961) also recognized as a key approach for communication and integration if interdisciplinary work is to progress (see Spash, 2012b).

[4] The epistemic fallacy can briefly be summarized as operative when someone ignores ontology (that is, fails to state what constitutes reality) while maintaining epistemological (that is, knowledge) claims and so implicitly describes reality. Ontology is then effectively merged into epistemology.

down with orthodox economists who have already heavily invested in the defence of their paradigm and the existing power structures in society.

4. A PHILOSOPHY OF SCIENCE FOR ECOLOGICAL ECONOMICS

If different methodologies can be seen to follow from different understandings of reality (Dow, 2007: 453), then we might ask what is the ecological economists' understanding of reality? A vision seems to be required before we can proceed. In which case we might, as others have suggested (Costanza, 1996; Daly, 1991; Daly and Farley, 2004; Munda, 1997; Özkaynak et al., 2002), invoke Schumpeter's (1994[1954]) concept of vision as the 'preanalytic cognitive act'. What Schumpeter (1994[1954]) is discussing parallels calling for an explicit account of ontological presuppositions. This may be understood as answering a series of questions: what do we understand as being the reality with which we are engaging, what are its key features and how do the various elements then fit together, and what are their properties?

In order to proceed we must start from the basis in our conceptual understanding of the world. From this understanding empirical reflection can follow and help refine our knowledge. As Schumpeter (1994[1954]: 42) states:

> The first [analytic] task is to verbalize the vision or to conceptualize it in such a way that its elements take their places, with names attached to them that facilitate recognition and manipulation, in a more or less orderly schema or picture. But in doing so we almost automatically perform two other tasks. On the one hand, we assemble further facts in addition to those perceived already, and learn to distrust others that figured in the original vision; on the other hand, the very work of constructing the schema or picture will add further relations and concepts to, and in general also eliminate others from, the original stock.

Schumpeter goes on to mention 'the surviving elements of the original vision' as being subject to more rigorous standards of consistency and adequacy. Through such a process he believes scientific models can be developed and scientific propositions refined. This is strikingly similar to Neurath's repeatedly used analogy of knowledge creation being like completely rebuilding a boat while at sea (Uebel, 1996).

There is a clear divergence between the elements of narrowing and refining in this epistemology and calls for methodological pluralism in ecological economics. Costanza (1996: 12), for example, merely states: 'Scholars from various disciplines collaborate side-by-side using their own tools and techniques, and in the process develop new theory, tools, and techniques as needed to effectively deal with sustainability'. He seems to regard any potential attempts to reject content, or tools, as a violation of the transdisciplinary approach. Of course this form of pragmatism and instrumentalism leaves unanswered how scientific progress is meant to be achieved.

The need to jettison the current form of methodological pluralism, as I have argued, is clear. Tacconi (1998: 103) argues for the rejection of logical empiricism and for developing a more specific ontology and epistemology suited to ecological economics. In this regard he selects post-normal science and strong social constructivism for consideration. Strong social constructivism faces some problems in providing a position consistent with the preanalytic vision of ecological economists because of its relativist ontology. As Tacconi (1998: 99) notes: 'in constructivist ontology being is determined by knowledge. Consider the Earth without human beings. A reality would exist but would not be socially constructed'. On this basis Tacconi accepts the existence of a reality independent of human cognition but the proposed epistemology appears inadequate for addressing this. An additional, but related, issue is the treatment of biophysical limits. In social constructivism these are subject to a variety of interpretations dependent upon who is asked, rather than being independent constraints on human society. In addition, Tacconi (1998: 100) is not prepared to accept the total lack of independence of observer and observed as proposed by social constructivists.

A foundational aspect of ecological economics is then recognizable. That is, unlike other social sciences and most other heterodox areas of economics, there is a primary concern for a physical reality and how the integration of natural and social science knowledge can be meaningfully advanced. The idea that all reality is socially constructed conflicts with the status given to the Laws of Thermodynamics, as scientific realizations of biophysical reality, that are central to the conceptualization of what is wrong with economics (a repeated core concern in ecological economics; Daly and Farley, 2004; Georgescu-Roegen, 1971; Martínez-Alier, 1990; Munda, 1997). At the same time there is awareness that we cannot know 'the truth' about that reality (Røpke, 1998: 144), and hence the status given to ignorance and social indeterminacy (what Spash (2002) terms 'strong uncertainty'). However, that reality can be understood or interpreted in different ways does not mean humans may construct their own reality at will. The search is for an approach that captures both realism and the inadequacy of our ability to know.

This is presumably why post-normal science has been popular amongst ecological economists and especially those who have struggled with finding an epistemology (for example, Munda, 1997; Tacconi, 1998;

Özkaynak et al., 2002). Post-normal science postulates that knowledge about a physical reality can be known through experimentation under restricted conditions (broadly in accord with logical empiricism) but that the realm of such knowledge creation is limited, and increasingly so. Thus, as we move away from the controlled laboratory, and physics, towards complex interactive global systems, and environmental problems, we need a different basis for creating knowledge that involves broad participation by the lay public, as an extended peer community (Funtowicz and Ravetz, 1991; Funtowicz and Ravetz, 1994). The problem with this transdisciplinary approach, in the current context, is that it does not provide a clear theory of science, but is rather an attack on the practice and rhetoric of modern science. There is in part a prescriptive epistemology in that critique, but one that leaves unanswered the role of traditional science (i.e., is even restriction to some physics laboratory valid, or is all science really post-normal?). The ontological presuppositions are vague but seem to cluster around complex systems theory (Kay et al., 1999). Then, as Tacconi (1998) notes, the methodology is underdeveloped, leaving the ongoing task of putting the abstract argument on science quality assurance into practice (although some progress in this direction has been made; see van der Sluijs et al., 2005). So post-normal science is struggling with some of the same definitional issues as are being discussed here for ecological economics (for a review see Turnpenny et al., 2011).

Some defining ontological features can be drawn from this discussion. The case for the existence of a non-human reality seems rather uncontroversial. Anyone who accepts the theory of evolution must believe in the existence of a world prior to the emergence of humans. The attempts of Latour, and related strong social constructivist debates, to totally dismiss the concept of Nature as distinct from human society have failed and forced retractions and fundamental qualifications (Pollini, 2013). Then there is Sayer's (2000) point that if we humans controlled the construction of reality we could never get anything wrong, but as we do get things wrong, quite a lot of the time, this disconfirms such an explanation of reality as all in the human mind.

The problem then arises that reality may differ from how humans conceive it and this human perspective on reality may change over time. This raises the philosophical difficulties surrounding a correspondence theory of truth, where a belief is true if and only if it corresponds to reality. As Mackie (1970: 332) explains: 'A correspondence theory of truth is analogous to representative realism as a theory of perception, whereas what we want, at least with regards to truth, is direct realism'. His answer is a modest proposal: 'To say that a statement is true is to say that things are as the statement states'. The importance of this lies in enabling beliefs or statements to be answerable to how things are, something outside themselves, to reality. Acceptance of this position means we look to reality for confirmation of truth rather than, for example, justifying statements on the basis of their current usefulness or coherence with other statements.

Next we can ask: 'what meaning does the non-human world hold for us humans?'. Environmental ethics has emphasized the importance of recognizing that a reality without humans is indeed meaningful. This raises questions as to our value commitments to the non-human world, as exemplified by the last person thought experiment (Sylvan, 2009[1973]). That is, does wilfully destroying life on Earth matter if you are the last human on the planet; is it wrong? If ecological economists answer in the affirmative, as I believe they should, then they call for a change in the ethics, attitudes, values and evaluations of economics. In contrast, environmental and resource economists, for example, would be committed by their theory to accepting the last person's preferences. So, in terms of a preanalytic vision for ecological economics, I think the case is strong for including commitment to aspects of realism, empiricism and ethical significance of the non-human. This connects in part with a feminist and green ideological position reflected in a concern to care for and respect Nature beyond the purely instrumental reasons for meeting human ends (McShane, 2007a; 2007b).

Then there is the issue of the distinction to be drawn between natural and social science investigation or, less dichotomously, between different sciences moving from the natural to the social. For ecological economists, such as Tacconi (1998), the case for the rejection of logical empiricism (if narrowly defined) appears clear with regard to the social sciences, but for the natural sciences there is an implicit begrudged acceptance of its potential relevance, if a highly qualified one. For example, anyone invoking post-normal science accepts the role of normal science, as defined in that literature, in having achieved advances in human understanding and for curiosity-driven research. The strong constructivist position is therefore rejected. The qualifier is that normal science is regarded as of limited use for addressing modern environmental problems, because of their specific characteristics, for example, strong uncertainty, high decision stakes, complexity.

Ecological economists struggling with epistemological issues are aware of the need for something of a middle path (Baumgartner et al., 2008; Tacconi, 1998). As Jacobs (1996: 16) explains, ecological economics requires an approach that 'accepts neither the scientific reduction of the natural environment to its physical characteristics, nor the constructivist position which denies biophysical constraints on social life'. Ecological economics, like post-normal science, is trying to steer a course between the postmodern temptation to be nihilistic, while avoiding the modernist temptation to claim a single optimal answer or truth (Spash, 2002: 144). The naïve objectivism of the latter is prevalent in mainstream economics but also common in science policy. The exaggeration of the scope and power of traditional scientific knowledge leads to institutionalized censorship of critical opinions (Spash, 2010; 2014). This creates 'a vacuum in which should exist a vital social discourse about the conditions and boundaries of scientific knowledge in relation to moral and social knowledge' (Wynne, 1992: 115). These epistemological concerns raise a broader ontological question as to how we distinguish between natural and social realities.

5. CRITICAL REALISM AND ECOLOGICAL ECONOMICS

One possible aid in developing a preanalytic vision for ecological economics is to appeal to critical realism,[5] which also aims to provide an understanding of the interaction between physical and social systems (Bhaskar, 1978; 1979; Collier, 1994; Sayer, 1992b; 2000). Critical realism accepts that we can never demonstrate that we have discovered the truth even if we have (fallibilism), but does not reject the idea of there being an underlying objective reality. The description under critical realism is of an ordered hierarchy of sciences, for example, molecular sciences, biological sciences, social sciences (Collier, 1998b). There is real (ontological) difference in the strata so they are not regarded as just cognitively (epistemologically) convenient. The real distinctions between the strata and their irreducibility one to another (contra reductionism) are used to explain distinctions between the various sciences and the reason for a plurality of sciences to exist. So, for example, everything is governed by the laws of physics, all biological entities are physical but not vice versa, so biological sciences are embedded within the physical and, likewise, the social within the biological, and the economic within the social. At the level of mechanisms there is a one way hierarchy (Collier, 1994: 108–109).

This type of embeddedness is one of the key messages ecological economists have been at pains to communicate, that is, the economy is embedded in the Natural environment and subject to the Laws of Thermodynamics. Yet embeddedness should not be confused with reductionism. That

[5] I have found only two references to such a potential link by ecological economists. One was in a footnote to a book chapter by Røpke (1998: 144) and the other a brief mention in the book on institutions and the environment by Vatn (2005: 55–6).

elephants are constructed of physical and chemical components does not mean the behaviour of elephants can be understood by analysis of or reduction to those components (Georgescu-Roegen, 2009[1979]: 109). Similarly, irreducibility means society is not merely a collection of individuals and cannot be understood by simple aggregation on the basis of knowledge about individuals. Such an approach seems more in line with ecological economics than other epistemologies.

The stratified ontology of critical realism contrasts with single-level ontologies. These come in three forms (Collier, 1998a):

1. Those claiming parts are mere aspects of some whole, so that ultimately there is only the Absolute, of which everything is an aspect. This is the position put forward by Daly and Farley (2004).
2. The wholes are mere collections of parts, understood only when broken down into their components, which alone are ultimately real, for example, atomistic mechanism.
3. Some intermediate-level entities (for example, selves) are the only reality, their parts being mere aspects, and the larger entities, which they make-up, being mere collections, for example, some forms of methodological individualism.

The critical realist position rejects all these single-level ontologies.

A negative interpretation of the stratified and hierarchical ontology is worth mentioning at this point, due to its practical implications. This is the belief that truth lies in natural science while social sciences are merely a means of communication for that truth. Indeed a few ecologists, claiming to have placed economic values on the environment, have been known to acknowledge their lack of economic training as if to signify that 'anyone can do this stuff'. Social and economic research is then regarded as instrumentally important by such individuals (that is, pragmatically justified), because politicians and the press listen. This denies the importance of non-natural science subjects, or strata, and their independent contribution to knowledge. So we should be clear that the distinction required is not one of dichotomous division (social vs. natural), nor ranking (physics is best or hard, economics is Queen of the social sciences because it emulates physics, and so on). This is not a matter of superiority, but rather of substance.

If we pursue contributions to critical realism a bit more, some further insights arise of relevance to ecological economics as a policy or issue driven movement. Social science, including economics, can be differentiated on a substantive basis from the natural because it involves (contra Hume) an inseparability of facts and values. In order to explain this I borrow from Collier (1998a).

Social science presents ideas claimed to be true of the object studied. Unlike the natural sciences, the object (that is, society) includes ideas. Society can only exist on the basis of human agents acting, reproducing and transforming social structure. Human agents act in accordance with ideas (for example, religions, political ideologies). This means an account of structure requires an account of ideas. Collier (1998a) gives the example that there can be no understanding of the English Civil War without an account of Puritanism (that is, explanation of economic and class structure may be primary but inadequate). Significant ideas in any society include ideas about features of that society. Understanding social phenomena (for example, unemployment) requires addressing the real structural causes (for example, financial institutions, government policy, world markets) and prevalent ideas. Those ideas appear as social attitudes and political behaviour. Thus, explanations arising from a social-scientific study entail criticism of some ideas in society.

This means, if the social science is correct, that the people it describes who have an opposite explanation must be wrong. Social science criticizes part of its object and is different from natural science. For example, that black holes exist is no criticism of them, even if we find them unpleasant. In contrast, as Collier (1998a: 446) explains:

> To say that some institution causes false beliefs is to criticize it. Given that (other things being equal) it is better to believe what is true than what is false, it is also better (other things being equal) that institutions that cause false beliefs should be replaced by, or transformed into, those that cause true ones.

Furthermore, there is often a functional relationship between institutions that cause false beliefs and beliefs about those institutions. False beliefs may be spread in order to preserve the institution and its power. Thus, the rhetoric of the liberating character of 'free-markets' and benefits of material growth may be used by corporations and governments extracting resources, dislocating indigenous populations and creating environmental destruction. In such cases to propound the truth is not just to criticize, but to undermine the institution. 'Hence, the production of explanations of social institutions is not only, as a general rule, a precondition of criticizing and changing them; sometimes, it is criticizing them, and beginning the work of their subversion.' (Collier, 1998a: 446).

Open realization and acceptance of this position makes ecological economics far more radical than orthodox economics, which pretends to give objective, value-free advice while actually supporting the existing institutional structures. As Söderbaum (2011) points out: 'Neoclassical economics is science but at the same time ideology. As ideology, neoclassical economics can be described as the ideology of the present capitalist system. Some other institutional arrangement or kind of capitalism appears to be needed if we wish to deal constructively with present problems.' Being open about these fact-value relationships means ecological economics has a clear role in communicating its findings – concerning the character of social and environmental problems, the structures behind them and the institutions involved – to those who will implement institutional change and address the false beliefs in society. Indeed this can already be witnessed as happening (see Martínez-Alier et al., 2011; 2013). There are then fundamental differences in ontological presuppositions between ecological economics and the mainstream, leading to very different approaches to the science-policy interface.

Ecological economics can also be seen as sharing aspects of heterodox economic thought in its ontological presuppositions. For example, in a comparison with Post-Keynesian economics, the state of the world is seen in common as one involving strong uncertainty, social indeterminacy, emergent properties and a historical dynamic process (Holt and Spash, 2009). In contrast, the mainstream can be seen as treating individuals as passive agents in a static closed system with an ontology of isolated atomism. This justifies the orthodoxy in their formulation of social reality as typified by regularities, so allowing the methodology of deductive reasoning and mathematical formalism. Ecological economics, like other heterodox traditions, accepts the transformative power of human agency with emergent properties arising from a dynamic interconnected process of multi-layered social interactions. Modern heterodoxy is then distinguished from the mainstream by allowing theory and method to be informed by insights into social reality. Heterodox economists resist the mainstream reformulation of their concepts (for example, uncertainty, evolutionary developments, institutions, motives, ethics) not so much through being committed to them per se, as insisting on their possessing specific ontological properties (Lawson, 2006).

On the basis of the existing foundational literature in ecological economics I believe our main ontological presuppositions can be relatively easily established. My argument for establishing new foundations has been the need for the explicit statement of that ontology and the development of an epistemology (Spash, 2012a). This epistemological task has already progressed in the recognition of the need for a synthesis of realism and weak constructivism and the rejection of pluralist eclecticism. I have argued that a critical realist perspective has much to offer in this regard. Clarifying this contribution in more detail will in turn lead to a firm basis for a methodology suitable for social ecological economic enquiry. Our experience and practice in the world can then enable the refinement of our understanding and help us test the adequacy of our knowledge. Ecological economics might then aspire to becoming a meaningful critical social science embedded in a good understanding of biophysical reality.

6. CONCLUSIONS

The main reason the case for pluralism appeared early on was to protect ecological economics in its infancy from domination by a naïve objectivist and prescriptive epistemology, and so avoid losing the opportunity to develop and experiment with other approaches. After over two decades the time for a more progressive stance on the philosophy of science appropriate for ecological economics is long overdue, as is a total break from mainstream economics. The continued support for mathematical formalism and quantification as providing the sole means to scientific rigour and validity is damaging to an alternative vision for ecological economics.

Ecological economics is, and should be in part, an empirically based subject, but the form of that empiricism needs development and should not be restricted to a narrow, dogmatic, anti-pluralist, prescriptive caricature, nor based upon appeals to what appear in fashion as the most popular methodology. There seems no hope for progress if all that is done is to follow a methodology one abhors on the grounds that it is believed to be dominant amongst those whom one opposes.

New foundations for ecological economics are necessary. This must involve rejection of the claim that everything can be included and that failing to include all other disciplines and their tools in an indiscriminate manner is paramount to an 'intellectual turf war'. Ecological economics is not free from ontological or epistemological positions which have methodological implications. The preanalytic vision cannot involve backward-looking apologetics that force persistence with the claims to relevance of naïve objective science or deductive economics.

Knowledge creation requires refining and rejecting information and approaches. This does not mean that all pluralism is to be thrown out. Rather, grounds for making pluralism meaningful are required and that implies finding common ground for interaction and communication using common concepts. I have argued that those commonalities lie between ecological economics and heterodox economic schools of thought. Neoclassical approaches and concepts are in fact then detrimental to developing an alternative economic vision and conflict with epistemological progress. If people wish to undertake such approaches, and adopt such misconceptualizations, they should do so elsewhere, and so free ecological economics from having to pretend to agree with a series of orthodox fallacies, including: the pretence that there is no biophysical reality imposing limits and economics can be value-free. Ecological economics can either develop a more rigorous approach and establish a theoretical structure or become increasingly eclectic, unfocused and irrelevant. Ecological economics as a conservative movement is an unnecessary waste of time, merely shadowing environmental and resource economics. Ecological economics as a radical movement is required today, more than ever, in order to criticize and change the social organizations and institutions that spread false beliefs about economic, social and environmental reality.

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3. Analytical philosophy and ecological economics

John O'Neill and Thomas Uebel

Analytical philosophy has had a long but little noted influence on the development of ecological economics. The work of the left Vienna Circle, in particular of Otto Neurath, defended two central claims of ecological economics: first, economics needs to address the various ways in which economic institutions and relations are embedded within the physical world and have ecological preconditions that are a condition of their sustainability; second, reasonable economic and social choices cannot be founded on purely monetary valuations. Both of these claims were developed in two distinct but related debates that Otto Neurath engaged in. The first was the socialist calculation debate. The arguments of the Austrian critics of the possibility of socialism there, in particular Ludwig Mises and Friedrich Hayek, were aimed not only at socialism but at these two central claims of ecological economics. The second was the little known debate between the left Vienna Circle and the Frankfurt School in the 1930s. In this debate one can discern the origins of two distinct traditions of political ecology that still remain in tension in subsequent debates: a science-based approach that is concerned with the material and ecological conditions for human well-being and social relationships; and a science-sceptical approach that takes the environmental crisis to be founded in a technocratic commitment to the domination of humans and nature that is built into the constitution of scientific reason. In this chapter we explore these different debates and show the continuing significance of the analytical tradition to a defensible ecological economics. As shall be evident, running through the debates is a common theme about the nature and limits of scientific and practical reason, a theme that retains its importance for understanding the relationship between ecology, democracy and political economy.

1. NEURATH, MISES AND WEBER: CHOICE IN THE ABSENCE OF MONETARY UNITS

We begin by establishing Neurath's role in the development of ecological economics by exploring the connection between his work and that of

K. William Kapp.[1] One of the central claims of social ecological economics concerns the limits of monetary exchange values in making social and environmental decisions. Consider the following formulation of that claim by Kapp:

> The formulation of environmental policies, the evaluation of environmental goals and the establishment of priorities require a substantive economic calculus in terms of social use values (politically evaluated) for which the formal calculus in monetary exchange values fails to provide a real measure – not only in socialist societies but also in capitalist economies. Hence the 'revolutionary' aspect of the environmental issue both as a theoretical and a practical problem. In short, we suggest that environmental values are social use values for which markets provide neither a direct measure nor an adequate indirect indicator. (1974: 38)

Neurath and Weber are marked out by Kapp as the major figures whose work could found an understanding of these claims. Why is this? The origins of this claim can be traced back to Kapp's own earlier work on the socialist calculation debates. His doctoral dissertation *Planwirtschaft und Aussenhandel* (1936) engaged with Mises' critique of socialism. A distinctive feature of Kapp's understanding of the socialist calculation debates is the observation that the turn it had taken in the discussion of market models of socialism by Lange, Taylor and others had obscured what was at issue in the original debates between Neurath, Mises and Weber: 'the controversy initiated by O. Neurath, von Mises and Max Weber got sidetracked in various attempts to calculate the prices of productive factors by means of Walras' and Cassel's systems of equations and O. Lange's later elaboration of a theoretical model of "competitive socialism".' (Kapp, 1955: 682).

What was at stake in the earlier debate and was lost in the shift to market models of socialism was precisely the question about whether human well-being and its environmental conditions could adequately be captured by the monetary valuations of the market.

This question was raised by Neurath's post-World War I proposals for socialization to which both Mises and Weber responded. As Kapp notes, for Neurath a socialist planned economy was based on social use values:

> By stating that 'useful effects' or free 'disposable time' are the measure of real wealth and thus of the quality of life Engels and Marx must have been

[1] The relevance of Neurath's argumentation for ecological economics was first noted in Martínez-Alier (1987) and the parallel between Neurath and Kapp was stated in Martínez-Alier (1991a) and (1991b); the influence of the former on the latter was observed in Martínez-Alier (2002: 33).

> convinced to have specified at least in general terms the alternative criteria for the planning and decision-making process in a socialist planned society. Few marxist writers have taken up these hints while many have simply followed the general trend toward a subjective theory of value and price. The great exceptions were Otto Neurath and Max Weber . . . (1974: 38)

Neurath's own plans for total socialization were radical in drawing out possible implications of an economy based on use-values. A socialist economy, since it was to consider the use-value of goods only, would have to be a non-market 'economy in kind', an economy *in natura*, in which there would exist no role for monetary units to compare options to guide decisions of resource allocation. In a socialized economy, while physical statistics about energy use, material use and so on would be required, there would be no need for a single unit of comparison: 'There are no units that can be used as the basis of a decision, neither units of money nor hours of work. One must directly judge the desirability of the two possibilities.' (1919/1973: 145). In the absence of a single unit of measurement for decision making, choice requires direct comparisons of alternatives in various dimensions. The consequence is that there is no possibility of excluding political and ethical judgements from even 'technical' decisions.

Mises accepted one claim that Neurath made, that in a socialist economy monetary exchange values cannot be used to choose between different plans, but then drew a very different conclusion, that this shows that no rational economic choices can be made within a socialist society. While choice in the absence of a single cardinal measure was possible for final consumption goods, it was not possible for higher order production goods.

> It is an illusion to imagine that in a socialist state calculation *in natura* can take the place of monetary calculation. Calculation *in natura*, in an economy without exchange, can embrace consumption goods only; it completely fails when it comes to dealing with goods of a higher order. And as soon as one gives up the conception of a freely established monetary price for goods of a higher order, rational production becomes completely impossible. Every step that takes us away from private ownership of the means of production and from the use of money also takes us away from rational economics. (1922/1981: 13)

Rational choice concerning higher order production goods requires commensurability, that is, rational economic decision-making requires a single measure on the basis of which the worth of alternative states of affairs and uses of productive resources could be calculated and compared. Only then can rational choices be made between 'the bewildering mass of intermediate products and potentialities of production' (ibid.). In market economies money provides a common unit of measurement for comparing options: 'calculations based upon exchange values enable us to reduce values to a common unit' (ibid.: 99). Exchange values can impute the relative worth of different productive factors on the basis of consumer valuations. In the absence of private ownership of the means of production, there could be no market price on the factors of production: since 'it is impossible to use money as an expression of the price of the factors of production (including labor), money can play no role in economic calculation' (ibid.: 15). Non-market economies, beyond simple householding economies, lack a common unit of comparison between different uses of productive factors. Like Neurath, Mises rejected labour-time and energy units as alternative commensurating units. Hence, Mises concluded, rational economic choices are only possible in market economies; socialist economies do not allow for rational choices. In this chapter we will not consider in detail whether or not Neurath's plans for a marketless economy *in natura* can be defended. Our purpose here is narrower – to show how his arguments point to weaknesses in both the Austrian and neo-classical arguments for market modes of environmental governance. As Kapp (1974) puts it: 'environmental values are social use values for which markets provide neither a direct measure nor an adequate indirect indicator'. Neurath's defence of this claim remains important.

Environmental considerations about the use of resources across generations were central to Neurath's argument from his first contributions to the socialist calculation debates.[2] In denying that there exists any single unit for making choices across different plans, Neurath was criticizing not only the market and monetary measures, but also socialist alternatives to the market that employ single units in making decisions, employing labour time as a unit of calculation, or the early precursors of an energy economics such as Popper-Lynkeus and Ballod-Atlanticus that advocate the use of energy units for making comparisons between different plans. Using labour time alone allows for no consideration of the effects of the use of energy and resources for future generations.

> Some had the idea to introduce a certain amount of labour as a unit. But how could this make it possible for the excessive exploitation of a coal mine to figure as a negative entry in the balance? How could a quantity of electricity which a river provides us with be entered as an increase in amounts of labour units? Or the increase in wind power used in the running wind mills? (Neurath, 1925/2004: 468)

However, similarly, consideration for energy alone fails to properly consider the effects of choice on the quality and quantity of labour time

[2] See Uebel (2005) and (2008).

allowed. An economy that was considered with use-values would have no single unit to make comparisons over different plans:

> The question might arise, should one protect coal mines or put greater strain on men? The answer depends, for example, on whether one thinks that hydraulic power may be sufficiently developed or that solar heat might come to be better used, etc. If one believes the latter, one may 'spend' coal more freely and will hardly waste human effort where coal can be used. If however one is afraid that when one generation uses too much coal thousands will freeze to death in the future, one might use more human power and save coal. Such and many other non-technical matters determine the choice of a technically calculable plan . . . we can see no possibility of reducing the production plan to some kind of unit and then to compare the various plans in terms of such units. (Neurath, 1973: 263)

To put the argument in more recent terms, decisions across different plans would of necessity need to employ multi-criteria decision tools and judgements. There is no single unit of comparison that will do the work required.

The arguments between Neurath and Mises turn on a number of issues that retain their importance for ecological economics: (1) the limits of market demand as a guide to defensible choices within and between generations; (2) the problems of value incommensurability, and more specifically the adequacy of monetary valuations to capture the goods and losses at stake in both social and environmental choices; (3) the nature of rational choice between different social plans and outcomes.

1. Mises' arguments against socialism claim that, in the absence of markets and private property in the means of production, it is not possible to impute the relative worth of different productive factors on the basis of consumer valuations. Neurath's rejection of the imputation problem in this form is in part a rejection of the claim that valuations of current consumers provide an adequate basis for judging the relative values of different uses of productive factors. A major distinctive feature of Neurath's contribution was the explicit introduction of intergenerational concerns. Not only was it the case that, as socialists had long noted, within any generation the social well-being of actors who lack monetary means disappears from social choices, it was also the case that across generations, the well-being of future generations who are necessarily absent from current markets cannot be directly captured in market exchange. Intergenerational decision making could not be left to market mechanisms. Nor could alternatives like labour time units do the job. It required socially informed multi-criteria decision making procedures that included the full range

of the dimensions of well-being and domains of affected agents to be included.

2. Neurath's arguments here are based on assumptions about the incommensurability of the different dimensions of human well-being. Neurath argues that no monetary measure, or indeed any other single measure, is able to capture changes in well-being. Welfare concepts, such as the standard of living, are multidimensional: 'The attempts to characterize the standard of living are like those which try to characterize the "state of health". Both are multidimensional structures' (1937/2004: 520). The point is one that Neurath had already made in an early lecture which rejected the possibility of units of pleasure providing such a metric for utilitarianism (1912). This claim that the standard of living is multidimensional is combined with a second claim, that the measures of these different dimensions of well-being cannot themselves be treated as separable items that can be added: 'We cannot regard [the standard of living] as a weight made up of the sum of the weights of the various parts' (1937/2004: 516). Choices between options are a matter not of assessing the value of different dimensions and then adding them to coming to an aggregate score, but rather considering each 'as a whole'. (1909: 244).
3. A third central point of contention in this debate is the nature of practical rationality. Two central claims are of importance here. The first concerns the nature and limits of rational choice in the use of productive resources. Mises assumed here an algorithmic conception of rationality. The rational use of resources requires a single cardinal measure through which their optimal uses can be computed. The absence of monetary measures in a socialist economy on this account rules out the possibility of rational economic decisions. Neurath rejected the possibility of any such computation given the distinct dimensions of value that a choice must confront. More generally, Mises' assumptions about the nature of rationality exhibit what Neurath called 'pseudorationalism'. For reasons we outline further below, Neurath took the knowledge that informs decision making to be uncertain and incomplete, and even given what is known, the norms of rationality rarely determine a unique answer. A proper rationalist recognizes the boundaries of the power of reason in arriving at decisions: 'Rationalism sees its chief triumph in the clear recognition of the limits of actual insight' (1913/1983). It is a mark of the pseudorationalist to believe that there exist technical rules of choice that determine optimal answers to all decisions including those about resources. No such decision procedure exists. Thus, to employ again his environmental examples, given a choice between

> alternative sources of energy – say coal and hydraulic power or solar energy – a variety of ethical and political judgements, for example about intergenerational equity and the distribution of risks, comes into play. One cannot arrive at some optimal outcome through some technical procedure employing some single unit, either monetary or non-monetary.

These disputed assumptions about rationality also figure in the important differences between the contributions of Weber and Mises to the socialist calculation debates. Weber's criticisms of Neurath and the possibility of rational calculation in socialism parallel some of those by Mises. However, his contribution is marked by a distinction that is absent in Mises' argument, that between formal and substantive rationality. It is this distinction that grounds Kapp's assertion of Weber's importance to the debates.[3] Weber drew the distinction as follows:

> The term 'formal rationality of economic action' is used to designate the extent of quantitative calculation or accounting which is technically possible and which is actually applied. The 'substantive rationality', on the other hand, is the degree to which the provisioning of a given group of persons (no matter how delimited) with goods is shaped by economically orientated social action under some criterion . . . of ultimate values, regardless of the nature of these ends. (1921–22/1978: 85)

On this account then an economic system is 'formally' rational 'according to the degree in which the provision for needs, which is essential to every rational economy, is capable of being expressed in numerical, calculable terms, and is so expressed' (ibid.). Like Mises, Weber took money-based economy to be required for formal rationality within any complex changing economy: 'From a purely technical point of view, money is the most "perfect" means of economic calculation. That is, it is formally the most rational means of orienting economic activity. Calculation in terms of money, and not its actual use, is thus the specific means of *instrumentally* rational economic provision.' (ibid.: 86; italics indicate a term restored. We owe to Christian Scholz the observation that in the English translation by Talcott Parsons still being used, the word 'instrumental' is absent, undermining the actual meaning of the statement. In the original German version Weber speaks explicitly of '*Zweckrationalität*' (instrumental rationality) (1921–22/1972: 45).)

A Neurathian economy in kind, Weber argued, would be inferior to a

[3] For a useful discussion of the influence of Weber and the later Menger on Kapp, see Berger (2008).

market economy in terms of its formal rationality. However, Weber, unlike Mises, allowed that this does not rule out criticisms of market economies in terms of their substantive rationality according to some wider ends in which the '"purely formal" rationality of calculation in monetary terms is of quite secondary importance or even is fundamentally inimical to their respective ultimate ends' (1921–22/1978: 86). Mises' argument contrasts with Weber's in assuming that formal instrumental rationality exhausts the scope of rationality in economic activity, a difference obliterated by the available translation (as noted).

The distinction between the types of rationalities is central to later ecological economics. It is the reason why the debate between Neurath and Weber was taken by Kapp to be so central to understanding the failures of standard economic analysis of environmental problems. The failure of standard economic analysis of the economy in terms of monetary exchange and the attempt to catch all values within monetary prices is that it is concerned only with the formal rationality of the economy and not its substantive rationality (Kapp, 1963/1977: 306–7). The importance of the contributions of Neurath and Weber lies precisely in the focus of one, Neurath, on the need for multiple non-monetary measures of human well-being and his acknowledgement of the physical embeddedness of the economy on wider environmental conditions, and of the other, Weber, on the claim that while markets may be superior to other economic systems in terms of formal calculability, this is independent of the question of whether they are substantively rational. The later debates get sidetracked since they concern simply questions of different models of economic calculability, of whether socialist economies can match the formal rationality of capitalism. The importance of the environment for Kapp lies in the way it highlights the need for economics to focus again on problems that concerned the original debates between Neurath and Weber:

> The challenge to economics is due to the complexity of the causal chain which gives rise to environmental disruption and the magnitude of the social costs. These defy any treatment in terms of such traditional concepts as 'externalities', GNP, etc. – and, moreover, put in question the validity of our traditional measures of efficiency and optimalization by economic units or subsystems of the economy. The answer to this challenge will have to be found not by means of formal welfare criteria but in terms of concepts defining a substantive rationality reflecting actual human needs and requirements of human life. (Kapp, 1970: 847)

Kapp's own programme of research can be called broadly Neurathian. Well-being should be conceptualized in terms of a series of 'existential minima representing minimum adequate levels of satisfaction of essential human needs.' (Kapp, 1965: 77). Indicators of those minima and the specification of the physical and social conditions for meeting those minima should form the object of both decision making and the comparative judgements of different social organizations.[4]

2. NEURATH AND HAYEK: POLITICAL ECONOMY AND EPISTEMOLOGY[5]

The problems about the nature and scope of rational choices that were central to the debates between Neurath and Mises were also central to Neurath's debates with Hayek. Hayek's criticisms of Neurath, like those of Mises, address themes that have been central to ecological economics. His arguments aim in part against *in natura* calculation, calculation in kind. However, Hayek's arguments against Neurath also raise wider and distinct epistemic themes. These themes about the nature and limits of science in decision making mattered not just in his debate with Hayek, but also in the debate with very different participants – the Frankfurt School – to be discussed later in this chapter. Both started from criticisms of the scientism that Neurath is taken to exhibit.

Hayek's papers 'The counter-revolution of science' and 'Scientism and the study of society' (Hayek, 1941/1979; 1942–44/1979) are of particular significance for the tradition of ecological economics. In those papers Hayek criticizes various forms of scientism in the social sciences, in particular what he calls 'objectivism', represented by the physicalism of logical positivism. Those criticisms are directed not just at socialist planning but also at the tradition of ecological economics.[6] Hayek questions the two assumptions central to the tradition of ecological economics outlined at the start of this chapter: (1) that economics should be concerned with the ways in which economic institutions and relations are embedded within the physical world and have real physical preconditions which are a condition of their sustainability; (2) that rational economic choices between options cannot be founded upon purely monetary valuations but require

[4] There are also clear differences between Kapp and Neurath. Kapp operates within an objective state account of well-being, whereas Neurath remains Epicurean, concerned with subjective states. However, in practice the approaches converge. Neurath's own measures are concerned with the objective measures of the conditions of life. Kapp also acknowledges with the Vienna Circle the need for an approach that brings together different disciplines into such choices, although he rejects the specific models of the unity of the sciences offered by Neurath and Carnap (see Kapp, 1988: 60–64).

[5] This section draws on O'Neill (2004).

[6] For further discussion see Martínez-Alier (1987).

direct reference to their physical characteristics. Precursors of ecological economics such as Ostwald, Geddes, Soddy and Solvay are all objects of criticism, their work on energy units taken to exemplify 'scientistic objectivism' typical of an engineering mentality. Their objectivism is exhibited in their belief in the desirability for calculations in kind in economic choices as against calculations in monetary valuations (Hayek, 1942–44/1979: 90 and 171). The work of Neurath becomes a primary target of Hayek's criticism, since in his work objectivism, socialism and *in natura* calculation most clearly come together: 'The most persistent advocate of . . . *in natura* calculation is, significantly, Dr. Otto Neurath, the protagonist of modern "physicalism" and "objectivism"' (ibid.: 170).

Neurath responded to these criticisms in a set of unpublished notes and letters to Hayek in 1945 which Neurath had hoped would form the basis for a public exchange (Neurath, 1945). The public exchange never occurred. Neurath died in late 1945 and it is difficult to discern in Hayek's letters much enthusiasm for the exchange.

Hayek claimed that scientism in the social sciences provides a central example of an illusion about the scope of human reason and knowledge that underpins the socialist project. The doctrine of 'objectivism', typified in Neurath's 'physicalism', is an exemplar of such scientism. The terms 'objectivism' and its opposite 'subjectivism' are used in a variety of logically independent senses within the Austrian economic tradition.[7] In Hayek's scientism essay, 'subjectivism' is used primarily to capture a hermeneutic thesis about the nature of social objects, that they are in part constituted by beliefs and social meanings. The objects of the social sciences are constituted by beliefs and ideas that individuals have about them: 'Neither a "commodity" or an "economic good", nor "food" or "money" can be defined in physical terms but only in terms of views people hold about things.' (1942–44/1979: 53). Objectivism, by contrast, is the view that such references to mental states can and should be eliminated. Hayek asserted that the demand that social science requires the elimination of all terms that cannot be given a characterization in a purely physical language characterizes Neurath's physicalist programme (ibid.: 78).

The doctrines of objectivism and physicalism, Hayek claimed, provide support for the belief in the possibility of '*in natura*' calculations in economics discussed in the last section. Objectivism is expressed in 'the characteristic and ever-recurrent demand for the substitution of *in natura* calculation for the "artificial" calculation in terms of price or

[7] See O'Neill (1998: ch.3).

value, that is, of a calculation which takes explicit account of the objective properties of things' (ibid.: 170). The central political implication of Hayek's arguments against objectivism is the denial of the existence of any physical units for planning economic production, including the energy units offered by earlier precursors of ecological economics such as Ballod-Atlanticus, Popper-Lynkeus, Ostwald, Soddy and Solvay (ibid.: 90–91). Hayek rejected the eliminativist physicalist claim that all economic activities 'can be ultimately reduced to quantities of energy, [and] man should in his plans treat the various things . . . as the interchangeable units of abstract energy which they "really" are.' (ibid.: 91). However, Hayek, in rejecting objectivism, also defended a logically independent, stronger and less plausible form of subjectivism that inverts the physicalist eliminativism he criticized. He rejected 'the more widespread . . . conception of the "objective" possibilities of production, of the quantity of social output which the physical facts are supposed to make possible' (ibid.: 91).

The belief in objectivism and *in natura* calculation is for Hayek an expression of an illusion about the scope of knowledge and reason that is typical of the social engineer. The belief in the realizability of a technical optimum, derived from the notion of objective possibilities of production, represents an illusion since it fails to acknowledge the limits of knowledge that any particular individual can possess.

> The application of the engineering technique to the whole of society requires . . . that the director possess the same complete knowledge of the whole society that the engineer possesses of his limited world. Central economic planning is nothing but such an application of engineering principles to the whole of society based on the assumption that such a complete concentration of all relevant knowledge is possible. (ibid.: 173)

Objectivism and the belief in *in natura* calculation involve a commitment to the possibility of complete knowledge that Hayek rejects in his epistemological arguments against planning and in defence of the market.

The belief in planning involves an erroneous belief in the omnipotence of reason, a belief that Hayek variously calls 'rationalism', 'superrationalism' and 'Cartesian rationalism'. Against such rationalism Hayek claims 'it may . . . prove to be far the most difficult and not the least important task for human reason rationally to comprehend its own limitations' (ibid.: 162). What are the sources of human ignorance to which this argument appeals? The first is what Hayek calls 'the division of knowledge' in society, that is, the dispersal of knowledge and skills throughout different individuals in society. While Hayek framed the argument in terms of the division of knowledge in society, the key to his argument is the nature of the knowledge dispersed: practical knowledge embodied in skills and know-how that cannot be articulated in propositional form, and knowledge of particulars, local to time and place. Such knowledge cannot be passed on to a central planning body but remains inevitably dispersed throughout society. The market alone is claimed to solve this epistemic problem. The market acts as a coordinating procedure which, through the price mechanism, distributes to different actors that information that is relevant for the coordination of their plans (1937; 1942–44/1979: 176–7; 1945).

Central to that coordination is the activity of the entrepreneur who is alert to new opportunities in the market place but who is faced with a second source of ignorance, a future that at the point of decision is unpredictable. Wants change with the invention and production of new objects for consumption. Since the progress of human knowledge is in principle unpredictable – if we could predict future knowledge, we would already have it – and since human invention relies on the progress of knowledge, future human wants are also in principle unpredictable (Hayek, 1942–44/1979: 157–8; 1960: 40–41; cf. Popper, 1944–45). The market is presented as a discovery procedure in which different hypotheses about the future are embodied in entrepreneurial acts and tested (Hayek, 1978: 179–90; cf. Kirzner, 1985).

Given this view of the price system as a solution to the problem of ignorance, to give up prices for calculation in kind is to give up a solution to the problem of ignorance for the illusion of the possibility of complete knowledge required for central planning. There is no *in natura* alternative to the monetary measures. If Hayek is right, this is not just a criticism of socialist planning. It is a criticism of the wider tradition of ecological economics, which is concerned with the physical preconditions of economic activity and in particular its ecological preconditions, and which does defend the use of non-monetary measures and indicators of economic activity.

Neurath noted at the outset of his reply to Hayek that there is no dispute about whether he defends either physicalism or *in natura* calculation. What is in dispute is whether Hayek properly characterizes either and whether, once properly stated, they are open to the objections that he presents. Much of Neurath's response to Hayek is taken up with clarification of the meaning of physicalism.[8] 'Physicalism' in its basic sense refers to the

[8] For a detailed discussion of the concept of physicalism, of its evolution and defensibility throughout the protocol sentence debate in the Vienna Circle during the 1930s, see Uebel (2007a); of its role for Neurath in social science, see Uebel (2007b). In this chapter we will limit our discussion of the concept of physicalism to clarification of its role in the debate with Hayek about the nature and possibility of *in natura* calculation.

doctrine that all statements in the sciences, social sciences and everyday life should be controllable by sentences whose terms refer to spatio-temporal particulars. In the context of his debate with Hayek, the significant point is that physicalism in the sense that Neurath employed was not the view that all the sciences could be reduced to physics, nor that all the terms of language could be translated into those of physics. Neurath's approach to sociology is not physicalist in the sense that Hayek outlines and his physicalism is not committed to the elimination of all 'intentional' vocabulary or mental terms from social science. Moreover, Neurath's social theory is institutionalist. It is a form of (non-eliminativist) social behaviourism which takes public institutions and social orders as the starting point for analysis. Hence, for example, his insistence that monetary exchanges be understood as parts of particular institutional arrangements like others and their study to be approached anthropologically. In developing the point, Neurath exploited the now well-trodden analogies between monetary exchange and games like chess which are constituted by certain public rules (1944: 39).

Clarification of the senses of 'physicalism' matters to the debate about the possibility of *in natura* calculation. Because Hayek mischaracterized Neurath's physicalism, much in Neurath's account of *in natura* calculation is untouched by many of Hayek's criticisms. The doctrine that Hayek criticized is that there are some purely physical units, like units of energy, which are independent of human use or belief and which could be employed for planning. But not only did Neurath not defend physicalism in this sense, he similarly rejected the doctrine that there are purely physical units that could be employed for socialist planning and with it the technocratic idea that there is any optimum solution to social problems. Neurath opposed 'what is called the "technocratic movement"', which assumes there exists:

> one best solution with its 'optimum happiness', with its 'optimum population', with its 'optimum health', with its 'optimum working week', with its 'optimum productivity' or something else of this kind [and which] asks for a particular authority which should be exercised by technicians and other experts in selecting 'big plans'. (1942/1973: 426–7)

A number of points about the elements of *in natura* calculation deserve notice here. First, they are plural. Second, they are not purely 'physical' in the sense that Hayek assumes. The material preconditions of human activity do feature in Neurath's account of in-kind calculations. But so also do the social dimensions of life. The inventory of the conditions of life includes 'everything about work load, morbidity, mortality, food, clothing, housing, educational possibilities, amusement, leisure time etc.' (1925/2004: 421). It includes 'the environment in its broadest sense'

(1937/2004: 524). In discussing real wealth, Neurath was not abstracting from human relations and human conditions. Correspondingly, institutional arrangements matter: self-government and freedom and other human relations belong to the 'happiness conditions' of human beings (1942/1973: 427). Neurath's account of *in natura* decision making is consistent with the institutionalist character of his approach to economics and social science in general.

Neurath's rejection of the forms of technocratic reason that Hayek ascribes to him forms the basis of much of his response to Hayek. For Neurath, the belief in some kind of technical optimum discoverable through science is a mark of pseudorationalism. Indeed Neurath's remarks about the limits of reason – 'Rationalism sees its chief triumph in the clear recognition of the limits of actual insight' (1913/1981: 8) – find a remarkable parallel in Hayek's later objections to 'superrationalism', as Neurath himself noted. 'I am the arch-enemy of the "illusion of complete knowledge" and from this point of view I think Professor von Hayek should praise me and appreciate my never ceasing efforts to destroy such illusions' (Neurath, 1945).

In his correspondence with Hayek, Neurath linked the rejection of pseudorationalism with his logical empiricism. Thus he invokes a series of claims about science that he was in part responsible for placing at the centre of the philosophy and sociology of science. Scientific theory is underdetermined by empirical evidence. Evidence itself is uncertain and provisional – observation or protocol statements are open to revision. Theories are a mass of statements that are logically interconnected and confront the world as a whole, not individually. In the metaphor he uses in a variety of different places, we are like sailors who have to patch up their boat at sea. There are no methods or rules of science that can be employed to definitively confirm or falsify theories.

A sign of pseudorationalism is the failure to acknowledge the underdetermination of theory by evidence and uncertainty in prediction. Neither can such uncertainty and ignorance be resolved by treating them as if they could be translated into quantifiable probability statements (1941: 147–8). This general scepticism about predictability is taken by Neurath to have particular relevance when it comes to social decision making. The unpredictability in science in general underpins his rejection of the technocratic ideal of the discovery of an optimal solution to social decisions we noted earlier:

> If science enables us to make more than one sound prediction, how may we use science as a means of action? We can never avoid a 'decision', because no

> account would be able to show us one action as 'the best', no computation would present us with any 'optimum', whatever actions have to be discussed. (Neurath, 1946/2004: 552)

Neurath also appealed to the very features of the unpredictability of human knowledge that were central to Popper's case against historicism and Hayek's view of the market as a discovery procedure. It is a feature of human knowledge and invention that we cannot predict what will be novel, and since social change depends in part on theoretical and practical invention, we cannot predict social change (1943/2004: 527). This point was also central to the final sections of his *Foundations of the Social Sciences* where its implications are stressed in the closing remark which returns to his analogy for the development of knowledge, that scientists are like sailors at sea who cannot put into dock but must modify the ship with materials at hand: 'A new ship grows out of the old one, step by step – and while they are still building, the sailors may already be thinking of a new structure, and they will not always agree with one another. *The whole business will go in a way we cannot even anticipate today*. That is our fate' (1944: 47, emphasis added).[9]

Neurath's response to Hayek offers an important defence of the central two claims of the tradition of ecological economics which Hayek criticizes. He allows that the economy is physically embedded without falling for the kinds of physicalist reductionism that Hayek properly criticizes, for example, of treating all decisions through energy units. Hayek clearly overstated his case. That one cannot give a physicalist reduction of economic categories does not entail that there is not a perfectly good role for physical descriptions and indicators in economic analysis. Correspondingly, Neurath pointed out that monetary measures of productivity and growth have to be kept distinct from measures of physical and institutional changes that are relevant to human welfare, and that what in more recent terms would be called material flow analysis of economies and physical indicators of sustainability have a role in economic theory and policy analysis.[10] He properly noted that monetary measures fail to adequately capture changes in human welfare. What Neurath called in-kind decision making is close in conception to what would now be called multi-criteria decision analysis and shares the advantages of that approach against attempts to reduce choices to single monetary units through a cost–benefit analysis.[11]

[9] For an account of the uses and contexts of the simile of the sailors throughout Neurath's work see Cartwright et al. (1996: 89–166).

[10] For further discussion see Martínez-Alier et al. (2001).

[11] For further discussion see Martínez-Alier et al. (1998) and (1999).

Finally, note that, for Neurath, ignorance and unpredictability are universal features of social choice:

> Professor von Hayek thinks people think too much of the society as a factory, as if we were able to predict so much better in a factory. I want to stress the point that in the factory we are not able to predict as comprehensively as Professor von Hayek thinks. I have to over-Hayek Professor Hayek: [there] we are not in a position of comprehensive prediction either. (Neurath, 1945)

The problem of decision making in conditions of uncertainty is a general feature of social life. As he had put it years earlier, all action is 'an anticipation of unpredictable events' (Neurath, 1921/1973: 159).[12]

3. THE LEFT VIENNA CIRCLE AND THE FRANKFURT SCHOOL: COMPETING TRADITIONS OF POLITICAL ECOLOGY[13]

Neurath's criticisms of pseudorationalism and technocratic decision making are central to a debate which retains continuing importance to ecological economics. His debate with the Frankfurt School left a lasting legacy in political ecology. It defined two distinct approaches to political ecology, which remain in troubling tension with each other. On the one side there is a body of work in political ecology which is concerned with the physical and biophysical conditions for human well-being. The approach is typically concerned with the ways in which different economic activities, practices and structures are limited by environmental conditions required for resource provision, waste assimilation, climate regulation and so on. In making claims about the physical conditions for economic and social provisioning, the approach draws on both the natural sciences and social sciences. The historical origins of this approach in the work of Neurath and the left Vienna Circle, and later in Kapp, we have noted above. On the other side is a body of work in political ecology which takes environmental problems to have a cultural origin in a crisis of 'Western reason'. This approach is sceptical of science in that scientific reason itself is taken to be a form of ideology responsible for the domination of both nature and of human beings. At the same time, scientism, and in particular the identification of practical rationality with instrumental rationality, precludes critical reflection on the sources of domination. In doing so it fosters an

[12] For a discussion of the implications of the outcome of this debate generally and for science policy, see O'Neill (2004) and (2012).

[13] This section draws on O'Neill and Uebel (2005).

unreflective technocratic politics of experts. This second approach has its origins in the Frankfurt School, in particular in the work of Horkheimer, Adorno and Marcuse.

The role of the *Institut für Sozialforschung* (Institute for Social Research), the Frankfurt School, is an interesting one. On the one hand it gave financial support to both Neurath for development of his work on the standard of living and to Kapp for his work on planning. The support of both belonged to a tradition of empirical social research and work on planning in particular that is to be found in the early Frankfurt School. On the other hand the central trajectory of the work of the Frankfurt School moved from the late 1930s onwards in an entirely different direction, towards the view that science itself was necessarily committed to the domination of nature. In developing this view, it converged on an account of the Vienna Circle that we have already seen expressed in the work of Hayek as involving a form of scientism that was committed to a technocratic politics. These two very differently motivated Hayekian and Frankfurt criticisms are largely responsible for the now standard but mistaken association of logical positivism with technocratic politics and for the use of 'positivism' as a term of academic abuse.

A useful starting point to understanding the bifurcation in the traditions of ecological thought is the first issue of volume 6 of the Frankfurt School's journal, *Zeitschrift für Sozialforschung* (*Journal for Social Research*), published in 1937, which contains two papers which make for unusual companions.[14] The first of these papers was Horkheimer's 'The latest attack on metaphysics' (1937a), a critique of logical positivism. According to standard history, this paper, along with 'Traditional and critical theory' (1937b), marked the beginning of the transition from the programme for interdisciplinary empirical research that characterized the early work of the Institute to the central themes of Critical Theory, which promised a hitherto unavailable philosophical comprehension of social totality, that defined its second. The paper also marked an important turning point in the history of the reception of the work of the Vienna Circle, providing the starting point for the now familiar picture of the logical empiricists, especially in left circles, as committed to a technocratic and instrumentalist view of politics, unable to sustain any critical standpoint on existing society. The second paper was by Neurath, one of the main targets of Horkheimer's paper, and was titled 'Inventory of the standard of living' (1937). This paper reformulated some of the central themes in Neurath's long-standing attack on the attempt to capture changes in welfare in purely monetary terms.

[14] For a detailed discussion of this issue see O'Neill and Uebel (2005).

The co-presence of Horkheimer's paper with that of a leading logical empiricist may appear surprising until the wider context is appreciated. For all their early philosophical differences, which were substantial, there existed many actual and potential points of contact between the early interdisciplinary materialism of the Frankfurt School and the radical physicalist sociology of writers like Neurath. Indeed, that journal issue was preceded by a number of meetings and some partial cooperation. However, this is not to say there were no surprises in the co-presence of the two papers. For Neurath himself, the strength, uncharitableness and polemical nature of Horkheimer's critique did come as an unwelcome surprise: he had no idea that such a confrontation was planned but had hoped for a further narrowing of their differences. In reply he wrote a deliberately understated and remarkably unpolemical response for publication in the journal. This response Horkheimer refused to publish. Not surprisingly, further contact between the Frankfurt School and members of the former Vienna Circle was minimal.

Horkheimer's criticisms of Neurath and logical positivism in 'The latest attack' also needs to be placed within the complex context of the development of Horkheimer's thought, from the early programme of interdisciplinary materialism, through the second phase of the articulation of Critical Theory initiated in the 1937 papers, to the third phase beginning around 1940 during which his criticism of instrumental reason was developed in close cooperation with Adorno.[15] The second and third phases saw the development of the central claims of the Frankfurt School that have been influential in the development of political ecology.

The materialism of Horkheimer's earlier work has some affinities to the form of empiricism defended by Neurath, just as Neurath's Marxism had meant that his account of physicalism was much more sympathetic to materialism than others in the Vienna Circle. Both Neurath's and the early Horkheimer's work were concerned with developing a programme that might be characterized as materialism without metaphysics. For both, while it did not entail any ethical position, their materialist attitude was associated with a particular set of political and ethical concerns reflecting their shared Marxist assumptions. Both held that a rejection of metaphysics had ethical implications in so far as it ruled out any appeal to abstractions that were separate from the particular lives of particular human beings. While for Neurath it involved a commitment to a politics on 'the earthly plane' (1928/1973: 295), for Horkheimer materialism 'opposes every attempt to play down the importance of insight into the

[15] This now canonical periodization was developed by Dubiel (1978).

earthly order of things by turning man's attention to a supposedly more essential order' (1933/1972: 26). Horkheimer granted a partial overlap with positivism in their common opposition to the use of metaphysics to reconcile individuals to their fate in existing social orders (ibid.: 6).

The papers of 1937 saw a shift in Horkheimer's views towards the more influential critique of scientific reason and with it a marked alteration in the conception of the role of philosophy. Philosophy becomes a resource that has to be distanced from science, since it is not just the social context in which science operates that is now taken as the central critical concern, but the nature and telos of science itself. Virtually inverting the view which animated the early materialist work, philosophy wholly separate from the sciences becomes the central source of Critical Theory. This shift becomes still more pronounced in the third phase of the Frankfurt School's work in which the earlier interdisciplinary programme is altogether abandoned.

During the second phase Horkheimer's philosophical reflection increasingly focused on the role of science in the productive processes of industrial capitalist societies and on the ideological role of philosophies of science. Science was viewed as a form of knowledge that was constituted by an interest in the manipulation of its object for productive ends.

> What scientists in various fields regard as the essences of theory thus corresponds, in fact, to the immediate tasks they set for themselves. The manipulation of physical nature and of specific economic and social mechanisms demand alike the amassing of a body of knowledge such as is supplied by an ordered set of hypotheses. The technological advances of the bourgeois period are inseparably linked to this function of the pursuit of science. (1937b/1972: 194)

One of the marks of 'traditional' as opposed to 'critical' theory was taken to be the lack of self-consciousness of this fact. Thus traditional theory takes the particular form of scientific knowledge as given: 'the real social function of science is not made manifest' (ibid.: 197). Unconsciously, the scientist renders invisible his or her own role in reproducing existing society, thereby ensuring 'the conservation and continuous renewal of the existing state of affairs' (ibid.: 196). One particular scientific conception of theory is treated in an unhistorical way and in doing so becomes 'a reified, ideological character' (ibid.: 194). Logical positivism on this account is but a particular expression of a conservative ideology. This, and the claim that science is committed by its very nature to a purely instrumental understanding of its object, became central not only to the later work of the Frankfurt School but also became the basis of a central component of one important strand of political ecology.

The central question that Neurath raised regarding Horkheimer's position in its shift from an empirically grounded reflection on the social context of the sciences which is central to the early work, concerns the criterion for determining the acceptability or rejection of competing claims about science and about the social world in which science develops. As Horkheimer noted in his reply to Neurath, 'The weakest point of my piece was pointed out by you, naturally, on page 13 of your reply. "Horkheimer nowhere indicates by means of which control one can determine when a point of view is 'correct' and when it is 'incorrect'."[16] Horkheimer responded by questioning the vagueness of the criteria of empirical control that the logical empiricists offered, but this left unanswered Neurath's central objection to his position. It is unclear on what basis he took himself to be developing his non-naturalistic account of a philosophy that is autonomous from the sciences. To what criteria of reason could it appeal?

The problem became increasingly apparent as Horkheimer's criticisms of the concept of reason that informed the Enlightenment project became more radical. Thus in *Eclipse of Reason*, reason as such is taken to be based in an interest in the domination of nature: 'The disease of reason is that reason was born from man's urge to dominate nature, and the "recovery" depends on insight into the nature of the original idea, not on a cure of the latest symptoms.' (1947/1974: 176). However, in developing his critique of reason, Horkheimer does not want to reject the norms of reason as such. The critique is a 'self-critique': 'in such self-critique, reason will at the same time remain faithful to itself' (ibid.: 177). But how can such a radical self-critique of reason be sustained without undermining the grounds of the critique? As Habermas later put it, 'the radical critique of reason proceeds self-referentially; critique cannot simultaneously be radical and leave its own criteria untouched' (1986/1993: 57). Horkheimer rejected any turn to irrationalism and held on to the critical role of reason – but without offering a defensible account of how it survives its own self-criticism.

The radical critique of reason left a problematic legacy for the Frankfurt School just where it is most influential in political ecology – in their critique of science. Part of the problem in the identification of science with instrumental reason lies in the lack of clarity in what overcoming instrumental reason is taken to involve. The problems are clearly apparent, for example, in Marcuse's influential account of science as ideology. Marcuse repeats the strong claim about the relation of science and the domination of nature: 'science, by virtue of its own method and concepts, has projected and promoted a universe in which the domination of nature has remained linked to the domination of man' (1968: 135). But Marcuse, unlike Horkheimer and Adorno, did not give up on the idea of

[16] Horkheimer to Neurath 29 December 1937, in Horkheimer (1995: 348).

radical social change. Thus he found himself forced to claim that the end of domination requires a new science grounded in a different interest, and with a different view of nature, not as an object to be manipulated but as 'a totality of life to be protected and cultivated' (1972: 61). This change in the interests of science would carry with it changes in its content: 'Its hypotheses, without losing their rational character, would develop in an essentially different experimental context (that of a pacified world); consequently, science would arrive at essentially different concepts of nature and establish essentially different facts.' (1968: 136). Marcuse's idea is implausible. What the 'rational character' of the new science would look like, what its criteria of theory choice would be, what would characterize the new types of concepts, are all left opaque.

A related difficulty is also apparent, albeit in a very different way, in the work of Habermas. Habermas, while accepting the claim that scientific knowledge is constituted by an interest in technical control, rejects the idea that this limitation can be overcome: 'The idea of a New Science will not stand up to logical scrutiny . . .' (1968/1970: 88). Habermas restates the problem as one of the colonization of the life-world by instrumental reason. Scientific reason has its proper place in the sphere of instrumental action: the problems arise when it leaves its proper domain. Habermas also offers, through his account of communicative rationality, what Horkheimer never managed to offer: an account of what the criteria of rationality are outside the sphere of the natural sciences. Habermas' account of communicative rationality (see his 1981) has its roots in Kant's defence of the public use of reason as a condition of enlightenment: dialogue is rational to the extent that it is free from the exercise of power and strategic action and participants are equal in their communicative capacities to state and evaluate arguments, such that the judgements of participants converge only under the authority of the good argument. However, while the Habermasian project avoids some of the internal difficulties of Horkheimer's position, it has its own problems in offering an account of the role of science and scientific expertise in public deliberation. Indeed those problems are visible in the influence that Habermas's theory has had in public policy.

In Habermas's account, what remains of the Frankfurt critique of science and instrumental reason is a claim about their extension beyond their proper domain. Technocratic politics, the scientization of politics and public opinion, involves the elimination of the practical sphere of public debate about norms. It involves the reduction of political issues to matters of technical reason.[17] Now while there may be considerable power

[17] This is a constant in Habermas' work ever since his 1963 book.

to this claim, it leaves problems about scepticism and trust in the claims of scientific expertise itself untouched. Habermas's position fails to properly formulate one of the central democratic problems of science in modern public policy. This is the problem that, at one and the same time, citizens have to rely on scientific knowledge and yet have good reasons for maintaining some scepticism about its claims. In particular, the assumptions of epistemic equality that are built into Habermas's account of communicative rationality render it ill-equipped to address the problems of ineliminable epistemic inequality in public life and the problems that this raises for democratic politics.[18]

Public decisions in the modern world rely on claims by experts, the grounds for which are opaque to direct inspection by the citizen and indeed by other scientists. Nor is this opacity eliminable. The capacity to make and evaluate particular claims in the special sciences relies on a background of training within particular scientific practices. It relies on particular competences and know-how, not all of which is open to explicit articulation. Both citizen and scientist in most matters rely on the competences of others which they lack. Habermas's assumption of equality of competence that is built into the model of communicative rationality fails to acknowledge the existence of epistemic inequality even in the ideal conditions of his non-coercive speech community. While the assumption of epistemic equality may have power in the moral domain, it is implausible in that of the sciences. As a result Habermas's account is forced to gloss over some of the real difficulties about the role of science in modern public life, in particular that of simultaneous reliance on expertise coupled with proper scepticism about its claims. Yet it is just in this context that the official opponent of the Frankfurt School, Neurath, speaks most clearly.

Evidence of Neurath's scepticism about the technocratic movement can also be found in both of the key papers in Neurath's engagement with the Frankfurt School, in 'Inventory' and in his unpublished reply to Horkheimer. In the first, Neurath develops a theme that was central to his contributions to the socialist calculation debate, the rejection of any single measure, monetary or non-monetary, through which one could arrive at a technically optimal social outcome. Alongside this specific argument from the incommensurability of different options, Neurath's rejection of technocratic accounts of social choice is also founded on a more general set of arguments against the view of theoretical and practical reason involved. Those arguments have their basis in the kind of

[18] For a discussion of this claim see O'Neill (2002).

sceptical naturalistic reflection on science that Neurath reiterated in his response to Horkheimer: the underdetermination of theory by empirical evidence; theories as bodies of logically interconnected statements which confront the world as a whole, not individually; the uncertainty and provisionality even of observation statements. This fallibilism itself has to be understood naturalistically in terms of the history and sociology of science. It was reflections about the nature of scientific knowledge that founded Neurath's scepticism about excessive claims for the role of science and technical expertise in offering unique determinate answers to problems and his rejection of assumptions about knowledge that underpins the 'technocratic movement' with its various claims about optimal social decision making.

The problems of choice in conditions of necessarily uncertain and incomplete knowledge are not new. However, they are becoming increasingly to the fore in ecological problems. So also is the recognition of the problem that our decision making needs at the same time to both rely on scientific expertise and be open to proper scepticism about its limits: 'Our life is connected more and more with experts, but on the other hand, we are less prepared to accept other people's judgements, when making decisions' (Neurath, 1996: 251). There is no permanent solution to such conflicts – while institutional conditions for social trust are important, scepticism of expertise is not something to be eliminated. Democracy is 'the continual struggle between the expert . . . and the common man' (ibid.). Democratic deliberative processes are in part about ways of living with that conflict and guarding against the recurrent dangers of technocratic pseudorationalism.[19] The naturalistic scepticism which informs Neurath's criticism of a technocratic politics speaks more closely to the problems of the place of science in public life than does either the radical criticism of instrumental reason of the first generation of the Frankfurt School or the account of instrumental and communicative reason offered by Habermas in the second. As we noted above, applications of the Habermasian model of deliberative institutions cannot avoid addressing the Neurathian problem of the simultaneous reliance on and proper scepticism about science in public life. So while there is nothing in Neurath's work that approaches a detailed account of public deliberation, the theory of deliberative democracy that arises out of the work of Habermas could do with a reconciliation with the forgotten heritage of his precursors' 'positivist' opponents. At the level of public science policy, the two traditions of political ecology have much to say to each

[19] On the wider contemporary relevance of Neurath's mature writings on social organization, see O'Neill (1998: Postscript), (2003a) and (2003b).

other.[20] Here too, we believe, political ecology can only gain from continuing to build on the input of the analytical philosopher who helped shape its foundations.

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[20] There remain, of course, deep conflicts between the social Epicurianism of Neurath, which was deeply anti-Kantian and the reformulation of a Kantian ethic by Habermas – although a similar conflict exists within the Frankfurt tradition between discourse ethics and the early materialism of Horkheimer.

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4. Value deliberation in ecological economics

Christos Zografos

> Governance requires the integration into policy (whether greenhouse policy or European agricultural policy or local urban policies) of scientific and lay opinions, sometimes contradictory among themselves, relevant for different scales and different levels of reality. Who then has the power to decide the procedure for such integrated analysis? Who has the power to simplify complexity, ruling some languages of valuation out of order? This is one basic issue for ecological economics and for political ecology.
>
> (Martínez-Alier, *The Environmentalism of the Poor*, 2002, p. 271)

1. INTRODUCTION: WHY VALUE DELIBERATION IN ECOLOGICAL ECONOMICS?

The topic of value deliberation in ecological economics has to a large extent developed as an attempt to provide a normative answer to the issues raised by the above Martínez-Alier quote. Deliberation involves a process of debate and dialogue among agents holding different positions on a matter, which stimulates preferences to be transformed through reflection over available information (Dryzek, 2000). There are three main reasons why ecological economics embraces deliberation as a necessary tool for environmental governance, all of which are directly or indirectly touched upon by Martínez-Alier.

First, the *democratic* motive. The field has long argued that conventional methods of monetary environmental valuation exclude values that cannot be expressed in monetary or quantitative terms. As a result, such valuations comprise a form of voice silencing that generates democracy deficits when valuations are used to determine decisions over environmental resources. Ecological economics considers that environmental values are incommensurable, albeit weakly comparable to each other (Martínez-Alier et al., 1998), which means that environmental decision-making should involve processes that allow for values to be expressed in different languages and transparently negotiated (Martínez-Alier, 2010). Essentially, this is a concern with and an attempt to integrate procedural environmental justice – that is, concerns with how and by whom environmental decisions are made – as an element of robust and fair decision-making. This concern involves the need to bring into relevance the three key elements of procedural justice: recognition, participation and legitimacy (Paavola and Adger, 2006). Recognizing the widest possible range of values as relevant for environmental governance and securing their participation in the process of decision-making are key elements for improving the legitimacy of environmental governance (O'Neill and Spash, 2000). Value deliberation has the potential to deliver this.

This links to the second, *substantive* motive behind the uptake of deliberation in ecological economics: a concern with improving the quality of policy assessment methods by incorporating new types of knowledge. The literature on post-normal science emphasizes that the failure of the scientific discourse to provide definitive answers for some environmental issues (for example, debate on global warming) requires that scientific values are just one set of values that needs to be considered side by side with other (for example, lay) values (Funtowicz and Ravetz, 1993). This has contributed to the promotion of more interactive and inclusive forms of decision-making such as extended peer reviews that use society, for example activist knowledge, as a peer community and the requirement that scientific inquiry be values-sensitive and engaged with the interests and knowledge of lay stakeholders (Funtowicz and Ravetz, 1991). Deliberation has an increased capacity not only to facilitate interactive planning for our common future, but also to produce improved and more democratized knowledge over issues where stakes and uncertainty are high (Norgaard, 2007). It can also operationalize social learning through stakeholder interaction as agents learn from each other and can thus generate ways of addressing or considering complexity and uncertainty (Garmendia and Stagl, 2010). This links to the third motive for adopting deliberation in ecological economics, the *instrumental* one, which postulates that policies developed through participation and deliberation are likely to receive better acceptance or face less opposition, and thus improve the effectiveness of decision-making (Zografos and Howarth, 2010). In sum, the importance of incorporating *plural values* in environmental governance from both a normative (for example, procedural justice) and a positive (for example, post-normal science) standpoint, and the capacity of value deliberation to achieve this, that is, improve democracy (inclusion; legitimacy), quality (through social learning), and effectiveness (acceptability) of environmental decision-making, has spurred the integration of value deliberation in ecological economics.

The aim of this book chapter is to present the 'state-of-the-art' of value deliberation scholarship in ecological economics, also termed *deliberative* *ecological economics* (Zografos and Howarth, 2008). This scholarship has produced work that falls within two broad themes: environmental decision-making methods, and the study of deliberative environmental governance. The first theme mostly focuses on combining deliberation with monetary valuation and multi-criteria analysis (MCA). Research-wise, it investigates the capacity of such combinations to generate collective preferences that can be then used in decision-making. The second theme focuses its inquiry on the capacity of deliberation – not necessarily in combination with the above-mentioned environmental decision-making methods – to accommodate inclusiveness, social learning and transformation. After a brief introduction on the theory of deliberation,[1] I move into describing those themes in more detail. I then explore more recent, state-of-the-art contributions in both themes. This is followed by a discussion section where I reflect on the significance of state-of-the-art developments in the field with reference to broader and deeper debates regarding deliberation, and what further lines of research they require in order to advance the field. I wrap up the main points of the chapter in a short concluding section, where I also discuss some trends and perspectives that recent developments on value deliberation in ecological economics reflect.

2. THEORY AND THEMES IN DELIBERATIVE ECOLOGICAL ECONOMICS

The theory of deliberative democracy assumes that humans make sense of the world through interpersonal communication, that is, by exchanging information that allows them to shift their positions with regard to an issue (Dewey, 1927). Individual preferences are not fixed but transformable through such interaction with each other. By inducing reflection through information exchange among different agents, deliberation has the capacity to transform individual preferences towards consensus or else a 'collective' preference. The basic condition for genuine deliberation is that communication induces such reflection in the absence of any sort of direct or indirect coercion or information distortion (Dryzek, 2000). Deliberation is based on arguing and persuasion as non-hierarchical means of achieving a reasoned consensus (Risse, 2006), the main assumption behind it being that better and more legitimate decisions will result through open and reasoned argument (Bäckstrand et al., 2010).

The whole concept of deliberation is premised upon Habermas'

[1] For a detailed one, see Dryzek (2000).

communicative rationality view of human action. Communicative action postulates that the essence of rational action is to reach understanding between oneself and other actors or society in general instead of achieving instrumental goals. This understanding results from inter-subjective communication between actors during which they shape their views or shift their preferences by reflectively considering the viewpoints of those with whom they communicate. Communicative rationality reflects logics that go beyond instrumental seeking of pre-defined ends, which is the logic of action entrenched in *homo economicus* (Zografos and Howarth, 2008). According to Habermas communicative rationality is better placed than instrumental rationality for advancing the democratic development of society through discussion and quest for consensus. As ecological economics has long maintained that preferences are neither fixed nor formed outside social interaction (Vatn, 2005), the model of communicative rationality that underlies deliberation fits well with the field's rejection of *homo economicus* and its instrumentalism as a model of human action upon which environmental decision-making processes should be premised (Zografos and Paavola, 2008).

Deliberative democracy recognizes the need to consider plural viewpoints but at the same time underscores the importance of communication and reflection in the quest of consensual decision-making (Dryzek, 2000). This is an attractive element for fields exploring environmental issues, 'phenomena upon which there is much debate, conflict, and contestation' (Barry and Proops, 1999), so it is not surprising that advocacy for deliberation can be found in different sub-fields of environmental social science, such as environmental planning (for example, Wolsink and Devilee, 2009 – on managing waste infrastructure risks); sustainability science (Jerneck et al., 2011); marine policy studies (Espinosa-Romero et al., 2011); and ecosystem services (Wegner and Pascual, 2011). Ecological economists have, *inter alia*, advocated deliberation as a way of integrating different languages of valuation (Martínez-Alier, 2010); as a means of establishing links between facts and values (Roggero, 2013); and as a way of linking philosophical pragmatism with social ecological economics. But more specifically, value deliberation scholarship in ecological economics has pursued the development of a deliberative ecological economics *for* policy-making, side-by-side with the study *of* deliberative policy-making.

2.1 Theme 1: Deliberation and Environmental Decision-making

Ecological economics has long maintained that environmental preferences are not a priori held but formed through interaction and information exchange among actors (Van den Bergh et al., 2000), that environmental values are socially constructed through institutional influences and that they may reflect more collective/communitarian and less individualist ethics (Vatn, 2005). This has given rise to a type of ecological economics research that treats environmental preferences as group preferences, and tries to integrate deliberation with preference elicitation procedures in order to arrive at group-based consensual preferences and incorporate multiple values in environmental policy through deliberative monetary valuations (DMV) or MCA. This is the first main area of work on value deliberation in ecological economics.

DMV uses deliberation in order to elicit more precise estimates of group-based environmental values. The approach is based on the idea that environmental value is a group value and should not be sought as an aggregate of individual values (Zografos and Howarth, 2008). Environmental preferences do not exist *ex ante* but are socially constructed and values are sensitive to changes in issue framing and information brought to the attention of the public in the process of value elicitation (Vatn, 2004). DMV turns the value elicitation process into a preference-constructing process and at times incorporates concerns over social equity in the practice of valuation (Wilson and Howarth, 2002) by building information regarding equity issues into the valuation exercise. This work has demonstrated that employing choice rules based on consent in deliberative groups, permits an aggregation of individual values in a way that is different from simple, additive aggregation procedures used in cost–benefit analysis (Howarth and Wilson, 2006). It has also empirically confirmed that employing deliberation in the process of valuation makes it possible to both change individual preferences and obtain a shift from individual to collective preferences (Álvarez-Farizo and Hanley, 2006; Ito et al., 2009).

DMV has tried to improve ways in which aggregate social values are obtained, focusing attention on ways of structuring group processes in the elicitation of group values. This is a crucial issue as it can influence a move from individual to group-based values and facilitate reflective changes of preferences during DMV. There are indications that deliberation can influence preference formation, and in particular it can enhance willingness-to-pay measured through stated preference techniques (Whittington et al., 1998). Conjoint analysis as a preference elicitation tool can enable group deliberations to move from position to interest and value-based and thus produce a fundamental transformation of stakeholder preferences, although good stakeholder processes must be designed with an eye towards managing and addressing differences in power and expertise (Hermans et al., 2008).

However, the surge in DMV in ecological economics has been accompanied by scepticism regarding the potential to combine environmental valuation with deliberative processes (Niemeyer and Spash, 2001). Scholars have cast doubts on the capacity to combine what they see as two essentially different and even conflicting decision-making processes (Holland, 1997) and hold that DMV tries to combine two incompatible valuation processes (O'Connor, 2000). They argue that the approach is used to justify stated preference methods by adding a variety of often superficial forms of deliberation, while unintentionally raising issues about the meaning of social and communal, as opposed to individual values (Spash, 2008). This challenges DMV practitioners to consider whether the economic model they use is well-suited for comprehending results from their studies.

Ecological economists have also attempted to improve environmental decision-making by combining deliberative methods with MCA (Gregory and Wellman, 2001). Deliberative processes, for example citizens' juries, are used to assist with the elicitation of consensual weights over criteria employed in multi-criteria evaluations (Proctor and Drechsler, 2006). In MCA, weights represent stakeholder preferences concerning the relative importance of each assessment criterion used in the evaluation, so shifts in weight allocations during deliberations represent a reflective shift of stakeholder preferences. Other applications include assisting juries to deliberate and reach consensus by showing them results from sensitivity analysis of the impact of several changes of their preferences (weights) on the ranking of 'best' scenarios. Although the main objective is to reach consensus, those applications also aid decision-makers in understanding crucial aspects of complex decision-making problems (Proctor and Dreschler, 2006). More critical applications have contrasted policy priorities derived from deliberative multi-criteria exercises to government allocations of resources on environmental issues (Cook and Proctor, 2007). Other applications have mobilized deliberation to rank criteria not easy to quantify (for example, risk) in MCA, and then have used results to filter or screen options from assessment (White et al., 2008).

2.2 Theme 2: Analysing Deliberative Environmental Governance

Beyond preference formation, there is a second theme of interest to ecological economics research on value deliberation, which focuses on the conditions and principles that are necessary for facilitating deliberative environmental governance (Álvarez-Farizo and Hanley, 2006). Research in this theme involves studies of the *quality* and *potential* of value deliberation processes to bring about the goals of deliberative democracy in environmental decision-making, such as inclusiveness, reflection, and so on. When compared to the first area of research in deliberative ecological economics, this area is more positive and less normative in its research orientation and interests, that is, it is more interested with understanding and analysing how such potential may emerge or be improved. Using the example of the Millennium Ecosystem Assessment (MEA), Norgaard (2007) has illustrated the capacity of deliberative knowledge generation for the study of environmental change and the production of science related to sustainable development. Premised on a rejection of the precept that some things are more fundamental than others, Norgaard has shown how shared deliberative processes used in the MEA have been powerful learning processes that not only enhanced a more global understanding of ecosystem change, but also facilitated democracy in the process of knowledge creation by generating shared ways of knowing. Deliberative processes can also be instrumental in building trust in the decision-making process, as they can reduce factual uncertainty through participation and interaction with experts (Tsang et al., 2009). Nevertheless, and although deliberation provides a process where actors can learn from each other, the success of this social learning exercise is based on their capacity to question the assumptions that underlie their actions, values and claims to knowledge (Garmendia and Stagl, 2010).

Nevertheless, scepticism has also been expressed regarding the capacity of deliberation to embrace plurality of epistemological and normative ideas, interpretations and practices (Zografos and Howarth, 2010). On-the-ground experience with deliberative forums for environmental planning have shown that formal and informal aspects of power prevent a fulfilment of public participation based on the empowerment of citizens and weak groups as postulated by Habermasian communicative rationality (Pløger, 2001). Unequal power, operating both within and outside deliberative forums, results in the dominance of some ideas over others, stripping deliberation from its democratic potential. A well-developed literature on urban planning has observed two phenomena relevant for understanding the operation of power in relation to value deliberation.

First, the occurrence of front-stage dramaturgical behaviours coupled by back-stage 'substantive' representations. Power relations are not simply left at the door of deliberative forums the moment that actors enter these; instead, they are brought into and end up significantly shaping deliberation processes. For example, dramaturgical behaviours have been observed in deliberative forums in which actors adopt front-stage performances or modes of interaction, which are acceptable within the forum but which hide a very different power-shaped reality that exists back stage (Tewdwr-Jones and Allmendinger, 1998). Ironically those artificial front-stage attitudes are sometimes taken to represent reality. For example, business representatives avoid openly expressing their values and objectives during the deliberative process because they think that they may be too conflictive and instead prefer alternative communicative channels to make their substantive representations (Bickerstaff and Walker, 2005), that is, advance their priorities to influential bodies, for example government agencies.

Second, the disconnection of the outputs of deliberative forums from actual decisions taken on the same issues on which those forums deliberate. A heavy focus on ways of improving and innovating regarding the format of deliberative institutions seems to have deviated attention from thorny issues such as the study of the limited impacts of forums on existing institutions and decision-making structures (Bickerstaff and Walker, 2005). Scholars have hence argued that more basic questions regarding the distribution of political power (inside and outside deliberative forums) and the institutional capacity for democratic change need to be addressed. Beyond empowerment, discourses may also have a normative effect upon social practices: the result of struggling to find shared values and consensus through deliberative processes may sometimes be the silencing of values instead of giving them voice (Tewdwr-Jones and Allmendinger, 1998).

Those issues inform a research agenda on value deliberation in ecological economics. A first topic of interest involves identifying power and coercion mechanisms and analysing their operation within deliberative environmental decision-making processes in order to improve their democratic legitimacy and effectiveness. Another priority involves establishing what type of deliberative decision-making most limits the influence of power imbalances by testing, for example, how different deliberative MCA (DMCA) designs affect power and priority negotiation, for example during the phase of determining criteria weights (Proctor and Drechsler, 2006). Moreover, we need to understand why and how overarching institutional frameworks within which deliberation takes place limit or overlook the output of deliberative processes in order to improve their institutional relevance and capacity for change. Case study research (Yin, 2003; Flyvbjerg, 2006) is well-suited for pursuing such research priorities.

3. TRANSFORMING INDIVIDUAL TO COLLECTIVE PREFERENCES

The main focus of this theme involves developing DMV and DMCA applications for environmental decision-making. However, at the same time, this work also explores whether deliberation does indeed influence preference formation and in particular whether it enhances willingness-to-pay or preference convergence. DMCA applies deliberation for arriving at group decisions as regards criteria weights used in the analysis. The process typically starts with one round of identifying initial stakeholder weights (preferences), it then moves on to deliberation, that is presentation of stakeholder weights, a discussion of the rationale behind them and their relevant merits, and concludes with a new weighting exercise where preference convergence and a group weight is identified (or not). Consensus is not necessary as a final outcome (Cook and Proctor, 2007). Recent applications have introduced one more round of intermediate (that is, between initial and last weighting) deliberation, which they call a 'ratification process' and in which groups ratify the matrix of evaluation of impacts upon each criterion 'by examining it in great detail and by collectively assigning a new performance score if necessary' (Liu et al., 2010). This helps groups take ownership of the process, remove linguistic uncertainties, and avoid assigning weights irrespective of impacts. DMCA is proving useful both for tackling uncertainty, which makes it difficult to communicate risks and understand complex socio-environmental phenomena (for example, invasive species), and for arriving at group decisions through making trade-offs between competing goals. This happens because it offers a platform for stakeholders to interact and make trade-offs through deliberation and learning.

But beyond celebrating the potential of deliberation to feed into MCA and help achieve weight preference convergence, scholars also identify challenges related to the practice. Practical challenges include the fact that deliberation amongst stakeholders should be given a considerable amount of time in order for them to interact meaningfully (Lennox et al., 2011), which coincides with insights from DMV that giving more time to think and discuss helps generate value convergence (Álvarez-Farizo et al., 2009). DMCA practitioners also identify systemic barriers: where governance is adversarial, it is difficult to constructively include stakeholders in decision-making through DMCA (Lennox et al., 2011). Also, participants may find it difficult to reconcile their participation in such informal, collaborative processes with their parallel participation in environmental governance disputes (Lennox et al., 2011).

Beyond DMCA, some scholars mobilize MCA as a methodological framework to improve the design of deliberative processes. They use the stages of MCA to design different stages in a deliberative decision-making process and then assign roles to different stakeholders, for example experts to score alternatives, in the process (Soma, 2010). This combination of deliberation with MCA aims at improving the transparency and legitimacy of deliberative processes, ensuring that citizens alone are assigned with the task of reaching agreement on final decisions. The approach is interesting in that it makes use of the structure instead of the aggregation facilities of MCA to improve deliberation (Soma, 2010).

Non-monetary deliberative assessment methods confirm that mutual learning and information exchange through deliberation is critical for developing group consensus (Randhir and Shriver, 2009). Work using Q methodology finds that deliberation changes individual positions and allows people to move closer together in terms of their positions around different discourses (Hobson and Niemeyer, 2011). Similarly, work in DMV supports that it is possible to move from individual to collective values through deliberation. Values change by giving people more time to think and by giving them the opportunity to enter into a discussion; heterogeneity in responses also diminishes over various sessions (Álvarez-Farizo et al., 2009). What is more, preferences can converge without people undergoing dramatic changes in their values. With deliberation, differences in values between decision-makers who initially disagree do not have to diminish in order to achieve preference convergence towards consensus (Lo, 2013). This implies that in order to achieve consensus, value plurality does not need to diminish. Interestingly, through deliberation, preferences can also converge in making ecosystem services obtain incommensurable values. Social learning through deliberation may induce decision-makers to become unwilling to trade-off ecosystem services for money: as their livelihood depends on them, these are considered priceless and not of the same order as money (Kenter et al., 2011). This raises questions about how valuation can deal with unwillingness to trade-off key ecosystem services, which may result in the breakdown of monetary valuation methods (Kenter et al., 2011).

Indeed, criticism of DMV persists. A key assumption behind the development of the practice is that the difference between the public nature of ecosystem services and individual valuations carried out by conventional valuation techniques suggests a need to identify group-based instead of individual values (Wilson and Howarth, 2002). However, and although conceding that group willingness to pay is more consistent than pure individual payments, critics argue that DMV sidelines the issue of incommensurability and more importantly 'mixes collective reasoning and consensus building over principles and norms with individual trade-off calculations' (Vatn, 2009). This links to a concern that scientific progress in ecological economics is hindered by 'the pretence that opposing ontological presuppositions and epistemological positions could be combined or at least held in conjunction' (Spash, 2013).

Environmental appraisal methods such as monetary valuation, MCA and deliberation are environmental value articulating institutions, that is, vehicles for articulating and assigning value to the environment

(Vatn, 2005). Each method induces different rationalities to come forth and be articulated in the process of assigning values. For example, monetary valuation induces one to understand one's action in instrumental terms and mobilize an individualist, utilitarian rationality to come forth and an expression of their values in quantitative, monetary terms. Deliberative methods induce a collective rationality to develop in the process of assigning values to the environment and reaching decisions. In other words, the framing of decision-making processes influences which types of value become relevant and legitimate to consider (Soma and Vatn, 2010). The concern then becomes deciding which value articulating institutions are more appropriate to use in environmental appraisal. Environmental appraisal methods that favour social and communicative action to tackle the incommensurable value dimensions and complex character of ecosystem services are preferable (Vatn, 2009). But scholars raise doubts as to the capacity of deliberative methods to involve a wide range of parties and be representative. This involves a 'second-order question' for deliberation that is 'which ideas should govern the choice of case specific appraisal methods' (Vatn, 2009). Nevertheless, ecological economics has suggested that focusing on arguments rather than individuals or 'interest groups' may be more relevant for understanding representativeness in deliberative decision-making, and that Q methodology could be used to operationalize this (Davies et al., 2005). Moreover, including multiple stakeholders does not equal inclusivity as some discourses and priorities may still be left out (Schouten et al., 2012). This further underlines the crucial role that the Q method can play (Zografos and Howarth, 2010) in selecting forum participants and fulfilling criteria of inclusiveness at the level of discourses. Ecological economics work is slowly taking on this challenge (Cuppen et al., 2010).

4. QUALITY AND EFFECTIVENESS: POWER AND VALUE DELIBERATION

Although value deliberation can be crucial for effecting democratic environmental governance, the danger of either governance not being sufficiently deliberative, or that some governance arrangements presented as deliberative lack this capacity is a concern. Moreover, no matter how authentic deliberative processes may be, their impact on actual decision-making may be marginal, turning them into ineffective, 'ceremonial' institutions (Aguilera-Klink and Sanchez-Garcia, 2005). Those issues have been detected early on by studies in the field of urban and regional planning (Tewdwr-Jones and Allmendinger, 1998) and brought to the attention of ecological economics scholars working with deliberation (Zografos and Howarth, 2010).

To mediate this concern, scholarship that investigates the quality and effectiveness of deliberative processes is slowly developing within ecological economics. This research establishes criteria for assessing the deliberative-democratic quality of governance, which it then applies to real-life cases. All in all, those criteria assess the deliberative capacity of governance arrangements by looking at their internal operation as well as their connections to the context of deliberation in an effort to draw lessons from experience and improve governance. Those criteria comprise (Dryzek and Stevenson, 2011; Schouten et al., 2012):

1. inclusiveness, which assesses the extent to which decision-making processes (also termed 'empowered spaces') contain the diversity of existing interests and discourses (also termed 'public space') relevant to an issue;
2. 'transmission', that is the extent to which the range of discourses ('public space') over an issue is represented within the 'empowered space';
3. authenticity, which looks at the extent to which decision-making processes (that is, deliberative forums) actually show characteristics of deliberation, for example absence of coercion and strategizing;
4. consequentiality (also termed 'decisiveness'), which assesses both output, that is the degree to which deliberative processes determine the output of deliberation; and outcome, that is the effect that deliberative processes have on policy and change.

To those criteria, Dryzek and Stevenson (2011) add accountability, which involves whether the decision-making process (or 'empowered space') is accountable to the range of interests and discourses that exist ('public space'); and, meta-deliberation, which involves 'the reflexive capacity of those in the deliberative system to contemplate the way that the system is itself organised, and if necessary change its structure' (Dryzek and Stevenson, 2011).

This work has explored the democratic quality of private multi-stakeholder governance of responsible soy and sustainable palm oil production roundtables (Schouten et al., 2012), and the deliberative democracy capacity of global earth systems with a particular focus on climate change governance (Dryzek and Stevenson, 2011). The studies find out that there is a high degree of authenticity as the communicative process shows characteristics of authentic deliberation, for example demands are adequately justified and debates are respectful and with traits of constructive politics (Schouten et al., 2012), although some bargaining may also be taking place (Dryzek and Stevenson, 2011). However, both investigations identify shortcomings as regards inclusiveness and transmission, as well as consequentiality. A key issue is that discourses seen as 'radical' are neither represented nor properly transmitted in the decision-making ('empowered') space, which makes it easier for hegemonic, or 'dominant' discourses to emerge. And although output consequentiality may be high, as deliberations do determine the output produced by forums, if one considers the limited variety of discourses present in the process, output consequentiality becomes low. Importantly, also outcome consequentiality or 'decisiveness' is low, as the policy impacts of deliberative forums is limited (Schouten et al., 2012) and some actors can still exert power behind the scenes to ensure that their priorities are well represented and established in final policy decisions (Dryzek and Stevenson, 2011). Although good for motivating collaborative work and as a framework to systematize discussion, deliberative visioning faces a real challenge when there are insufficient mechanisms to integrate effectively with other processes of social and policy change and when there is lack of a collaborative culture (Kallis et al., 2009). Similarly to broader observations regarding participatory processes (García-López and Arizpe, 2010), deliberations fail 'to generate real social change because of their inability to deal with issues of power and politics' (Hickey and Mohan, 2005).

Ecological economics scholarship has come to a realization of the relevance of power relations for value deliberation and has called for research investigating how power intrudes into actual deliberative processes in order to release their full democratic and transformative potential (Zografos and Howarth, 2010). Value pluralism implies accepting that we should expect value conflict as a standard occurrence in environmental governance, that power relationships should be addressed side-by-side with the ethical basis for public policy and the more general issues of governance and democracy (Spash, 2013). 'Deliberation in small groups like citizens' juries, consensus conferences and the like has little value if it is not integrated in a public discourse more at large' and '[p]ower-free communication may not be a possibility for powerless people' (Vatn, 2009).

Despite a rhetoric of deliberation, certain groups may still dominate decision-making through a complex interplay of power and knowledge among actors with unequal access to deliberative governance. For example, symbolic violence may be used to cultivate beliefs about some actors holding superior knowledge, and thus create boundaries among actors and produce a closure in the deliberation process that is internalized and accepted by those excluded from deliberation (Ojha et al., 2009). Failing to connect with public forms of governance implies failure to achieve the very purposes of deliberation (Schouten et al., 2012), and practitioners should keep in mind that improving governance implies modifying deeply rooted patterns of power that affect deliberative processes themselves (Ojha et al., 2009). Interestingly, as Schouten et al. (2012) show, the three main elements of deliberative capacity, that is, inclusiveness, authenticity and consequentiality, are connected: less inclusiveness increases consequentiality (within deliberative forums) and authenticity, probably because people are capable of communicating better as they have closer starting points, for example due to the exclusion of radical discourses; but also, under the same circumstances of low inclusiveness and high authenticity, consequentiality outside forums is low probably due to their voluntary nature. The relation between power, for example the power to exclude, and authenticity may be more convoluted than one may think in the first place.

Nevertheless, not everybody in ecological economics shares the same level of concern about the operation of power. Although not rejecting power concerns, Collins and Ison (2009) maintain that the emphasis on how social power dimensions of participatory processes may preclude genuinely inclusive participation is excessive. Instead, they argue that social learning within such processes has more to offer than conceptualizing interactions as struggles between citizens trying to access more power and controlling institutions that try to limit this. They criticize static conceptions of power, arguing that instead this is more relational and that it contributes in forging identities through social learning. In environmental challenges characterized by uncertainty, complexity and multiple stakeholding that lead to controversy about the nature of the issues at hand and ways to address them, the roles, responsibilities and purposes of those involved need to be reconceptualized and this can be achieved through participation as a process of social learning about the nature of challenges and the various ways to respond. However, empirical work in ecological economics shows that deliberative processes may be less successful in stimulating social learning than assumed. Social learning does happen, but to a lesser extent than expected, and the depth and breadth of learning depends on workshop design, time given to process, and the type of participants (Garmendia and Stagl, 2010).

This difference in focus as regards the relevance of power or social learning within deliberative governance seems to be premised upon different political science schools of thought as regards theories of the state (Garmendia and Stagl, 2010): some ascribe to theories that consider policy-making as a process of social learning (Sabatier, 1988) where policy change occurs as a result of the formation of discourse coalitions through the negotiation of difference (Hajer, 1995); whereas others (with more

Marxist leanings) base the foundation of policy change in power struggles. It also relates to a key division between consensus-based (Habermasian) and confrontational (Foucauldian) approaches to governance (Aylett, 2010), discussed in the next section. This tension is essential for research on the second strand of deliberative ecological economics, as it informs either enthusiasm or scepticism when approaching the issue of value deliberation in environmental decision-making. Perhaps the truth lies somewhere in between, with some cases of policy change being the result of the former process (compromise) and others of the latter (conflict). Or perhaps both phenomena occur in all public decision-making processes, albeit at different scales.

5. FUTURE RESEARCH: STRETCHING THE CONFINES OF DELIBERATIVE REASON

I now turn my attention to where those results of empirical research leave the field of value deliberation in ecological economics in relation to broader debates about deliberation and what sort of future research directions this suggests. This is important as it helps to both improve our vision concerning next steps and put ecological economics in pace with developments in other areas of environmental social science. I will – somehow confusingly – begin by first considering the second strand of research in deliberative ecological economics, and then move on to look at DMV and MCA.

The diminished quality of deliberation due to lack of representation of some discourses in deliberative decision-making processes is not incidental: it is structural and sometimes even results from the logic of forums (Schouten et al., 2012). This is a logic that seeks solutions within the current system of socio-environmental relations, and hence marginalizes radical discourses that demand systemic changes and address the causes of socio-environmental challenges. Following Bourdieu, Ojha et al. (2009) point out that a vital aspect in raising the quality of deliberation involves the redistribution of cultural/ideological power and a change in the structure of access to all forms of capital, be it physical/economic, social status–cultural, ideological–symbolic, and political–institutional resources. This connects to a deeper criticism of deliberation which holds that its normative emphasis ignores the ubiquity of power in social relations and the practical context of power surrounding and pervading environmental decision-making (Zografos and Howarth, 2010). Critics argue that the emphasis and quest for consensus reached via (communicative) reason can end up generating counter-productive results for democracy, such as the silencing of values (Tewdwr-Jones and Allmendinger, 1998). This can happen because such emphasis downplays and crowds out the importance of *conflict* for democracy, and the relevance of *emotions* and other human traits beyond reason for communicative interaction and decision-making. The second criticism comes from the perspective of agonistic democracy (Mouffe, 1999) and is somehow an extension or further elaboration of the first criticism that is inspired by the work of Michel Foucault.

Communicative action idealizes consent and formal institutions and 'ignores the role of conflict in energizing continued community participation, counterbalancing the influence of business on local government, and pushing the state to expand what is considered in participatory processes' (Aylett, 2010). Far from being undesirable, social conflicts 'are the true pillars of democratic society' (Hirschman, 1994), as they produce 'the valuable ties that hold modern democratic societies together and provide them with the strength and cohesion they need . . . [hence] there is good reason to caution against an idealism that ignores conflict and power' (Flyvbjerg, 1998). The drive for a final resolution of conflict puts democracy at risk (Brown, 2009), and can lead to the undemocratic idea that we could reach a stage beyond politics where antagonism and conflict will be eliminated and a perfect democracy realized (Mouffe, 2005). Agonistic democrats celebrate conflict as an expression of pluralism and aim at providing a framework where this can be expressed as 'an agonistic confrontation among adversaries' (Mouffe, 2000) who do not see each other as enemies to be destroyed but as legitimate foes (Brown, 2009). Agonistic democracy seeks a clash of democratic positions acknowledging that any consensus will always be a conflictual consensus (Mouffe, 2000).

Moreover, the call for deliberation can deny heterogeneity and privilege certain voices, in particular the voice of reason at the expense of emotional aspects of human experience. Deliberative democracy 'neglects the central role played by passions, emotions and acts of collective identification in fostering democracy' (Brown, 2009). As Nelson (2011) explains, we live in an unsafe, interdependent, and uncertain world that is not amendable to cool, detached investigation and democratic rational deliberation, which although reasonable, corresponds to a world that is safe, rational and certain. This world and the challenges it presents, for example climate change, calls for action, and action is based more on motivation than reason. Beyond principles and deliberation, emotions, imagination, narrative, socialization and bodily activity play a crucial role in shaping motivation and moral action. These build on an image of a 'homogenized – you might say sterilized – rational subject' who settles things through conversation and rational deliberation and is apparently 'not prey to ambivalence, anxiety, obsession, prejudice, hatred, or violence' (Meyers, 2010).

Nelson advocates good leadership for taking urgent action, as a more needed alternative to current bad leadership than radical decentralization and (perhaps impossible) ideal democratic conversations. Empirical work also ponders that although deliberation can generate support for collective action, strong governance signals and leadership are still essential for taking up crucial challenges such as climate change action (Hobson and Niemeyer, 2011).

Those criticisms are deep, relevant and important to take into account for future research in order to improve methods for embracing value plurality in environmental decision-making. Nevertheless, consensus reaching can involve consensus on disagreement, that is on points on which participants disagree, without a need to force a single decision. Beyond that, a main issue with the celebration of conflict – which is undoubtedly crucial for democracy – and the agonistic approach is the type of *attitude* that they suppose for participants entering into negotiation between diverse values over an issue, be it within the context of an antagonistic or deliberative process. Specifically, the insistent pursuit of conflict and difference makes one wonder: to what cost and *at whose expense* does it make sense for democracy to maintain conflict? Who bears the burden of maintaining conflict in a situation of value negotiation? Because an imperative to maintain and celebrate conflict may also imply a shifting of the costs of conflict, for example violence, to weaker groups while other groups participating in value negotiation continue to maintain conflict to their own benefit. In other words, the key issue seems to be how to ensure that participants in deliberative decision-making processes avoid strategizing through using either consensus or conflict instrumentally to achieve their ends, and not so much whether consensus or conflict is the best attitude for one to employ and outcome to seek in processes of value negotiation. A second 'attitudinal' issue to consider when celebrating conflict is whether this privileges some actors better positioned to engage in conflict. Is everyone really equally endowed materially and psychologically to bear and operate, that is, to be able to make a case for their values, within conflict? In a sense, this could be the flip side of a similar criticism to deliberative processes claiming that those better positioned to make reasoned arguments have more power inside the process. Both concerns and possible ways of mediating them require consideration.

The argument about emotions, imagination and bodily activity is incisive. Emotions are relevant and should not be sidelined either in deliberation or any other decision-making process and, although the idealized democratic conversation archetype does prioritize reason, there is no reason why deliberation should suspend or suppress emotions. The problem with deliberation should not be to give space and equal value to emotional dimensions and expressions around issues considered in a forum, but with strategic manipulations of emotions that create disadvantage for those who cannot act in this way. The challenge when participating in deliberative processes is not to empty oneself of emotions, imagination and bodily activity, but to acknowledge that one's emotions are not a priori more valid and should take precedence over other people's emotions when negotiating collective decisions. Indeed, more experimental methods of participatory decision-making attempt to integrate emotions by creating spaces for expressing conflict, emotion and bodily interaction parallel to the more structured, principally reason-oriented decision-making processes (http://www.canmasdeu.net/colectivo-de-vida/?lang=en). Finally, good leadership can make sense if it is disentangled from creating authority and power imbalances that influence fair representation of values and worldviews.

Both attitudinal issues and the argument on emotions point to a fundamental question: is value plurality best accommodated when participants enter into a value negotiating process as if it were a process of seeking to establish common priorities through mutual reflection and backing down on their priorities, or instead with an attitude that seeks to 'win' a debate in order to promote their otherwise sidelined values and priorities? The evidence from ecological economics research on value deliberation that high authenticity in deliberation is linked to low inclusiveness (Schouten et al., 2012) could be pointing out that authentic deliberation requires some sort of an 'agreement of minimums', that is of discourses that share some bottom lines (for example, necessity of maintaining current system of socio-environmental relations). This could suggest that deliberation is less relevant, perhaps impossible, for negotiating widely diverse values where perhaps agonistic approaches may be more relevant for advancing value plurality. Under what socio-economic, political (for example, power balances), and environmental (for example, criticality of resources in question) conditions does deliberation advance value plurality? More research is needed for understanding ways in which the elements of authentic deliberation, that is, authenticity, inclusiveness and consequentiality are connected (Schouten et al., 2012). Given the relevance of power for understanding part of those relations, specifically high authenticity and low inclusiveness and (outcome) consequentiality (Dryzek and Stevenson, 2011; Schouten et al., 2012), research should enquire how discourse exclusions occur and are legitimized in the context of setting up and running deliberative forums. Political ecology uses the term 'green governance' to refer to the different ways in which power operates either as coercion or consent in environmental governance (Peet et al., 2010), offering useful tools for exploring this 'how' question. Understandings of power also as agenda-setting (Bachrach and Baratz, 1962), thought control (Lukes, 1974), and Gramscian hegemony as well as the right to act (Hindess, 1996) may also need to be mobilized. Closer analysis of the socio-political context of deliberation, and on how outside conditions, such as the position of deliberation within decision-making, shape forum shortcomings should be further established. In short, it is high time for ecological economics studies on value deliberation to get out of the forum and into the big context into which forums operate to try to find out what practices, processes and discourses provide obstacles for forum results to have consequence.

Interestingly, research priorities of DMV coincide in their emphasis on the importance of linking deliberative (monetary valuation, in this case) forums to the wider context, albeit in different ways. For example, the issue of how to aggregate value estimates from valuation workshop settings to the wider population is a difficult one but needs to be addressed (Álvarez-Farizo et al., 2009). This is because participants' preferences and values at the end of a deliberative session change with respect to their preferences and values before entering the workshop. In order to improve understanding of how collective values develop, scholars suggest testing different experimental designs that separate the effects of information, group discussion and collective choice (Álvarez-Farizo et al., 2009). Moreover, and although a consensus rule for deciding collective values is more appropriate for resolving conflict among stakeholders than a majority rule decision in DMV, further research is required to understand how a broader range of decision-making rules applies to various situations (Ito et al., 2009). Although DMV studies confirm that individual preferences and (monetary) values do transform into collective ones, they also identify disparities to the extent that this can occur for some environmental attributes. For example, unwillingness to trade off ecosystem services that are key for livelihoods and which may emerge after the deliberative stage of DMV, calls for further research to evaluate the capacity and appropriateness of valuation for assessing deeper held values (Kenter et al., 2011).

This links to another crucial research agenda question. For the field to advance, DMV studies should systematically explore implications for the method that are raised by criticism of the approach. This criticism poses that empirical studies unintentionally highlight 'issues about the meaning of social and communal, as opposed to individual, values, and that distinct realms of value arise from different framings' (Spash, 2008). What are the implications for understanding the relationship between context/ framing and value of the observed divergence between values expressed through stated preferences and those arrived at through deliberation? How does incommensurability arise, for example in the process of deliberation

(Kenter et al., 2011), and how can we use results that show a disparity between individual and group (social) values to update or reconsider models of economic behaviour and preference formation? Closer collaboration between DMV practitioners and other social scientists, such as social psychologists and economic anthropologists, could help design and conduct research advancing the field in those directions.

Similarly, DMCA applications also flag the need to consider contextual factors for understanding the potential of the method to obtain collective values. Beyond observing it, it is important to understand the reasons behind group preference changes including factors such as new exposure to and different formats of presenting information, group dynamics and group education level (Liu et al., 2010). Also, the potential of trust and common understanding as a key facilitating element for arriving at criteria weightings and producing an overall 'result' should be considered (Lennox et al., 2011). Similarly to the previous theme and to DMV, research needs to look at relationships between institutional structures and behaviour, as we do not know enough about the effects and acceptance of some elements of the deliberation processes such as different ways of authorizing members in forums and securing accountability (Vatn, 2009). Future research in DMCA can be used to improve accountability and facilitate the communicative processes (Vatn, 2009), for example through exploring best designs in terms of encouraging communicative reason and interaction (Zografos and Howarth, 2010). What is more, research should consider the implications of systemic barriers, such as a context of adversarial governance and stakeholder engagement in environmental governance disputes, to seek ways to constructively include stakeholders in decision-making through DMCA (Lennox et al., 2011).

Beyond contextual issues, DMCA research focuses on three issues. First, the 'time issue', which concerns the need for forum participants to be given considerable amounts of time for deliberation to interact meaningfully (Lennox et al., 2011). This coincides with DMV observations that more time to think and discuss helps generate value convergence (Álvarez-Farizo et al., 2009), and with other combinations of MCA and deliberation that identify time constraints as a key challenge (Soma, 2010). To overcome this, some suggest running DMCA processes in the course of several months (Cook and Proctor, 2007). In all cases, and as regards preference elicitation, the introduction of a 'ratification' stage within the process (Liu et al., 2010) seems to offer promising results and should be further considered with more empirical evidence. A second issue concerns selection, also flagged for DMV in terms of the representativeness of small deliberating groups (Spash, 2008). DMCA scholars argue that different juries would give different results (Cook and Proctor, 2007; Liu et al., 2010) and suggest that other methods such as stakeholder analysis and Q methodology could be employed for participant selection (Cook and Proctor, 2007). A starting point for investigating this further should be the understanding that stakeholder analysis type of tools help decide participant selection on the basis of personal and group traits, whereas Q methodology does so in terms of different worldviews held by potential participants (Davies et al., 2005). In principle, and in view of the original ecological economics concern to ensure plural values in environmental decision-making, a choice on the basis of different worldviews may seem more reasonable for ensuring plurality. A final issue concerns the value of adopting more critical stances in the use of DMCA. Such is, for example, the application put forth by Cook and Proctor (2007), who use DMCA not only to identify the collective importance (preference) of exotic species (pests and diseases) for bio-security in Western Australia, but also compare this collective perception to state fund allocation for dealing with the threat of those exotic species, and find a disparity between the two. Certainly, we need more of such critical takes on DMCA in order to avoid transforming the tool into a technocratic MCA exercise (De Marchi et al., 2000).

6. CONCLUSIONS

Value deliberation in ecological economics has emerged as a response to the need to pursue value plurality in environmental decision-making. This need is premised upon democratic, essential and instrumental premises, which postulate that plurality improves the democratic legitimacy and the quality of public decisions. Deliberative ecological economics has pursued the direct integration of deliberation in environmental decision-making through DMV and DMCA, a first 'theme' or area of research in the field. A second theme has focused on the analysis of deliberative environmental governance arrangements themselves. Those advances have been accompanied with concerns about the epistemological limits of combining monetary valuation and deliberation, as well as about the capacity of deliberative processes to achieve inclusiveness, social learning and transformation. Nevertheless, the two themes have developed into a more coherent agenda that enquires the *capacity* of value deliberation to: transform individual to collective preferences, or the capacity of methods used, specifically DMV and DMCA, to elicit collective preferences (Theme 1); and, be genuinely inclusive and democratic (Theme 2). Those developments reflect a trend towards less normative focuses as regards the first theme, specifically interest to engage in more basic questions as regards the nature of collective values and preferences. As regards the second theme, ecological economics research reflects a trend to move from more conceptual/ theoretical contributions as regards the importance of deliberation, towards engaging with empirically-based work for understanding and improving the quality of deliberation.

Questions in the broader social science and environmental social science literature about the capacity of deliberation to consider elements such as conflict and emotions that are key for democracy and equally crucial as reason, help contextualize the findings of recent ecological economics research. They suggest that future research directions should seek to stretch the confines of deliberative reason by looking at the relevance of elements (for example, information availability, different decision-making rules) that are key for obtaining collective values, for example, via DMV workshops; through DMCA exploring the relevance of group dynamics, systemic barriers (for example, a context of adversarial governance), trust and institutional structure for achieving behavioural and policy changes through deliberation; and by investigating the conditions under which deliberative as opposed to agonistic democracy governance arrangements advance environmental value plurality, and the relevance of power in limiting or facilitating this both within and outside deliberative forums.

The work done on value deliberation in the field of ecological economics both highlights trends within the field (for example, developments as regards deliberative evaluation) as well as showing an interest on broader issues related to environmental values and how these can be brought into governance (for example, the challenge and relevance of emotions). This work reveals that the field is now mature enough to accommodate diverse and multi-disciplinary research perspectives while obtaining a better focus of enquiry, specifically one concerned with the *capacity* of the concept and principle of deliberation for plural value integration in decision-making. It also shows a capacity to host both research more akin to traditional economic methodologies and concerns, such as valuation and the possibility of transforming individual to group values, and research that looks at values beyond mere monetary expressions of worth, through DMCA. Equally diverse and inter-disciplinarian is the type of research that engages with the literature on deliberative and agonistic democracy. This research has the potential to bring into that literature evidence from the vantage point of *environmental* values, which is relevant for understanding those broader questions and for improving public decision-making through consideration of plural values.

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5. Social metabolism: a metric for biophysical growth and degrowth

Marina Fischer-Kowalski and Helmut Haberl

INTRODUCTION

Addressing a social system's metabolism means looking upon its economy in terms of biophysical stocks and flows. The term 'metabolism' evokes an organismic analogy: metabolism is the process by which an organism builds up and maintains its structures through exchanging energy and materials with its environment throughout its life. Such an analogy is warranted for social entities that share some of the key system characteristics of organisms: the ability to create and reproduce their own elements,[1] a high degree of internal interdependency between system compartments, and the ability to reproduce a clear boundary *vis-à-vis* their environment while exchanging energy and materials. 'The substantive meaning of economics derives from man's dependence for his living upon nature and his fellows. It refers to the interchange with his natural and social environment, insofar as this results in supplying him with the means of material want satisfaction' (Polanyi, 1968, p. 139).

What can you see when you look at economies in biophysical terms that you miss when looking at them in monetary terms? One key piece of information you get is what natural resources social systems draw upon and in what quantities; you can relate these quantities to natural sources and discuss scarcity and abundance; you can relate these quantities to the numbers of humans and compare the burden a human represents on the resource base between different social systems; and you can relate these quantities to economic output and discuss resource productivities and efficiencies. Throughout the sociometabolic process, you can look at stocks and flows, recycling, wastes and emissions; you can analyse stocks and what they consist of, and how large the flows are that will be needed to maintain society's stocks in the future. You have the advantage that for many issues you can draw on natural science laws for modelling

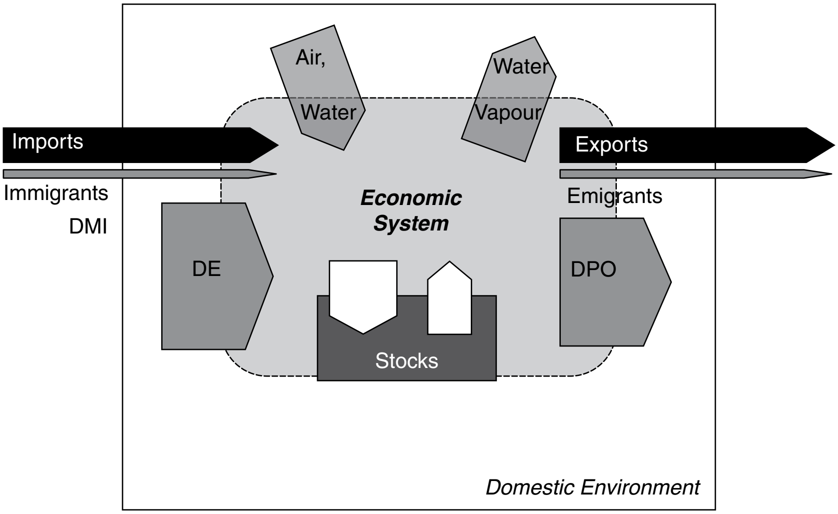
[1] This important feature of complex systems was termed 'autocatalytic' by Maturana and Varela (1975); the term Luhmann uses for social systems is 'autopoietic' (Luhmann, 1984).

interrelations: thermodynamics, the law of conservation of matter, technical relations between mass and energy, but also biological and biochemical relations that allow the determination of metabolic processes of plants, animals and humans, help to construct causal models to cross-check observations, fill data gaps, find plausible alternative interpretations for surprising observations and answer, for example, questions concerning future developments. As will be seen below, analysing social metabolism is a truly interdisciplinary endeavour crossing the 'great divide' (Snow, 1956) between the natural and the social sciences; it is not a hostile takeover of social issues by the grid of presumably deterministic natural science. But it does indeed make visible constraints that are accessible neither to monetary expenditures nor human ingenuity, and it delivers explanations that sometimes undermine the self-ascribed importance of human agency (see for example, Hall and Klitgaard, 2012, ch. 2).

The chapter outlines the concept of social metabolism and how it has been evolving. Next, it discusses the energetic metabolism of societies, methodological and conceptual issues as well as relevant findings such as the increase of metabolic rates across human history. The following section is devoted to societal material metabolism, major issues of measurement as well as findings, among them the '1970s syndrome' of metabolic stagnation in high-income countries, while so-called 'emerging economies' display rapid physical and economic growth. The section on policy uses of sociometabolic concepts and indicators shows that in particular indicators on resource use and the relation between resource use and economic growth have gained prominence; we ring a certain sceptical note as far as decoupling and maximizing resource productivity as policy strategies are concerned. Finally, we look into the question regarding how far sociometabolic theories can provide guidance for a sustainability transition.

THE CONCEPT OF SOCIAL METABOLISM

The intellectual history of social metabolism (sometimes also addressed as societal or socioeconomic metabolism) has received ample attention and needs not to be revisited here in detail (Martínez-Alier, 1987; Fischer-Kowalski, 1998; Fischer-Kowalski and Hüttler, 1998; Foster, 2000); the above quotation from Polanyi on the meaning of economics relates back to Marx's concept of regulating and controlling the metabolism between man and nature through the labour process (Marx, 1976/1867, p. 283). In the late 1960s, social metabolism re-emerged as a concept and term, and is coming into ever-wider use. The term 'metabolism of cities' was coined by Wolman (1965) and further developed by Boyden et al. (1981), and the term 'industrial



Notes: DE: Domestic extraction; DMI: Direct material input = DE + Imports; DPO: Domestic processed output; DMC: DMI − Exports.

Source: Matthews et al. (2000), slightly modified.

Figure 5.1 The material metabolism of a national economy

metabolism' was first used for a joint conference of the United Nations University and UNESCO in Tokyo in 1988 (Ayres and Simonis, 1994).

In the 1990s, a robust model of the metabolism of social systems actually evolved, the respective indicators for material flows developed in an internationally comparative way, and the World Resources Institute consecutively published two influential reports (Adriaanse et al., 1997 and Matthews et al., 2000). The basic model places material flows within a wider picture of social metabolism (Figure 5.1) that has become something like a paradigmatic heuristic model of the field. The key conceptual decision, in line with complex systems theory, was first to define the 'stocks' of a social system, usually comprising humans, durable infrastructures and animal livestock. These 'stocks' are defined both physically, in the sense that they are present in a certain territory, and socially or institutionally, in the sense that they 'belong' to the social system and are continuously reproduced by activities of the social system.[2] Secondly, as soon as stocks

[2] Anthropogenic structures that are no longer reproduced, such as ancient ruins or deserted belowground infrastructures, are not considered as stock in the above sense.

are clearly defined, it is possible to identify the (energy and material) flows required to reproduce these stocks or produce new stocks; only those flows are considered part of the social metabolism. Moreover, because of the law of conservation of matter, input flows equal output flows plus net additions to stock (although with variable delays).

By conceptually linking metabolic flows with biophysical stocks in this way it became possible to operationally define boundaries for social systems without ambiguity (both vis-à-vis their natural environment and vis-à-vis each other) and to create a consistent metric for material and energy flows for social systems also on other scales (local communities, firms or cities). For nation states, material flow accounting has become a regular part of public statistics in Japan, in the European Union and a number of other countries (Fischer-Kowalski et al., 2011). This means that reliable annual accounts of material use can be given in physical terms and can be compared across time and with economic accounts.

THE ENERGETIC METABOLISM OF SOCIETIES

Theories and accounts of the energetic metabolism of societies (not necessarily by this term) most directly compete with and challenge mainstream economics in the explanation of wealth and economic growth, and tend to provide their own fairly different outlooks on the future.

While the classical economists Adam Smith and David Ricardo generally thought that it was human labour that was the principal generator of wealth, natural resources, in particular land, still played a major role as a source of use value and as a constraint to unlimited economic growth. Later Karl Marx, while still seeing human labour as the source of value, removed this constraint by referring to the evolution of the 'means of production' (that is, technology) that only depended on (principally unlimited) human ingenuity. In the twentieth century, the explanation of wealth left natural resources behind and focused on capital and labour only (see production functions by Cobb and Douglas, 1928 and Solow, 1956). As in mathematical calculations there remained a large 'residual', this was attributed to technological innovation (that could not, however, be properly measured). Authors like Cleveland et al. (1984a), Cleveland (1991), Ayres and Warr (2005) and Hall and Klitgaard (2012), in contrast, attributed this residual to energy (or exergy) input into the economy and were able to provide convincing empirical evidence: unexplained residuals disappeared.

The debate is receiving new impulses from the discussion on climate policy and the implicated need to withdraw gradually from fossil fuels, or inversely, the declining supply of easily accessible fossil fuels.

From the perspective of climate-change mitigation it is very clear that using all fossil fuels that we may be able to retrieve in the next decades would result in much more global warming than the 2°C global warming limit recommended by the IPCC and accepted in many international policy documents (Meinshausen et al., 2009). Widely diverging estimates abound related to the future availability of fossil fuels (Murphy, 2012; GEA, 2012). There are two distinct camps for this issue. One camp, the 'technological cornucopians', believes that market forces, technological progress and resource substitution will allow humans to supply sufficient energy resources more or less indefinitely into the future (Bentley and Smith, 2004). The second camp, the 'peak oilers', is composed of scientists relating to the pioneering work of M.K. Hubbert (1956) who holds that global peak oil will occur soon or has already occurred (Campbell and Laherrère, 1998); according to more recent estimates, peak gas and even peak coal may also not be so far away (Murphy, 2012).

From a sociometabolic perspective, it is not just the amount of accessible energy resources that matters, but the so-called 'energy return on investment', EROI. EROI is the ratio of energy returned from an energy-gathering societal activity compared to the energy invested in that process (Hall and Klitgaard, 2012, p. 310). The advocates of EROI claim that net energy analysis is a useful approach for assessing the advantages and disadvantages of a given fuel or energy source.[3] The calculation of EROI very much depends on the system boundaries drawn (that is, what is considered as energy investment into an energy-gathering activity) and is not trivial. Findings for the US show that EROIs for oil and gas mining have decreased from 100:1 (in 1930) to 12:1 (in 2007) for oil imported to the US, for coal (at mine mouth) from 80:1 (in 1930) to 30:1 (in 1970); for bitumen from tar sands and shale oil ('unconventional sources'), the EROI is estimated as low as 2 to 5:1 (see overview in Hall and Klitgaard, 2012, p. 313). As the net energy is relevant for what can be spent on other activities than energy generation, this decline in EROI matters for disposable income and consumption levels. It also matters, of course, for choices of alternative energy sources; renewables, except for hydropower, at current technologies do not rate very highly in EROI, and some (such as bioethanol) may even have an EROI below 1 (which means they need to be subsidized by other energy sources).

The idea that the control of energy matters for society, and even

[3] The concept of EROI is derived from Howard Odum's work (Odum, 1971); with the publication of Cleveland et al. (1984b) in *Science* it received broader attention.

determines the advancement of civilization, has a long tradition in social theory, prominently represented by H. Spencer. In his *First Principles* in 1862, the process of societal advance and the differences in stages of advancement among societies can be accounted for by energy: the more energy a society is able to consume, the further advanced it is. Societal progress is based on energy surplus. First, it enables social growth and social differentiation. Second, it provides room for cultural activities beyond basic vital needs. Similarly, the beginnings of cultural anthropology were marked by energetic evolutionism (as in the works of Morgan, 1877[1963], later White, 1949 and Steward, 1955). Along a less ideological vein, Cottrell (1955, revised edition reprinted in 2009) ventured a careful analysis of the relevance of the sources and amounts of societally available energy for social processes. The physicist Smil's periodic compendia on *General Energetics: Energy in the Biosphere and Civilization* (1991) up to *Energy in Nature and Society* (2008) compile encyclopaedic knowledge on how energy matters socially and economically. Ayres and Warr (2009) demonstrate theoretically and empirically the close link between economic growth and 'exergy' (energy actually put to use). The historian Sieferle (1982, 2001) analysed the rise of the United Kingdom into industrialization and political hegemony as an outcome of its 'subterranean forest', that is, its use of coal, which gave it access to an order of magnitude more energy than would have been available if the UK had had all its territory covered with forest and had burned its yearly wood increment for energetic use. Currently, the issue of reducing fossil fuel consumption, both because of 'peak oil' (and perhaps peak gas as well; see Rogner et al., 2012 for a balanced discussion) and for reasons of avoiding dangerous climate change and its potential consequences for economies and societies, is stimulating much research on the potential consequences of changing society's energy base and possibly reducing the energy intensity of social processes altogether.

It is an extraordinarily important achievement of Sieferle (1997) to conceptualize the modes of societal organization not simply as socially or socio-economically distinct, but to systematize them so that they can be characterized as socio-ecological patterns, comprising social organization (in the widest sense of the word) and concomitant modifications of the environment, intended or unintended environmental impacts. Key to the distinctions that Sieferle draws is the source of energy and the dominant conversion technology of energy that societies use. The charm of this classification is that it helps to understand the differences in functional problems that societies face when trying to establish and maintain themselves within their environment, the evolutionary advantages and drawbacks that occur and therefore gives clues on possible directionalities of change. Sieferle distinguishes between the hunting and gathering mode, the agrarian mode (with some subdivisions) and the industrial mode. The energy system of hunters and gatherers is 'passive solar energy utilization'. They live on the products of recent photosynthesis (plants and animals for their food, firewood for heat). They use fire to cook (or grill) their food, thereby widening the spectrum of edibles – but still, only a very small fraction of their environment qualifies as food.[4] Its collection requires mobility, both on an everyday basis and seasonally, and allows only for very low population densities.

The agrarian mode, in contrast, offspring of the Neolithic revolution that occurred at different times on all continents but Australia, is based upon 'active solar energy utilization'. This means that certain areas are cleared of their natural vegetation and solar energy on these areas is as far as possible used for plants producing food for humans and feed for livestock. In effect, this contributed to deforestation of large tracts of land (and the enrichment of the atmosphere with the CO_2 that previously had been stored in trees and soils), to a sedentary way of life, and to a large human labour burden (which even increases with progress in technologies to raise returns upon the land; Boserup, 1965, 1981). The sedentary way of life (plus milk from livestock plus ceramics in which to boil liquids) allows for a much higher fertility, and the large labour burden motivates having children to share the labour. Thus high population growth creates high population densities and an expansion of the agrarian mode across the world. Control of territory, tools, livestock and stored reserves is essential, and frequent territorial conflicts bring forward specialized classes of people to defend and attack territories, social hierarchies to control them, and urban centres. In many parts of the world, these systems develop into major empires and civilizations that also collapse at some time (Diamond, 2005; Tainter, 1988).

In the sixteenth century, a new energy regime emerges: a fossil fuel-based energy system that supplies society with an amount of energy never accessible before. At first, it is the Netherlands using peat in large quantities (Gales et al., 2007), but still this is a very limited resource. In the United Kingdom, the use of coal instead of the increasingly scarce fuel wood allows a rapid process of urban growth and manufacturing. Textile production for export becomes very profitable and sheep gradually crowd out farmers growing food. The invention of the steam engine finally kicks off what is known as industrialization. This turn of history in Europe

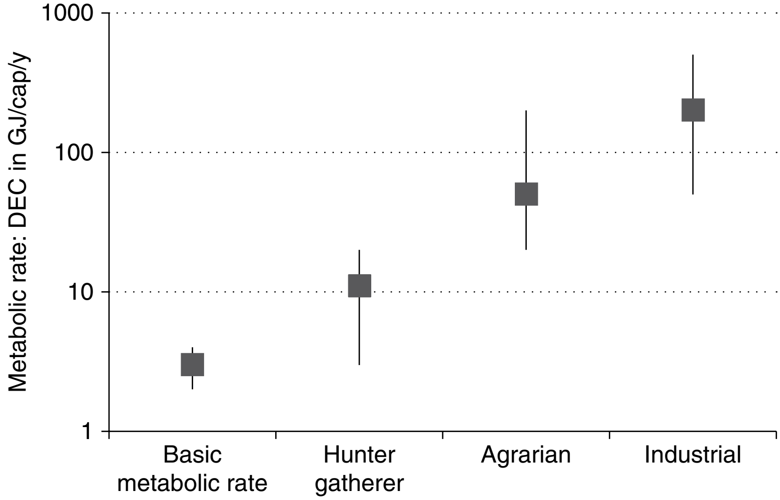
[4] See Wrangham (2009) for the fundamental evolutionary advantage of humans achieved by using exosomatic energy (fuel wood) to 'pre-digest' human food instead of relying on endosomatic energy in digestion only.

('The European Special Course', Sieferle, 1997, 2001) could, as some argue, also have happened in the East (Pomeranz, 2000), or maybe could not have happened at all.

In the footsteps of Sieferle, and with the help of a number of recently much improved time series data on energy, population, income, agricultural yields, settlement patterns and the like (Pallua, 2013; Maddison, 2008; Krausmann et al., 2013; Klein Goldewijk et al., 2010), it became possible to quantitatively reconstruct human history, its energetic metabolism and the consequences of this metabolism both for the organization of human society and for the impact of humans on the environment. In order to look at societal energy use beyond the historical confines of industrial society, it is necessary to employ a more comprehensive concept of social energy use. The common modern concept underlying conventional energy statistics and producing indicators such as TPES, 'total primary energy supply', refers to primary energy used for 'technical', that is exosomatic purposes such as the production of heat, light and mechanical power. The energy use of societies that derive mechanical power solely from human and animal labour (and maybe some water and wind power) is not adequately represented in TPES; energy consumed as food and feed and converted by endosomatic processes should also be included (Haberl, 2001a; Haberl, 2001b). These considerations guided a concept of primary energy use including the food for humans and the feed for the animal livestock, complying with the system boundaries in Figure 5.1. Within this concept, biomass plays a much more important role as source of energy, and the energy system of the agrarian society, which mainly relies on muscle power and hence food and feed, becomes visible, which is not the case for energy balances used today for industrial societies (Haberl, 2006b; Krausmann and Haberl, 2002).[5] Such a concept of societal energy use allows the social impact upon the environment to be represented much better: for energy produced by photosynthesis in plants, humans actually compete with other species; if they extend their share, it is at the expense of others.[6]

[5] This concept was developed by Haberl (2001a, 2001b) and defined, for a given nation state, an indicator 'domestic energy consumption' (DEC) that equals the amount of energy extracted from the national territory plus the amounts of energy imported, minus the amounts of energy exported, and is usually expressed in joules per year. This approach is useful to assess the total amount of energy metabolized by society, which is important because it is related to a multitude of environmental issues resulting from energy supply (Haberl, 2006a), thereby complementing rather than substituting or competing with energy analysis approaches accounting for the use value of energy (Giampietro, 2006).

[6] This is even more specifically expressed by the concept of 'human appropriation of net primary production' (HANPP) that measures the amount of plant energy appropriated by humans through harvest plus the amount of plant energy not produced (compared to a



Notes: Averages (squares) and range of dispersion (vertical lines) presented here are based upon a number of case studies; see Fischer-Kowalski and Haberl (2007, p. 231). The 'basic metabolic rate' is the physiological food demand of humans.

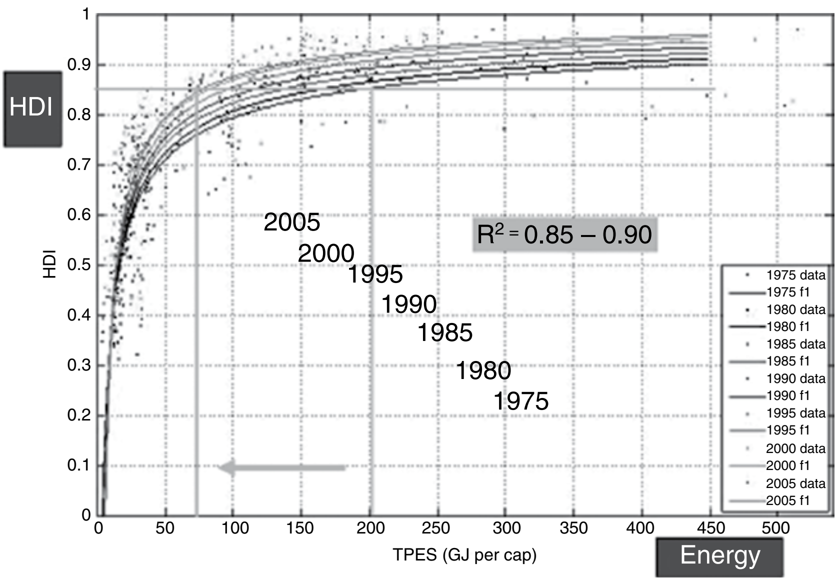
Source: After Fischer-Kowalski et al. (2014a).

Figure 5.2 Metabolic rates (primary energy use per capita per year) by mode of human subsistence

As visualized in Figure 5.2, primary energy per person has been increasing by roughly one order of magnitude from one sociometabolic regime to the next. The average differences in energy use between modes of subsistence obscure the differences within: the inhabitant of a contemporary industrial society uses about a hundred times more energy annually than his or her endosomatic metabolism would require, and about five times more than the inhabitant of an average agrarian society. Civilizational 'progress' is thus associated so far with an ever higher human energy demand. What is usually enveloped in the term 'technological progress' does not only rely upon human learning and ingenuity, but also on a rising energy supply from nature.

Steinberger and Roberts (2009) analysed the interrelationship between human development (as measured by the Human Development Index,

state of no human intervention) due to land cover changes, for example road construction (Vitousek et al., 1986).



Source: Steinberger and Roberts (2009).

Figure 5.3 How much energy does development require? Energy consumption in relation to the Human Development Index for 74 countries by time period

HDI, for countries) and the required primary energy supply (measured as TPES per capita and year; see Figure 5.3). Their findings suggest that in the year 1975 a country needed 200 GJ/cap*y to achieve an HDI of 0.85 (which is the threshold for high development), while by 2005 the amount of energy required was only 73 GJ/cap*y. This means that energy requirements for development are far from immutable: in the course of these thirty years, energy requirements for well-being dropped by more than 50 per cent.[7] It is also apparent that in the low range of energy intensity a small increase in energy supply is associated with a substantial rise in HDI, while in the upper range of energy intensity more energy per capita hardly impacts HDI any further.

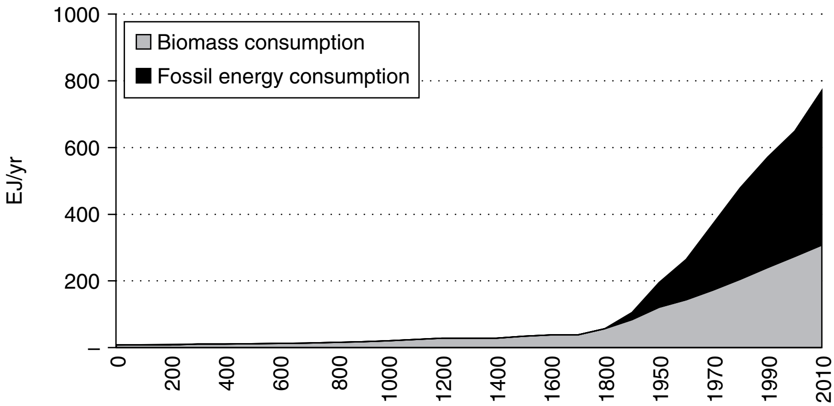
The historical increase in societal primary energy supply could only

[7] Steinberger et al. (2012) followed up on these results by checking whether the improved relation between energy (carbon) and HDI might be due to outsourcing energy services by trade; their findings suggest that the inclusion of trade effects does not change the overall picture.

be achieved by exploiting fossil fuels. As long as societies' metabolism is based upon biomass as the dominant source of energy, there is a negative feedback mechanism in place: if population size (and population density) grow beyond a certain threshold, food security is threatened.[8] The same negative feedback prevents urban growth, and thus technological development: in agrarian societies, the urban population rarely exceeds 10 per cent (Centre for Global Economic History, 2013) because under the conditions of agrarian society, the surplus produced by farmers is only a small fraction of total production; hence one farm can barely supply more people than those living on the farm (Sieferle et al., 2006). As soon as fossil fuels come into play, these negative feedbacks gradually disappear and give way to substantial population and urban growth, in combination with rising energy use per capita and technology development. In a recent study, the global amount of fossil fuel use (in the early years: peat and coal, later oil and gas additionally) was traced back to 1500 and related closely to urban growth and to population growth in general (see Figure 5.4); when Newcomen invented the steam engine in 1715, coal already had a share of 20 per cent in UK's primary energy input. In the UK, as frontrunner, the time delay between the beginnings of coal use and the technological take-off of the industrial revolution was about 200 years; for every other country starting to use coal, this transition was much faster and is currently continuing with the most populous countries of the world.

While it is very common to refer to technological innovation (for which an aggregate indicator is missing) to explain and date social and economic change, the importance of raising the scale of socioeconomic energy supply by tackling additional natural resources (and therefore the role of nature in this change) is often overlooked. Of course there is a link between technology and society's ability to tackle certain energy sources, but this link is fairly complex: it includes changing demographic patterns, urbanization (as the first trigger of fossil fuel use (Allen, 2012; Fischer-Kowalski et al., 2014a)) and cultural change. A key difference between the two processes, namely technological change and the use of fossil energy sources on top of biomass, is the fact that while Marx may have been correct in considering human inventiveness to be unlimited, additional

[8] We agree with Boserup (1965, 1981) that there is no clearly defined 'carrying capacity' for agrarian societies, but that increasing population density results not only in more hungry mouths, but also in a larger work force. Moreover, it inspires innovations such as multicropping that allow higher yields; these higher yields, according to Boserup, come at the expense of increasing labour input; this again feeds into a high demand for child labour, and into high fertility rates. (See several chapters in Fischer-Kowalski et al., 2014b.)



Note: Time axis is not to scale for different periods: AD 1–1900: 100-year intervals; AD 1950–2010: 10-year intervals.

Source: SEC database.[9]

Figure 5.4 Global primary energy supply to human societies (biomass and fossil fuels) from AD *1–2010, measured as DEC (primary energy supply including food and feed)*

energy sources are not. Thus, a continuation of the grand historical trend of massive increase of energy supply to human society is unlikely.

In particular, it will not be possible to support a continuation of current growth trajectories of humanity's energetic[10] metabolism by switching from fossil fuels to (modern) bioenergy. While a decade ago most estimates of global technical primary bioenergy potentials exceeded 500 EJ/yr, that is, roughly current global fossil energy use, these figures have come down quite a bit in recent years due to a growing recognition of the importance of land-use competition (Lambin and Meyfroidt, 2011).

[9] The material and energy flow database of the Institute of Social Ecology (SEC database) comprises a set of national and global long-term historical time series on extraction, trade and apparent consumption of materials and primary energy. The data have been compiled following the concept of material- and energy flow accounting (MEFA; Krausmann et al., 2004) using historical statistical sources and standardized estimation procedures. In the last decades of this timescale, the small amounts of other modern energy carriers are also included in the 'fossil fuel' count, such as nuclear, geothermal and hydropower. For the most recent version see Pallua (2013, http://www.uni-klu.ac.at/socec/downloads/WP148_webversion.pdf).

[10] Even if we think of the abundance of solar energy, its collection requires devices to be installed over suitable areas, which are not unlimited. Although the conversion efficiency of solar panels is improving, this will also be limited.

Undisputedly there exist potentials to gain more energy through a strategy of 'cascade utilization' (Haberl and Geissler, 2000), that is, the utilization of biogenic wastes and residues from agriculture and forestry such as straw, manures or wastes from the food industry. An integrated optimization of food and energy production might help to produce more bioenergy without jeopardizing food supply, for example through optimized crop rotation schemes and (re-)integration of cropping with livestock husbandry (Amon et al., 2007). In some cases, bioenergy production can be combined with restoration of degraded ecosystems (for example, Tilman et al., 2006; Harper et al., 2012). Beyond these largely benign but quantitatively limited options (Coelho et al.; 2012, Rogner et al., 2012), expansion of bioenergy production requires more land, more water and other inputs that are also required for food production and represent vital inputs to the functioning of ecosystems. Overly aggressive expansion of bioenergy production hence would result in competition for limited resources, thereby causing socially, economically as well as environmentally adverse outcomes such as reduced food supply, higher food prices, increased pressures on biodiversity and ecosystems, and high GHG emissions from land-use change. Current estimates suggest that planetary boundaries related to land availability restrict the earth's biophysical capacity to provide bioenergy to below 250 EJ/yr (Haberl et al., 2013), while sustainable potentials are likely much lower (Haberl et al., 2010).

THE MATERIAL METABOLISM OF SOCIETIES

The discussion of the material metabolism of societies dates back no longer than to the late 1960s when on the one hand Ayres and Kneese (1969) proposed that environmental pollution and its control be viewed as a 'materials balance problem' of the economy, claiming that 'the common failure [of economics] . . . may result from viewing the production and consumption process in a manner that is somewhat at variance with the fundamental law of conservation of mass' (p. 283). At about the same time, Georgescu-Roegen (1971) discussed the problem of increasing wastes and emissions as a process of entropy production. On the other side of the Cold War divide, in the Soviet Union, Gofman et al. (1974) articulated an analogous critique of the state-planned economy and attempted a comprehensive material flow analysis (MFA) of Russia.[11]

Another twenty years passed before these early achievements bore fruit. In

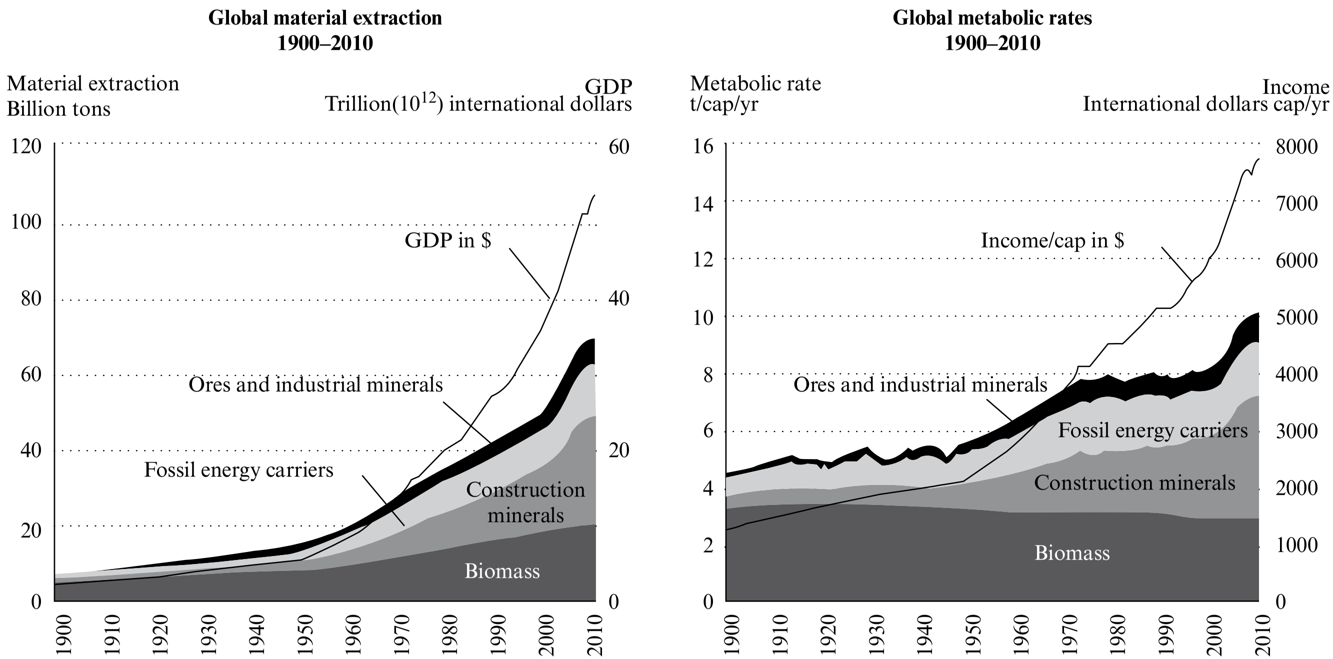
[11] This early text can be accessed in an English translation as a Social Ecology working paper at: http://www.uni-klu.ac.at/socec/downloads/Gofman_94_web.pdf.

the 1990s, more or less simultaneously, but at first independently, an empirically productive strain of material flows research emerged, at the National Institute for Environmental Studies (NIES) in Japan, at the Wuppertal Institute in Germany, and at the Institute for Social Ecology (SEC) in Austria. All three institutes had good linkages with their national statistical agencies and produced first material flow data for their respective countries in the early 1990s (for example, Japan Environment Agency, 1992; Bringezu, 1993; Steurer, 1992). At this stage, Eurostat, the statistical office of the European Union, started to play a major role. It forged a path towards including MFA data in its standard programme of environmental information. Based upon better data, subsequently obtained from national statistical offices, including new EU member states, a practical guide and an updated series of MFA indicators (1970–2004) were published in the second half of the decade (Eurostat, 2007a, 2007b). Only recently, a revision of the guide and an updated dataset has been made available from Eurostat, and in the EU there is now an obligatory reporting of MFA data by its member states as a module within the System of Environmental Economic Accounting (SEEA).

Next to Eurostat, the OECD also became active and adopted a first council recommendation on MFA in 2004 (OECD, 2004), and with a series of workshops and publications (OECD, 2008a, 2008b, 2008c) contributed to the advancement and international harmonization of material flow accounting methods. The Sustainable Europe Research Institute (SERI) generated a first global multinational database for material extraction (Behrens et al., 2007) that is regularly updated (SERI, 2009; www.mosus.net/), while CSIRO with the help of UNEP generated a full MFA dataset for all countries in Asia and the Pacific, analysing their material development trajectories (see UNEP, 2011b). As a recent comparison between the various datasets on material flows showed, there is now strong international agreement on conceptual assumptions and methods (complying with Figure 5.1 above), and the resulting data and indicators show a high degree of reliability (Fischer-Kowalski et al., 2011). This makes it rewarding for researchers to use these data to pursue a broad range of research questions, some of which we will address below.

In a long-term perspective, Krausmann et al. (2009) have documented the changes in the material metabolism of societies globally across the twentieth century (Figure 5.5).

Figure 5.5 displays global material flow data in tons per year according to the most conventional disaggregation into biomass, construction minerals, fossil energy carriers, and ores and industrial minerals. Water and air, conceptually (and practically) part of social metabolism, are usually not displayed in material flow accounts, as their quantity exceeds all the



Source: Data from Krausmann et al. (2009); GDP (at constant international dollars) from Maddison (2008).

Figure 5.5 The global material metabolism of societies 1900–2010, in relation to GDP growth other materials by an order of magnitude[12] and would, in a literal sense, drown the other information. In early discussions on sustainability, it was claimed that societies should use so-called renewable resources only at the rates of their natural reproduction (the classical formula for sustainable forestry), and as few non-renewable resources as possible (Daly, 1977). What actually has been happening in the course of the twentieth century is a massive shift towards the use of non-renewable resources (in particular fossil fuels and industrial minerals/ores); while the societal resource base in 1900 had been biomass, the share of biomass has since decreased to one third, although increasing in quantity. In sum, the extraction of natural resources by societies has increased eightfold during this last century. This increase, nevertheless, is much lower than the increase in global GDP (in constant international dollars), which multiplied by a factor of 23. This difference in growth rates is usually addressed as 'decoupling' of economic and material growth and will be investigated more closely below.

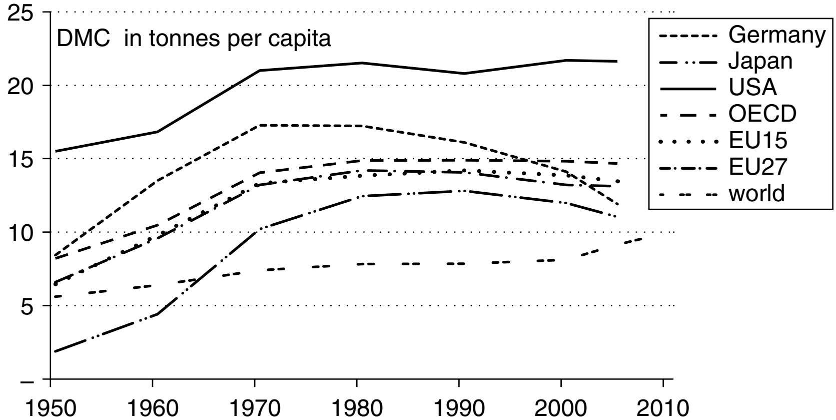
The twentieth century was also marked by a fourfold increase in human population; the right-hand graph in Figure 5.5 takes this into account and displays the changes in material flows as changes of 'metabolic rates', that is, as material (and monetary) flows per capita. A closer inspection reveals four phases: a phase of slow growth in metabolic rates up to the end of World War II; a phase of rapid growth from then on to the early 1970s;[13] a phase of relative stagnation up to the year 2000, and, finally, again a rapid rise in metabolic rates in the course of the beginning of the twenty-first century. In monetary terms, the phases are not as distinct by far.

The last two phases have received particularly close attention. Wiedenhofer et al. (2013) have identified a '1970s syndrome' of stagnating materials use in most highly developed industrial economies, starting more or less with the first oil price shock and lasting well into the twenty-first century. For some industrial countries, even a decrease of overall material use can be observed (for example, for Japan, Germany and the UK). For all industrial countries investigated, with the exception of the USSR, statistically significant structural breaks can be identified in their respective materials use trajectories between the late 1960s and the late 1970s (see also Figure 5.6). In the USSR, the break occurred in 1991.

The authors interpret this as a potential new phase in long-term industrial transformation, as the saturation or stabilization phase (Rotmans

12 The water metabolism of societies sparked scientific interest very early on (e.g. Wolman, 1965); currently, there are ongoing efforts to harmonize the methodology applied to water metabolism with material flow analysis (Hoekstra and Mekonnen, 2012). A more detailed report on water metabolism is beyond the scope of this chapter.

13 This phase was coined the 'Fifties syndrome' by Pfister (1995).



Source: After Wiedenhofer et al. (2013); SEC database; Fischer-Kowalski and Hausknost (2014).

Figure 5.6 The 1970s syndrome of stagnating materials use in major industrial economies

et al., 2001) after a phase of accelerated transition to a higher metabolic level. A number of processes could work together to produce such an outcome: a certain saturation of infrastructure investments, an older population with already satisfied household investments, an acceleration of industrial investments in efficiency because of rising price levels for energy, a structural shift from commodity production to services, and more policy attention to resource efficiency and saving.

Quite another interpretation, well in line with the upward turn of materials use with the beginning of the twenty-first century, refers to the rapid rise of a number of 'emerging economies' that use the comparative advantage of lower wages to increasingly produce those goods that industrial countries consume but do not produce any more. In effect, rising consumption levels in high-income industrial countries would increasingly rely not on domestic production but on international trade.

Steinberger et al. (2013) have undertaken an international study of development trajectories since 1970, both in terms of income and in terms of materials use (DMC). They achieved country groupings into 'mature', 'emerging' and 'developing' by cluster analysis. While there is a diversity of possible development (and not a single dominant trajectory), they find that mature countries generally have lower economic-material coupling coefficients than developing countries, and sometimes even significant negative coefficients, indicating absolute decoupling (Germany, the Netherlands, UK). The 'successful developers' who attained industrialized status by 2004 (such as Greece, Portugal, Republic of Korea, Spain and Singapore) and the group of 'fast developers' (China, Colombia, Indonesia and Thailand) showed high levels of economic-material coupling.[14] Another interesting finding of the panel analysis is a consistently negative and often significant time trend which the authors interpret as 'autonomous technological progress' improving material productivity. This would set the pace for economic growth consistent with absolute dematerialization (and decarbonization): as long as economic growth remains below this rate, material use could still decline.[15]

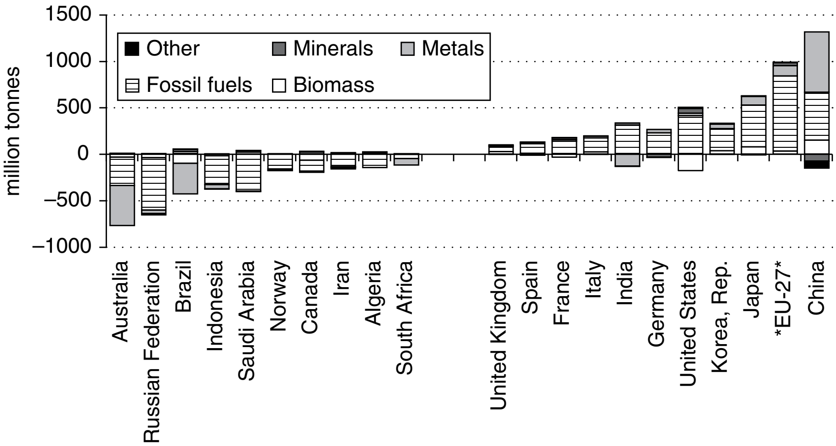
A different picture emerges when materials use is not looked upon using a territorial 'production-based' approach, but with a 'consumption-oriented' perspective that takes trade into account. As Dittrich (2012) has shown, world trade, both economically and physically, was more dynamic than global consumption. From 1980 until the financial crisis in 2008, physical trade volumes increased twice as fast as global material extraction.[16] Still, domestic extraction, production and consumption clearly dominate: globally, nearly nine-tenths of material extraction are consumed domestically, while one-tenth of material extraction is reallocated via international trade (Dittrich, 2010). These proportions look different when we include a perspective on the upstream material requirements of traded commodities. Out of the 70 billion tons of materials extracted globally in 2008, some 40 per cent were only extracted and used to enable exports of goods and services to other countries, even if part of those materials never left their country of origin (Wiedmann et al., 2013).

If considered in per capita terms, the largest importers of materials are high-income industrial countries, which is consistent with the hypothesis that part of their apparent stagnating material use (DMC) is due to outsourcing energy- and material-intensive processes to developing countries, thereby contributing to the rising material intensity of those countries. For energy and CO_2 emissions, this has been repeatedly demonstrated (Peters

[14] It would be a mistake, however, to conclude that a high material–economic coupling is a recipe for successful development: there are a number of countries with high coupling that did not attain fully developed status during that period.

[15] According to the authors a rate below 2.1 per cent GDP growth would allow the total of all materials to stagnate or to decline, and a rate below 1.8 per cent GDP growth would allow carbon dioxide emissions to stagnate/decline (Steinberger et al., 2013, p. 9).

[16] For the 1970s, the physical dimension of trade has not been documented. The increase from 1980 onwards is driven by the sheer growth of the total amount of materials traded, plus by a prolongation of production chains: the same material is traded several times (and therefore counted several times) before it arrives at the point of final demand. It can be roughly estimated that currently around 20 per cent of global physical trade volumes arise from increasing specialization and lengthening of value chains.



Source: Dittrich (2012).

Figure 5.7 Largest net exporters and importers by material composition in 2010

and Hertwich, 2008; Davis et al., 2011). Nevertheless, recent studies on global trade point in the direction of structural change. Throughout the twentieth century, there seemed to be a dominant pattern of industrialized countries consuming the world's material resources and developing countries delivering low processed commodities to satisfy this demand (Muradian and Martínez-Alier, 2001; Muradian et al., 2012). Meanwhile, emerging economies have begun to play a stronger role as demanders of resources, and a number of mature industrial economies have increasingly shifted into the role of suppliers (such as Australia or Canada; see Figure 5.7). Since the turn of the twenty-first century, this coincides with a change in price trends: while resource prices had declined throughout the twentieth century, which analysts also interpreted as a symptom of unequal North–South exchange (Chichilnisky, 1994; Frank, 1966), there is a rising trend now since the turn of the century.[17] At the same time, South–South trade relations are becoming stronger (Chatham House, 2012; McKinsey & Company, 2013).

Approaches accounting for upstream material requirements have been the subject of intensive research efforts in the past decade. Still, the findings from these studies are not yet very conclusive (see Schaffartzik

[17] In 2013, the oil price unexpectedly started to decline and in consequence also lowered other resource prices. It is very hard to tell whether this trend reversal will last.

et al., 2013); they are based on different methods or combinations thereof, build upon different system references and time frames, and in effect, results cannot easily be compared. In the sections below we make an effort at giving an overview.

The estimation of resources embodied in trade is basically done via two approaches: the first approach uses environmentally extended multi-regional Input–Output (MRIO) models to trace inter-industry deliveries through the economy and between economies down to final demand categories. The second approach uses coefficients from Life Cycle Assessment (LCA) of products with which traded goods are multiplied in order to calculate the upstream material, energy and water or land requirements. These two approaches can also be combined in so-called 'hybrid' approaches.

The systems reference of the two approaches is fundamentally different: for the Input–Output approach, the reference system is the national economy in a specific year, and in resource terms it is the amount of (and kind of) materials extracted domestically in this year. These materials are then, with the help of economic coefficients, allocated to final demand categories, within the country and to its exports. On the global level, for the global economy, no comprehensive I–O table exists; national I–O tables have to be interlinked to so-called multi-regional I–O (MRIO) models. This is a very complex procedure and requires a number of assumptions that are not yet fully standardized. The same holds true for regional aggregates. But still, the basic principle applies that the resources extracted in the reference year are top-down distributed to the final demand in various countries, and so the sum total of resources allocated to final consumption, and their composition, equals the sum total of resources extracted.

For the Life Cycle Assessment (LCA) approach, the systems reference is the extraction–production–consumption chain of specific products or groups of products. The basic idea of LCA is to assess all environmental burdens connected to a product or service consumed in a certain country in a certain year, irrespective of where and when they were produced. Since the early 1990s, great efforts were made to create LCA inventories for a broad variety of products and services and to standardize procedures (Klöpffer, 1997; Jolliet et al.; 2003, Frischknecht et al., 2007). The original purpose of LCA was to guide comparisons between products and services across a standardized set of indicators for environmental burden, among them resource use. If LCA-based coefficients are used for the analysis of upstream resource requirements of international trade, this follows a bottom-up procedure with the respective national consumption as point of departure. Due to the complex international, intertemporal and inter-product linkage of extraction–production–consumption chains it cannot be secured that the global sum-total of resources used equals the sum-total of resources actually extracted.

The I–O-based approach is interested in the amount of raw materials used by societies. It answers the question regarding how much and what kind of resources are connected to the final demand of a certain country in a certain year, and whether they have been (directly or indirectly) imported from elsewhere or have been extracted domestically. It allows the direct trade flows to be expressed as 'Raw Material Equivalents' (RME; Eurostat, 2001); that is, the sum of materials directly traded plus their respective upstream material requirements. Physical trade balances (PTB) for countries can then be calculated not only as direct imports minus direct exports, but also by including upstream material requirements, that is raw material equivalents of imports minus raw material equivalents of exports ($RME_{imp} - RME_{exp}$) to become Raw Material Trade Balances (RTB). Raw material trade balances may convey a somewhat different picture to what could be gathered from the analysis of direct trade flows.

A study commissioned by Eurostat, the European Statistical Office, and conducted by Schoer and colleagues (Schoer et al., 2012) on the raw material trade balances of the European Union, revealed that the raw material trade balance (RTB) for EU27 was more pronouncedly negative (more imports than exports) than when measured as physical trade balance (PTB) based on direct trade flows. For biomass and non-metallic minerals, the EU27 is mostly self-sufficient and thus does not require additional raw materials from other countries or regions. For metals and fossil fuels though, direct imports are of high importance, and particularly in the case of metals, these imports draw on large amounts of upstream material requirements. According to this study, there was a decline in RTB from 2000 to 2009 (while direct trade slightly increased).

Only recently, some results from a study were published by Wiedmann et al. (2013) which is the most comprehensive so far, covering the trade flows between 186 countries for 1990–2008 based on the disaggregated MRIO model 'EORA' (www.worldmrio.com) without drawing on additional LCA information. For industrialized countries, the authors found the upstream requirements of net imports to be significantly higher than the amounts of direct net trade, confirming an 'outsourcing' of material use through trade. For emerging economies, this difference is much smaller and for resource-extracting economies the picture is the reverse; their material use includes significant amounts of materials associated to final demand in other countries. Based on this study, Wiedmann et al. propose a new indicator on the country level, namely the 'material footprint'. Like the more traditional domestic material consumption (DMC), the material footprint is expressed in tonnes per year and equals the amount of materials extracted in a country plus the net upstream requirements of the trade of this country. This is a 'consumption'-oriented indicator as it is supposed to contain all material flows (within the country and outside) that are required to satisfy the final demand of this country. In consequence, high-income industrial countries tend to have a larger footprint than is judged by their DMC, and low-income countries have a relatively smaller footprint. Two questions arise. One concerns the allocation of investments: in national accounting, investments are reported as part of final demand. From a consumption-based perspective, they can also be thought of as an input into the production process (for example, machinery and production infrastructure are necessary inputs to production). The manner in which capital investments are included and how (or if) they are depreciated, significantly affects the results obtained for the raw material equivalents of exports. If infrastructure investments (whether in monetary terms or as domestic extraction of construction materials) are not depreciated over time, importing one and the same product from an emerging economy currently building up its infrastructure is associated with much more embodied material than importing it from a mature economy which has significantly invested in its infrastructure in the past – this must not be confused with a difference in technical efficiency (which may or may not exist on top of that phenomenon). This asymmetry is a problem that needs to be dealt with.

Another issue is a political or moral one: is it justified to attribute all material (or energy) flows associated with products to the consumer? Is the consumer the one interested and having the key benefit, and therefore bearing the responsibility for all unwanted side-effects? It has become quite common to think so, but is this the only valid perspective? There is obviously an interest on the producer side, in jobs and profits as well as in revenue for further investment; it is often the producer who makes efforts to convince consumers to buy products, and it is the producer who has control over production methods, efficiency and environmental side-effects of production. The consumer can influence all of this only very indirectly, by selecting between products and producers, or by opting not to buy a certain product at all.

So in effect, both perspectives in material flow analysis, the 'production perspective' that reflects itself in indicators like Domestic Extraction (DE), Domestic Material Input (DMI) and Domestic Material Consumption (DMC), and direct trade and its physical balance (PTB),[18] as well as

[18] These indicators can be calculated according to standard Eurostat (2001) methods, or they can be extended to cover so-called unused flows; the term then used is Total Material Requirements (TMR) (Bringezu and Schütz, 2001).

the 'consumption perspective' as reflected in Raw Material Equivalents (RME), Raw Material Trade Balances (RTB) and Material Footprints (MF), have their legitimacy. Only a combination of both perspectives will achieve a sufficiently comprehensive understanding of socioeconomic metabolism.[19]

POLICY USES OF SOCIOMETABOLIC CONCEPTS AND INDICATORS

Originally, there was the simple idea that a social system's metabolism was sustainable if it used renewable natural resources only at the pace at which they were regrowing, and that it used non-renewable resources as little as possible or only to the degree that they could be expected to be substituted by renewables or recycling (Daly, 1973). As of now, we are far beyond this point: societies are using an ever-higher share of non-renewables, and often overuse renewables beyond regeneration capacities (fish stocks, primary forests, groundwater, air and water as sinks). As the simple concept of a sustainable social metabolism is being practically so far transgressed, it becomes increasingly hard to define plausible standards. The most frequently chosen solutions for this dilemma are policy proposals for resource efficiency (or resource productivity) increases, and/or outright physical downsizing of metabolic flows.

'Resource Efficiency' is even the title of a policy report edited by UNEP and CSIRO (2011a) on the social metabolism and its transformations in Asia and the Pacific, taking its point of departure from social-ecological regimes, metabolic profiles, describing the ongoing industrial transformation in metabolic terms and searching for pathways of 'greening' the economy (p. 4). For each country in that region, the report presents key sociometabolic indicators – among them material intensity (the inverse of resource productivity). The interesting finding of this report is that resource efficiency in many Asian and Pacific countries has been declining in the last decades, because their transition from an agrarian to an industrial mode implied an increase in energy and material use that was more rapid than their increase in income. Nevertheless, the policy recommendations are clearly directed towards resource efficiency, although it is admitted that without 'system innovations' there will be no pathway towards

[19] UNEP's International Resource Panel has initiated a cooperation between all major institutions worldwide to jointly generate a material flows and material footprints database for all countries of the world, from 1970 to 2010. This will be publicly available from UNEP by the end of 2015.

a green economy (p. 233 ff.).[20] A follow-up report by ESCAP, ADB and UNEP (2012) addresses the (mainly government) investments required for such system innovations: into renewable energy, sustainable transport and city infrastructures, and into so-called 'natural capital' (that is, agriculture and water management). One of the key arguments is that rising resource prices will not allow for the continuation of current wasteful practices. As Asia and the Pacific currently are the single largest users of natural resources worldwide, and will become so even more, it is highly important that they increasingly generate and analyse data on their social metabolism and learn to make it accessible to policy interventions. While concepts like the Chinese 'circular economy' (Ren et al., 2005) in the beginning appeared somewhat naive, now the understanding of sociometabolic functionalities is deepening and material and energy flow analysis may become an increasingly important tool – for guiding interventions, and even more so for controlling outcomes. Nevertheless, an industrial economy increasingly based on fossil fuels cannot be 'circular', it is entropic. Stocks of energy constituted in the distant past by photosynthesis are extracted and used. The energy they contain is 'dissipated'. It cannot be used over and over again.

Another example for policy strategies based upon the analysis of social metabolism is a high profile report published by UNEP, International Resource Panel (2011). It pleads for decoupling of natural resource use and environmental impacts from economic growth. 'Resource decoupling means reducing the rate of (primary) resources per unit of economic activity. This "dematerialization" is based on using less material, energy, water and land resources for the same economic output.' (UNEP, International Resource Panel, 2011b, p. 4). The report illustrates, on the one hand, that a certain degree of 'decoupling' has already occurred in the past (see also Figure 5.5 above); on the other hand it presents global material resource use scenarios up to 2050 based upon the dynamics of metabolic rates for industrial and developing countries and distinguishing also by population density.[21] The business-as-usual scenario ends up with an almost threefold increase of global material resource use by 2050; it reflects the rapid catching up of the metabolic rates on the part of the 'emerging' economies plus population growth. Such an increase in global material consumption is considered as practically unfeasible. In contrast, a 'moderate contraction

[20] See in a similar fashion, with a focus on Africa, Swilling and Annecke (2012).

[21] It is interesting to note that the population density of a country strongly matters for metabolic rates; countries with a population density above the average of 50 persons/km^2 have only little more than half the metabolic rate of low density countries, irrespective of their development status; see Krausmann et al. (2008a).

and convergence' scenario assumes a halving of metabolic rates on the part of industrial countries, and a convergence of the rest of the world to these rates by 2050. Even under these scenario assumptions, the annual global extraction of material resources would keep rising. Only a 'tough contraction and convergence' scenario leads to a stabilization of global material extraction and, given population growth, would require metabolic rates not much higher than at the beginning of the twentieth century. Such policy scenario exercises are very important because they illustrate what implications it would have to take global equity (at least between countries) seriously; the ongoing 'spontaneous' process of convergence (namely stagnation of metabolic rates on the part of industrial countries and rising rates on the part of many developing countries), if continuing, would lead to a massive overcharging of the world's material resources.

Also the EU resource use reduction strategy puts its emphasis on 'decoupling', or, in other words, increasing resource productivity (Mudgal et al., 2010). 'Decoupling' owes its attractiveness as a strategy to the promise of reducing resource use (or waste volumes) while keeping the chance for economic growth intact. In the early phases of the use of this concept, technological optimism (and technical case studies as a method to legitimize this optimism) gave rise to policy slogans like 'factor 4' (Weizsäcker et al., 1997) or even 'factor 10' (Schmidt-Bleek, 1994) as biophysical reduction targets through innovations that would not hamper, but even drive economic growth. Also currently, the whole idea of 'green growth' refers to such visions.[22] However, empirical studies that not only look at case studies or selected resources, but take into account the full range of resources required for social metabolism, have so far not provided support for such high-flying hopes. Nevertheless, an absolute reduction of resource use is politically desirable, and it is possible without economic growth turning negative. Of course, the reference to GDP growth is highly questionable in itself – but this is so far beyond the debate led by organizations such as UNEP or EU.

The word 'coupling' implies that the change rates of two variables are causally linked, with the elasticity of this link subject to modifications. If economic activity grows, resource use grows, too – but the link can be very weak, with an elasticity close to zero. If the elasticity is zero, there is no link any more, and this would be – in a precise use of the word – 'absolute decoupling'. It is not possible to ever have zero elasticity, because every activity requires energy and material processes. However, it is not only these two variables – economic activity and resource use – that come into play, but also a third variable, technological improvement, that is,

[22] For example, OECD http://www.oecd.org/greengrowth/oecdworkongreengrowth.htm.

increases in resource productivity. Moreover, this variable is – by definition – linked negatively to resource use, but probably (maybe not too strongly) linked positively to economic activity. In order to achieve absolute reductions in resource use, the growth rate of resource productivity must be larger than the growth rate of economic activity. If this is the case, there still may be some economic growth, but at the same time an absolute reduction in resource use may occur. As soon as economic activity grows a little faster, we are back to growing resource use (because economic activity is linked positively to resource use, even if this link is weak).

According to these considerations, it does make sense politically to strive for increases in resource productivity, particularly under conditions of rising commodity prices (McKinsey & Company, 2013). If commodity prices keep rising, as the World Bank and major business consultants currently assume (see also Chatham House, 2011), increases in resource productivity are less inclined to become subject to rebound effects, as the potential rebound is consumed by price increase.[23] Thus there is indeed a chance for absolute reductions in resource use through productivity gains. Recent comparative studies of decoupling (for example, Steinberger et al., 2013; Wang et al., 2013) arrive at the conclusion that in phases of pronounced economic development as with so-called 'emerging economies', there is a relatively strong coupling between GDP growth and resource use;[24] in mature industrial countries, particularly under conditions of moderate growth, strong decoupling is common. However, driving up resource productivity does not work as a general recipe to simultaneously stimulate economic growth and absolutely reduce resource consumption – these processes may co-exist, but only within narrow boundary conditions.

Substantial reductions in the social metabolism both of mature industrial countries and as a sustainable development model can be expected not so much from technological progress, but rather from complex systemic changes – some of which appear to be ongoing.

- A strong factor in this is demographic change – a less fertile and aging population may require only smaller flows to maintain its stocks.

[23] 'Rebound effects', also known as the 'Jevons paradox', are rising levels of consumption (of a commodity, for example), although the amount of this commodity required for specific uses has declined (efficiency gains). Declining resource use may make products cheaper and thus boost their consumption; or it may set free purchasing power for other products. (Polimeni et al., 2008; Sorrell and Dimitropoulos, 2008).

[24] Still, this coupling is subject to policy efforts, as Wang et al. (2013) demonstrate for China.

- This refers to food: in the mature industrial countries, a shift towards a lower share of animal products in human nutrition, and less food wastes and overfeeding, could be a systemic change saving material and energy resources in the order of magnitude of one-third (while improving human health and looks; see Stehfest et al., 2009).
- This also refers to built infrastructure: there is no need to further expand these stocks and encounter the increases in future flows to maintain them.[25]
- There is local resistance to the export of raw materials in some countries or territories, local 'externalities' translate into local environmental movements, resource caps and 'post-extractivist' politics, as in Latin America.
- And last but not least, a systemic change away from fossil fuels towards some forms of renewable energy carriers (e.g. wind and solar) would lead to substantial dematerialization, particularly in the period after the core investments have been taken: fossil fuels amount to approximately one-third of all materials use, and they amount to two-thirds of materials transported via trade. Harbour, vessel, truck and road capacity could be downsized substantially if the main energy flows were reduced to electricity and to pipes for, say, transporting hydrogen.

GUIDANCE FOR A SUSTAINABILITY TRANSFORMATION?

What guidance can a theory of social metabolism give to understanding a possible transition to a more sustainable future society?

While for a long time in the scientific debate mainly environmental science expert knowledge was invoked to provide remedies for the rising impact of human societies upon the environment, and the issue of social change was merely addressed as the need for ecological modernization, lately there seems to be increasing attention on the potential of a more fundamental social transformation. Most prominently, this is invoked by the debate about global climate change and the need for a transition towards a low carbon society (WBGU and German Advisory Council on Global Change, 2011), but it is also nourished by discussions about 'peak oil' (see Murphy, 2012) and a declining natural resource base (UNEP and International Resource Panel, 2011b). Such imminent changes are

[25] These are also among the 'multi-return strategies' proposed to the European Commission for its resource strategy (Mudgal et al., 2012).

increasingly also addressed in the form of threats: in 2012, the most prominent interdisciplinary science journals each published a special feature on 'Critical perspectives on historical collapse' (PNAS, 2012), 'Human conflict' (*Science*, 2012), and *Nature* featured 'History as science' and the predictability of cycles of violence (Spinney, 2012). In a letter to PNAS, Pearson and Pearson (2012) recently stated:

> usually, we think of transformation to collapse as inadvertent . . . Positive societal change to new states, such as the global need to transform to sustainable, equitable, low carbon societies, requires deliberate transformation. We call on all colleagues investigating societal change to clarify the attributes and characteristics necessary for societal transformation and resilience for a sustainable future.

Such an emergent new scientific agenda brings the somewhat neglected social and historical sciences back centre stage and calls for a much more intimate collaboration on epistemological, theoretical and methodological levels.

The theory of social metabolism has, from very early on, developed an understanding of major socio-natural change as a two-way coupled process (Norgaard, 1997; Ruth et al., 2011). Clearly, the transition ahead, in its core, needs to be a transformation of society's energy system, away from its currently dominant fossil fuels towards renewable sources (Haberl et al., 2011). This transition some time ahead is inevitable, due to the exhaustibility of fossil fuels. How far ahead and whether the transition happens inadvertently or by deliberate planning and intervention, is an open question. Second, the theory of social metabolism allows the currently ongoing globally explosive change to be understood as a new onset or continuation of the major sociometabolic transition of the past, namely the transition from agrarian to modern, that is from a land and biomass-based to a fossil fuel-based system. This perspective, thirdly, allows both transitions to be captured as different phases of evolution of complex systems, or rather, co-evolution of complex societal with equally complex natural systems.

For the evolution of such two-way coupled systems, there would be boundary conditions: if they are transgressed, major features of the systems functioning will change. In the extreme case, the system may collapse (if it is an organism, die), or else it may resume its self-organization in a new 'state'. Both would then be called a transition. The typical model of alternating system states is the so-called S-curve (Rotmans et al., 2001), although other models have also been considered, such as the so-called 'lazy eight' (Berkes and Folke, 1998), lock-in situations or system collapse (Tainter, 1988), or 'tipping points' in earth systems (Lenton et al., 2008). From the notion of complex system transition, there follows an understanding that no linear, incremental path leads from one state or phase to the other, but rather involves a possibly chaotic and dynamic intermediate process, or a discrete 'jump'.[26]

Can we think of sustainability transitions as a kind of inevitable, logical step beyond the past, leading to a more 'mature' state of the system? The sociometabolic approach claims that a transition to a (more) sustainable state implies a major transformation, comparable in scale to the great transformations in history such as the Neolithic or the Industrial Revolution (Haberl et al., 2011). It is inevitable, because the present sociometabolic dynamics can no longer continue for very long, and it is improbable because the changes need to depart from known historical dynamics rather than being a logical step from the past into a more mature future state. Depending on the reasons for and the speed of an energy transition, parts of the system at a certain point in time may be under different energy regimes: urban industrialized centres, for instance, may coexist with traditional agricultural communities, or industrialized countries with agrarian colonies. Such a 'synchronicity of the asynchronic' (Füllsack, 2011) influences the overall course of transitions. How these processes evolve is contingent upon specific conditions. The sociometabolic approach shares with complex systems theory the notion of emergence: neither can a state be deliberately transformed into another, nor can the process be fully controlled. One deals with self-organizing dynamics (Maturana and Varela, 1975) to which orderly governance or steering are not applicable. The sustainability transition with regard to energy needs to be a change away from fossil fuels, and probably back to solar energy again, thus somehow reversing the historical transition from the agrarian to the industrial society and ongoing contemporary 'development' that were and are a shift from solar energy to large-scale fossil fuel use.[27]

What drives sociometabolic regime transitions? On such a broad and long-term scale one cannot easily talk about actors and their deliberate

[26] One has to be aware, though, that these distinctions are extremely sensitive to the observer's choice of scale. From a wider perspective, something may appear as a continuous process, progressing steadily. Yet from a closer perspective, the same process may appear as whimsical, sharply fluctuating. Thus, descriptions of processes as transitions or as gradual change do not necessarily exclude each other. One type of process may well be 'nested' into the other.

[27] It is frequently overlooked (see, for example, Grübler, 1998; Moe, 2011; an exception is Smil, 2008) that the most dominant source of energy, amounting to almost 100 per cent, in pre-industrial societies is biomass: human and animal nutrition, and firewood. The common overestimation of the importance of technological sources (such as windmills) is supported by modern energy accounting such as reflected in the indicator TPES (total primary energy supply), which leaves food and feed as energy input out of consideration. It is maybe one of the key achievements of the Vienna sociometabolic approach to capture in its systemic perspective the total energy base of societies (Haberl, 2001a).

efforts. What one can mainly analyse is structural change of interlinked social and natural systems, across a broad range of variables. Among these, the sociometabolic approach focuses on a relatively narrow set describing the society–nature interface for which quantitative measurements can be reliably obtained in very different contexts. The advantage of this self-restraint is that it is possible to demonstrate the interconnectedness of socioeconomic changes and changes in natural systems (between population growth, diets, land use and species extinction, for example) and to generate models for important requirements and boundary conditions for system perpetuation. When the energy regime changes, society and its metabolism undergo a transformation, and the natural system it interacts with changes as well. A regime can be characterized by the sociometabolic profile of the society involved, and the associated modifications in natural systems that occur either as an unintended consequence (such as resource exhaustion or pollution) or as intentional change induced by society (such as land use).[28]

Based upon the sociometabolic approach, research has been undertaken into historical cases of transitions. McNeill and Winiwarter (2004) have approached the issue of soils as the main resource base of agriculture, and made a modelling effort to determine when for example a historical agricultural village would have to be given up (Winiwarter and Sonnlechner, 2000). Krausmann et al. (2008b) have shown the role of resource and land scarcity for European history on various scales. There was a modelling effort to determine the limits to city growth under agrarian conditions, given certain yields and the constraints to land transport, while considering metabolic needs for food, construction material and fuel wood, as well as varying rates of appropriation of agricultural surplus by cities (Fischer-Kowalski et al., 2004). These are no more than examples of efforts to understand what happens when social systems challenge the boundary conditions of their environment and transgress their own coping capacity, and attempts at explaining under which conditions transitions (collapses sometimes) occur. Under the agrarian regime, this is easier to determine, as its resource base is much narrower and local constraints play a key role.[29]

Table 5.1 attempts to use the insights gained from such historical

[28] Society itself is seen as a structural coupling of a communication system (Luhmann, 1995) with biophysical compartments such as: a human population, livestock, and physical infrastructure; (Fischer-Kowalski and Weisz, 1999); social metabolism serves to produce and maintain these biophysical compartments within a certain territory (Fischer-Kowalski and Haberl, 2007).

[29] See, for example, Krausmann et al. (2008b) for a description of the agrarian–industrial transition in the UK and Austria. There are also some links with the work of Boserup (1981),

Table 5.1 Framework conditions favourable or unfavourable to unleashing sociometabolic transitions

			New resources / opportunities	
			(1) not perceivable	*(2) perceivable, appear promising*
Previous resources / opportunities	*(1)*	*still intact*	status quo maintained	status quo defended + eventual expansion
	(2)	*threatened or exhausted*	system collapse	transition dynamics triggered

Source: Fischer-Kowalski (2011).

studies. It spells out a set of hypotheses on a more general level, so that they might also be applicable to a sustainability transition.

In general terms one might say that what drives a transition of the coupled society–nature system is the structural exhaustion of opportunities for the social system, and at the same time the opening of new opportunities (see Table 5.1). If only previous opportunities are exhausted, and no substantial new opportunities open up, one may typically expect system collapse (Diamond, 2005; Tainter, 2011). If previous opportunities are not exhausted when new resources/opportunities offer themselves, vested interests in the status quo will usually be strong enough to prevent change. This case seems an inherently unstable situation: as long as the interest groups benefiting from the use of the 'old' resources are very strong, they may delay the use of the new opportunities for a long time, maintaining the status quo.[30] They also may give in gradually and allow for the additional utilization of the new resources that are connected to different interest groups. This may result in expansion (building one resource use upon the other), but in the longer run would give rise to a transition. Historically speaking, such a situation occurred in many countries when using coal as an energy source beyond biomass became a new opportunity, and the landed aristocracy sought to maintain the status quo and prevent the related institutional change that threatened their social position. A recent study could show that the known revolutions of the nineteenth and twentieth century were often closely linked to this transition in the energy

dealing with population growth and density as the main drivers of change in developing countries.

[30] See the notion of the 'incumbent regime' with Geels and Schot (2007).

regime.[31] At present, the oil, coal and car industries are in a position comparable to the former landed aristocracy.[32]

New energy sources, superior in energy density and cost, have of course historically been the prototype of new opportunities, of a 'pull' towards a new and better future. Such a grand new opportunity at present is not in sight. Maybe other new opportunities, such as sophisticated solar technologies in combination with low-energy IT, could play the same role, but it is questionable that they in themselves will provide sufficient 'pull' to trigger a transition. Moreover, they will require a spatial reorganization of societal patterns towards more decentralized structures to become viable. Within the scheme outlined in Table 5.1, the world seems rather in a position of field (2)/(2), with previous opportunities on the brink of exhaustion, and new opportunities perceived, but maybe not appearing as promising as to outweigh the advantages of seeking to maintain the status quo, or striving along the lines of a traditional development model, respectively. If this is so, it will take a major 'push' from the part of nature, maybe even a manifest threat of collapse (field (1)/(2) in Table 5.1), to accelerate a transition. We think some structural symptoms of such a transition as described above are already in sight.

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[31] Currently, violent conflicts around the world still are linked to local resistance against 'modernization efforts' that seek to gain benefits from the destruction of agrarian subsistence systems in favour of fossil fuels-based industrial systems (Martínez-Alier, 2002). In the current phase of the age of fossil fuels being rather in decline than the dawn of a new future, this is particularly tragic.

[32] Out of the twenty largest companies in the world in 2013, eight were oil/coal/gas companies (Forbes List 2013, http://www.forbes.com/global2000/), and one was a car company (and only one was an IT company!). This indicates the dominant economic position of directly oil-related economic actors. Among the large companies that joined the 'global climate coalition' to heavily and fairly successfully lobby against the IPCC and international climate agreements, were ExxonMobil, BP, Shell Oil USA, Texaco, DaimlerChrysler, Ford and General Motors (Rahmstorf and Schellnhuber, 2006).

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6. Macroeconomic policies and environmental sustainability

Alejandro Nadal

INTRODUCTION

Macroeconomic policies affect the rate of economic activity and therefore the usage rates of our natural resource base. Through the impact on key variables and prices, macroeconomic policies are capable of bringing about deep structural economy-wide transformations, determining the patterns of income distribution in a society, conditioning the dynamics of investment and thus the introduction of new technologies and the creation of new jobs in any economy. These policies also condition output composition and technology choice, influencing production and marketing strategies, as well as resource management capabilities of all agents, from the largest and most powerful industrial corporations, to the smallest agricultural units.

These economy-wide policies also affect asset composition of any investment portfolio, bringing about important changes in the way in which financial instruments interact with productive activities in the real sectors of the economy. In view of the relation between financial variables and commodities prices in the world's mercantile exchanges and futures markets, this is a very important aspect of relations between the financial sector and the environment.

When described in these terms, the relation between macroeconomic policies and environmental and social sustainability becomes self-evident. Environmental sustainability is not only a matter of microeconomics and relative prices, it is foremost a macroeconomic problem. However, the academic and policy-making communities have failed to recognize this. This is a very serious omission and may very well be the most dangerous blunder in international policy-making. This chapter concentrates on how the macroeconomic policy package works and how it affects the environment and sustainability. The chapter concentrates on macroeconomic policies precisely because they have deep implications for the environment's health and resilience. Conservationists and communities must learn to deal with these themes that have been the privileged hunting ground of mainstream economists.

An important notice is needed here. A serious campaign in favour of 'de-growth' has been going on for some time and has made important contributions. This movement has opened new avenues for debate and analysis on technology, credit, education and other important areas. But a fundamental problem with de-growth (or zero growth) theories is that growth is perceived as having cultural or psychological roots. In fact, growth is an essential feature of capitalist economies. The purpose of capital is to produce profits without end; that's the meaning of its particular form of circulation. Its purpose is not to produce useful things or useless stuff; its object is to produce profits without end and produce more capital. This is the engine of accumulation and it is fuelled by inter-capitalist competition.

In Marx's words (Marx, 1857) 'capital exists and can only exist as many capitals, and its self-determination therefore appears as their reciprocal interaction with one another.' Capital can only exist as private centres of accumulation that are driven by (inter-capitalist) competition. In its quest to expand and survive (as an independent centre of accumulation), capital is continuously opening new spaces for profitability: new products, new markets. The corollary of this is that it is not possible to have capitalism without growth.

The structure of this chapter is as follows. Section 1 contains a summing up of the most important theoretical perspectives offered by post-Keynesian macroeconomics. Examining the evolution and theoretical debates of the past six decades is not possible in this chapter, but a summary of post-Keynesian breakthroughs and their implications for sustainability is an essential task.[1] Section 2 identifies basic criteria for policy-making when macroeconomics and sustainability are put together. Section 3 discusses specific guidelines for macroeconomic policy reform when sustainability becomes the overarching strategic objective. This chapter has a strong normative component and the final section presents concluding remarks on the urgency to implement the policy changes examined in this chapter.

SECTION 1: MACROECONOMICS: THEORETICAL PERSPECTIVES AND SUSTAINABILITY

Redefining macroeconomic policy priorities to serve the objective of sustainability requires the examination of how real world economic processes have been taking place and how economists and others have been thinking

[1] A detailed analysis can be found in Nadal (2011).

about growth and the workings of economic aggregates. A brief summary of macroeconomic debates is the object of this section. But it will be presented against a backdrop of real world economic events.

In the quarter century after 1945 the world economy experienced average annual GDP growth rates of 5 per cent. These high expansion rates were sustained for more than a quarter century. This was in very marked contrast with the experience of the inter-war period and especially the 1930s, when the Great Depression had ravaged the world economy. During that decade, the world's richest economies had suffered chronic deficiencies of aggregate demand, output had dropped below normal and financial chaos left an ugly scar. Because market forces alone had been unable to restore aggregate demand to normal levels, public policy intervention became a matter of routine. David Felix (2006) shows that the *historic lesson* appeared to be that guidance and public policy intervention were required to achieve these rapid growth rates.

Although the environment was just the landscape against which the drama of balanced or unstable growth would unfold, a new preoccupation arose: what happens when the supply of non-renewable natural resources is exhausted? In 1968 the Club of Rome was born with the objective of raising worldwide awareness regarding the complex web of relations between unrestrained growth in material consumption in a world with finite resources and an ever more fragile environment. But just how capitalist economies worked was left out of the radar screen. Ironically, the limits to growth debate got started just as the world economy was about to start a long period of slower growth rates. In fact, the period of 1971–73 experienced growth rates that were 50 per cent lower than those of the golden years of the post-war period.

In the early 1970s the institutional framework that had regulated the fast growth performance of the post-war era was destroyed and replaced by a new regulatory regime. And today, after three decades of neoliberalism the worst crisis since the Great Depression exploded in 2008. Today, six years after the almost meltdown of the global financial system recovery is not a given, and below-par economic performance is forecast for many years to come. There are three important features of this crisis that need to be taken into account. First, this is a macroeconomic crisis, not a sector-level mishap. Second, its epicentre is in the core economies of the world, not on a few scattered developing countries. Third, it is an endogenous phenomenon, engendered by internal forces and the contradictions of the neoliberal policy package. The frenzy of deregulated markets and the grip of policy mantras without any theoretical or empirical support have led to a crisis of historical proportions that has left millions in unemployment and poverty. Astronomical amounts of liquidity have gone into the financial system in the form of bailouts or as a consequence of quantitative easing, a lax posture in monetary policy. As a result, worldwide investments in conservation and environmental stewardship will suffer for years to come.

Mainstream economic theory failed to forecast this crisis, and when it erupted it was incapable of designing and implementing policies to mitigate its effects. In general terms, a macroeconomic policy posture is strongly determined by one's theoretical perspectives. If one believes that market forces lead to efficient allocations (once equilibrium prices are formed), the policy stance will be one in which intervention in economic life will be limited. If, on the other hand, one questions the foundations and logical consistency of this theory and takes into consideration the wealth of empirical evidence that refutes this notion, then regulation and direct intervention in economic life will be accepted as normal. Since the early 1980s the policy posture in most countries was based on the first type of idea. The goal of full employment was replaced by the objectives of price stability and balanced budgets. It was thought this would lead to growth, prosperity and development. This is a surprising event and one laden with implications for sustainability.

Neoclassical market theory reached an impasse in the early 1970s when it became clear that the goal of proving that market forces lead to equilibrium prices and allocations would not be attainable. In 1974 three neoclassical authors showed that the Arrow–Debreu general equilibrium model, the main theoretical workhorse used by neoclassical theory in its attempt to prove this hypothesis, would *always* require ad hoc assumptions in order to demonstrate that free markets do lead to equilibrium prices. The Sonnenschein–Mantel–Debreu theorem also reveals that the excess demand function for an economy is not restricted by the usual rationality conditions of individual demands in that economy. Therefore, microeconomic rationality assumptions have no macroeconomic equivalent.[2] One critical implication is that aggregating individual agents' behaviour does not preserve the standard assumptions used at the individual level and therefore, the so-called representative agents of many mainstream macroeconomic models are simple fictions without any rational foundation (Kirman, 1992).

Ironically it was during those years that free market ideology rose triumphant in the realm of political ideology. And with it, macroeconomic policy and theory proceeded as if general equilibrium theory had demonstrated that free markets lead to optimum allocations and

[2] Sonnenschein (1972), Debreu (1974) and Mantel (1974).

growth trajectories. In macroeconomic policy this was translated into the following priorities: price stability, balanced budgets for fiscal policy, deregulation of the capital account, international trade liberalization and minimum state intervention in the economy. The performance of this policy mix left much to be desired: it did not lead to adequate growth rates, nor did it provide equilibrium of domestic aggregates and balanced external accounts. Clearly there is need to move ahead and design and implement alternative development strategies that also look after environmental and social sustainability.

Post-Keynesian theory provides an alternative framework that is logically consistent, more realistic and closer to the needs of sustainable development strategies. The term 'post-Keynesian' is applied to theoretical work that developed the main insights that Keynes presented and developed in his *General Theory* and later essays. The initiators of this perspective were Joan Robinson (1956) in the UK and Paul Davidson (2012) in the US. These authors and their followers rejected the standard mainstream view that the IS–LM model (Hicks, 1937) represented Keynes' theoretical developments. In fact, for post-Keynesians, the IS–LM model has almost nothing to do with Keynes' theory and actually betrays his most important insights.

Post-Keynesian theory is embodied in a wide array of rigorous research covering not only macroeconomics, but also microeconomic price formation processes. It is not only a critique of neoclassical mainstream theory, but offers an accurate and policy-relevant framework of analysis.[3] In the next paragraphs we describe the fundamental characteristics of post-Keynesian theory that are relevant for a discussion on sustainability.

First, the economy is demand determined and not constrained by supply. According to the principle of effective demand, the production of goods adjusts itself to the demand for goods. This is related to a case of reverse causality: investment always causes saving (not the other way around). Investment and capital accumulation are not tied to intertemporal decisions by households on saving and consumption.

The study of effective demand reveals that capitalist economies are inherently unstable because aggregate demand is made up of two components: consumption and investment demand. Of these two, consumption is stable but insufficient to maintain an adequate level of aggregate demand. This is due to the fact that the marginal propensity to consume is always less than unity. Investment is thus required to lift aggregate demand, but investment is quite unstable as it depends on expectations in a highly

[3] See for example Lavoie (2006).

uncertain world. In post-Keynesian analysis, unemployment is not caused by disequilibrium in the labour market but by inadequate levels of aggregate demand.

Second, post-Keynesian theory centres on the workings of a monetary economy. Money is not a neutral device (a transactions technology) that can be abstracted from when analysing capitalist economies. Contracts are denominated in money terms, and production is organized in order to obtain money to pay debts. In capitalist economies money contracts have been developed in order to provide legal certainty concerning future cash outflows and inflows (Davidson, 2012). Everyone's ability to meet one's monetary contractual commitments is the foundation of a monetary economy. This is in stark contrast with neoclassical theory that reduces money to a transactions technology and carried out its analysis of markets and prices in real (that is, non-monetary) terms.

Keynes' theory of liquidity preference is closely related to the role of money in an uncertain world. If a significant amount of people believe the future has in store unpleasant surprises, they will increase their liquidity position in order to cope with those undesired events. This creates a decline in aggregate expenditure and demand shrinks. Faced with this decline in demand, firms will cut their production, curtail investment and reduce their wage bill. Thus, although the role of money is to provide stability in an uncertain world, the essential properties of money pose critical problems.

According to neoclassical theory, the financial system provides liquidity in a well-organized manner so that instability is minimized and households and firms avoid payments crises. The efficient market hypothesis completed this picture by introducing the assumption that agents are able to price assets correctly because they all possess statistically reliable knowledge over future events (including on cash flows that affect their commitments). In this artificially rosy world, no agent would ever be forced to default (Goodhart and Tsomocos, 2011).

In the real world, the financial system cannot play this role and, in fact, it has become a privileged space for speculation through securitization and the creation of derivative financial assets that were supposed to diversify risk and enhance stability. In fact, these instruments led to greater opacity and made risk assessment a very difficult task. Derivatives were at the centre of the global financial crisis but mainstream theory had nothing useful to offer in terms of explanations and remedies. Post-Keynesian theory had a much better perspective due to its starting point concerning the features of a monetary economy.

Third, the interest rate is not a reward for saving (or not spending), but a reward for parting with liquidity. It is not determined in a special market of loanable funds. It is not the price determined by the intersection of a downward-sloping demand for funds and an upward-sloping supply curve of (loanable) funds. Interest is a variable that has a totally different nature (this will become clearer when we describe the identity relation between savings and investment). It is the price for parting with liquidity. Interest is a variable linked to the choice of assets in which a person wants to place their savings. Thus, it plays an important role in the economy, but not in the decision to save.

Post-Keynesian theory has been able to find an answer to the complex questions posed by the nature of the interest rate. In the words of Tily (2007: 183), by turning his attention to money as a store of value and leaving momentarily aside its function as a means of exchange, Keynes was able to integrate uncertainty and expectations into his analysis and reveal that the rate of interest is the driver, and not the passive result of the level of economic activity. A corollary of this is that because this variable depends on expectations, the authorities can have full control of the rate of interest through monetary and debt-management policies. The interest rate ceases to be an endogenous variable, although it does depend on the dynamics of other variables. This is a result of the utmost practical importance in policy-making.

Fourth, there is no such thing as a labour market. This means that wages are a distributional variable and not a price that equilibrates the supply and demand for labour. It is not possible to aggregate the entire set of diverse transactions where labour is hired into a single market in which one price is determined, namely wages. The level of wages can be used to describe the evolution of aggregate demand, but it is not the price of a factor of production. Sraffa's analysis has shown that wages are not a price but rather a distribution variable.

The standard theory on labour economics postulates a microeconomic approach, where a market for labour determines wages (at equilibrium labour's marginal productivity is equal to labour compensation or wages). Graphically this can be described in a price-quantity space with a standard downward-sloping demand curve and an upward-sloping supply curve. The supply curve indicates that more labour will be supplied as wages increase. In this context, the labour market always clears if there is flexibility of wages: involuntary unemployment does not exist. However, the upward-sloping supply curve is not supported by standard microeconomics because a higher wage can provide both a higher income and greater leisure (with fewer hours of work). Thus, the income effect destroys the assumption of a well-behaved labour supply curve.

Fifth, monetary creation is carried out by private commercial banks and not the monopoly of a central bank. They create money out of thin air, as Schumpeter (1934: 73) pointed out. Banks do not need deposits to carry out loans. In fact, loans create deposits, not the other way around. This is something that can be verified empirically through the examination of modern practice in the banking industry and through an analysis of the monetary aggregates in any modern capitalist economy. Base money created exclusively by central banks typically amounts to less than 5 per cent of total money supply. The other 95 per cent corresponds to part of M1, M2 and M3 created by the private banking system. One of the implications of this conclusion is that there is no such thing as a money multiplier (on this point see Carpenter and Demiralp, 2010). As for the role of central banks, they do not have control of money supply and must behave in a more passive mode, delivering reserves in response to the requirements of the commercial banking system.

This implies that banking is an inherently pro-cyclical activity: banks will expand credit in good times and contract it in bad times. The different phases of the business cycle tend therefore to be amplified by the activity of private banks, aggravating the severity of crises. This is especially serious in the case of small open economies where capital flows add to volatility and intensify the pro-cyclical dynamics that are so well described in Minsky's financial instability hypothesis.

It is important to clarify that Keynes did not take money as an exogenously determined variable. He was fully aware of the importance of credit's role in the process of monetary creation. His theory relies on the assumption that money is endogenously created by the banking system responding to effective demand. Banks respond to a demand for loans (borrowing) by business firms that is not already satisfied by the existing stock of money. If the request for credit is deemed profitable and collateral is considered adequate, the loan is approved and a deposit is created.

Sixth, investment is identical to savings. This is one of the most important findings of post-Keynesian theory. The identity is brought about by the fact that the development of the banking system brings about widespread acceptance of deposits as money for transactions. Because loans make deposits, investment is not constrained by prior savings. Investment is an autonomous variable and depends only on (expectations concerning) aggregate demand, not on savings. Thus, the old model in which savings and investment are balanced in the market for loanable funds needs to be discarded: savings and investment are just two names for the same thing. This identity does not only arise from simple manipulation of standard national accounts. It is supported by the analysis of the causal mechanisms that involve monetary creation by the banking system. When credit is approved to meet the request of investors, a deposit is created for the same amount. Spending the deposit transforms it into somebody's income and, as Tily (2007: 154) points out, at any subsequent point in the economic process these deposits are somebody's savings.

Seventh, price flexibility may have adverse or destabilizing effects. Post-Keynesian analysis rejects the notion that the workings of competitive forces lead to the formation of equilibrium prices. This is why post-Keynesian analysis is consistent with the disappointing implications of the Sonnenschein–Mantel–Debreu theorem. This applies to the analysis of all markets, whether in a partial or a general equilibrium setting. Perhaps the most important example here is provided by flexible wages. According to neoclassical theory, flexible wages are the key to stability because a decrease in wages will lead to greater employment creation. In post-Keynesian theory the reduction of wages makes matters worse because it further depresses aggregate demand and increases the debt burden of firms, leading to bankruptcies and greater (not less) unemployment.

Eighth, capital flows pose serious risks because they have destabilizing potential. These pools of liquid assets enter the space of a host economy with the sole purpose of obtaining higher rewards than what they can expect in other countries. Capital inflows depend on expectations and arbitraging with respect to two variables: real interest rates and exchange rate stability in various countries. If changes take place in these variables, the whole affair is recalculated.[4] This is why capital flows are portfolio investments that retain a high degree of liquidity (in contrast with so-called greenfield foreign direct investments). Capital flows aim for speculative profits and do not necessarily make a positive contribution to growth or job creation.

Capital flows affect the exchange rate, and if a country wants to keep these inflows, it must maintain (comparatively) high real interest rates as well as exchange rate stability. Also, capital flows contribute to generating artificially positive expectations concerning the 'robust fundamentals' that the recipient country may (or may not) have. In essence, capital flows are intimately associated with financial speculation. And as Keynes wrote (Keynes, 1973: 159) 'speculators may do no harm as bubbles in a steady stream of enterprise. But the position is serious when enterprise becomes the bubble on a whirlpool of speculation'. Finally, when financial crises explode in a pattern resembling Minsky's 'financial instability hypothesis', the whole process is exacerbated by the presence of capital flows.

Ninth, inflation is not always and everywhere the result of an excess supply of money (as argued by monetarists). In post-Keynesian analysis,

[4] These arbitraging operations curtail the policy space for countries that would like to receive capital inflows. Their capacity to embark in expansionary policies is severely restricted.

inflation is not the result of an excessive rate of growth of money supply. In fact, if there is a causality link here, it is conditioned by the reverse causality found in the nexus between savings and investment. Causality in this relation between money and inflation operates in a different direction: the growth rate of prices and output bring about an increase in the stock of money (Lavoie, 2006: 58).

From a standpoint of heterodox microeconomics, post-Keynesians disagree with the notion that rising levels of capacity utilization lead to rising costs. It may very well be the case that rising utilization rates and fast growth are associated with increased productivity that compensates for rising wage costs. In addition, stability or high inflation periods are phenomena related to structural features of the economy, like income distribution. Thus, during the 'Great moderation' inflation was subdued not because of a healthy monetary policy but through wage declines and falling import prices caused by increased international competition and exchange rate effects (Perry and Cline, 2013). Thus, for post-Keynesian theory, inflation is the result of conflicts over income distribution. Adequate bargaining institutions can prevent high inflation rates even in the context of high utilization rates (which may be brought about by higher spending).

Tenth, post-Keynesian theory reserves a special place for uncertainty. In stark contrast with neoclassical or mainstream economics, post-Keynesian theory emphasizes the fact that the future is unknowable and very different from the past. The key point here is that the notion of uncertainty is radically different from that of risk because it is not amenable to any sort of calculation using probability distributions. In the terms of Lavoie (2006: 17) 'the world is non-ergodic, meaning that the averages and the fluctuations observed in the past will not necessarily be observed in different time periods'. Rejecting the ergodic postulate provides post-Keynesian theory with a more realistic take on the real world, but in a way it also involves a cost because it does not offer a pretty result in terms of an optimum outcome.

SECTION 2: CRITERIA FOR MACROECONOMIC POLICY-MAKING AND SUSTAINABILITY

Macroeconomic policy priorities are marked by political choices, not defined by scientific necessity. This is something we need to take into account when redefining the main objectives of macroeconomic policy. There is no 'scientific imperative' and the priorities in the agenda are not science-driven because the agenda is driven by political choices. There is a much greater space for alternative policies than what was preached in the heydays of neoliberalism. And this applies both to developing and developed countries, but designing alternatives and implementing reforms should not be done in terms of the old priorities. The new policy space needs to be oriented towards social and environmental sustainability.

Environmental policy itself should be thought of as macroeconomic policy. Although internalizing externalities (and 'getting the prices right') may be important in many cases, sustainability objectives should be recognized as critically involving the entire economy, and this is why environmental policy needs to be considered as an essential part of macroeconomic policy. In other terms, environmental sustainability is not only a matter of microeconomics and relative prices, it is foremost a macroeconomic problem. This means not only giving additional importance to the so-called green national accounts such as the ISEW index. It goes much beyond this and implies that all other objectives and policy instruments must be aligned as a function of sustainability objectives. In practice, this means that monetary and fiscal policies, for example, must go through a process of redesign and redefinition in order to comply with the paramount objective of sustainability, not the other way around. Just as macroeconomic policy-making was dominated by full employment between 1945 and 1970, and just as it was ruled by the imperatives of price stability after the 1970s, today macroeconomic policy has to obey the dictates of 'full sustainability'. The following paragraphs examine the main considerations that environmental macroeconomics needs to take into account.

Macroeconomics and Structures

Macroeconomics focuses on aggregates, but this does not mean that the *composition* of these aggregates is unimportant. In fact, macroeconomic policy for sustainability only makes sense when the *structure* of these aggregates is taken into account. The outstanding balance of the trade account may show a surplus, and this is judged as a positive result by any macroeconomic standard. However, if exports are heavily biased towards goods that are natural resource-intensive, or if they are produced by cheap labour, then that surplus may not be sustainable.

Suppose an economy or a region shows acceptable results in its struggle to control inflation. The obvious question is how this was attained. If the answer is that this achievement is the result of the containment of aggregate demand via a restrictive incomes' policy (that is, wage controls), cuts in public spending, high interest rates and a tight monetary policy, or that it is related to an overvalued exchange rate, then we can start worrying.

Stagnant real wages will intensify inequality and slow growth due to high interest rates will not help poverty. Reductions in public spending typically affect social expenditures and will have a negative effect not only on social equity, but also on productivity. Environmental expenditures are one of the first items to be affected by these cuts. All of this will conspire against sustainability. Thus, the structure of macroeconomic aggregates provides a relevant indicator for social and environmental sustainability.

Macroeconomic Policy and Heterogeneity

Macroeconomic policy relies on economy-wide prices or variables to carry out adjustments and send signals to every sector and agent in the economy. Herein lies one of the informational advantages of macroeconomic policies: economy-wide adjustments take place at great speed and without the need to adjust all the individual prices of the myriad goods in that economy. But the downside of these informational advantages is that these signals do not discriminate among sectors or agents. They may carry unfair and/or distorting messages to different groups and firms, and there are winners and losers when these general policies are implemented. These signals affect the productive and investment strategies of all agents, as well as their use of resources, and thus ultimately impact the environment. Because the environment is a multi-dimensional heterogeneous object, a special effort is required to allow macro policy instruments to deal with heterogeneity.

Heterogeneity may be defined in terms of physical features, type of goods being produced, or by the final destination of goods. Some forms of heterogeneity may be extreme in developing countries where distribution of productivity gains between sectors is extremely unequal and there are intense asymmetries in income distribution. In addition, the business cycle itself is made up of a set of heterogeneous boom and contraction phases (Ffrench-Davis, 2000). Circulation of capital in finance and industry is another aspect of heterogeneity. The differences in the supply and use of credit by different types of agents have profound macroeconomic implications in terms of growth and stability.

From the perspective of expenditures, fiscal policy has the ability to discriminate by sectors as funds are allocated in the country's budget. Different environmental considerations can be introduced when preparing a country's budget. For example, priorities can be defined in terms of specific projects for water and soil conservation or a set of biosphere reserves, or preventing marine pollution. So, from the viewpoint of environmental heterogeneity, fiscal policy may have its own mechanisms that allow for fine-tuning and adequate targeting. But the advantages of this flexibility disappear when everything is shaped by the macroeconomic imperative of a primary surplus.

From the viewpoint of fiscal revenues, heterogeneity can also be reinforced through progressive tax structures. Discriminating between sources of revenues is another way of introducing heterogeneity in fiscal policy. One important source of revenues can be found in financial transactions. Even a modest tax on financial transactions can go a long way in generating an adequate flow of resources that can be used for social expenditures as well as for environmental conservation and restoration.

In general terms, monetary policy appears to be more homogeneous in its effects than fiscal policy. If differential impacts are desired, some form of flexibility needs to be introduced: heterogeneity for monetary policy must be restored (Ffrench-Davis, 2000). This can be done through selective credit policies, something that requires regulatory changes, because by itself monetary policy is incapable of doing this. Many countries had regulations over banking activities that constrained banks to lend to activities that were judged to be strategic, like agriculture. Also, differential margins for interest rates were frequently part and parcel of these regulations. Thus, the banking sector was surrounded by regulations that affected the composition of its loan portfolio. In order to use monetary policy as a more effective instrument, it will be useful to re-regulate banking activities in this direction. The need to re-regulate the banking business becomes clearer once it is understood that banks have the capacity to create money and that the relation between deposits, savings and loans is not what standard textbooks pretend.

Short of making the banking sector a strictly public venture, which makes sense from many perspectives, re-regulating banking is a strategic option. Issues such as capital reserve requirements, prudential conduct of business, as well as the prohibition of engaging in risky speculative investments, are important. Re-regulating banking means ensuring that adequate resources are made available for agents that play a key role in environmental sustainability (for example, small-scale agricultural producers). It also means putting in place regulations that prevent financing environmentally destructive projects.

Macroeconomics and Sector-level Policies

Sector-level policies are crucial, and without them macroeconomic policies may never attain their objectives. This applies to industrial and agricultural policies alike. In order to achieve a better integration of macro and sector-level policies for sustainability, we need to reject today's straitjacket imposed by the 'kicking away the ladder' syndrome (Chang, 2003). For over two decades this has denied developing countries access to sector-level policy instruments that were used by developed countries to attain their current levels of per capita GDP. As a result, agricultural and industrial policies that were important to modify economic structures in developing economies were banned, something that was sanctified by WTO prohibitions and forcefully implemented through its system of countervailing measures.

The process of de-industrialization that has affected so many developing countries has dismantled the matrix of inter-sector and inter-branch linkages in the industrial system. This has contributed to the 'structural deterioration in the links between GDP growth and the trade balance' (Ocampo, 2003: 296). These linkages need to be rebuilt if we want to ensure that sector-level policies contribute to the goals of sustainability. Greater consistency between the macro and sector levels will help integrate the short-term preoccupations of macroeconomic policies and the pressing goals of long-term sustainability.

Short and Long Run

Macroeconomic policies have always concentrated on the short run. This is one of the key characteristics of mainstream macroeconomic theory. Most of the issues it addresses are related to stabilization problems and these are associated with short-term horizons. In many instances, the effects of macroeconomic policies last a very short period of time (for example, the effects of a fiscal stimulus will typically last for a couple of years). In fact, macroeconomic priorities such as price stability and fiscal balance make sense in the short run. In strong contrast, the problems pertaining to environmental sustainability are linked to medium and long-term horizons. This is why we need to integrate these differences in time horizons when designing a true environmental macroeconomics.

In spite of the above, it is interesting to point out that key macroeconomic problems of instability can be integrated into models dealing with long-term growth of capitalist economies. For example, the Harrod (1939) and Domar (1946) growth model stems from Keynesian macroeconomic theory and concentrates on the most volatile component of aggregate demand: investment. The Harrod–Domar model examines how full employment can be maintained if investment and the other sources of aggregate demand increase just fast enough to exactly absorb the increased output that the new investment made possible. But the model also showed that the economy lacked an adjustment mechanism to prevent being driven to greater disequilibria in a vicious circle. Thus, a growth model centred on a long-term horizon showed there was a need for macroeconomic policy interventions in order to keep aggregate demand consistent with the economy's productive capacity resulting from capital accumulation.

Of course, environmental considerations were not part of the picture in the Harrod–Domar model, but short-term policy interventions were integrated in a model where long-term horizons provided the temporal frame of reference. A similar result can be found in mainstream macroeconomics where a significant part of the academic debate over macroeconomic policy-making revolves around the validity of the assumption that in the long run, the economy converges to equilibrium. But in the short run some kind of public intervention may still be needed. So, for mainstream analysis, events taking place over long-term horizons fall outside the scope of macroeconomic policy but macroeconomic policies can be integrated into the analysis, presumably in an inter-temporal frame of analysis.

Policies for sustainability need to operate in a combination of time horizons. Soils take dozens if not hundreds of years to recover, forests take decades to recuperate, fishery stocks may take one generation to replenish, and so on. How short-term policies can be aligned with long-term problems is a fundamental issue that has not received enough attention. Debates about discount rates emphasize the differences in results when long time horizons are involved.[5] These debates concern the rationality of investing now in conservation so that the welfare of future generations is improved or at least not diminished, but they systematically ignore the critical question of how we can articulate short-term policy considerations on economic activity, employment and trade imbalances, for example, with long-term issues of environmental integrity.

Countercyclical Macroeconomic Policies and Sustainability

In the realm of rational expectations and the new classical macroeconomics, macroeconomic policies have no role to play, even in the short run. This was translated into specific policy goals through the Washington Consensus, where fiscal balance, a tight money supply, and a balanced set of external accounts (with a surplus in the capital account) became the core components of the macroeconomic posture in both developed and developing countries. The importance of these balanced accounts implied the extinction of countercyclical policies and an almost complete disregard for what happened in the real sectors of the economy. As monetary policy

[5] This debate has ignored the fact that discount rates can be the object of a re-switching phenomenon, much as the one described in the controversy over capital theory (Baumol, 1997).

concentrated on price stability and fiscal policy on a balanced budget, a pro-cyclical stance was adopted.

All of this was aggravated in the neoliberal (open) economy model through financial and trade liberalization. One of the contradictions of the neoliberal (open) economy model is precisely this pro-cyclical bias in macroeconomic policy-making. Given the impetus of trade liberalization, perhaps one of the most important pro-cyclical biases in the neoliberal macroeconomic model lies in the prohibition to use standard measures to redress the trade balance (Nadal, 1996).

A macroeconomic policy stance that has sustainability as its core objective has to involve a countercyclical stance that implies reworking monetary and fiscal policies. It has to be accompanied by the re-regulation of the financial sector and some form of control over capital flows. It also has to integrate the fact that in the boom phase of the cycle expectations by agents tend to favour increased risk adoption, the over-estimation of assets' values, as well as high leveraging (Minsky, 2008). This is why financial markets exhibit strong pro-cyclical trends with disastrous consequences for developing countries. Deregulation in the financial sector distorted investment patterns and promoted speculative behaviour that caused a long string of financial crises and deepening inequality.

SECTION 3: REDEFINING MACROECONOMIC POLICY PRIORITIES

Neoliberal macroeconomic policy relies on three key macroeconomic policy priorities. Price stability is the first one and all others orbit around this paramount objective. The second is fiscal balance and the third corresponds to financial and trade liberalization in order to optimize allocation of funds. It is believed that these three priorities can deliver growth and employment creation with equilibrium for internal aggregates, as well as balanced external accounts. Every other policy target is defined in a subsidiary mode. The key priorities of a primary surplus, low inflation rates and free capital flows are the macro policy objectives to which all other considerations must submit. Sector-level policies, whether for health, education, housing or the environment, are disciplined by these macroeconomic priorities. Whether soil erosion or biodiversity, mainstream macroeconomic policy-making is adamant: these are sector-level issues that need to be disciplined by macroeconomic imperatives.

The following paragraphs examine how the trajectory of macroeconomic policy-making can be redefined. We include here a list of items that need to be explicitly incorporated as key policy objectives in view of the post-Keynesian theoretical perspectives outlined above.

Growth and Full Employment

The main shift in priorities relates to the question of expansion and job creation. Development strategies need adequate growth rates, and economic expansion does not need to be associated with inflation. The overarching priority of price stability has not delivered the results it promised. In most developing countries, this policy objective was pursued through the repression of aggregate demand via high interest rates, the contraction of fiscal expenditures, wage controls and overvalued exchange rates. It is no surprise these economies experienced mediocre growth rates. This in turn brought about high unemployment rates, unsatisfactory fiscal revenues and the growth of public debt. In fact, price stability did not even bring about macroeconomic stability.

Capitalist economies do not possess an inherent tendency towards full employment. With Say's law jettisoned, the loanable funds theory and the notion of a labour market being discarded, the notion that a capitalist economy tends towards full employment if left undisturbed must likewise be abandoned. In post-Keynesian analysis, unemployment is not caused by disequilibrium in the labour market but by inadequate levels of aggregate demand. Unemployment cannot be solved through adjustments in the wage rate. Involuntary unemployment depends on the level of aggregate demand. If aggregate demand drops below certain levels, employment may only be restored through government expenditure.

Reducing Inequality

Inequality is not the result of a bias in technological skills or of disparities in the contribution of each person or group to social production (the marginal productivity theory). Inequality is a political economy event aggravated by the wrong mix of macroeconomic policies.[6] Unsustainable indebtedness is probably the most important one as it also leads to financial instability. Macroeconomic policies for sustainability need to have as a core objective the reduction of income disparities and social inequality.

[6] Although inequality may be aggravated by the direction of technological change (technical bias) it is a much more complex process that responds to deeper roots in the macroeconomic policy package. It is closely related to the fact that real wages ceased growing after the early 1970s in the United States and this process followed suit in most advanced capitalist countries shortly after.

Inequality will not disappear through trickle-down effects and anti-poverty programmes. Social policy cannot be replaced by these limited policy objectives. Social and environmental objectives need to be put at the centre of macroeconomic policy-making right from the start, not as an afterthought. We also need to recover the redistributive role that fiscal policy can play, with a truly progressive tax reform and an intelligent structure for expenditures in sustainability items (that is, all those items that are related to social welfare policy, as well as the environment). Also, incomes policy must cease to be an instrument to control aggregate demand by forcing negotiations to focus on expected instead of real inflation.

Fiscal Consolidation versus Fiscal Policy for Development

The primary surplus syndrome has been the dominant trait of fiscal policy worldwide. This is a perverse posture that ultimately implies transferring resources from the real sectors of the economy to the financial sphere. This policy posture undermines a country's capacity to attain sustainability objectives, sacrificing everything for the sake of satisfying short-term objectives related to the needs of the financial sector and debt management. The failure of this approach is revealed by the fact that the magnitude of the debt and its burden continues to weigh heavily on the developing world. In fact, even though the debt of developing countries has been 'managed' through this type of policy for more than two decades, the problem has not been solved and the external debt has been replaced in importance by domestic public debt, a distinction that is superfluous in the context of an open economy.[7]

To restore equity into tax policies, governments have traditionally opted for a differentiated structure of tax rates, as a function of income. However, the progressiveness of this system has been severely curtailed as taxes for top income brackets were significantly reduced. In the case of indirect or value added taxes, which have been promoted as an alternative to income taxes because they cover the so-called informal sector, the regressive effect is even stronger. Greater flexibility can be attained by having different rates for different goods, exempting critical categories of goods (medicines and food) and by putting greater pressure on commodities that pose health or environmental hazards.

Discriminating between sources of revenues is one way of introducing heterogeneity in fiscal policy. One important source of revenues can

[7] Using World Bank data, the Committee for the Abolition of Third World Debt (CADTM) reveals that the internal public debt of all developing countries rose from \$1300 to \$3500 billion between 1997 and 2005. See www.cadtm.org.

be found in financial transactions. Today the astronomical quantities of resources exchanged daily in the stock exchanges of the world, or in the global currency markets, to mention just two examples, offer a valuable opportunity for taxation. Even a modest tax on financial transactions can go a long way in generating an adequate flow of resources that can be used for social expenditures as well as for environmental conservation and restoration. The empty rhetoric about distortion of financial markets has to be rejected and a more realistic approach to the role of finance in capitalist economies has to be introduced in macroeconomics for sustainability.

We have already noted that from the standpoint of expenditures the syndrome of a primary surplus needs to be rectified. Expenditures in sectors such as health, education, housing and infrastructure have been lagging behind for many years in developing countries. There is an urgent need to restore them as key priorities because sustainable development depends crucially on these areas. In addition, the role of subsidies in developing economies needs to be seriously reassessed. There are many cases in which subsidies play a very important role in correcting problems that the market economy is not only incapable of redressing but in fact may be provoking. All subsidies must be redirected to sustainability objectives. If well planned, one advantage of these subsidies for environmental objectives is that they will increase the value of assets related to these activities.

Monetary Policy and Banking

The capacity of monetary authorities to pursue expansionary policies is severely curtailed as inflation targeting induces a potent bias in favour of high interest rates. This of course has a depressing effect on growth and employment. It also has important implications for environmental stewardship: 'rentier' economics is not a healthy recipe for social and environmental sustainability. Monetary policy may entail high interest rates for stabilization or to maintain a 'competitive' level and attract capital flows, but this imposes restrictions on rates of return, investment and under certain circumstances it may favour high rates of extraction of natural resources. In the context of a monetary policy that incorporates sustainability objectives a wise balance will have to be maintained between short-term rates and long-term rates that aim at fostering development.

In a world of endogenous money, the interest rate is an exogenous variable that can be manipulated by monetary authorities. This has significant effects upon the entire spectrum of interest rates. Lowering the key interest rate in an economy reduces the level at which investment projects become profitable and will also help reduce the differentials between active and passive interest rates, enabling large sectors of the economy to use financial services.

Determining the interest rate has implications for the exchange rate in the context of a deregulated capital account. Thus, determining an interest rate that is compatible with long-term priorities of sustainable development must work together with adequate controls over short-term capital flows and re-regulating activities in the banking sector. This is due to the role of private commercial banks in monetary creation and to the closely related fact that central banks do not control money supply.

In modern capitalist economies money supply is essentially controlled by private commercial banks. This means that the crucial function of monetary creation is carried out in the pursuit of private profitability by special firms called 'banks'. The creation of money by banks is debt-related and corresponds to credit demand by business (and consumers). It is therefore a highly pro-cyclical activity that may lead to quite undesirable results, especially in the context of extreme deregulation. In times of favourable expectations banks may look at market demand in an equally positive way. These expectations or market sentiment may feed on exaggerated news concerning future benefits and may lead to the creation of bubbles in asset prices, intensifying the severity of cycles. Although banks will evaluate investment projects before approving a loan (and opening a deposit account for the investor), it is clear that banks are also susceptible to the favourable news from the market and will be inclined to open new loans because their profitability depends on the willingness of business to engage in greater indebtedness. On the other hand, when expectations are unfavourable, banks will normally put a brake on their lending activities and will further contribute to decelerating economic activity, deteriorating unemployment and affecting prospects for long-term sustainable development. This pro-cyclicality of monetary creation by private banks is one of the most powerful reasons for re-regulating banking activities. In many ways the crisis that exploded in 2008 was generated by the exuberance of the financial market in the context of runaway expectations in deregulated financial markets.

Re-regulating the activities of the banking sector is a complex and multi-purpose task. There are at least five important aspects to this regulatory effort if banks are to make a positive contribution to sustainable development. First, re-regulating the banking system is required to dampen the pro-cyclical bias that is inherent to private banking. One way to do this is to impose strict capitalization requirements and reserve coefficients because banks will find in this an important moderator of their expectation-formation process. This will of course encounter strident objections from the banking sector, but it is an important instrument to reduce the amount of leverage with which banks can operate. Reserve and capitalization requirements involve strict accounting, transparency and intense supervision by regulatory bodies. These are important regulations, and yet they may not be enough to guarantee the good health of banks. In fact, many of the banks that failed during the worst years of the financial crisis would have been found to comply with Basel III regulations. In the next paragraph we examine another important aspect of banking regulations that is required.

There is another closely related aspect of private banking and monetary creation that is highly relevant to development strategies. The types of activities into which loans are channelled may or may not be relevant for sustainable development. In this sense, credit will go to wherever the market calls for new loans. The activities that may be behind the new loans may or may not be relevant for a long-term development strategy. Re-regulating banking activities may be needed to make sure that key sectors or branches in the economy have access to financial services.

Second, the set of activities in which banks can get involved offers another area for regulation. Separating conventional banking operations (the so-called 'boring' activities like mortgages and loans to small firms) from activities related to securities, the creation of investment vehicles and operations with higher risks that are the realm of investment banks is of course one of the first priorities in this context. In addition, severe limitations are required to prevent banks from engaging in over-the-counter activities and operations with derivatives that are largely unregulated today. Monitoring and enforcement activities will meet several important challenges.[8]

Third, regulating banking for sustainable development should also involve channelling credit into certain types of sectors or branches of the economy. In development strategies this type of regulation has played an important role, allowing for the acquisition of endogenous technological capabilities that later became the foundation of competitive advantages. Another consideration is that this may allow sectors like small-scale agriculture to have access to adequate financial services. This part of the

[8] All off-balance-sheet transactions must be outlawed. In 2007 and 2008, Lehman Brothers Holdings, Inc. used these off-book operations to understate its leverage and deceived shareholders about its ability to withstand losses. The complex financial operations that took place were compatible with the Generally Accepted Accounting Principles and, from this perspective, were not illegal. But these practices are on the fringes of deception and speculation, and they allow agents to escape regulations, constituting a negative incentive to engage in fraudulent operations that can lead to the collapse of the entire financial system. Stealthy operations are incompatible with healthy regulation.

regulatory agenda must be accompanied by active industrial and agricultural policies.

Fourth, regulations for the banking sector need to be based on the idea of differential treatment for the different types of banks. This is a *de minimis* condition for an adequate regulatory framework. There is no reason why large banks that concentrate assets and equity need to be treated in the same manner as small banks, or even as credit unions. Some of these institutions are more prone to generating instability and pose systemic risk (for example, the 'too big to fail' syndrome), while others are socially useful institutions that may be discriminated against when faced with the same regulations imposed on large commercial banks.

None of the above regulatory steps will put the banking sector under complete control of public policy. From a more radical perspective, complete nationalization of banks may be considered the only rational manner through which monetary creation can be put at the service of social priorities. This would effectively place the volume of credit and the sectors to which loans would be channelled under public control. This approach to banking would return control of the money supply to banking authorities, something that does not happen today.

Central Banks

One of the most important aspects of macroeconomic policy calling for serious re-examination in the interest of sustainable development priorities is the question of central bank autonomy or independence (Palley, 2011). The idea that central banks should be institutionally separate from government institutions to prevent political interference in monetary policy-making gained predominance during the late 1980s (Bibow, 2010). This was seen as a fundamental companion to the objective of price stability as the paramount priority in monetary policy. However, the global financial crisis clearly shows that price stability is not equivalent to macroeconomic stability, so central bank independence (CBI) does not seem to guarantee constancy and overall better performance.

The most important aspect of CBI is the notion that if governments have the capacity to run deficits in their own currency in cases where the treasury has control over the central bank, then it will force the monetary institute to monetize public debt. To counter this possibility it was thought that independence of central bank authorities would lead to the formulation of ideology-free policies and that this would increase credibility and certainty for investors. The central idea here is that preventing the central bank from acting as the financial agent of the government would restrict the ability of politicians to monetize abusive fiscal deficits.

In fact, what happened was that central banks became subordinated to the priorities of finance capital and governments lost their ability to finance long-term projects that could be crucial in development strategies. By the same token, governments had now to resort to private financial markets to obtain credit for their operations, just like any private entity. The justification here is that this imposes market discipline on public finance. In fact, amputating the capacity of self-finance of modern states has brought about greater chaos and an intensification of the crisis in Europe. Countries like Spain have been forced to accept all the conditions imposed by private finance in order to finance their deficits. Some of those conditions were translated into severe fiscal retrenchment that has intensified and prolonged the recession. Also, CBI led to corporate capture of the central bank's regulatory and policy powers. Deregulating and getting rid of critical pieces of the regulatory framework that had kept the banking system in place for decades is just one example of this corporate capture. And as for developing countries, CBI is problematic and may be incompatible with long-term sustainable development objectives. Of course, it would be foolish to get rid of CBI and not impose democratic and political controls that can ensure the responsible management of this powerful financial instrument.

Capital Account Regulations

In order to recover control over interest rates, monetary policy and the exchange rate, it is essential to establish controls over capital flows. Recent studies have shown that countries that used capital controls performed better during the global financial crisis (Gallagher et al., 2012). The main objective behind the deregulation of the capital account was to provide access to international capital sources (foreign savings) and thus supplement domestic savings. However, opening the capital account has led to capital flows that in the short run have strong destabilizing effects and in the long run are accompanied by three critical structural distortions. First, in the case of countries that have a chronic current account deficit, capital flows artificially maintain a country's capacity to import goods, irrespective of its ability to have a good export capacity. As Bhaduri (1998) shows, this can have negative effects through the perverse application of the Kahn–Keynes multiplier where imports lead to reductions in aggregate income.

The second distortion is related to the interest rate and the money supply. As requirements for capital flows increase, the interest rate becomes the key reward to attract these flows. In order to keep the money supply stable, sterilization is used and this maintains the interest rate at an artificially high level, affecting the entire spectrum of interest rates in the economy. The third problem concerns the rigidities imposed on the exchange rate as a result of these capital flows. In the presence of capital flows the exchange rate loses its flexibility. In fact, capital flows tend to appreciate the exchange rate and this prevents it from performing its role as an adjustment variable. On the other hand, capital flows also impose the need to maintain exchange rate stability to prevent the reversal of capital flows. This invariably leads to exchange rate appreciation. Capital controls prevent these effects and allow policy makers to regain some autonomy for a countercyclical monetary policy.

CONCLUDING REMARKS

Global economic relations reveal several important structural features that affect both social and environmental sustainability. At least five critical characteristics can be identified: (a) dominance of the financial sector; (b) inequality and poverty; (c) concentration of market power; (d) severe international imbalances (between surplus and deficit countries); (e) international debt. All of these have been and continue to be shaped by macroeconomic policies. And yet the debates concerning sustainability continue to omit any reference to macroeconomic policies. The latest example is the final outcome document of the Rio+20 conference held in 2012, an international effort to deal with the challenges of sustainability that managed to make no references to the ongoing global crisis or to macroeconomic policies (Nadal, 2013). Our analysis urges environmentalists and progressive movements to reclaim the right to define the general trajectory of macroeconomic policies.

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7. Modeling a non-growing economy: an autobiographical note[1]

Peter A. Victor

INTRODUCTION

The 1960s stand out for many reasons. The coming of age of the post-World War II baby boomers had a remarkable influence on music and politics, both of which thrived on university campuses around the world, especially in the West. Keynesianism, as represented in textbooks such as Samuelson's ubiquitous *Economics*, dominated macroeconomics and came to rival microeconomics for popularity in the degree programs offered in departments of economics. I was a student of economics in those days, enjoying a first class training in the subject at universities in the UK and Canada. When the time came to choose a topic for my doctoral dissertation, I resisted the fashion of the day, which was to run regressions using the newly available power of IBM mainframe computers. Instead I sought to understand the relationships between economies and the social and natural systems in which they are embedded. This required a different perspective on economics rather than statistical testing of hypothesized relationships drawn from economic theory.

My dissertation was published as a book (Victor, 1972), the second paragraph of which begins: 'Taking the view, then, that economic activity is a part of human society, and that in turn, society itself is only a subset of the phenomena that constitute the universe, the focus of this study will be the connections between human society and the rest of the universe that are attributable to economic activity' (ibid.: 17–18). I then went on to write that 'existing economic models can be extended, both theoretically and empirically, so that the quality and quantity of these material flows become determined by the economic activity of society' (ibid.: 18). My approach was to apply the principle of materials balance to input–output models and to develop the first estimates of direct and indirect material flows generated by the final demand for goods and services for a national economy. At the time, my choice of topic invited occasional sarcastic comments from some members of faculty who meant well, along the lines of

[1] This chapter is based on Victor (2008) and (2012a).

'Victor, I hear your dissertation is a load of rubbish.' I was unperturbed, not least because my indomitable supervisor, Gideon Rosenbluth, was an enthusiastic and staunch supporter of my research.

I am very pleased that environmental extensions of input–output analysis have since become commonplace. The standard text on input–output analysis (Miller and Blair, 2009) devotes an entire chapter to environmental input–output analysis and another to its sister subject, energy input–output analysis. There exists an extensive literature on both of these, and with the advent of publicly available global input–output tables that incorporate key material flows (Timmer, 2012), environmental and energy applications of input–output analysis are bound to increase.

Input–output models in general have well-known limitations. For example, the usual assumption of fixed inputs per unit of output are acceptable for relatively short-term impact studies but less so for projections far into the future when significant changes in these coefficients can be expected. Consequently, input–output models are not well suited for use as the primary tool for modeling a non-growing economy. This was not a concern to me in the 1960s. When the viability of long-run economic growth was called into question in the 1970s with the publication of *The Limits to Growth* and other seminal texts, I was moving out of academia into the civil service in Ontario, Canada and subsequently to consulting where these longer term issues were of little interest. It was when I returned to academia in the mid-1990s as Dean of the Faculty of Environmental Studies at York University, and really only when my term as Dean finished in 2001, that I took up the question of what economic and environmental policy objectives might be achievable in a non-growing economy.

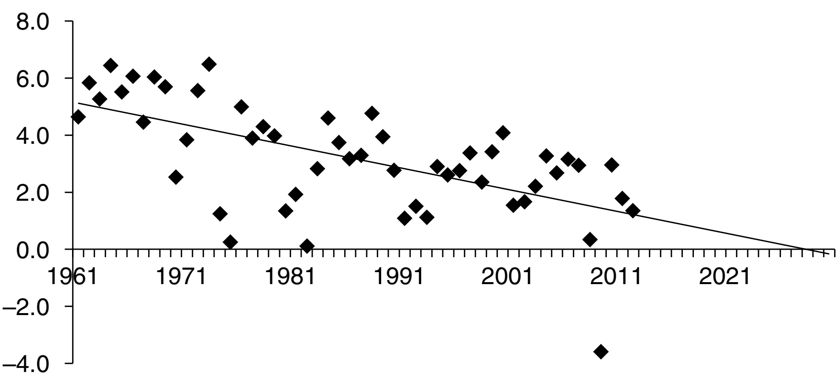
This question about the possibility of a non-growing economy was posed to me by Gideon Rosenbluth, who had supervised my dissertation some thirty years previously. Now in his eighties, Gideon asked me to collaborate on an inquiry into the macroeconomics of no growth, which we proceeded to do (Victor and Rosenbluth, 2007). The model that we built, named LowGrow, incorporates principles of Keynesian economics within the framework of systems dynamics. This choice of approach sacrificed the empirical detail offered by input–output analysis in return for flexibility to model non-linear relationships and feedback which are especially important when thinking about economies over the long term.[2]

It is worth pointing out that interest in modeling a non-growing economy does not presuppose that no growth (that is, zero growth in real GDP or real GDP per capita), should be adopted as an overarching

[2] For a review of alternative macro-modeling approaches, see H. Pollitt et al. (2010).

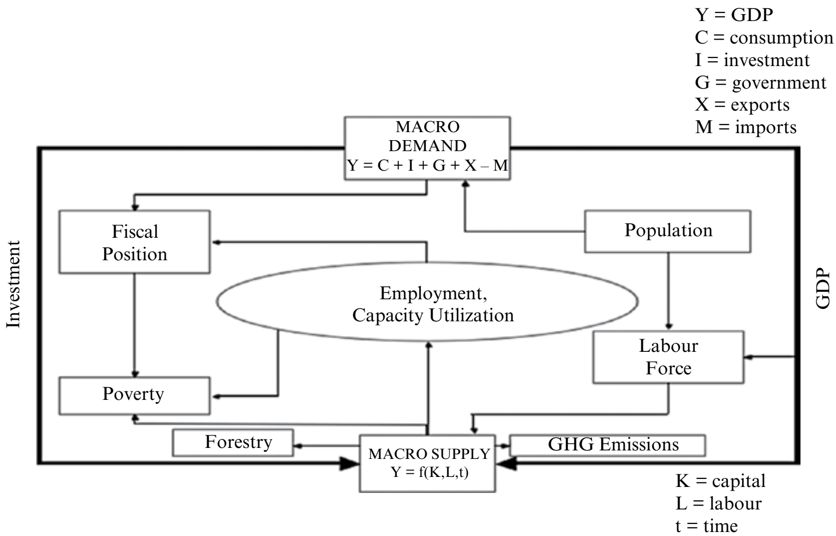
macroeconomic policy objective to replace the pursuit of economic growth. While this could be a conclusion informed by modeling, it is more important and more relevant to recognize that by giving priority to growth, other policy objectives, ranging from environmental protection to reducing income inequality, take second place. Their achievement is often sacrificed in the pursuit of economic growth. Allowing the exploitation of fossil fuel deposits in 'protected' areas is just one example. 'Right to work' legislation, which is deliberately intended to weaken the power of labor unions and lower wages in the name of competition, is another. If it can be shown that a wide variety of social, economic and environmental goals can be met in economies that are not growing then we should be less concerned about the implications for growth of taking the necessary steps to do so. Furthermore, if the secular decline in the rate of economic growth in high-income countries continues (see Figure 7.1), then it will be all the more important to understand what can be accomplished within that context and the extent of the changes in policy and in our institutions that may be called for to make the most of these new circumstances.

The following sections describe the LowGrow macroeconomic model and some scenarios generated with it. This work was completed several years ago. My more recent and ongoing work on 'ecological macro-economics' has been done in collaboration with Tim Jackson (UK). The chapter closes with a brief outline of the approach Jackson and I are taking to modeling national economies though a full report on this work has yet to be written.



Source: Based on data from the World Bank Development Indicators.

Figure 7.1 Annual rate of growth (%) in real GDP in high-income countries: 1961–2012



Source: Based on Victor (2008, Figure 10.1).

Figure 7.2 The high-level structure of LowGrow

THE LOWGROW MACROECONOMIC MODEL

All models are simplifications of whatever they represent. This is as true of computer models as it is of model aeroplanes and model villages. Whether they are satisfactory simplifications depends on their intended uses. Figure 7.2 shows the structure of LowGrow in its most simple and compact form. At the national level, macro demand is determined in the normal way as the sum of consumption expenditure, investment expenditure, government expenditure, and the difference between exports and imports. Their sum total is GDP (gross domestic product) measured as expenditure. There are separate equations for each of these components in the model, estimated with Canadian data from about 1981 to 2005, depending on the variable. Production in the economy depends on employed labor and employed capital (that is, buildings, equipment, software and infrastructure). Changes in productivity from improvements in technology, labor skills, and organization are captured depending on time. Macro supply is shown at the bottom of Figure 7.2, and it determines and is determined by employment and capacity utilization shown in the center of the figure.

There is a second important link between macro demand and production.

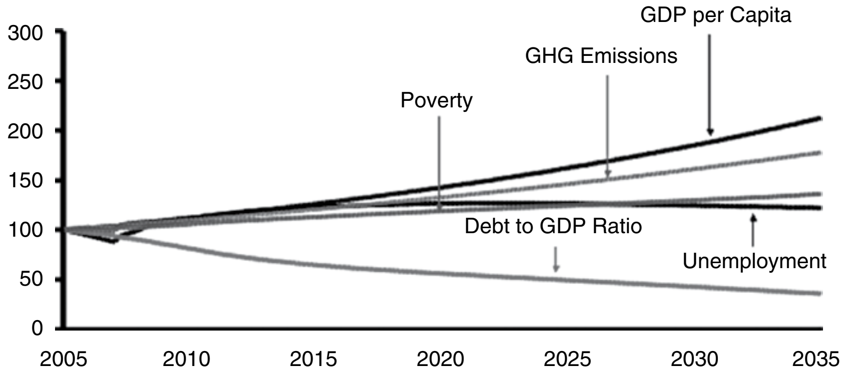
Investment expenditures (net of depreciation), which are part of macro demand, add to the economy's stock of capital, increasing its productive capacity. Also, capital and labor tend to become more productive over time. It follows that, other things being equal, without an increase in macro demand, these increases in capital and productivity reduce employment: as labor becomes more productive over time, less is required to produce any given level of output. On this basis, economic growth (that is, increases in GDP) is needed to prevent unemployment rising as capacity and productivity increase.

Population is determined exogenously in LowGrow, which offers a choice of three projections from Statistics Canada. Population is also one of the variables that determine consumption expenditures in the economy. The labor force is estimated in LowGrow as a function of GDP and population.

There is no monetary sector in LowGrow. For simplicity, I assumed that the Bank of Canada, Canada's central bank, regulates the money supply to keep inflation at or near the target level of 2 percent per year. LowGrow includes an exogenously set rate of interest that remains unchanged throughout each run of the model. A higher cost of borrowing discourages investment, which reduces macro demand. It also raises the cost to the government of servicing its debt. The price level is not included as a variable in LowGrow, although the model warns of inflationary pressures when the rate of unemployment falls below 4 percent (effectively full employment in Canada).

LowGrow includes features that are particularly relevant for exploring possibilities for an economy that is not growing. It includes emissions of carbon dioxide and other greenhouse gases, a carbon tax, a forestry sub-model, and provision for redistributing incomes. It measures poverty using the United Nations' Human Poverty Index (that is, HPI-2 for selected Organisation for Economic Co-operation and Development, or OECD, countries) (UNDP, 2006). LowGrow allows additional funds to be spent on health care and on programs for reducing adult illiteracy (both included in HPI-2) and estimates their impacts on longevity and adult literacy with equations from the literature.

Expenditures on anti-poverty and environmental programs are automatically added to government expenditures in LowGrow. Other changes in the level of government expenditures can also be simulated in LowGrow through a variety of fiscal policies, such as an annual percentage change in government expenditure that can vary over time and a balanced budget. LowGrow keeps track of the overall fiscal position of all three levels of government combined (federal, provincial and municipal) by calculating total revenues and expenditures and by estimating debt repayment based



Source: Based on Victor (2008, Figure 10.2).

Figure 7.3 Business as usual

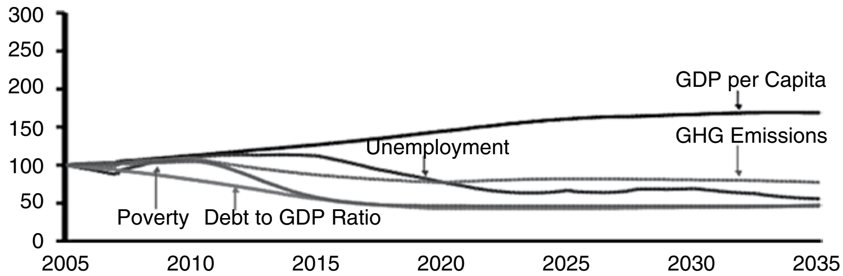
on the historical record. As the level of government indebtedness declines, the rates of taxes on personal incomes and profits in LowGrow are reduced endogenously, which is broadly consistent with government policy in Canada.

In LowGrow, as in the economy that it represents, economic growth is driven by: net investment, which adds to productive assets, growth in the labor force, increases in productivity, growth in the net trade balance, growth in government expenditures, and growth in population. Low- and no-growth scenarios can be examined by reducing the rates of increase in each of these factors singly or in combination.

A BUSINESS-AS-USUAL SCENARIO

It is convenient to start analysing low- and no-growth scenarios by establishing a base case with no new policy interventions. This is the 'business-as-usual' case illustrated in Figure 7.3 and describes what would happen in the Canadian economy if the trends in the years before 2005 were to continue for another thirty years. It is not a prediction of the future, but rather a benchmark against which to compare alternative scenarios.

In the business-as-usual scenario, between the start of 2005 and 2035, real GDP per capita more than doubles; the unemployment rate rises, then falls, ending above its starting value; the ratio of government debt to GDP declines by nearly 40 percent as Canadian governments continue to run budget surpluses; the Human Poverty Index rises, largely due to



Source: Based on Victor (2008, Figure 10.6).

Figure 7.4 A low/no-growth scenario

the projected increase in the absolute number of unemployed people; and greenhouse gas emissions increase by nearly 80 percent.

A LOW- OR NO-GROWTH SCENARIO

A wide range of low-, no- and de-growth scenarios can be examined with LowGrow.[3] One such scenario is shown in Figure 7.4. Compared with the business-as-usual scenario, GDP per capita grows more slowly, leveling off around 2028, at which time the rate of unemployment is 5.7 percent. The unemployment rate continues to decline to 4.0 percent by 2035. By 2020 the poverty index declines from 10.7 to an internationally unprecedented level of 4.9, where it remains, and the debt-to-GDP ratio declines to about 30 percent, to be maintained at that level to 2035. Greenhouse gas emissions are 31 percent, lower at the start of 2035 than in 2005, and 41 percent lower than their high point in 2010.

POLICY DIRECTIONS FOR A LOW- OR NO-GROWTH SCENARIO

What does it take to achieve the kind of outcomes illustrated in Figure 7.4? One purpose of a simulation model like LowGrow is to help answer this question. The scenario is based on a number of key changes in the model which could come about by the cumulative changes in autonomous behavior of individuals and organizations, by policy

[3] For a degrowth scenario generated with LowGrow see Victor (2012b).

measures introduced by government, or, most likely, by some combination of the two.

The scenario in Figure 7.4 results from a variety of changes, some more controversial than others, that would be required to transform the business-as-usual scenario in Figure 7.3 into an attractive scenario in which economic growth is not required to meet economic, social and environmental objectives. These changes include:

- *Consumption*: Consumption is one of the main driving forces of the economy. In a successful economy not geared to growth, we would expect the pattern and level of consumption to be very different from a growing economy. For example, well-being would be enhanced with a greater emphasis on public goods, which includes the environment; on shared provision of private goods, as we are already seeing with cars and bicycles in many cities; and on services, rather than commodities. More controls on the content and placement of advertising would be helpful.
- *Investment*: In economic terms, investment refers to the purchase of new infrastructure, buildings and equipment. Some of this investment replaces what has been worn out. The rest adds to the stock of built capital and is a major source of economic growth since it increases the productive capacity of the economy. A viable low- or no-growth scenario requires major changes in the quantity and type of investment. These changes will transform the capital stock so that environmental impacts are reduced, degraded ecosystems are restored, renewable materials and energy are substituted for non-renewables, and people are better served in terms of housing, transportation, education, health care and other social services.
- *Employment*: One aspect of the dilemma of growth is that with an expansion of the capital stock, labor becomes more productive. Unless there is economic growth, an inevitable consequence is unemployment, since fewer and fewer people are required to produce any given level of output. A complicating factor is that in most economies, paid employment is the primary source of income for most adults, so higher rates of unemployment threaten an increase in poverty. This aspect of the dilemma can be overcome by several changes. First, in a more socially just economy – especially one with an aging population – there would be more jobs in the human services sector where increases in labor productivity are likely to be less than in the production of goods. Second, by strengthening the social safety net and establishing a guaranteed minimum income, we would rely less on income from employment

for distributing the output of the economy via wages. Any concern that this might reduce the incentive to work is less problematic in an economy in which growth is no longer regarded as an imperative. Third, a reduction in average hours spent in paid employment provides a means by which people can benefit from increases in labor productivity other than through an expansion of economic output. Beyond some level of material well-being – different for each person, but likely within the range already surpassed on average in developed economies – more leisure makes a greater contribution to well-being than a higher income.

- *Population*: The scenario in Figure 7.4 is based on an assumption that the population and labor force will stabilize over the next twenty years or so. In Canada, as in many developed countries, the fertility rate (that is, the average number of children born to a woman over a lifetime) is less than the replacement rate of about 2.1. Under these circumstances, net immigration becomes the source of population growth. Stabilization of the Canadian population would require a reduction in net immigration to about 200 000 people per year. This would still allow Canada to maintain a level of about 100 000 immigrants in its family unification and refugee categories and require a reduction only in immigrants admitted to Canada to promote economic growth.
- *Poverty*: The idea that poverty can be eradicated through the trickle-down effects of economic growth has been shown wanting. Poverty is more than a matter of inadequate income. It is also about social exclusion, which is closely related to the distribution of income and wealth and not just their amount. Recent experience in many developed countries has shown little or no increase in real living standards for the majority of people despite economic growth, the gains from which have been enjoyed by a relatively small proportion of the population. It is clear that more focused anti-poverty programs that address the social determinants of illness and provide more direct income support are required to eliminate poverty. Such measures are included in the scenario shown in Figure 7.4.
- *Technological change*: Technological change has been an important aspect of human progress ever since the Stone Age. Today's seemingly magical technologies in areas such as communications, entertainment, medicine and transportation represent a rapid acceleration of trends that have been in play for millennia. To say that new technologies are often a double-edged sword is a cliché, itself a metaphor based on a technology that in previous times had considerable military significance. Our contemporary environmental

problems are evidence of the second edge. The way forward will require novel technologies that reflect an approach to life in which social and ecological as well as economic consequences are considered in advance of their widespread adoption. This can be achieved through technology assessment, changes in the education of scientists and engineers, and the adoption of a broader range of objectives by those engaged in technology development than just financial gain.

- *Government expenditures*: The scenario in Figure 7.4 allows for some increase in total government expenditures followed by an eventual leveling off as the size of the economy stabilizes. The precise level at which this leveling should take place will be determined by the respective roles determined for the public, private and not-for-profit sectors. The scenario in Figure 7.4 corresponds to a level quite similar to the traditional role of the public sector in Canada.
- *Trade*: International trade can be mutually beneficial, but it can become destabilizing if a country's imports and exports move significantly out of balance. The scenario in Figure 7.4 is based on a small but positive trade balance in which Canada earns slightly more from its exports than it spends on imports. Eventually, if the economy is not growing, we should expect imports and exports to balance.
- *Greenhouse gases*: The emission of greenhouse gases would very likely diminish as the rate of growth slows, and this effect is captured in Figure 7.4. In addition, the scenario assumes the imposition of a substantial revenue-neutral carbon tax in which there is a tax on energy use based on the carbon content of the energy. In the scenario, revenues from the carbon tax are exactly matched by a reduction in personal and corporate income taxes, so that there is no increase in overall government revenues from the carbon tax.

The scenario in Figure 7.4 is based on all of these changes. In addition, there are other changes that would usefully complement those included in the LowGrow simulation but that are not directly provided for in the model. Among these is the adoption of better measures of success than growth in GDP to drive policy. There are several candidates, such as the UN's Human Development Index and the Genuine Progress Indicator, both of which show that prosperity and economic growth are only loosely related. Climate change is only one of several environmental problems facing humanity in the twenty-first century. A comprehensive approach will require limits on throughput, and comprehensive ecological fiscal reform where, for example, taxes are shifted from labor to activities that cause environmental damage and space is used less aggressively through better land-use planning and habitat protection.

LowGrow is a modest first step in the development of tools grounded in economics for describing alternative futures in which economic growth is not given priority. Numerous other models have been created with the clear intention of showing how economic growth can be sustained, even accelerated, while the burden on nature is reduced (UNDP, 2011). And yet other models – such as World 3, which was used to develop the famous scenarios in *The Limits to Growth* – provide interesting, even inspirational scenarios without economic growth, but they were not designed according to established principles of economics (Meadows et al., 1972). Furthermore, LowGrow was built with data for Canada and, while the broad conclusions that emerge from it apply to other developed economies, national differences would no doubt yield rather different numerical results. Since its publication a few years ago, there has been considerable interest in LowGrow in many parts of the world, and a few researchers in other countries (Sweden, New Zealand, Germany) have adapted LowGrow, with mixed results.

In 2008 I was invited by Tim Jackson, who was then a member of the UK Sustainable Development Commission and also Director of the Commission's research team, to give a seminar on 'Managing without Growth' and LowGrow in London, England. We struck up a friendship and in 2010 agreed to collaborate on a more comprehensive macroeconomic model of a national economy designed to address the following questions:

1. Is growth in real economic output still required in advanced economies in order simultaneously to maintain high levels of employment, reduce poverty, and meet ambitious ecological and resource targets?
2. Does stability of the financial system require growth in the 'real' economy?
3. Will restraints on demand and supply – for example, in anticipation of or in response to ecological and resource constraints – cause instability in the real economy and or financial system (Victor and Jackson, 2012)?

These important questions require better answers than are currently available, but for which credible answers are needed if we are to make the thoughtful, deliberate transformation of our economy that the mounting evidence of environmental degradation, financial instability, and increasing social and economic inequality indicates is necessary. Our new macroeconomic model is based on principles of stock-flow consistency (Godley and Lavoie, 2007) and is being calibrated simultaneously for Canada and the United Kingdom with later extensions planned for other

OECD economies. The model incorporates the financial economy, the real economy, and material and energy flows to and from the biosphere. It has several other distinguishing features such as the inclusion of detailed demographic and housing sub-models and endogenous expectations. The model, even before completion, is providing insights into the three problems noted above and to a host of related issues. We are optimistic that it will produce more comprehensive and detailed scenarios than those obtained from LowGrow, showing how we might live well in an economy that does not depend on economic growth. Most important of all, it will enable us, at least analytically if not emotionally, to free ourselves to think more broadly and more imaginatively as we contemplate the end of growth.

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8. Degrowth: between a scientific concept and a slogan for a social movement

Panos Petridis, Barbara Muraca and Giorgos Kallis

INTRODUCTION: WHAT IS DEGROWTH?

Degrowth is a new keyword. It is on the one hand a keyword that has a scientific basis on the recognition that continuous economic growth is not only unsustainable but also undesirable, and on the other, a keyword that aspires to mobilize a social movement, a 'movement of movements', that will act politically to stop the self-destructive path of growth economies, creating a better society along the way. The theoretical sources as well as the political background of the different social groups inspired by degrowth make it difficult to speak of 'one' social movement, or a 'degrowth movement' in the strict sense.[1] Likewise, degrowth is a 'concept in the making', and it is equally difficult to find a single comprehensive definition. In its latest academic renaissance, degrowth has been described as the transition – via the gradual and equitable downscaling of production and consumption – to a quantitatively smaller and qualitatively different economy that respects the environment, increases human well-being and aims at social equity (for example, Schneider et al., 2010). Degrowth is also described as 'an attempt to re-politicise the debate on the much needed socio-ecological transformation', by becoming a 'confluence point where streams of critical ideas and political action converge' (Demaria et al., 2013: 192–3). Degrowth is therefore, at the same time, a critique, a proposed transition process, a vision and a political project (Latouche, 2010).

As a result, degrowth is a term used in many contexts and with various interpretations. Different proponents may consider it as either an inevitable path and a challenge to modern societies, and/or as a normative goal for a democratic, egalitarian and ecologically sustainable society. In the first case, the dilemma becomes whether degrowth should come as a result of continuing with business as usual and taking the form of a recession with catastrophic consequences and a forced adaptation, or else whether

[1] For a detailed overview of the historical and ideological origins of degrowth see Duverger (2011b), Muraca (2013) and D'Alisa et al. (2014).

awareness will be raised in time for the need for a radical redesign of the basic structures of society. In the second case, degrowth is not a destiny but a desired state of affairs, independent of the current dynamic, and as such offers a rallying cry and a political goal for environmental struggles all over the world (Martínez-Alier et al., 2010). The critique of growth as it is formulated within the degrowth literature not only addresses the technical dimension of GDP growth, but also encompasses the pervasive logic of growth, which implies competition, acceleration and expansion. Using the words of one of its key figures, Serge Latouche, what is at stake is the so-called 'social imaginary of growth', that is the overall legitimation background that somehow makes sense of our practices, institutions and habits in the society we live in (Latouche, 2009). According to Latouche, we are growth-addicted, caught within a compulsive attitude, which is functional to the systemic drivers of modern societies.

The degrowth discourse has gained popularity in times of crisis. Indeed degrowth is considered by some as a direct and necessary response to the triple environmental, social and economic crisis (Schneider et al., 2010), following the view that crisis can be an opportunity to reorganize societies and manage a 'prosperous way down' (Odum and Odum, 2006), before environmental collapse becomes catastrophic. Nevertheless, degrowth is considered desirable for its own sake by most of its proponents and should not be reduced to a response to an environmental emergency. The conceptual roots of the movement follow a long tradition of thinkers exposing the weaknesses of the notions of linear progress, Western development, self-interested individualism, productivism and more recently sustainable development. In particular, degrowth-advocates criticize continuous economic growth for, after a certain threshold, it intensifies social inequalities and exacerbates environmental problems.

Put simply, the degrowth proposal starts off with the proposition that in the so-called rich countries of the West a further growth of the economy is socially, ecologically and economically unsustainable (Alexander, 2012), and hypothesizes that people can live better with less, working less in the paid economy and having an improved quality of life as a result. Therefore, if degrowth – in the literal sense of a declining state – is 'inevitable', the question is *how* it can become socially sustainable (Kallis, 2011). For that reason, advocates of degrowth in a broader sense call for an organized and voluntary exodus from the capitalist growth economy. At the conceptual and cultural level, degrowth is opposed to the dominant ideology of *economism*, that is the idea that the economic logic pervades other spheres of social life and reduces their autonomous logics to merely instrumental rationality – a view stemming from the mainstream depiction of the economy as an isolated system, separate from the social, political and ecological spheres. Looking beyond GDP growth, it aims to redefine the collective values and core objectives of public policies. At the same time, through research, experimentation and participation in a democratic process, it begins outlining an ideal form of societal organization.

At the level of institutions and daily practices, degrowth ideas offer a coherent conceptual framework for various proposals and initiatives, which are born in different social movements and sometimes find political expression in parts of the Green and the radical Left. Thus, degrowth overlaps to a certain extent with claims and strategies put forward by movements, such as Transition Towns, the Indignados/Occupy, the movement for reclaiming the Commons, Solidarity Economy, Peer-to-peer production, and Global Environmental and Social Justice. It is in this sense that degrowth aims to act as a structuring concept, and a rallying slogan, for a movement of movements.

CRISIS OF GROWTH AND THE NEED FOR A SOCIAL AND ECOLOGICAL TRANSFORMATION

Economic growth has for a long time played a crucial role in stabilizing modern industrialized societies, by guaranteeing employment, social mobility, tax revenue, and thus social pacification. Modern capitalist societies, in fact, keep stabilizing and reproducing themselves dynamically, that is by means of a steady process of expansion and intensification with regard to space, time, energy and creative activity. As long as this process can carry on, stability is continuously yet dynamically restored. Expansion indicates the continuous occupation of new territories in a strict sense, as has been the case with territorial expansion of colonial powers at the dawn of industrialization, but also in a wider sense in terms of access to relatively cheap natural resources and to new markets. Expansion refers also to the ongoing appropriation of time by means of intensification and of externalization to the future: the shift from renewable to fossil sources of low entropy enabled a relative independence from the time needed for the regeneration of renewable sources (see next section). The intensification of exploitation in time not only affects natural resources. It can also be framed in terms of a steady acceleration of social, cultural and technological innovation: what Rosa calls an ‘overall acceleration of the pace of life’ (Rosa, 2005), by means of increasing positional competition and the drive to profit accumulation.

We are currently faced with a fundamental crisis of this dynamization logic that turns out to have dysfunctional effects with regard to the socioeconomic, political and cultural reproduction of modern, capitalistic societies (Dörre et al., 2010). On the one hand, external limits to growth, such as ecological constraints in terms of resource scarcity and sinks absorption, increasingly reduce the margin of profitability of capitalist investments (Mahnkopf, 2013) and spell therefore the approaching end of 'easy' economic growth. On the other hand, the immanent dynamics of stabilization have reached a point at which they undermine their own very conditions of reproductivity. Industrialized countries seem to have reached a threshold at which the feasible growth rates no longer secure employment, social mobility and welfare.

The 'limits to growth' debate, which in the early 1970s was framed mainly in terms of external, ecological limits and resource scarcity, is reaching a new, momentous turning point. We are now facing a double economic–ecological crisis, in which measures to enhance economic growth inevitably increase the pressure on the ecological systems and in the long run not only compromise economic development, but also erode the basis of democracy. While promising a return to the golden age of growth, austerity politics instead foster recession, leading to a massive redistribution from bottom to top, and requiring dramatic cutbacks on basic liberties. The trust in economic growth as a solution path is shaking as well. The exacerbation of environmental conflicts worldwide and the aggravation of the ecological crisis with regard to non-human nature and future generations boost an increasing moral critique of economic growth considered as the main driver for the environmental crisis (for more on this, see Muraca, 2012).

Moreover, the promise of growth as a condition for the improvement of quality of life for an increasing number of people has lost credibility, not only from a structural point of view, but also in the perspective of social actors. An increasing number of people in Western countries are becoming aware that the promise of growth for a better life no longer holds. As several scholars have repeatedly shown in subsequent studies, after a certain threshold economic growth decouples from both subjective well-being (Easterlin et al., 2010) as well as quality of life calculated by indicators such as ISEW (Max-Neef, 1995). Due to positional competition, the steady struggle for an improvement on one's own life is doomed to fail repeatedly. According to Binswanger we are all somehow 'trapped' within so-called treadmills, which, while promising happiness, foster constant dissatisfaction; for example, due to a phenomenon similar to the rebound effect, innovative time-saving devices lead to an intensification of the workload, which requires even more time than before, rather than saving time for other 'free' activities (Binswanger, 2006).

Growth has turned from a preferred means for securing well-being into a goal of its own. As such, it is not only exacerbating the pressure on the environment, but also jeopardizing democratic stability and social cohesion. Green growth strategies fail to work due to rebound effects (Polimeni et al., 2008) and the risks related to ongoing monetization of non-human nature, such as the impossibility of calculation and aggregation, the incommensurability of valuation languages, and the short-term perspective of economic cost–benefit analysis (Holland, 1995; Martínez-Alier et al., 1998). Keeping on a growth path at any cost increases the willingness to take risks (fracking, deep-water drilling) and to push exploitation beyond collectively negotiated boundaries (in natural reserves, fisheries, and so on). Whereas a growth-based society is destabilized by a recession path, a radical social and ecological transformation of the basic structures of society might help in transitioning towards a society independent from the growth addiction. When degrowth activists state that 'your recession is not our degrowth', this is precisely what they mean: since a growth-based society, which is no longer growing, is doomed to collapse, we are in need of a new vision for a radical transformation of the basic structure of society towards a degrowth path (Muraca, 2013).

EVOLUTION OF A SCIENTIFIC CONCEPT

From Ecological Economics to Degrowth

Occasionally used by critical French-speaking economists as a translation for downshifting, the term *décroissance* appeared in the political and cultural arena of France in the early 1970s. After the publication of the report by the Club of Rome, *The Limits to Growth*, in 1972 (Meadows et al., 1972), and the subsequent reactions in Europe to then-President of the European Commission Sicco Mansholt's explicit plea for a reorientation of the economy towards social utility instead of economic growth (see Duverger, 2011a: 118ff.), a vivid and controversial discussion arose among the French intelligentsia in particular. In 1973, *Les Cahiers de la Nef* dedicated a whole issue to this topic under the headline 'Les objecteurs de croissance' (growth objectors). In a paper of this issue, Amar introduced the term *décroissance*, which he intended in a rather unspecific way (not clearly distinguished from zero-growth). From a 'culturalist' perspective, Amar considered the paradigm of growth as rooted in the spirit of modern Western Civilization and criticized the moral and anthropological aspects of it (Amar, 1973). After the publication with the title '*La décroissance. Entropie – Écologie – Économie*' of some of Nicholas Georgescu-Roegen's main papers in a collection appearing in 1979 (Georgescu-Roegen, 1995, preface by Grinevald and Rens; Muraca, 2010, 2013), the term finally established itself in a more specific sense as an alternative to '*zégisme*' (the concept of zero growth). Georgescu-Roegen referred explicitly to John Stuart Mill's vision of a 'declining state' of the economy in terms of an improvement of quality of life and of the societal relations among people. He criticized Daly's 'steady-state' economy because the reductions it demanded were already too small in an economy such as the United States' in the 1970s.

According to Georgescu-Roegen, since all evolutionary processes are necessarily irreversible, economists will very soon have to reconsider their profession and move on from solely engaging with the issue of economic growth to identifying criteria to plan the declining state. He postulated that economic processes, rather than being mechanical reversible phenomena, resemble biological 'open systems', and as such they are creative, metabolic and qualitatively transformative: they rely on the qualitative difference between available and non-available energy and are therefore not simply quantitative phenomena of increasing size. Like biological processes, they feed on the low entropy of their environment. Entropy is for Georgescu-Roegen not so much the measure for absolute planetary limits, but rather a frame for conceiving the *unidirectionality* of time and the *irreversibility* of creative, qualitative and cumulative (since path-dependent) processes that take place on the planet. Entropy and evolution are thus the two sides of the very same coin. Planetary limits refer to the *rate* of use of resources and the limiting regenerative *time* of natural, living processes (Muraca, 2010).

Organic bodies survive and develop by feeding wisely on the single 'infinite' resource of low entropy available on our planet: the solar energy that is captured by the Earth's surface (land) just as a fishing net catches the fish. However, the flow of solar energy, which is infinite in its amount, is not at our disposal with respect to its rate. Endosomatic development depends on the flow rate of its basic source captured in the net of land as well as on the regeneration processes that keep that very 'net' at a constant level of functioning in order to support life. In their technological development, human beings managed to disentangle themselves from this temporal limitation by resorting to the so-called terrestrial stocks of low entropy (the result of a particular condition in the history of the planet, during which a big reservoir of low entropy – fossil resources – accumulated into stocks). Other than solar-based flows, stocks of low entropy are not infinite in size, yet their flow rate can be fixed at will according to society's needs.

The shift from renewable to non-renewable fossil sources has enabled a remarkable acceleration and intensification in the production of new instruments resulting in what we call the industrial revolution. Moreover, terrestrial stocks have been successfully utilized for increasing and accelerating the productivity of renewable processes (see, for example, the use of fossil-based fertilizers). However, for Georgescu-Roegen, this is not an indefinite path due to the limited availability of terrestrial stocks. In the end, the shift from renewable to non-renewable sources is based on the accelerated depletion of the terrestrial sources and is in the long run parasitic. Along this path is what Georgescu-Roegen calls an infinite regress, in which the maintenance flows[2] for a particular economic process are produced by another economic process and so on: the continuous intensification of productivity is rooted in the possibility of this shift onto terrestrial resources. In the long run, however, this acceleration spiral leads back to the only unlimited source of low entropy, which is solar radiation captured by land and is limited with respect to its flow rate.

Thus, the amazing development due to industrialization relies on a continuous displacement of environmental impacts to other sites (for example, to the Global South: Muradian et al., 2002) and to the future. By using and abusing terrestrial stocks today in order to intensify the productivity of funds, we compromise the options of future generations to do so (Muraca, 2010). 'Growth' – including green growth – roots itself in the exponential intensification and in the accelerating spiral of infinite regress that can keep the economic process growing further. 'Growth' becomes thus a goal in itself: the spiral has to keep going for its own sake, although in the long run this path is not only illusory, but also hazardous.

Modern History: a Pattern Emerges

Two decades later, the Rio Conference in 1992 revived the international debate on the ecological and social limits to growth, eventually leading to the controversial definition of 'sustainable development' (WCED, 1987: 43). For degrowth proponents the term 'sustainable development' is an oxymoron, that is, a contradiction in terms: by drawing on Georgescu-Roegen, they claim that with the dominance of the growth paradigm in the economic mainstream, economic development cannot be sustainable (Latouche, 2007). Latouche identifies the Colloquium 'Défaire le développement, refaire le monde' (Undoing development, redoing the world) held in spring 2002 at the UNESCO in Paris, as the date of birth of the *décroissance* movement. The Colloquium aimed at unmasking the

[2] Maintenance flows are all those factors that regenerate stocks – they encompass all those assimilative or absorptive services, referred to as sink functions, that render economic processes possible in the long run (all those factors that keep workers in good conditions are also maintenance flows).

destructive potential of the dominant model of economic development for third world countries: 'Western aid programs, financial or other, tend to disrupt local systems of resistance and self-reliance, simple "poverty" regressing into a state of material, social and cultural destitution' (Giornal, 2002). Latouche reclaims the 'post-development' tradition as the main origin of degrowth.

The 'modern' history of degrowth stems from social movements at the beginning of the century in France and Italy, and only re-entered the academic world recently, marked by the organization of the First International Conference on Economic Degrowth in 2008 in Paris, followed by similar, larger conferences in Barcelona (2010), Montreal (2012), Venice (2012) and Leipzig (2014). Moreover, in the last few years, degrowth has been on the research agenda of different international academic conferences held by the Society for Ecological Economics, as well as surfacing in political debates in many countries.

These movements were deeply inspired by, and in a way revisiting, Georgescu-Roegen's (1971) and the Meadows et al. (1972) 'limits to growth' debate. Some other key influences and main ideological standpoints of degrowth include the critiques of the technological society, or large organizations and the consumer culture (Ellul, 1964; Illich, 1973), as well as the Castoriadian notion of autonomy and the 'social imaginary' (Castoriadis, 1998[1975]). Table 8.1 outlines the main intellectual sources of degrowth, including some of the main authors associated with or inspiring the movement. An explicit recognition of the diversity of its sources listed is considered essential in order to avoid reductionist criticisms and misconceptions fundamentally incompatible with the ideas of the degrowth movement (Demaria et al., 2013). In degrowth the concern with biophysical limits or environmental degradation is always considered together with justice and democracy.

DEGROWTH AS A SLOGAN FOR A SOCIAL MOVEMENT

A Vision for the Radical Transformation of Society

After more than two decades of meagre results from policies in the name of sustainable development and ecological modernization it becomes increasingly clear that market or technological mechanisms alone are unlikely to bring about the envisioned change. A full ensemble of environmental and redistributive policies is required that, exactly because they threaten to 'harm' the economy, are less and less likely to be implemented

Table 8.1 Degrowth's main intellectual affiliations

Degrowth's conceptual roots	Key authors
Political ecology, environmental justice, critique of commodification, equity, redistribution	Cornelius Castoriadis, André Gorz, Joan Martínez-Alier
Culturalist critique of development, post-colonial and post-development critique on the westernization of cultures, buen vivir	Alberto Acosta, Arturo Escobar, Gustavo Esteva, Ivan Illich, Serge Latouche, Ashish Nandy, Helena Norberg-Hodge, Gilbert Rist, Wolfgang Sachs, Shiv Visvanathan
Critique of *homo economicus* and alternative anthropologies, anti-utilitarianism	Alain Caillé, Marcel Mauss, Marshall Sahlins
Meaning of life, happiness, non-violence, voluntary simplicity	Richard Easterlin, Ernst F. Schumacher, Henry D. Thoreau, Ted Trainer
Ecological economics, bioeconomics, strong sustainability, steady-state economy	Herman Daly, Nicholas Georgescu-Roegen
Direct, participatory democracy, conviviality, 'right to be lazy'	Cornelius Castoriadis, Jacques Ellul, Ivan Illich[3]

Note: Due to the dynamic nature of the movement, the list is only indicative and by no means exclusive.

Source: Modified from Flipo (2009), Schneider et al. (2010), Demaria et al. (2013) and Muraca (2013).

within existing market economies, whose basic institutions depend on and mandate continuous economic growth. An intertwined cultural and political change is needed that will embrace degrowth as a positive social development and reform those institutions that make growth an imperative. Sustainable degrowth is therefore not just a structuring concept; it is a radical political project that offers a new story and a rallying slogan for a social coalition built around the aspiration to construct a society that lives better with less (Kallis, 2011).

Degrowth in its core offers a vision for the radical transformation of society. More than just a critique to GDP growth, it provides a holistic critique and a radical questioning of the growth society with its heteronomous, hierarchical power structures that degrade human

[3] See also the special issue by Cattaneo et al. (2012) of the Journal *Futures*.

behaviours, as well as a tentative vision for a post-carbon, post-growth future. In this sense the degrowth discourse contributes to building a counter-hegemonic narrative (D'Alisa et al., 2013), and in many respects is an attempt to envision the next 'Great Transformation' (Haberl et al., 2011). Also influential within the degrowth community is degrowth's anti-systemic potential which, in Gorz's and Castoriadis' terms, 'is not primarily in the sense of a replacement of a certain system by a different, possibly better one. Rather, it is the critique of the very idea of "a system" as a functional given structure reproducing itself almost independently from the needs, aspirations and desires of people' (Muraca, 2013: 166).

A commonly cited vision is Castoriadis' notion of a revolution as the radical transformation of society, via the self-conscious creation and modification of society's institutional structure by the citizens (Asara et al., 2013; Muraca, 2013). According to Castoriadis, an autonomous or 'post-revolutionary' democratic society should not be simply a self-managed society, but a society that self-institutes itself explicitly, not once and for all, but continuously (Castoriadis, 1988). This then requires a democratic culture and a democratic identity (Olson, 2006). 'Revolution' is therefore not only about reacting, but most importantly about the building of alternative values that will lead to institutions less totalitarian, more democratic, more participatory.

Degrowth as a political project can trigger this process of societal transformation. It proposes a new storyline and provides a platform that would stimulate the creation of collective visions of a future that is simpler, but not regressive (Romano, 2012), ecologically sustainable and socially equitable, away from economism, towards autonomy. This interpretation of degrowth, somewhat ambitiously, requires nothing less than a total change in attitudes and a complete reordering of values. It requires the decolonization of the current social imaginary and the creation of a radically different organization of our society, since there is nothing worse than a growth society without growth (Latouche, 2009). Even more provocatively, Fournier (2008) proposes 'replac[ing] the consumer by the citizen', by resuming degrowth's political dimension and calls for a true democracy that would provide the conditions for new beliefs and norms to be instituted.

It comes as no surprise then that the degrowth proposal criticizes reactionary 'solutions' such as sustainable development and managerial approaches to overcome the ecological crisis, where conflicts are largely ignored. Instead, it intends to explicitly repoliticize and democratize the 'limits to growth' discourse, by opening spaces of deliberation, also giving voice to the marginalized (rather than speaking in the name of the poor), exploring the option space for sustainability and envisioning new socio-ecological futures. In the tradition of political ecology, it aims at unmasking societal conflicts, making them explicit, exposing vested interests and power structures.

From Vision to Practice

The concept of transformation is central and explicit within the degrowth debate. As the closing phrase of the Declaration of the Second International Conference on Degrowth in Barcelona 2010 outlines, '*the challenge now is how to transform, and the debate has just begun*' (Degrowth Declaration Barcelona, 2010). How is this transformation to come about then? From a degrowth perspective, the object of transformation is the current (Western) consumer–capitalist society, including its institutional structure and associated value system, that is the current capitalist (growth) social imaginary (Latouche, 2010) and the domination of 'economism' (Kallis et al., 2009) in all spheres of social life. Growth is considered integral to this system: 'It is not that this society *has* a growth economy; it is that this *is a growth society*' (Trainer, 2012: 593, emphasis in the original). It is exactly this 'growth society' that forms the object of a degrowth transformation.

Multiple subjects of transformation can be identified within the degrowth literature. The role of individuals, civil society and the state is considered more important and there is generally less faith in market policies and reforms. The political subject of degrowth is not traceable along conventional lines of class, but consists of a greater alliance between activists, academics, practitioners, ecologically concerned citizens, unemployed and underemployed, and includes those struggling for environmental justice in the Global South (Martínez-Alier, 2012), and peripheral North (Zografos, 2013). Other actors include research institutions, civil society, social movements and even national governments, shaping the public discourse, creating spaces and experimenting with alternative institutional structures.

Respectively, the means of transformation, also referred to as 'degrowth strategies', vary from oppositional activism to building alternatives and reformism from local to global levels (Demaria et al., 2013). Oppositional activism involves direct action by civil society such as demonstrations, boycotts and civil disobedience that does not bring transformational change by itself, but can slow down unsustainable paths and raise awareness.

The building of solidarity economy alternatives, also described as 'nowtopias' (Carlsson and Manning, 2010), refer to the creation of new institutions outside of present ones. In the words of Trainer (2012: 597), 'we do not have to get rid of consumer-capitalist society before we can begin to build the new society. The way to transcend the consumer–capitalist system in the long run is to ignore it to death'. Examples include co-housing projects, producer–consumer cooperatives, permaculture initiatives, ecovillages, open source technologies, non-monetary exchange systems and so on. These examples contain seeds of a different culture and an alternative model of a low-scale, low-carbon economy and society in practice that, overall, create a political proposal and not a blind return to an idealized past. Beyond the short-term provisioning of specific needs, they help deconstruct the consumer–capitalist anthropological type and promote the creation of a collective political subject. Based on non-hierarchical structures and concepts such as solidarity, collectiveness and collaboration, they create spaces of experimentation, building alternative structures and effectively creating a new model of societal organization, while having the potential of changing values and perceptions. They do not provide a ready-made example, but provide existing examples that attract people open to new ideas, calling for the collective co-formulation of alternative proposals and life forms. Rather than seeking to first define and then make alliance with the subject that is relevant for degrowth, the basic idea is that by participating in such ventures, a new collective political subject is created.

A further strategy is the reform of current institutions to create the conditions for societal transformation. Some consider this as conflicting with the goal of degrowth as a revolutionary project. However, we cannot escape the fact that a 'degrowth society' has to emerge from the current, capitalist, system (Boonstra and Joosse, 2013), so even a transformation must include steps of 'revolutionary reformism' (Demaria et al., 2013: 207), that is, a reformism that destabilizes hierarchical structures and opens spaces for radical new forms of social organization to emerge, creating in the process a new anthropological type. This closely follows Gorz's (1967) idea of a non-reformist reform: 'while a reformist reform subordinates its objective to the criteria of rationality and practicability of a given system, a non-reformist reform implies a modification of the relations of power and implies structural reforms' (Muraca, 2013: 166). Examples include environmental policies (resource and CO_2 caps, extraction limits), social policies (basic income, maximum income, social security guarantees, reduced working hours) and economic proposals (social enterprises and cooperative firms, ethical banks, environmental taxation), as well as an array of more radical proposals, such as the restriction on advertisement and the creation of commerce-free zones (Jackson, 2009; Johanisova et al., 2013; Kallis et al., 2013; Korten, 2008; Latouche, 2009; Speth, 2012).

The strength of degrowth is both the plethora of theoretical sources from which it draws, and the diversity and complementarity of its strategies, ranging from oppositional activism to academic research and from bottom-up ‘nowtopias’ to policy proposals. Some open questions that remain are: to what extent and until which level can nowtopias take place parallel to existing institutions, filling the gap of the central state? To what extent can or should they be institutionalized? Can radical policy proposals emerge through liberal democratic regimes? And finally, what can the institutional framework be of a ‘degrowth society’? These and many, many others are the questions that a degrowth framework generates. Of course one cannot (and should not) give a clear and definite answer to those questions. Degrowth is therefore also fundamentally a call for new research; it is a new paradigm, in the sense that it sets and demands answers for questions that were not posed before.

ECOLOGICAL ECONOMICS RESEARCH ON DEGROWTH: A TENTATIVE AGENDA

The literature on degrowth, much of it by ecological economists, has offered a strong critique of growth as a social objective, opening up explorations of alternative policies and trajectories beyond, or without, growth. However, there are many pieces missing in the puzzle of a coherent account concerning why and how the growth economy is failing, why the growth objective is sustained despite its apparent failures, how this deadlock can be changed, by whom, under what conditions and in what direction.

One could classify the degrowth research agenda into five main areas and sets of questions. The first task concerns strengthening the case that economic growth (even green growth) is unsustainable and prone to crises. Second, it is necessary to illuminate better the socio-political and economic forces that sustain growth as an objective in modern, capitalist economies and to identify how some of those rely on growth for their stabilization and reproduction. Third, we need to understand better the conditions under which degrowth may become socially beneficial. Fourth, it is important to study the grassroots initiatives that practise a degrowth imaginary and theorize the conditions under which they may be scaled up and generalized. Finally, there is a need to evaluate the institutional options and the policies that can facilitate a degrowth transition. The degrowth agenda is an interdisciplinary and transdisciplinary one *par excellence*, requiring collaboration between economists, sociologists, political scientists and philosophers, environmental scientists and scholars of energetics, ecologists, historians and anthropologists. As a transdisciplinary field of action-oriented research, Ecological Economics offers an ideal platform for this collaboration.

Strengthening the Case

Ecological economists, and not only them, have made a sound case that, above a given level, economic growth does not increase happiness, it has more social and environmental costs than benefits, and that continued growth cannot be sustained indefinitely given ecological limits. Green growth and dematerialization are seen as fundamentally limited by the Jevons paradox, that is, the postulate that increased efficiency in the use of resources leads to their accelerated use. Economic growth and the aversion of dangerous climate change are therefore fundamentally at odds.

While there is theoretical and empirical material supporting the above, the case against growth is far from closed, especially as far as 'the limits to growth' and the 'impossibility of green growth' theses are concerned. Ecological economists, for example, have postulated, but not empirically verified, that resource limits are *already* putting a brake on economic growth. Growth may be unsustainable in the (very) long term, as Georgescu-Roegen had shown, but this does not prove that such limits are to be experienced now, and not in hundreds or thousands of years. There are some mainstream economists who are suggesting that mature economies may be entering a period of stagnation, but the reasons typically given have to do with the exhaustion of technological innovations and investment opportunities, not ecological limits (Gordon, 2012). Others do argue, like degrowth advocates, that high oil prices are bringing an end to growth (Rubin, 2012; Heinberg, 2011). If so, however, it is not clear why this end should arrive only in Europe and the US and not Asia or Latin America. It is also not clear whether increased oil prices caused the crisis, or whether the crisis caused a rise of oil and commodity prices (since commodities are safe investment havens in a period of devaluation), or whether both the crisis and increasing oil prices were the outcome of a third force, namely capital flows from accumulated surpluses in Asia towards oil states and the US housing market. Finally, even if fundamentals in the oil market had a causal effect on the recession, it is not clear if they themselves were caused by supply limits, intentional underinvestment by producing countries, or growing demand for oil.

Research on the energy return on investment (EROI) of different energy sources hints at diminishing energy surpluses (energy returns on energy investment) over time and lower surpluses for new sources (for example, nuclear or wind energy) compared to conventional ones. However, as EROI proponents admit, there is much more empirical research to be done and conceptual problems in the calculation of EROI to be solved before substantiating these claims (Murphy and Hall, 2010). There is also no data, to our knowledge, supporting the claim that declining EROI is already halting the global economy, or that it leads to substitution of capital by labour, increasing working hours (Sorman and Giampietro, 2013). Both are plausible, yet so far untested hypotheses. Conventional energy scholars are more optimistic concerning the costs of new energy sources (Smil, 2010); the declining gas and shale gas prices, and the 'reshoring' of industrial activity they allegedly stimulate in the US suggest that the 'limits to growth' argument is far from settled.

The same applies for the case against dematerialization. Some mature economies, such as the American, the German and the English, are showing signs of absolute decoupling for energy or selected raw materials (UNEP, 2011; Fischer-Kowalski and Haberl, Chapter 5 in this *Handbook*). The extent to which this is a data artefact of the offshoring of production is not clear, but it cannot be ruled out that some genuine dematerialization is taking place in these economies. Indeed, one cannot assume a priori that the total (micro and economy-wide) rebound effects of any efficiency improvement will be higher than 100 per cent. There is a need for continued systematic empirical research that supports the degrowth hypothesis that genuine dematerialization is way too difficult, too little and too slow to make a difference.

The Production and Sustenance of the Growth Fetish

If economic growth does not increase well-being, is uneconomical for the majority of people and anti-ecological for the planet, what is it that sustains it as a primary national objective? This question welcomes research on various fronts. One is a subject of political science and the processes through which vested economic and professional interests work in the international and national political arenas to maintain GDP as the main indicator of national progress. Related is a question of Science and Technology Studies (that is, the anthropology and sociology of scientists), that is how and why economists and the economic profession perpetuate and reproduce the 'growth fetish' (Hamilton, 2003). At the level of culture and society as a whole, the question is: how did the idea/discourse of growth become socially dominant and how is its hegemony reproduced?

Finally, and most importantly, there are questions of political economy, where critical and institutional economics insights are relevant. First, there is the hypothesis that growth may be maintained as a goal even if it has become socially uneconomic, to the extent that powerful interests still benefit from it. In others, growth may continue as long as it is good for the 1 per cent, even if it is bad for the 99 per cent. In an alternative scenario, the end of economic growth might lead instead to a path of 'refeudalization' (Neckel, 2011), in which very few incomes keep growing while the great majority of the people are left coping with poverty and destitution (to put it simply: no GDP-growth and harsh redistribution from bottom to top as seems to be the case with the consequences of austerity politics in Europe).

Second, there is the question of how certain institutions and processes that are prevalent in capitalist economies make growth necessary. Van Griethuysen (2010, 2012), for example, has illuminated the ways in which the capitalization of property and the growth of credit guaranteed by property create a growth imperative, Loehr (2012) focuses on the role of positive interest rates, and Douthwaite (2012) and Mellor (2010) on the creation of debt and money by the banks. This calls more generally for research on the ways in which capitalism produces and requires growth (Blauwhof, 2012; Klitgaard and Krall, 2012; Nadal, Chapter 6 in this *Handbook*). The issue here is not whether capitalism without growth is theoretically possible (Lawn, 2011, argues it is), but rather that in real-existing capitalist economies, lack of growth leads to an increase in the rate of exploitation of the workforce if profits are to be maintained (Blauwhof, 2012; Harvey, 2011), which in turn makes degrowth socially detrimental and politically unstable.

Conditions for Sustainable Degrowth

Economic growth may be unsustainable, but it does not follow from this that economic degrowth will be sustainable, or in other words ecologically and socially beneficial. For example, as national income falls, unemployment may rise, living standards and life satisfaction decline and investments in environmental protection diminish. A crucial research question then concerns the conditions under which an economic contraction may turn out for the better, or at least be tolerable. Anecdotal evidence suggests that while some countries, such as Japan, fared relatively well without growth (leaving aside the alarming growth in the debt), others, such as Spain, have suffered from degrowth after 2008, especially because of unemployment. Why do some countries collapse while others remain stable, or even prosper without growth? There is scope here for econometric research correlating explanatory variables with positive outcomes as well as for in-depth case studies of political economy. Econometric research calls for the development of indicators of sustainable degrowth, since declining GDP is not a proxy. O'Neill's (2012) degrowth accounts are useful in this respect.

Related to this is the question concerning the conditions under which a fall in income may lead to an increase, or at least not a decrease, of life satisfaction. Happiness research has illuminated the links, or rather the lack of links, between income and happiness, but has not tested sufficiently the inverse hypothesis, that is, that happiness may not suffer as a result of degrowth. This is not an unreasonable hypothesis: if expectations adapt to rising incomes and if life satisfaction is a function of relative position and not absolute income, then declining incomes may not have a negative happiness effect in the long term, if inequality does not increase, or even better, if it decreases. This of course flies in the face of the anecdotal evidence of dramatic falls in living standards and life satisfaction in countries hit by economic crisis, such as Argentina or Greece. One issue to be investigated is whether the fall in life satisfaction in these countries is an outcome of declining incomes per se, or of structural adjustment and austerity programmes. The happiness research suggests that life satisfaction does not correlate with growth, but only once basic needs have been secured. In countries under austerity programmes, which suffer losses of basic welfare services (health, access to food and clean environments), it might as well be the case that growth does impair the satisfaction of basic material needs, hence the loss of well-being. Moreover, self-reported happiness bears the risk of merely mirroring coping strategies, modes of subjectivation, and cultural influences that might very well mask relations of domination, forms of discrimination and injustice. Further research linking degrowth scenarios with, for example, the capabilities approach or needs-related research (Max-Neef, 1991) will be of great importance in the future.

In capitalist societies, lack of growth is associated with stagnation and a stasis, if not decline, in the quality of life. Capitalism, however, and the period of continuous growth that it brought, is a relatively recent and geographically constrained phenomenon, seeing human history as a whole. A grand part of humanity lived (and some continue to live) in socioeconomic systems whose material production did not grow, and was not even intended to grow. Why and how have some societies organized to avoid accumulation and growth, or more rarely, to downscale? What can we learn from such 'original affluent societies' (as Marshall Sahlins, 1972 called them) that is relevant for contemporary societies? What were the institutional, cultural and environmental characteristics of such non-capitalist, non-accumulating societies? Anthropological research on so-called 'egalitarian societies' has much to offer here, not least the tentative hypothesis that egalitarianism (that is, a non-hierarchical distribution of power and resources) and lack of accumulation go hand in hand.

Finally, research on the possibility for sustainable degrowth would benefit from scenarios and precise, even if speculative, articulations of the specific economic, social and metabolic conditions envisaged. In other words, what do plausible degrowth futures at the national, regional or local level look like? How much will people work, paid and unpaid, in production and reproduction, and who will do this work? How much in materials, food calories or energy would they consume? How efficient would they be in their production? How many would they be? Putting numbers to degrowth proposals is necessary if the imaginary is not to be totally divested from material conditions and reality. Indeed, preliminary research with energy, work and income data (Sorman and Giampietro, 2013), as well as with standard income data (Victor, 2012), suggests that the level of degrowth required given energy or climate limitations is much higher than previously thought, and would not be possible without a dramatic reorganization of social life (Sorman and Giampietro, 2013). While some are pessimistic of this reorganization taking place without a social disaster and a catastrophic conflict (Sorman and Giampietro, 2013), others maintain that human societies can and do adapt to changing socio-environmental conditions by transforming their institutions (Kallis, 2013).

The Degrowth Imaginary in Practice

Degrowth is not only a theory. It is an imaginary that already informs, consciously or unconsciously, with precisely this or similar terminology, the imaginary of many collectives that produce on the ground alternatives to the growth economy. Carlsson and Manning (2010) document convivial 'nowtopian' communities of pirate programmers, outlaw bicyclists and vacant lot gardeners that do free (unpaid) work to produce for use rather than for market exchange. Conill et al. (2012) extend the subset included under such 'alternative' non-capitalist economic practices, and consider various forms of non-money-based sharing, cooperative production and consumption, and alternative forms of housing, financing and banking. Their empirical research in the city of Barcelona suggests that a much greater than previously thought part of the population dedicates at least part of its time and activity to such practices. They postulate a causal link between the crisis (and the failure of States and markets to provide for basic human needs) and the flourishing of such practices. There is still more research to be conducted on understanding why some people – voluntarily or involuntarily – downshift, experiment and organize collectively around such non-capitalist practices. Even more important is to understand when such initiatives succeed and propagate and when do they fail or get assimilated by the mainstream, growth-oriented, economy.

The mere fact that there are economic practices and networks nourished by a degrowth imaginary is important. Independent of the outcomes of such initiatives, it is important to learn whether, and how, degrowth theory informs such social innovation. On the other hand, from a less theoretical perspective, the question of whether, or how and in what ways, such localized experiences can be scaled up remains important. There is both a biophysical and a socio-political component in this question. How feasible, for example, is it to feed cities with small-scale organic cooperative farms? How would food and transport networks have to change towards this end? What is the ecological performance of existing nowtopian initiatives? Do they make a difference after all or are they feel-good projects? Cattaneo and Gavaldà (2010), for example, document significant reductions in energy and material consumption in communal ecological squats in the outskirts of Barcelona, but recognize that more research is required to evaluate and take into account how the members of these collectives benefit from collective infrastructures and the formal economy. Politically a crucial question is the transformative potential and the possibility of collective action by the participants in such initiatives. Do participants in networks of alternative economic practices politicize through their engagement, especially under the crisis, which attracts to these initiatives people driven by need rather than desire, or is this merely a lifestyle or survival choice? Do participants form a shared experience of a non-wage labour class, as Carlsson and Manning (2010) argue, or are these individual projects?

Such questions are part of the broader theme of the political potential for a degrowth transition. The changes hinted at by degrowth advocates are radical, and cannot plausibly come about unless a sufficient number of people and movements organize collectively and build fruitful alliances constituting counter-hegemonic blocks against the mainstream neoliberal regime. From a sociological perspective, the question is who struggles or may struggle, and how, for reforms that could bring prosperous degrowth. More research on societal transformation (see, for example, Brand and Daiber, 2012) and/or transition is required. How do existing social movements articulate the growth/degrowth problematic, and how influential is it in their deliberations? How does the degrowth imaginary nourish existing social movements, such as the Indignados/Occupy mobilizations? How do degrowth ideas get institutionalized in government plans and policies, thanks to whom, and through what socio-political dynamics? How effective are such incipient institutionalizations and what dangers do they hold? Is there a confluence between degrowth social movements in some rich societies and the larger environmental justice movements in the global South? (Martínez-Alier, 2012).

The degrowth research community, like – to a smaller degree – the ecological economics community is not a conventional scientific community, but is one where action and research are intertwined and reciprocally motivated. Degrowth researchers not only conduct 'scientific analyses *of* societal transformations' but also 'scientific analyses *for* societal transformations' (Driessen et al., 2013, emphasis in the original). Much of the research on alternative economic practices can be classified as what Martínez-Alier calls 'activism-led science' (Martínez-Alier et al., 2011), conducted by scientists involved in the very practices they study (for example, Cattaneo and Gavaldà, 2010, who are residents of the squats they analyse). Such Action Research produces knowledge intended to improve and expand such experiments, and not at the expense of objectivity and analytical rigour.

Policies for Degrowth

Several economic policies and institutional changes have been proposed as part of the degrowth debates. These include work-sharing (reduced working hours), an unconditional basic income or autonomy allowance (Liegey et al., 2013) and a job guarantee scheme; public control of money, alternative currencies and full reserve requirements. The first three aim to provide meaningful employment and economic security in the absence of economic growth and as indirect instruments for the redistribution of the (shrinking) economic product. The latter three focus on the reform of the monetary system, intending to stop the uncontrolled supply of money by banks, which is seen as fuelling bubbles and a virtual growth which has material and ecological consequences (Kallis et al., 2009).

Whereas degrowth scholars give logical arguments in favour of such policies (for example, Daly, 1997; Jackson, 2009; Latouche, 2009; Mellor, 2010), there is little formal or empirical work in testing the actual outcomes, and the advantages or disadvantages of such policies. The fact that the same proposals are put forward by some in the name of growth, suggests that degrowth scholars have to do a better job in formulating how and under what conditions such policies may foster sustainable degrowth, rather than growth. In reviewing the literature on working hours reductions, Kallis et al. (2013) find that reduced working hours may secure employment without growth. They argue, however, that whether reducing working hours has positive environmental outcomes depends on complementary policies. They also caution that there are important limitations in the effectiveness of the policy given the changing nature of work in service economies, and globalization forces that make national regulations of the labour market difficult. Dittmer (2013) reviews evidence on community currencies and is sceptical of their impact and scalability. There are scant evaluations of the impacts of other policies such as a basic (citizens') income or full-reserve requirements, and empirical research is limited by the fact that these are just proposals and have not been implemented anywhere.

CONCLUSIONS

Crisis can be perceived as a unique opportunity for transformational change (Schneider et al., 2010), for the self-institution of society, provided there is a vision of the desired direction. Degrowth, as an interpretative framework, intends to provide such a vision and a platform where 'radical' initiatives will come into contact with majoritarian parts of society. Degrowth invites rediscovering concepts such as the importance of community, cooperation, solidarity, hospitality, and the importance those had for prosperity in past societies, much more than a blind faith in economic prosperity. Past societies of course included many elements of oppression as well; the challenge for degrowth is indeed to highlight those elements that deserve to be saved and those that need to be overcome, deconstructing the idea of linear progress and following an alternative vision of prosperity. Future research should further explore the institutional and procedural framework of a degrowth society, incorporating insights from vibrant discussions on new forms of democracy.

The 'limits to growth' debate has been going on (and off) for many decades and ecological economics has been central in its advancement. Original concerns, also leading to the idea of a steady state economy, focused on the biophysical limits to growth. On the other hand, the biggest contribution of the degrowth debate so far is not the recognition that there are biophysical limits. It is rather the increasing and explicit emphasis on the social consequences that this realization entails and, at the same time, a call for how to make the 'inevitable' biophysical degrowth socially sustainable, between and within countries. Thus here lies the invaluable potential of the debate: rather than individual environmental policies, increasingly rejected because of their 'cost to the economy', degrowth offers a new narrative and vision, a new political project to trigger the process of a democratic socio-ecological transformation.

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9. Water: ecological economics and socio-environmental conflicts

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1. INTRODUCTION

There is a hydrological cycle, which would also exist if there were no humans (Arnell, 2005). Driven by sun energy, this cycle has a fundamental importance in the regulation of climate and in life on the planet (Ehrlich et al., 1977). Yet human agency has come to shape the circulation of water, through canals and dams, with abstractions for irrigation and drinking water and the modifications of the chemical, biological and hydromorphological properties of the watercourses for the benefit of some sectors of the population, and to the detriment of others. This is the hydro-social cycle (Swyngedouw, 2009b; Boelens, 2013).

Humans require certain amounts of water of different quality (for example, for drinking, agriculture or to cool thermoelectric power stations). Following Naredo (1997: 14), the 'gradient' of the water quality tends to decrease since it is available in the form of rain or snow until it reaches the sea. Through human agency, water accumulates polluting substances and organisms – making it unavailable for some human uses – until it reaches its maximum level of entropy on reaching the sea (Ma et al., 2009). Then, solar radiation returns water to the clouds and the cycle continues, although the global entropy production may have been expanded (Michaelian, 2012).

Of course, 'natural' water pollution occurs sometimes, as in the case of arsenic-containing bedrock formations in some Asian countries (Garelick et al., 2008; Sultana, 2011). In general, though, Naredo's description applies. When a mining company or urban areas use water to evacuate waste, the quality goes down. Therefore it cannot be used in other applications such as irrigation in agriculture unless its quality is enhanced again through costly water treatments. Changes in quality may be related to human-induced chemical pollution (Pastén-Zapata et al., 2014), thermal (Herb et al., 2008; Prats et al., 2010) or microbiological pollution (Kirschner et al., 2009). There is even the concept of biopollution to refer to damaging alien species introduced in aquatic ecosystems as an outcome of human action (Elliott, 2003; Olenin et al., 2007).

Historically, water management systems are designed to influence the hydro-social cycles by reshaping the river basin waterscapes (Linton and Budds, 2014; Schmidt, 2014; Williams, 2001; Molle, 2007). The search for adequate quality water has motivated the construction of wells and cisterns to collect rainwater for domestic use in areas of brackish groundwater and scarce surface water (Haddad and Mizyed, 2004). It has also motivated interbasin transfers of water (Molle, 2007; Andrade et al., 2011; Yevjevich, 2001) and investments – in money and energy – to obtain fresh water through desalination plants (Swyngedouw, 2013; Meerganz von Medeazza, 2004). Against geo-political pessimists who announce that 'water wars' are more intense than 'wars for oil' (El Kharraz et al., 2012), one can show a certain technological optimism regarding desalination for urban water needs (Haddad and Mizyed, 2004). This is different from pushing desalination for mining (as in Northern Chile), for agricultural luxury exports (as in coastal Peru), or for rich tourists in the Canary Islands (Meerganz von Medeazza, 2004).

Political ecology studies how the distribution of power (which is the main subject of political science) determines the use of the natural environment between categories of humans and with regard to other species (Robbins, 2012; Bryant and Bailey, 1997). The focus of political ecology is on how the costs and benefits associated with environmental change are unevenly distributed among humans. For instance, women are particularly exposed to tensions related to (safe) water access and unequal distribution of labour (and emotional) management costs (Sultana, 2011). Another angle is to understand how a reduction of inequalities of gender, caste, race or social class empowers the unprivileged, and changes ecological distribution (Robbins, 2012).

The notion of environmental justice (EJ) arose in the early 1980s in the United States from the inequity in the distribution of environmental risk among different segments of society (Bullard, 1994). Later, the definition expanded to encompass the recognition of representation of the social actors involved, and the guarantees for their effective participation (Schlosberg, 2003; 2007). In the last decades the EJ discourse has expanded geographically, horizontally across a broad range of issues, vertically in the global nature of injustices, and conceptually in relationships with the non-human world (Schlosberg, 2013; Walker, 2012). The new movements for 'water justice' or 'hydric justice', born from local conflicts and struggles on water, are an example. From their standpoint, water runs in the direction of power or water flows towards money (Boelens et al., 2011).

The main rationale behind this chapter is bringing together the literature on political ecology, water justice studies and ecological distribution conflicts. While systematically examining the interplay between the above fields, a key concern has been to highlight novelty. As an additional value added, the chapter brings to a broader audience contributions from a fertile Hispanophone literature in water justice studies and activism.

This chapter first examines common methodological approaches for the analysis of water conflicts. Then, case examples are discussed using a taxonomy of water conflicts based on the stages of the commodity chain. An argumentation follows on social mobilizations in water conflicts as effective providers of a management alternative. Conclusions are drawn in the final section.

2. APPROACHES FOR THE ANALYSIS OF WATER CONFLICTS

Political power appears in political ecology on two levels: first, the power to impose a decision by reason or by force; second, the power to impose a procedure that legitimizes the decision, including processes of knowledge generation.

2.1 Cost–Benefit Analysis vs. Plurality of Values and Multicriteria Evaluations

In economics Cost–Benefit Analysis (CBA) has been applied since the 1940s to legitimize decisions on multi-purpose development of river basins. It has traditionally played a key role in favouring dam projects (Kotchen et al., 2006), although it has also justified dam decommissioning (Pejchar and Warner, 2001). Since Krutilla (1967), cost–benefit analyses considered recreational values (*amenities*) of aquatic ecosystems for fishing or for sports or for the contemplation of beautiful landscapes, as economic values growing in importance in time compared to the revenue from the production of electricity and water for irrigation. Whatever its outcome, CBA by definition imposes commensuration (Samiolo, 2012), with discounted monetary valuation – in actual or fictitious markets – of all costs and benefits. Commensuration precludes some groups from deploying valuation languages that rely on alternative rationalities, for instance in terms of indigenous territorial rights, livelihood values or sacredness.

From a political ecology perspective, there are multiple ways in which impacts (or external costs) are created and affect particular groups, for example water shortage, floods, pollution (Molle, 2007). The multi-criteria evaluation (MCE) approach arose against CBA. It enables a plural account of the ecological functions of water in the ecosystems and their associated values, which are not readily measurable in money terms or in any other single unit. MCE methods help to structure social-choice problems involving ecological, social, political and economic objectives in conflict, considering various interest groups and different valuation languages (Munda, 2008). Technical MCE are helpful in exploring policy options and constraints in cases where water conflicts have been exacerbated by public policies in the past, like in the conflicts between ecological conservation and agricultural development in the Sanjiang Plain of China (Wu et al., 2012). Methods that account for different types of knowledge and provide opportunities for participation and learning better support necessary deliberations in environmental conflicts (Gerber et al., 2012). Such kinds of social MCEs have been used, for instance, in cases of water conflict in Southern Europe (Paneque Salgado et al., 2009; De Marchi et al., 2000; Antunes et al., 2011).

2.2 Water Social Metabolism

From the point of view of social metabolism, the natural water cycle is a 'fund' which constantly provides a flow of products and services, including water supply, an ever-renewable resource whose future availability does not depend on whether we use more or less of it. Water evaporates using solar energy and precipitates in similar amounts from year to year although with regional variability. However, there are also exhaustible water stocks. When groundwater pumping exceeds the replenishment rate, the aquifer gets depleted. This is similar to a biological renewable resource (timber or fish) that can become exhausted, although here the renewal rate does not depend on the biological reproduction but on the infiltration of water. Another effect of the destruction of water stocks is salinization and the subsidence and consequent compaction of the aquifer with loss of storage capacity. Surface water stocks, such as those in glaciers providing peasant communities with irrigation water (Vergara et al., 2007), decline due to global climate change or direct impacts of human activities (Urkidi, 2010; Vergara et al., 2007). What was renewable becomes exhaustible.

Virtual water (VW) is the amount of water used in the process of production of goods throughout their life cycle (Allan, 2003; Hoekstra, 2003). The per capita consumption of VW contained in the diet varies according to the type of diet. While a subsistence diet may require volumes in the order of 1 m^3 day, a diet with high meat means a use of virtual water of 5 m^3 day (Allan, 2011). The volume of VW trade and the number of trade connections are twice as big as two decades ago, increasingly pressuring water scarce sources (Lenzen et al., 2013).

In the same vein, the *water footprint* (WF) of an entity (individual, community or company) is the total volume of freshwater used to produce the goods or services consumed by this entity (Hoekstra and Mekonnen, 2012). The concept can be divided into the 'blue' water (that is extracted from the rivers, lakes and aquifers in production processes, for example, irrigation), the 'green' water (evapotranspired during the growth of crops) and 'grey' water (contaminated by agricultural, industrial or domestic use) (Mekonnen and Hoekstra, 2011). The Water Footprint Network[1] provides some examples that point to the inequities in the use of the resource. China's WF is in the order of 700 m^3 year per capita, of which only 7 per cent is obtained outside its borders. In contrast, also in Asia, the Japanese have on average a footprint of 1150 m^3 year, 65 per cent obtained abroad.

While the VW and WF indicators account for the water flows associated with a given economic or social entity, they do not properly analyse the interdependencies between production and consumption processes and the properties of the water cycle in which they are constrained (Madrid and Giampietro, 2015; Velázquez et al., 2011). New developments in this respect highlight the limits of human appropriation of water, by withdrawal or pollution, based on the stability of the ecological (hydrological) funds (Madrid et al., 2013).

2.3 The Ecosystem Service Approach

In addition to any extraction for human use, water has a fundamental role sustaining ecosystems: without water, life would not be possible (Ehrlich et al., 1977). Ecosystems' water demands depend heavily on their plant communities. Thus, the existence of areas with little natural vegetation can be understood as an ecological response to low rainfall. The introduction of irrigated vegetation in such areas generates scarcity, as with the introduction of golf courses covered with grass in the Mediterranean, or the extension of the agriculture frontier in seasonally water-scarce areas (Molle, 2007). In absence of this, the natural availability of water in each territory is a determinant of the kind of benefits that humans can expect of their ecosystems.

The identification of the environmental services provided by aquatic ecosystems is important for political ecology. In the 1990s, one decade before the 2005 Millennium Ecosystem Assessment, Daily (1997) and De Groot (for example, De Groot et al., 2002; De Groot, 1992; Gómez-Baggethun et al., 2010) vigorously supported the notion of environmental

[1] www.waterfootprint.org.

services seeking to analyse how the ecological functions serve human purposes, such as the water cycle (evaporation, precipitation) and the cycle of carbon (see Table 9.1 below). More recently, the initiative The Economics of Ecosystems and Biodiversity (TEEB) (Sukhdev, 2008) dedicated one of its reports to the nexus between the hydrological cycle and the provision of ecosystem services in aquatic ecosystems such as coral reefs, coastal systems, mangroves, other wetlands, rivers and lakes (Russi et al., 2013).

Environmental conflicts about water can be seen as conflict over who takes advantage and who loses access to environmental services, either services of provision, regulation, cultural or support. Table 9.1 provides supporting examples of water-related ecological distribution conflicts across these categories.

The appropriation of biophysical processes of water basins is often the foundation of large projects of economic development, as in the long-standing efforts by the different countries along the Mekong basin (Sneddon and Fox, 2012). However, trade-offs between ecosystem services are common, as in the case of irrigation and nature conservation (Molle, 2007; Wu et al., 2012; Walsh, 2013) or hydroelectric power production and support services (Kunz et al., 2011; Gong et al., 2006). From there, there is an emergence of social conflicts that can be studied looking at the languages of valuation deployed and the power of those involved.

Ecosystem services are fundamental in the survival and livelihoods of the rural poor, and their loss may result in increased poverty (Christie et al., 2012). Today it is common to preach in favour of the payment for environmental services (PES) to deal with these conflicts. A city downstream can pay to communities upstream for taking care of the water, compensating them financially for conservation practices or for not contaminating the water with agrochemicals. Here the distribution of power and the distribution of income are relevant, beyond market mechanisms and charming Coasean negotiations. For example, the sugar cane producers of the Valley of Cauca in Colombia make a token payment to the indigenous villages upstream (Echavarría, 2002). These payments are gradually changing property rights, so that the powerful cane growers feel as if they are owners of the water rather than the indigenous populations. The use of the ecosystem services framework, particularly in connection with PES, is seen as a step forward in the direction of nature's commoditization (Kosoy and Corbera, 2010). For this reason, its application for the study of environmental conflicts is fiercely contested by some environmental justice organizations. Moreover, it is not always possible to offset damage. A confluence of rivers (*prayag*, in the Himalayas) or a waterfall can be a place of worship, sacred to the local population (Colopy, 2012). If it is

Table 9.1 Ecological distribution conflicts on water and ecosystem service provision

Categories	Services	Example	Reference
Provision	Food provision (biophysical base for fishing, hunting and grazing)	Transition from commercial fishing to an amenity economy in coastal areas of North Carolina	(Campbell and Meletis 2011)
	Provision of raw materials (fibres, wood)	Tree plantation conflicts (Ecuador, Cameroon, South Africa)	(Gerber et al. 2009; Van Wilgen and Richardson 2012)
	Domestic water supply	Arsenic contamination of drinking water in Bangladesh	(Sultana 2011)
	Agricultural water supply	Increased demands for irrigation: after the Green Revolution in Thailand; since 1950s in large-scale farming in China	(Molle 2007; Wu et al. 2012)
	Hydropower production	Large-scale hydroelectric development in the Mekong River leads to inland fisheries decline	(Sneddon and Fox 2012)
Regulation	Water purification	In Colombia, wetland ecosystems (*páramos*) – threatened by coal and gold mining – purify water at a rate of 28 m^3/s	(Postel and Thompson 2005)
	Flood regulation	Resistance to beach levees in agricultural areas increased the intensity of flood wave in the River Odra, Poland, 1997	(Kowalczak and Kundzewicz 2011)
	Biological control	World's largest macroalgal blooms during 2008–12 associated with aquaculture in the Yellow Sea, China	(Liu et al. 2013)

Table 9.1 (continued)

Categories	Services	Example	Reference
Cultural	Tourism, recreation and aesthetics	Water inequity in Bali associated with tourism activities	(Cole 2012)
	Customary rights	Customary access to water impaired by tree plantations in Cameroon	(Gerber et al. 2012)
	Spiritual and religious benefits	Sacred rivers in South Asia (e.g., Ganges–Brahmaputra), degraded by pollution and dam building	(Colopy 2012)
Support	Contribution to the primary production	Decrease in nutrient loadings in the Yangtze River Estuary and the East China Sea after impoundment of the Three Gorges Dam with over 80% decline in primary production	(Gong et al. 2006; Chai et al. 2009)
	Wildlife habitat	Wetland conservation threatened by agricultural development in Qixinghe, China; and by irrigation infrastructures in the Rio Grande / Bravo	(Wu et al. 2012; Walsh 2013)
	Sediment and nutrient retention and mobilization	Globally, artificial impoundments possibly trap more than half of basin-scale sediment flux in regulated basins	(Vörösmarty et al. 2003; Kunz et al. 2011)

destroyed to build a dam, monetary compensation cannot really fit the diverse rationalities involved.

2.4 Water Conflict Mapping

Data sharing on water-related conflicts is a way to connect specific cases to the logic of a widespread water justice movement, which is itself part of a global EJ movement. For decades, networks involved in water conflicts caused by oil companies (such as Oilwatch[2]), dams (such as International Rivers[3] or MAB[4] in Brazil) or mining (such as the Latin American Observatory OCMAL[5]) have supported advocacy and information sharing. The analysis of conflicts beyond the observation of single case studies has been greatly facilitated through the creation of ad hoc databases linked to these networks of activism. This can be ascribed to a critical cartography that embraces the political nature of mapping practices (Crampton and Krygier, 2005) to use the discipline as an instrument of liberation rather than a tool of power control (Elwood and Leszczynski, 2013; Kitchin et al., 2013).

A global EJ research initiative, the project 'Environmental justice organizations, environmental liabilities and international trade' (EJOLT),[6] is currently compiling a database of ecological distribution conflicts on different topics, including water. The classification system of conflicts in this project is based on the idea that the increase of social metabolism in terms of use of energy and materials (including water) leads to the growth of environmental conflicts. Water can be the 'commodity' in dispute, as in the case of water privatization conflicts, or it can be the element impacted by a contested project.

As an example of mapping, Figure 9.1 shows emblematic water conflicts in Catalonia (Sisteré, 2012). The small number of cases does not allow statistical analysis in this case, but points to a classification of four kinds of conflict. There are cases of pollution of agricultural origin (manures in the Osona region), of industrial origin (persistent organic pollutants and mercury in the Flix reservoir), conflicts caused by material extraction (Sallent potash and salt mines). Supply conflicts are represented by the emblematic Ebro transfer, and also by the construction of the Segarra–Garrigues canal for irrigation, as well as the demands imposed by the

[2] www.oilwatch.org.
[3] www.internationalrivers.org.
[4] www.mabnacional.org.br.
[5] www.conflictosmineros.net.
[6] www.ejolt.org.

Note: Pollution conflicts (Osona slurry from pig breeding; Chemical pollution in the Flix Reservoir; Sallent potash and salt mines); Supply conflicts (Ebro water transfer; Segarra–Garrigues Canal; 'Inexhaustible thirst' of Barcelona: the Ter, the Ebro, the Rhone); Conflicts from urban pressure (Riverbank occupation in the Anoia River; Paving of the Llobregat Delta; Privatization of ATLL, the public water company); Conflicts for environmental flows (in the Ter, Segre and Gaià rivers).

Source: Own elaboration with cartographic data of the Ministry of Planning and Sustainability of the Generalitat de Catalunya, the Cartographic and Geological Institute of Catalonia (ICC) and GADM online repository. Cases from Sisteré (2012).

Figure 9.1 Water conflicts in Catalonia metropolitan area of Barcelona. Other conflicts are related to geomorphological alteration (as on the banks of the Anoia River or the Llobregat delta) or to privatization of the public distribution company Aigües Ter Llobregat. Finally, the debates on environmental flows, crucial in the management of Mediterranean rivers, are represented by the cases of the Ter and the Segre, and the extreme case of the Gaià River, legally deprived of water by the petrochemical industry until the year 2050.

3. ECOLOGICAL DISTRIBUTION AND WATER JUSTICE CONFLICTS

Table 9.2 classifies ecological distribution conflicts for water in two axes: first, by the stage in the commodity chain at which the conflict occurs (the extraction, transport, or post-consumption pollution); second, by their geographical scale. There are local conflicts (for example, the use of lake water in the proposed Conga gold mine in Cajamarca, Peru) and global conflicts (for example, human-induced global change leads to glacier retreat and possibly to ocean acidification, which can be brought into discussions on climate justice and the 'ecological debt') (Martínez-Alier et al., 2014).

Leaving aside global examples such as those in Table 9.2, conflicts related to water usually have a geographically more restricted reach. For example, the diversion of the river San Francisco in Brazil is not a local but a regional theme, affecting several states. Also 'interlinking of the rivers' projects in India, Thailand (Molle, 2007) or more modestly the Tajo-Segura or the Ebro water transfers in Spain generate regional debates. They exceed the local level but they are not global issues. Sometimes local or national conflicts become *glocal* (Urkidi, 2010) when they occur locally everywhere, responding to global drivers, or when acquiring global importance. That was the case of the dams in the Narmada River in India that led to the constitution of the World Commission on Dams (WCD, 2000).

3.1 Water Conflicts Related to Mining and Fossil Fuels

Many conflicts over the use of biomass, the urban territory or mining, are indirectly conflicts over water. Such connections have been shown by social movements in India with the slogan *Jal-Jungle-Zamin* (water, forest, land). Take the case of a mining company, such as Vedanta, Tata and Birla, contaminating the water in a village in India by the mining of bauxite, iron ores or coal. Families have no choice but to stock up on water streams or wells. The contribution of nature to the livelihood of the poor is not well

Table 9.2 Classification of socio-environmental conflicts over water / aquatic ecosystems

Stage of the commodity chain	Scale		
	Local	National and regional	Global
Extraction	Water for mineral extraction (Camacho 2012; Bebbington and Williams 2008) Sand mining in river beds (Özkaynak et al. 2012) Water used in oil (Joseph 2012) or gas (Thompson 2012) extraction Desalination (Meerganz von Medeazza 2004) Dams (Molle 2007)	Large-scale irrigation developments (Wu et al. 2012) Water for industrial tree plantations (Gerber et al. 2009) or for agrofuel crops (Ariza-Montobbio et al. 2010) Unsustainable fisheries (Campbell and Meletis 2011) Negative impacts of aquaculture (Liu et al. 2013)	Trend towards the privatization of water supply (and sanitation) (Loftus and McDonald 2001)
Transport and trade	Effects of transport infrastructure in aquifers and rivers (Melo 2011) Water supply mega-projects (urban (Domènech et al. 2013), agricultural (Walsh 2013)) Oil spills at sea (Garza-Gil et al. 2006; Carson and Walsh 2006)	Waterways (*hidrovías*) (Gottgens et al. 2001) Stairways of dams (Sneddon and Fox 2012) Transfers between basins (Molle 2007)	Trade of 'virtual' water (Dalin et al. 2012)
Waste and pollution, post-consumption	Urban pollution load into rivers (Kowalczak and Kundzewicz 2011) Groundwater contamination from diverse nitrate sources (e.g. intensive farming, synthetic fertilizers) (Pastén-Zapata et al. 2014)	Acid rain (Menz and Seip 2004) Pollution of entire watersheds (Pacheco-Vega and Basurto 2008)	Ocean acidification (Doney et al. 2009) Glacier retreat due to climate change (Vergara et al. 2007)

represented in monetary terms. If the water of a stream or the local aquifer is contaminated by mining, poor women cannot afford to buy bottled water. Therefore when the poor people of the countryside see their own subsistence is threatened by a mining project, a dam or a tree plantation or a large industrial area, they often protest not because they are card-carrying environmentalists but because they immediately need the services of nature for their own survival. That is the environmentalism of the poor and indigenous (Martínez-Alier, 2014), present in movements of resistance at the frontiers of extraction and pollution (Camacho, 2012; Gerber et al., 2009).

In Peru, the most water-stressed country of South America, over 50 per cent of peasant communities have been affected by mining activities (Bebbington and Williams, 2008). In Cajamarca, the Newmont Mining Corporation (USA) and Buenaventura (Peru) are the main shareholders of Minera Yanacocha, which operates one of the world's largest gold mines. The environmental liabilities involve destroyed hills, land illegally appropriated, water polluted in several provinces, and a mercury spill that ended in a court decision against the victims. Activist leader Marco Arana saved Cerro Quilish, a water reserve for the city of Cajamarca. In 2012 there was again resistance against a new gold mine named Conga that would destroy some lakes. Its final outcome is undecided. The demonstrators' motto was *el agua vale más que el oro* (water is worth more than gold).

Metal mining also drags disputes over water depletion. For instance, in Chile there is a mining and energy complex that exacerbates pressures on access to water sources. Chile's anti-mining protests are also about dams in the South for electricity or about depletion of scarce water sources and their contamination in the North (Camacho, 2012). Barrick Gold had to stop its operation in Pascua Lama because it was destroying glaciers (Urkidi, 2010).

Indigenous peoples, whose holistic rationalities collide against the utilitarian views of the mining industry (Camacho, 2012), often lead the protests. In Panama, the Petaquilla Gold project in Donoso meant the illegal removal of forest cover, the destruction of river beds and the throwing of mining waste into rivers. The ethnic group Rey Quibián demonstrated in defence of water outside the headquarters of the company in Canada (Telesur, 2012a). The Ngöbe-Buglé *cacica* (indigenous female leader), Silvia Carrera, led opposition to a new mining law in 2012. The Ngöbe-Buglé forcefully sing an anthem in their ceremonies expressing reverence towards the water and rivers (Telesur, 2012b).

Another mining-related item in the political ecology of water is the bursting of tailings dams (*presas de jales, diques de relaves*). A case in point was the spill in Andalusia in 1998, where polluting heavy metal waste was released by a tailings dam failure from a mine owned by the

Swedish-Canadian company Boliden, located in Aznalcollar. The waste flew to the Guadiamar River bordering the Doñana National Park. Restoration costs reached 90 million euros, paid for by the regional government, the Junta de Andalucía (Sanz, 2011).

Less notorious than copper, gold, bauxite, iron ore or uranium mining, the extraction of gravel and sand as building materials is an important item in the calculations of the Material Flows of an economy. In India there are many conflicts on sand and gravel mining in rivers, with complaints against *sand mafias* (Özkaynak et al., 2012). In Latin America, the conspicuous conflict in the Tunjuelo River in Bogotá is between the sand and gravel companies Holcim and Cemex, together with the Archdiocese of Bogotá, and the local population fearing by experience that changing the morphology of the river leads to floods and mudslides.

Conflicts due to impacts of fossil fuels on water quality are particularly intense in the extraction and transport stages. In one famous case in Ecuador, between 1965 and 1990, Chevron-Texaco deposited the extraction water coming out with oil in 'pools' of heavily polluted water, harming soils and groundwater. The company is liable for USD 9.5 billion for the extreme damage done to the waters, soils and the health of the people. The implications of the historical court decision of 14 February 2011 (ratified on appeal in 2012 and 2013) have been extensively analysed as a case of environmental injustice (Martínez-Alier, 2011; Joseph, 2012). Similar cases of damage by state or private companies, like Shell in the Niger Delta over many decades, have been also documented (UNEP, 2011). More recently the controversy on the impact of tar sands (Jordaan, 2012) and shale gas *fracking* (Thompson, 2012; Osborn et al., 2011) on aquifers has fuelled the discussion on oil-related environmental conflicts. In the transport stage, oil spills in the sea, such as the cases of the Exxon Valdez in the US or the Prestige in Spain, have contributed to create awareness at national and international scales (Carson and Walsh, 2006; Garza-Gil et al., 2006).

3.2 Water Conflicts Related to Biomass (Deforestation, Tree Plantations, Agrofuels)

When a geographical area exports biomass to another area, there is also an export of the water used to grow that biomass, as is shown in the cases of Colombian and Argentinian exports of coffee, flowers and soybeans (Pérez Rincón, 2006; Pengue, 2006). Sometimes, trade creates fatal dependences. For instance, nearly one quarter of the exports of Uzbekistan and Pakistan are raw cotton and yarns produced using locally scarce water (Lenzen et al., 2013). Water accounts, including virtual water exports, are therefore relevant for claims of 'ecologically unequal trade'.

The water used to grow commercial plantations is not available for biodiversity conservation or the provision of valuable ecosystem services (Van Wilgen and Richardson, 2012).

Eucalyptus plantations generate water conflicts worldwide (Overbeek et al., 2012). Since the 1970s, huge areas of eucalyptus plantation have been rightly tagged as 'green deserts' (Carrere and Lohmann, 1996). The concept refers to the loss of biodiversity in monocultures but also to water depletion generated by alien-tree plantations around the world (Gerber et al., 2009; Van Wilgen and Richardson, 2012).

The case of energy crops includes the controversy on jatropha. Governmental authorities assert in India and elsewhere that *Jatropha curcas* for biodiesel grows with little water and is drought-tolerant. However, if there is not enough rainfall or irrigation, the plant might survive, but its performance is much reduced. In practice, jatropha competes for water and land with other crops, as shown in detail in the villages of Tamil Nadu (Ariza-Montobbio et al., 2010).

3.3 Conflicts over Large Infrastructures (Dams, Water Transfers and Waterways)

As analysed above, water has important ecological functions that the market forgets. Ecological functions become environmental services providing monetary and non-monetary values to humans (MA, 2005; Russi et al., 2013). In the mid-twentieth century, large dams became fashionable, disrupting river courses. It did not matter whether political regimes were democratic or not, whether rigorous cost–benefit analyses were deployed or not. Under Nehru or under Mao, under Franco or Nasser or in the United States, the former USSR, Brazil or China, progress meant and still means large dams.

There have been dissenting voices against dams for a long time. In 2000, the World Commission of Dams (WCD) published a report that brought an innovative approach, seeking to protect the natural environment and those affected by dams (WCD, 2000). Medha Patkar, a leading voice of the Narmada Bachao Andolan against dams in India, was a member of the commission. Author Patrick McCully and the International Rivers Network later provided full information and critical views on the construction of large dams (McCully, 1996). Confronted with the fact that the Ganges and its tributaries are now being dammed (Colopy, 2012), the director of the Centre for Science and Environment in Delhi, Sunita Narain, asked for a minimum environmental flow of 50 per cent in all projects in the winter season before the monsoon (Sethi, 2013).

More than 45 000 dams over 15 metres high alter ecosystems and damage the populations that depended on them, in all major river systems of the planet (Nilsson et al., 2005). Upstream, dams displace populations without adequate compensation or relocation. Archaeological remains, cropland and biodiversity are lost. Downstream, water becomes scarce, fishing disappears. It is reported that 472 million people have been negatively affected downstream of large dams (Richter et al., 2010). There is also the risk of dam failure. In exchange, electricity is produced and there is water for irrigation or for urban use. Who wins and who loses, now and in the future? Regulated river systems alter the ecological diversity and the ecosystem functions, temperature and sediment flows. Reservoirs go hand in hand with biotic homogenization through the deliberate or accidental introduction of alien species favoured by environmental conditions in reservoirs (Poff et al., 2007).

Today, the most controversial dam across Latin America is Belo Monte, which is being built despite indigenous and environmental protests on the Xingu River in Pará near Altamira. Its capacity of perhaps 11000 MW will make it the world's third largest after the Three Gorges in China (20300 MW) and Itaipú on the Paraguay–Brazil border (14000 MW) (Jaichand and Sampaio, 2013). It is sometimes said that hydroelectric dams, as they do not burn charcoal, coal or gas, produce electricity without producing CO_2. Sometimes they are given 'carbon credits'. However, Belo Monte means the destruction of a very large area of forest storing and absorbing CO_2. In addition, forests flooded will rot under water and will generate methane, which is another greenhouse gas (Fearnside, 2006). In India, the dams in the Himalayas and the north-east involve 50000 MW of power (Colopy, 2012). There are plans for very large dams in the Republic of the Congo. Which are the costs, and in which units are they measured?

Dams are the main modernizing factor in the control of rivers, but not the only one. Transfers of water between river basins and waterways (such as the Paraguay-Paraná *hidrovía* between Argentina, Bolivia, Brazil, Paraguay and Uruguay within the framework of the IIRSA project)[7] are also controversial interventions in the hydro-social cycle (Gottgens et al., 2001). The transfer (*transposição*) of the São Francisco River in Brazil caught much attention since its approval in 2005 (Suassuna, 2011). A bishop, Luis Flavio Cappio, went on hunger strike against this transfer in the north-eastern state of Bahia.

There are many technical and institutional interdependencies between the construction of contested water-management infrastructures and other projects such as mines, plantations or utilities that in turn cause

[7] IIRSA, Integration of the South American Regional Infrastructure Initiative (www.iirsa.org).

social conflict. The historical and anthropological perspectives emphasize the role of physical infrastructures and the institutions that sustain them as intrinsic factors of political and economic developments (Walsh, 2013). In this respect, the type of infrastructures mentioned here tend to lock in concentrated power and wealth for the benefit of actors outside the territories where the infrastructures are located.

3.4 Urban Water and the Privatization Controversy

Similar controversies surround the development of large infrastructures for urban water supply handing over water management to the private sector at the expense of community-based alternatives, as in the case of the Melamchi Water Supply megaproject in Nepal (Domènech et al., 2013). In South Africa, there are constant complaints against high tariffs for water (and electricity) to poor households which are disconnected if they do not pay, while export mining companies enjoy subsidized rates (Sharife and Bond, 2012).

A decade ago, the privatization trend was particularly manifest in the United States and the UK (Bakker, 2003), but expanded globally afterwards. Currently, a small group of companies share the bulk of new water distribution and sanitation markets. Failed cases of privatization, like Buenos Aires (Loftus and McDonald, 2001), have led to a new trend of restoring public water management, as described below.

4. HERE IS THE 'POLITICAL': NEW INSTITUTIONS FOR WATER MANAGEMENT BORN OF CONFLICTS

Reconciling competing values in water-related debates is not without difficulties, particularly when formal political institutions are resistant to change (Campbell and Meletis, 2011). As shown in this section, social movements born of water conflicts are effective providers of alternatives that reshape power configuration, against the view that environmental justice movements are 'post-political' (Swyngedouw, 2009a).

Karl Wittfogel established the correspondence between lack of water, large irrigation works and 'oriental despotism'. However, even in areas of ancient irrigated agriculture, one can argue that historically there have been community institutions of water users. In the Andes, the offerings to the *Apus* (big snowy mountains) – which are the water source for terraced valleys – go together with community-regulated work on the channels for irrigation. In southern India and in Sri Lanka the local temples have regulated water use. Each temple has its tank of water (a small earth dam) for community water, also fulfilling other ecosystem services. Of course, community regulation of water use certainly does not imply equitable regulation as regards gender and caste.

In many villages in India communities have built new physical structures of *water harvesting*. Social institutions arise which allow cooperation and regulate water use by banning, for example, commercial crops requiring too much water. As described in the case of Hiware Bazar, new community institutions include *water audits* at village level (Singh, 2012). When water has been scarce, society itself has created institutions to manage it (Ostrom, 1990). Yet a simple rule of capture to access groundwater has often persisted. If the human and animal effort to draw water is reduced by the use of diesel or electric pumps, then excessive water withdrawals are likely and the water table subsides. A new rule needs to be instituted.

Three options of water management – community, state-run or privatized management – are valid to avoid problems of open access. However, the social implications of each one are different. Community institutions and possibly state administration more easily allow the articulation of ecological, livelihood and cultural values (such as sacredness) than private property in a capitalist system driven by economic profits.

4.1 National and Transnational Networks of Water Justice

Water conflicts can become a real boost to institutional innovations. This is true at levels of local community management, and also for public policies. Thus, in Spain, the reaction against the diversion of the Ebro projected in the National Hydrological Plan (NHP) of 2001 (BOE, 2001) triggered massive local protests, also opening a broad debate involving social movements and the scientific community. Many social groups popularized a so-called New Water Culture, such as the Platform for the Defence of the Ebro River,[8] whose symbol (a knotted pipe) became an icon, and the New Water Culture Foundation,[9] a forum of academics and professionals active in water management policies.

The NHP of 2001 was defeated (BOE, 2004). This achievement was two-fold. On the one hand, the New Water Culture (relying on water demand management, and the ecosystem approach) became a dominant discourse at the political level. Such principles are fully consistent with the Water Framework Directive (2000/60/EC) (OJEC, 2000) that guides the European Union's water policy. Opponents to the Ebro water transfer

[8] www.ebre.net.
[9] www.fnca.eu.

counted on support from Brussels. On the other hand, the intensity of the movement against the NHP contributed to strengthen representation and political clout of other movements in the same region against thermoelectric power plants, wind energy farms, and for the defence of the natural environment. As an activist said: 'When they are born, these social movements make evident the divorce between state policies and the local territory, they are policies of remoteness and oblivion [. . .]; our mobilizations respond to a feeling of defending the territory and a different model to that they want to impose on us' (Roser Vernet, in *La Vanguardia*, 9 July 2005). This is a view of territorial claims that fits into environmental justice and water justice, far from the 'NIMBY' claims alleged by the authorities.

Water is then a key ground in the reconfiguration of spaces of ecopolitical engagement, where citizenship plays a central role (Latta, 2013). In Latin America, there are numerous civil society organizations dealing with topics related to water. It is common that movements or networks against mining (like RECLAME in Colombia or *No a la mina* in Argentina) or promoting resistance to monoculture tree plantations (such as the World Rainforest Movement) include water among their main demands. Listed below are three national networks whose line of action is linked specifically to water conflicts.

The *Movimento dos Atingidos por Barragens* (MAB)[10] is a Brazilian movement of collective action in the fight against dams, with origins in the 1970s. The military government supported the development of hydropower that meant the displacement of tens of thousands of people. While political forces such as the Movement of Landless Workers or the Workers Party were growing, the discontent on dams was channelled through regional commissions of affected (*atingido*) people resisting hydroelectric projects or, at least, demanding fair compensation and acquisition of new lands. Emblematic cases were Tucuruí (Pará), Itaipu (binational with Paraguay), Sobradinho (Bahia), Itaparica (Pernambuco, Bahia) and other smaller dams in Rio Grande do Sul.

In Mexico, there are famous conflicts regarding La Parota and El Zapotillo dams. At the Las Cruces dam in the San Pedro River in Nayarit, the upstream indigenous Cora people are in alliance with downstream fishers and shell collectors. The Mexican Movement of People Affected by Dams and in Defence of Rivers (MAPDER),[11] founded in 2004, brings together social organizations and communities.

In Colombia, CENSAT Agua Viva[12] is a member of Friends of the Earth

[10] www.mabnacional.org.br.
[11] www.mapder.lunasexta.org.
[12] www.censat.org.

international. It has different areas of work, including mining. CENSAT is one of the major Latin American organizations for water justice fighting against dams, and addressing water privatization and its inclusion in free trade agreements and other international agreements.

This type of national network plays an important role in linking actors and local organizations in different places. On the international scale, one entity supporting water justice is the Latin American Water Tribunal (TLA),[13] bringing ethical resolutions with a basis in current legislation to controversies related to water systems. Meanwhile, a Latin American network against dams and for rivers and water (REDLAR),[14] established in 1999, brings together many organizations from 18 countries in the region. On a larger scale, since 1985 an international network of people affected by dams and of grassroots organizations with representation in five continents has created the International Rivers Network.[15]

4.2 Remunicipalization: the Response to the Privatization of Municipal Water Management

Following the neoliberal wave of the 1980s and 1990s, there were milestones of the struggle for water justice, such as the opposition to privatization of the urban water supply in Cochabamba (Bolivia) (Crespo Flores, 2000). In 1999 a private concession of the municipal water distribution company was granted, linked to a water transfer called the Misicuni Project. At the same time, at the national level, regulation of the water supply and sanitation was influenced by World Bank recommendations and the so-called Washington Consensus. The protest movement organized a 'Departmental Coordinating Platform for Water and Life', which grew until a 'symbolic occupation' of the city of Cochabamba was brutally repressed. Then in April 2000, the *Coordinadora* submitted the privatizing measures to a popular referendum. The result was 90 per cent in favour of public management. Facing such massive and permanent mobilization, the government finally rescinded the privatization contract giving the water management to the *Coordinadora*, together with the considerable debt of the company. Since then, water management in Cochabamba has emerged as an example of the struggle against the advance of the water multinationals. However, there remain supply problems in some areas of the city, mitigated through the creation of local water committees.

The tendency to regain public control of water management is forceful.

[13] http://tragua.com.
[14] www.redlar.org.
[15] www.internationalrivers.org.

Cases of remunipalization have been documented for Paris (France), Dar es Salaam (Tanzania), Hamilton (Canada), Malaysia (at national level) and Buenos Aires (Argentina) (Pigeon et al., 2012).

4.3 Agricultural Water Markets and Water Rights

As explained above, the increased use of water in the world is not due only to domestic or industrial demand but also to irrigated agriculture. Conflicts of access for irrigation water have existed historically, as in farmer–herder conflicts in Tanzania (Benjaminsen et al., 2009) or the Sahel (Turner, 2004), exacerbated by increased competition over a declining pool of resources. Expanding agricultural frontiers and agricultural modernization in Thailand (Molle, 2007) or China (Wu et al., 2012) – relying on increased water use – aggravated water conflict among users at different scales.

Water efficiency in agriculture is therefore a key issue in response to water conflicts (Wu et al., 2012). Scarcity and high water costs have led to new technologies such as drip or spray irrigation on the Mexico/US border (Walsh, 2013). However, these efficiency schemes seem to have caused a 'Jevons paradox for water', meaning that the alternative water use increases more than proportionally to the water savings, nullifying the efficiency improvement. These technologies can originate new conflicts, as in the case of reduced infiltration by lining earthen canals, which is detrimental to the preservation of groundwater or wetlands.

In rich economies it seems reasonable to aim at savings in agricultural water use, to transfer it to more profitable or priority uses or simply to increase river flows. Economic instruments such as higher prices (which should reflect the costs of the infrastructures built by public administrations) can stimulate the efficiency in water use. Markets for water may be introduced, whose operation depends on given allocations of 'property rights'. The commercial transfers of rights of use of water are not always wrong, provided they are part of a policy of demand management against the traditional policy of increasing supply by building dams and water transfers.

A water market works as follows. If a Federation of Irrigators or a private person wants to 'sell' the water for urban supply, this may be allowed (especially if the buyer is not far away), taking into account ecological factors and possible effects on third parties beyond the economic interests of buyers and sellers. The best-known case is the California water banks active in the early 1990s in times of shortage because of a drought. A public entity bought water from farmers at a fixed price, that is, the commitment not to use this water, and sold it at a higher price to urban buyers or kept it for non-market environmental applications.

If the instrument is the market, we must bear in mind that the economically efficient use is always in relation to a particular structure of initial allocations of water rights to different regions and social groups, and also to the purchasing power of users, which may be very uneven.

A demand approach does not mean that priorities should be established by the market. For example, in Gujarat and Maharashtra, profitable capitalist sugar cane growing 'steals' water from poor and low-caste families. In poor countries where the population depends for food on the irrigated land (India, Pakistan, China, Egypt, Iran, Iraq, and in part Mexico and Peru), the argument that water should go to more 'profitable' uses is not appropriate: chrematistic priorities are rarely social priorities.

4.4 The Human Right to Water

There is a relationship between income and consumption of water that, for domestic purposes, ranges between 1000 litres per person per day (pppd) among the richest people in California and 30 litres pppd of the urban poorest. Under 20 litres, cholera might appear. When reaching 1000 litres pppd, or even before, the income-elasticity of domestic water demand drops to zero. Besides the ostensible material challenge, conflicts for access to water are grounded in emotional geographies related with everyday survival struggles (Sultana, 2011).

Domestic water use depends not only on the income level but also on cultural factors (including awareness of the need for water savings) and lifestyles (such as the type of housing and urban settlement), and of course on the fee structure. In this respect, the 2003 World Water Forum in Kyoto was a major milestone for the global water justice movement. There, the pro-privatization World Water Council claimed a consensus on a corporate-controlled future for water that raised strong opposition. The firm commitment of the Council of Canadians was a key contribution to build an alliance with its own 'Vision Statement' under the slogan *Water is Life*. Since then, an Alternative World Water Forum (FAME, from the French acronym) has taken place in parallel to the official water forum and in the same cities (Mexico 2006, Istanbul 2009 and Marseille 2012), bringing together water justice organizations, advocacy groups, scholars, journalists, local activists and committees. It has been a watchdog on policies pushed forward by the World Bank, corporations and governments, including the EU (Martínez-Alier et al., 2014). There is now a water movement on a global scale. It cooperates with some local governments and also with workers' unions in the public services in order to defend a public management model and to profit from the workers' technical skills and knowledge. The network Reclaiming Public Water, established through

Table 9.3 Slogans of water activism

Slogan	Campaign / Organization	Country
We are water	March for Life, with various organizations led by CONAIE, the Confederation of Indigenous Nationalities of Ecuador	Ecuador
For water, for life	*No a la Mina*	Argentina
Rivers for life, our lives are the rivers	Taller Ecologista, Rosario	Argentina
Life cannot be stopped	'Without Sogamoso River Dam', Rios Vivos	Colombia
Water, a fundamental right	Committee on Social Justice – Diocese of Chimbote / National Coordinator of Human Rights	Peru
Water is a human right	European Citizens' Initiative 'Water and sanitation are a human right! Water is a public good, not a commodity!'	European Union
Water is a right, not a commodity	Engineering without Borders	International

Source: Own elaboration based on internet search.

the Transnational Institute, supports and backs efforts to bring water management back under public control (Balanyá et al., 2005).

Two ideas come to mind looking at the slogans of water activism campaigns (Table 9.3). On the one hand, there is an emphasis put on water as the source of life rather than as a socio-economic asset. On the other, is the idea that access to water has to be approached under the (human) rights rationale. Against such demands of universalist order, the World Health Organization and UNICEF recognize, sadly, that because of poverty, almost 900 million people lack access to safe drinking water and 2.5 billion (35 per cent of the world population) do not have adequate sanitation (World Health Organization and United Nations Children's Fund Joint Monitoring Programme for Water Supply and Sanitation, 2008). Moreover, because of the growing metabolism of the world's economy, many people are being deprived of access to water because of mining, fossil fuels and commercial biomass extraction.

In July 2010, after fifteen years of debates, the UN General Assembly adopted a resolution that recognized explicitly the human right to drinking water and sanitation (United Nations General Assembly, 2010;

Human Rights Council of the United Nations, 2010). The representative of Bolivia in the General Assembly, Pablo Solón, emphasized that:

> drinking water and sanitation are not only elements or components of other rights such as 'the right to an adequate standard of living'. The right to drinking water and sanitation are independent rights which should be recognized as such. [. . .] It is necessary to call on States to promote and protect the human right to drinking water and sanitation. (Solón, 2010)

Food and Water Watch, Red Vida at the pan-American level, Focus on the Global South, Jubilee South, and the African Water Movement are working towards actions and tools for the concrete application of this right. An important actor is again the Council of Canadians' Blue Planet Project. At the European level, the Italian referendum '*2 Sí per l'Acqua Bene Comune*' in 2011 was a turning point. The proponents of the referendum pushed forward a new concept where water is considered as a *commons*, which should not be privatized and subject to monetary valuation (Martínez-Alier et al., 2014).

4.5 Rights of Nature

In the practice of Andean peoples, land, water and air are the subject of rights, in the perspective of deep ecology. The invocation of the Pachamama is accompanied by the need to respect her, which translates into an ethical rule for the good of everything living and non-living. Building on this tradition, Article 71 of the Ecuadorian Constitution (Asamblea Constituyente de Ecuador, 2008) stipulates that nature has the right to be respected in relation to 'the maintenance and regeneration of its vital cycles, structure, functions and evolutionary processes. [Therefore, e] very person, community, people or nationality can claim from the public authorities respect for the rights of nature'.

In this context, when public works for expansion of the Vilcabamba–Quinara road in the South of Ecuador resulted in the disposal of large amounts of rock and excavation material, a court case was brought by Richard F. Wheeler and Eleanor G. Huddle, environmental activists, under article 71 of the Constitution. For three years, until 2011, the project promoted by the provincial government was conducted without environmental impact studies, increasing the risks linked to the floods of the Vilcabamba River during the winter rains. On 30 March, 2011, the Provincial Court of Justice of the city of Loja, recognizing the facts, made effective the constitutional guarantee in favour of the plaintiffs, settling a historical precedent in fulfilling the rights of nature (Melo, 2011; Corte Provincial de Justicia de Loja, 2011). Outside the scope of legal activism, moratoriums have been argued as another tool for the application of Rights of Nature (Campbell and Meletis, 2011).

5. CONCLUSION

This chapter reviews methodologies, types and political implications of water conflicts under an ecological economics and political ecology perspective. Ecological economics focuses on the analysis of water flows and the related values along the hydro-social cycle. Political ecology studies who has the power (by custom or law) to use the available water from a river or to dig wells that reach the water table, excluding others.

Thus together, both fields of study help to answer questions such as: How much are water flows related to specific commodities? Do humans recognize the 'rights of nature', and are there court decisions determining the right of a river or a lake to keep its morphology and its biological and chemical quality unchanged? Who has the power to make a dam that will flood farmland or forests, for the benefit of an electrical company and to the detriment of the riparian inhabitants upstream and downstream? Which decision procedures (cost–benefit analysis, multi-criteria evaluation) are valid in deciding whether such a dam can be built? Are local referendums allowed against mining projects or privatization of water supply? Who has the power to determine the process for reaching decisions on the alterations to the hydro-social cycle?

In water management, there is a dispute between the old school of increasing water availability for the economy (for extended agriculture, mining or tourism) and a new school emphasizing demand policies to direct water to more profitable or necessary uses and promoting its saving and reuse. Water metabolism indicators reveal links between production and consumption that can be used in the analysis, and also in management measures for raising consumer awareness. They are also relevant to signal the direction of virtual water flows. To reduce the use of water for the economy facilitates keeping enough water in the rivers' ecological functioning. This is a fundamental element of rupture with former supply-driven approaches to water management.

Taming rivers to avoid the water 'getting wasted' has been a motto of hydraulic engineers. From the ecological point of view, however, the water is not lost but plays many ecological functions, thus contributing to the prosperity of riverine and coastal areas. In this context, the emergence of water conflicts is related to changes induced in the availability of water in the quantity and quality desired by the rich and powerful. Environmental conflicts about water can be seen as conflicts over who takes advantage and who loses access to water and its associated benefits.

The extractive industries including biomass extraction have spillover effects on water quantity and quality. Everywhere in the world communities fight, not only against dams and water transfers, but also against mines, eucalyptus plantations or against energy crops taking water from the villagers. When they mobilize against such kinds of projects that cause the quality and quantity of local water to deteriorate, they are fighting for environmental and social justice and particularly for water justice. The management of urban water has also caused many conflicts. Neoliberal policy treats water as a commodity. The aim is to generate profits rather than give a good service to which both rich and poor are entitled. However, the increasing use of water is not just a product of neoliberalism, it is due to the growth of the metabolism of the economy. This would happen also and indeed it happens under state capitalism.

Water justice movements and organizations have not only been active in the promotion of the human right to water. They have also been the first to endorse the recognition of water, along with the earth and air, nature in short, as a subject of rights. Many mobilizations from water justice organizations are merely defensive, facing specific threats of displacement or loss of access to livelihoods. However, the claims go beyond this. From resistance, local or international networks and alternatives are born.

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10. The contributions of the ecosystem services paradigm to sustainability science, policy and practice

Rudolf de Groot and Leon Braat

1. INTRODUCTION

The current state of knowledge about the contribution of ecosystem processes and biodiversity to human welfare, and how human actions impact welfare through environmental change, has improved considerably with the introduction of the ecosystem services paradigm in the 1980s by Ehrlich and others (for example, Ehrlich and Mooney, 1983), and several important publications in the 1990s (for example, Costanza et al., 1997; Daily, 1997). The release of the Millennium Ecosystem Assessment (MA, 2005) and The Economics of Ecosystems and Biodiversity (TEEB, 2010) helped foster use of the concept of ecosystem services by policy-makers and the business community. Progress in its practical application in land use planning and decision-making has, however, been slow (for example, Daily et al., 2009; Naidoo et al., 2008), and even the Convention on Biological Diversity (CBD) responded in a very low-key manner until the Conference of Parties (COP) in Nagoya, in 2010, where governments renewed their pledge to take effective action to halt the loss of biodiversity. This pledge aims to ensure that by 2020 ecosystems are resilient and continue to provide essential services such as clean drinking water, crop pollination and recreational amenity. The COP 10 was considered highly successful because it resulted in a package deal including a new Strategic Plan for Biodiversity, a Resource Mobilization Strategy, and a Protocol on Access and Benefit Sharing. Subsequently, the UN has declared the years spanning 2011–20 as the UN Decade on Biodiversity. At the 11th meeting of the Parties (COP 11) in Hyderabad, India, governments were challenged to maintain the momentum created in the COP 10. Implementation has become the new mantra of the CBD. This slow progress stems not only from failures of markets and systems of economic analysis and accounting (and notably the ongoing obsession with GDP as welfare indicator) to capture social and economic values of ecosystem services, but also from still limited scientific understanding of: (a) how different services are interlinked with each other and to the various components of ecosystem functioning and the role of biodiversity; (b) how different human actions that affect ecosystems change the provision of ecosystem services; (c) the potential trade-offs among services; (d) the influence of differences in temporal and spatial scales on demand and supply of services; and (e) what kind of governance and institutions are best able to ensure biodiversity conservation and the sustainable flow of ecosystem services in the long term.

A major difficulty in achieving a widespread understanding and acceptance of the concept in both the science and policy communities is that many ecosystem[1] services are (mixed) public goods, and use levels are therefore difficult to regulate, even when they are at or near the point of exhaustion. Although recognition is increasing in both government and business executive circles that many people and businesses benefit from ecosystem services, individuals or groups have still insufficient incentives to maintain and manage ecosystems for continued provisioning of services. The problems of implementation of policies and management of ecosystems and their services stem from both poor access to available information and institutional failures. In many cases institutions, notably conventional market economics, hinder the implementation because they provide the wrong incentives. The fundamental changes that the TEEB 2010 reports indicated to be necessary regarding the way biodiversity, ecosystems and their services are viewed and valued by society are slowly taking shape, but with very different speeds when looking at different continents. Reviews have been published for Australia (Pittock et al., 2012), for Latin America (Balvanera et al., 2012), North America (Molnar and Kubiszewski, 2012), Africa (Egoh et al., 2012) and for Europe (Maes et al., 2012).

These two types of failure (lack of information and wrong incentives), and the complex dynamics of the interface between ecological and economic systems, continue to lead to large-scale and persistent degradation of the natural environment. The accelerating loss of ecosystem services and biodiversity is causing trillions of dollars in damage and restoration costs due to loss of ecosystem services (Costanza et al., 2014), so the point has been reached where the cumulative losses in ecosystem services should force society to rethink how to incorporate the value of these services into societal decision-making (see Braat and De Groot, 2012, for an overview and agenda for research and policy development). Without fundamental changes in institutions and incentives, further declines in natural capital

[1] To avoid having to use both the terms 'ecosystems' and 'biodiversity' simultaneously all the time, the term 'ecosystem' is used to include 'biodiversity' throughout the chapter unless indicated otherwise.

are the logical consequence, since those who gain from actions that deplete natural capital will continue to avoid paying the full costs of their actions and pass these costs to poor societies and future generations (Srinivasan et al., 2008). Although such estimations are fraught with difficulties, it can be argued that the cumulative loss of '*natural capital*' (see below) over the past decades has already cost, and still costs, the global community large sums of money in terms of damage, repair and replacement costs estimated at at least 10 per cent of global GDP (Bartelmus, 2009; Costanza et al., 2014).

In this chapter we give a brief overview of the history of the ecosystem services paradigm and existing frameworks and explain the main definitions and typologies used to analyse ecosystem functions, services and benefits. We also reflect on the ongoing debate regarding how best to 'value' (quantify the importance) of ecosystem services, which is essential if we want to use the concept for more sustainable policies and decision-making, and to implement it in practice for the conservation, restoration and sustainable use of our remaining natural capital.

2. REVIEW OF EXISTING FRAMEWORKS LINKING ECOLOGICAL AND ECONOMIC SYSTEMS

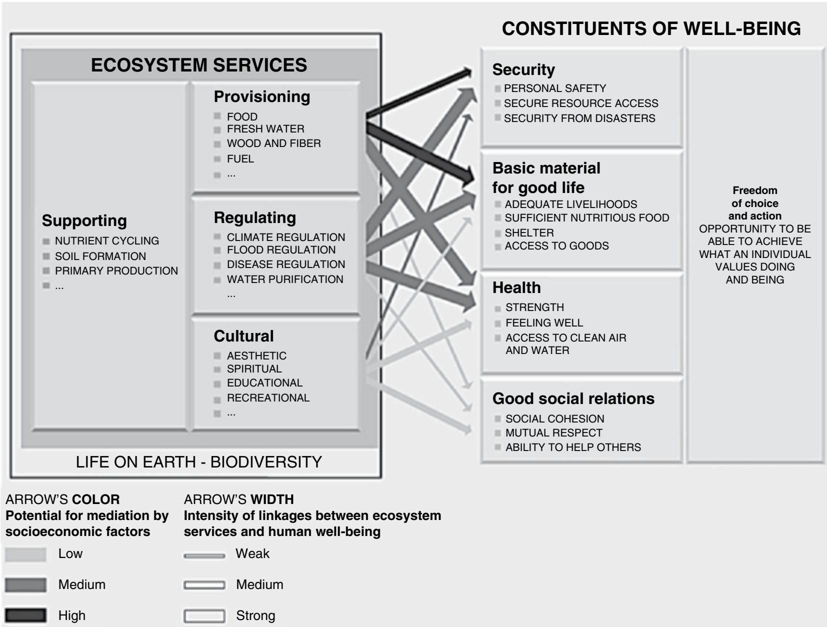
Over the past few decades many attempts have been made to systematically link the functioning of ecosystems with human well-being. Central elements in this 'link' are the intertwined notions of natural capital 'stocks' and the ecosystem services that flow like interest or dividends from those stocks. According to the Millennium Ecosystem Assessment (MA, 2005), natural capital is 'an economic metaphor for the limited stocks of physical and biological resources found on earth'. A significant problem is that if natural capital is lost, the genetic information embedded in natural biota (selected over aeons to maximize the use of natural energy sources) necessary to create new capital is lost. If economic capital is lost, society can create new capital, by borrowing or printing money; if natural capital is lost, 'nature' cannot easily print new genetic information. The continuing depletion and degradation of natural capital has generated concerns and debate over the capacity of the economic system to substitute for these losses with human-made capital, and the conditions for sustainable development, defined as non-declining welfare over generations (Pezzey, 1992; Pearce et al., 1989). While the degree of substitutability is ultimately an empirical question, it is generally recognized that substitution has limits (Barbier, 1994; Daly, 1996; Prugh, 1999; Daly and Farley, 2004), and that a critical amount of natural capital has to be preserved (TEEB, 2010).

2.1 Ecosystem Services: Early Developments and Recent Frameworks

Gomez-Baggethun et al. (2010) present a concise review of the history of the concept ecosystem services from early notions about people–environment interactions and their effects on human welfare, which stretches back centuries and includes writings from Roman times on the increase in population and decline in what we now call ecosystem services. Early modern writers on the subject include Marsh (1874), Leopold (1949), Carson (1962) and Krutilla and Fisher (1975), to mention but a few. In 1977 Westman published a paper in *Science* examining the link between ecological and economic systems entitled 'How much are nature's services worth?'. Ehrlich and Ehrlich (1981) later coined the term 'ecosystem services' and in the following decade ecologists further elaborated the notion of ecosystems as life-support systems, providers of ecosystem services and economic benefits (see for example, Ehrlich and Mooney, 1983; Odum, 1989; Folke et al., 1991; De Groot, 1987, 1992; Braat, 1996). But it was not until the late 1990s that the concept received widespread attention with the publications by Costanza et al. (1997) and Daily (1997). At the same time, the interdisciplinary field of ecological economics developed the concept of natural capital (Costanza and Daly, 1992; Jansson et al., 1994; Martínez-Alier et al., 1998; Dasgupta et al., 2000), which includes non-renewable resources and renewable resources and identifies ecosystem services as the 'interest' that can be derived from this capital, to demonstrate the significance of ecosystems as providing the biophysical foundation for societal development and all human economies (Common and Perrings, 1992; Arrow et al., 1995). In an attempt to facilitate discussion and systematic analysis of ecosystem services, De Groot et al. (2002) created a classification system specifying the relationship between, and transitions from, ecosystem processes and components and their transition to goods and services.

Based on these and other studies, the Millennium Ecosystem Assessment (MA, 2005) recognized four categories of services: supporting (for example, nutrient cycling, soil formation and primary production); provisioning (food, fresh water, wood and fibre and fuel); regulating (climate regulation, flood and disease regulation and water purification); and cultural (aesthetic, spiritual, educational and recreational) (see Figure 10.1).

The introduction of the concept of ecosystem services on the global policy agenda by the MA provided an important bridge between the imperatives of maintaining biodiversity (as stated in CBD, 1992 and updated and extended through CBD, 2012) and the challenges to meet the Millennium Development Goals (UN, 2000).



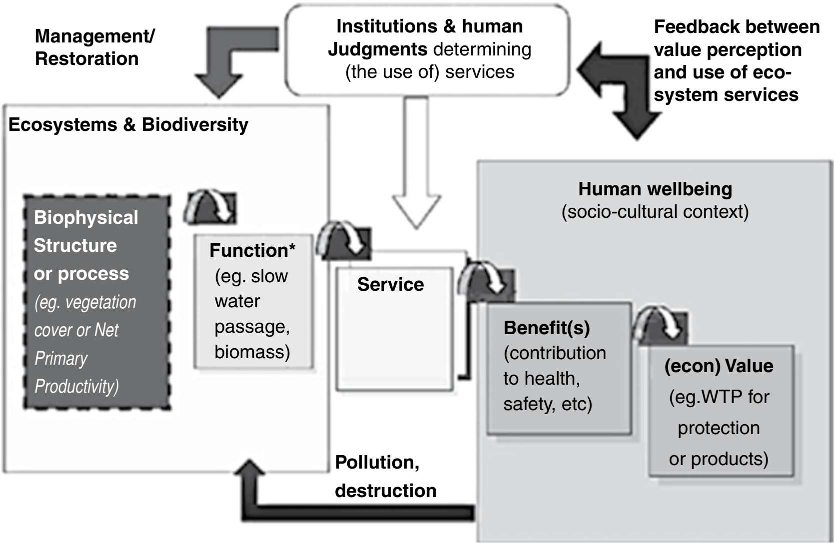
Source: MA (2005).

Figure 10.1 MA conceptual framework: linking ecosystem services and human well-being

2.2 The TEEB Approach

The Millennium Assessment, purposefully, did not pay much attention to the economics of ecosystem change, and therefore it was opportune to introduce, in 2008, the TEEB study (The Economics of Ecosystems and Biodiversity; see TEEB, 2010), both an extension and a revision of the MA framework (see Figure 10.2) for articulating the ecological and economic aspects of the analysis necessary for the valuation of biodiversity loss and ecosystem degradation. Figure 10.2 gives a schematic representation of the way TEEB proposes to disentangle the pathway from ecosystems and biodiversity to human well-being. A central concept in this figure is the separation between ecosystem services and benefits, as compared to the MA, which defined ecosystem services as 'the benefits humans derive from nature' (MA, 2005).

Figure 10.2 suggests the need to rely on counterfactual scenarios that differ through specific actions aimed at addressing the main drivers of loss.



Note: * One function is usually involved in the provision of several services and the use of services usually affects the underlying biophysical structures and processes in multiple ways. Ecosystem service assessments should take these feedback-loops into account.

Source: Adapted from De Groot et al. (2010).

Figure 10.2 The pathway from ecosystem structure and processes to human well-being

The TEEB approach involves three steps: (1) Identify and assess: indicators, mapping and quantification; (2) Estimate and demonstrate: valuation and monetization; and (3) Capture and manage the values (TEEB, 2010). Ecosystem extent and condition and (changes in) the delivery of services need first to be estimated and mapped in biophysical terms, which requires a sufficient understanding of the factors that drive their production and how they are affected by the actions put in place. Economic valuation can then be applied to the (changes in) services, which requires a good understanding of the service flows and of the determinants of demand. When the values of the ecosystems and associated land (or sea) use are mapped and established, the basis for 'capturing' the values for society is available and policy instruments such as subsidies and taxes, regulation, payments for ecosystem services and zoning of land use can be applied, and evaluated for their ecological sustainability, social justice (distribution of ecosystem based welfare and well-being) and economic efficiency.

Being spatially explicit is important in order to take into account the spatial heterogeneity of service flows, of the distribution of benefits to beneficiaries and of the economic values that can be assigned to them, as well as the variability of ecosystem conservation and management costs. It also allows the identification of mismatches of scales as well as analysing the distributional implications of decisions that affect ecosystems, and exploring trade-offs.

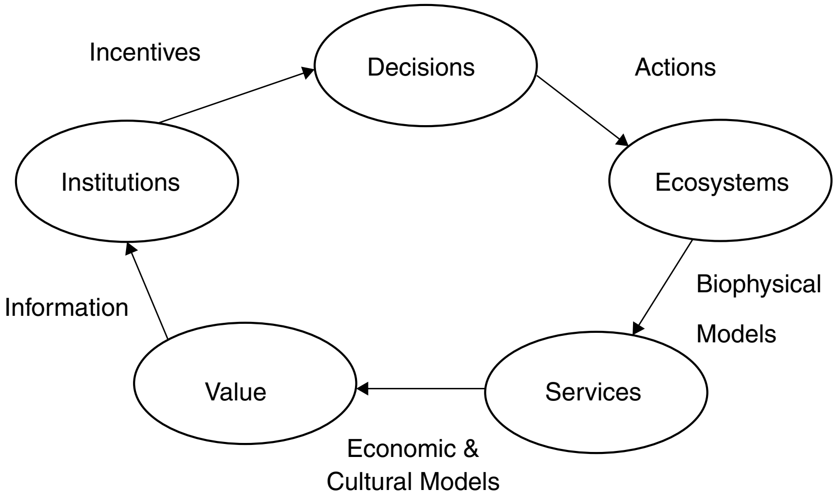
Marginal valuation in economic thinking assumes substitutability between services and is therefore only applicable within certain ecological limitations, requiring that no irreversible ecosystem changes occur. As Farley (2008) put it: 'In the vicinity of thresholds, marginal analysis is inappropriate'. Farley (2012) explains that 'when a system crosses a threshold, a very small change in economic activity can have enormous impacts. Crossing such thresholds can lead to the irreversible loss of critical natural capital, with unacceptable costs to society'. Next to these ecological limitations, socio-cultural considerations may delimit the range of valid cases for marginal valuation, as was noted earlier by Turner et al. (2003). Therefore, any valuation of biodiversity and ecosystem services needs to take account of the range of ecological and socio-cultural values that are not covered by mainstream economic valuation, but need different approaches and methodologies to be reflected in decision-making (EPA-SAB, 2009).

The TEEB valuation framework is largely consistent with others proposed in the analysis undertaken by the US National Research Council (NRC, 2005), including the Natural Capital Project (Daily et al., 2009), the EPA Science Advisory Board (EPA-SAB, 2009), Valuing the Arc (Mwakalila et al., 2009), and the French Council for Strategic Analysis (Chevassus-au-Louis et al., 2009). In all of these efforts, the essential links are between human actions, ecosystems, services and their contributions to human welfare (see Figure 10.3, building on Daily et al., 2009).

Human decisions lead to actions that have impacts on ecosystems, degrading as well as enhancing the conditions, causing changes in ecosystem structure and function, which in turn lead to changes in the provision of ecosystem services. Changes in ecosystem services have impacts on human welfare. A clear understanding of these links can provide information that can lead to the reform of institutions and better decisions that ultimately improve the state of ecosystems and the services they provide to society.

3. DEFINING ECOSYSTEM FUNCTIONS, SERVICES AND BENEFITS

Research efforts regarding the investigation of ecosystem services have increased strongly since Costanza et al. (1997) and Daily (1997). The



Source: Daily et al. (2009).

Figure 10.3 Ecosystem services: research agenda

papers in journals such as *Ecological Economics*, *Ecosystem Services* and the *International Journal of Biodiversity Science*, *Ecosystem Services and Management* have provided much insight into how to ensure that ecosystem service research is scientifically robust and credible, and also conveys a clear message to decision-makers in both the public and private sectors. In spite of the work done so far, there is still much debate about definitions and classifications (see Braat and De Groot, 2012 for an overview, including papers by Boyd and Banzhaf, 2007; Wallace, 2008; and Fisher et al., 2009) and perhaps we should accept that no final classification can capture the myriad of ways in which ecosystems support human life and contribute to human well-being (Costanza, 2008). Yet to make assessments comparable, it is essential to be clear about the terminology and classifications used. When dealing with complex relationships like coupled social-ecological systems, we need a rich language to describe their different features and interactions. While accepting that no fundamental categories or completely unambiguous definitions exist for such complex systems, and that any systematization is open to debate, it is still important here to be clear about the meaning of the core terms used.

3.1 Ecosystem Structure, Processes and Functions

The TEEB framework (Figure 10.2) starts with the upper-left-hand box which distinguishes ecosystem structure, processes and functions. *Ecosystem functions* are defined as a subset of the interactions between ecosystem structure and processes that underpin the capacity of an ecosystem to provide goods and services. The building blocks of ecosystem functions are the interactions between structure and processes, which may be physical (for example, infiltration of water, sediment movement), chemical (reduction, oxidation) or biological (photosynthesis and denitrification), whereby 'biodiversity' is more or less involved in all of them, although the precise detail of the relationship is often unclear or limited. The fundamental challenge is the extent to which it is practical (possible?) to fully predict the actual functioning of any defined ecosystem unit when relatively few (and rarely replicated) studies worldwide are available. It is often necessary to rely on various combinations of seemingly-appropriate indicators of ecosystem condition and function, which can in theory be applied more generally than in just individual cases.

From biophysical structure and process to ecosystem services and benefits
As Figure 10.2 shows, a lot of energy transformation is necessary in ecological systems (managed or not-managed) before services are provided, and in order to maximize social benefits, decision-makers need to understand what this involves. It is therefore helpful to distinguish 'functions' from the ecological structures and processes in the sense that the functions represent the *potential* that ecosystems have to deliver a service to humans which in turn depends on ecological structure and processes. For example, primary production (= process) is needed to maintain a viable fish population (= function) which can be used (harvested) to provide food (= service); nutrient cycling (= process) is needed for water purification (= function) to provide clean water (= provisioning service).

The benefits for individuals and society of these services are manifold, for example, food provides nutrition but also pleasure and sometimes even social identity (as part of cultural traditions); clean water can be used for drinking but also for swimming (pleasure) and other activities aimed at satisfying needs and wants. Thus, the role of woodlands in slowing the passage of water through a catchment is a function which has the potential of delivering a service (water flow regulation → reduced flood risk) if some beneficiary exists to enjoy the benefit (safety).

Services are actually conceptualizations ('labels') of the 'useful things' ecosystems 'do' for people, directly *and* indirectly, whereby it should be realized that properties of ecological systems that people regard as 'useful' may change over time even if the ecological system itself remains in a relatively constant state.

Clearly delineating between ecological phenomena (functions), their direct and indirect contribution to human welfare (services), and the welfare gains they generate (benefits) is useful in avoiding the problem of double counting that may arise due to the fact that some services (in particular supporting and regulating services) are inputs to the production of others (Balmford et al., 2008). Such differentiation is also crucial to provide a clear understanding of the spatial distribution of where the function occurs, where the provision of the service can be assessed, and ultimately where the benefits are appreciated.

The conclusion is that studies on ecosystem services should always be transparent on just which flows of energy and matter, or which results from ecosystem work are considered services, and how they are being valued and measured. An important research challenge for some ecosystem services is the relatively scant knowledge on how they are produced, maintained and affected by system or abiotic changes and how they are related to levels of biodiversity, although more and more is published on these topics (see, for example, Harrison et al., 2014).

It should also be realized that people in general benefit from ecosystem services without realizing it, which is characteristic for the regulating services (climate, air quality, water quality and so on), and thus fail to appreciate their value (importance). To make the dependence of human well-being on ecosystem services more clear, valuation studies should therefore not only include direct benefits (direct use values) but take due account of all the indirect benefits (indirect and non-use values) derived from ecosystem services. Another issue is how to deal with potential benefits or the 'likelihood of (future) use', for example, current functions like wildlife (as potential food source), water purification (keeping rivers clean) or attractive scenery in a remote area may not be used but may have great (economic) potential for future use.

Finally, to be consistent in the ecosystem services framework for man–environment relationships it should also be recognized that ecosystems may be viewed to provide *disservices*, for example, when they facilitate reproduction and dispersal of species that damage crops or human health and thus cause economic and social costs. It should also be realized that many of these disservices are the result of bad planning or management and are thus often man-made, for example, 'normalizing' rivers (leading to floods), cutting forest on hill slopes (causing erosion and landslides), and disturbing natural food webs (leading to outbreaks of pests).

In trade-off analysis, these social costs must be considered and, ultimately, the notion of benefits and 'dis-benefits' (that is, costs) should be included in a consistent ecosystem accounting framework (e.g. EEA, 2009, 2011).

From ecosystem services to (economic) value

Since ecosystems and their services affect so many aspects of human welfare, a broad set of indicators can and should be used to measure the magnitude ('value') of their impact. As with the interpretation of the terms 'function', 'service' and 'benefits' (see above), much debate still surrounds the use of the term 'value' in assessing the benefits of ecosystems to human well-being. The Oxford English Dictionary defines value as 'the worth, usefulness, importance of something'. The Millennium Ecosystem Assessment defined value as 'the contribution of an action or object to user-specified goals, objectives, or conditions' (after Farber et al., 2002), the measurement of which could include any kind of metric from the various scientific disciplines, such as ecology, sociology, economics (MA, 2003).

In mainstream economics, 'value' is always associated with trade-offs, that is, something only has (economic) value if we are willing to give up something to get or enjoy it. However, it is of course common practice, for example in industrial processes, to look at the value of input resources such as capital, technology and labour in terms of the relative contribution of these inputs to the production process and resulting products. This is analogous to the relative importance of ecological inputs and human inputs (for example, fertilizer in agriculture) in the production of ecosystem services (in this example: food, carbon sequestration and habitat for rural birds). The common metric in economics is monetary valuation, and some critics, both on the ecological and economic side, say the reliance on this metric has plagued many ecosystem service assessments, failing to incorporate several types of value which are critical to understanding the relationship between society and nature (for example, Norgaard et al., 1998; Wilson and Howarth, 2002; Christie et al., 2006). Valuation, and especially monetary valuation, is indeed sometimes understood to imply that ecosystems and their services must be privatized and commodified (traded in the market). First, this is not a necessary corollary, but secondly it is something that can be countered by demonstrating that public goods and services (and the natural capital they come from) may better be managed in the public domain (Braat and De Groot, 2012).

In addition to economic valuation, other ways to analyse the importance of ecosystem services include livelihoods assessments, capabilities approaches that emphasize the opportunities available to people to make choices (for example, Sen, 1993), and vulnerability assessments. Such considerations are necessary for integrating into the analysis some dimensions of human well-being that cannot easily or should not at all be measured in terms of money, such as freedom of choice and human rights. They are also important for measuring the services and benefits that are of a cultural and philosophical (spiritual) nature. However, while market-based monetary assessments only partially capture the total importance – that is, value – of ecosystem services to humans and their economies, they are vitally important for internalizing so-called externalities in economic accounting procedures and in policies that affect ecosystems, thereby influencing decision-making at all levels. It is of course crucial for decision-making with sustainability as the objective that the ecosystem services not traded in the market are included in an 'equivalent' manner (see, for example, Braat and Ten Brink, 2008).

3.2 Typology and Measurement of Ecosystem Services

Ecosystem services are defined in TEEB as 'the direct and indirect contributions of ecosystems to human well-being'. This basically follows the MA definition except that it makes a finer distinction between services and benefits and explicitly acknowledges that services can benefit people in multiple and indirect ways.

TEEB proposes a typology of 22 ecosystem services divided into four main categories: provisioning, regulating, habitat and cultural services. An important difference, as compared to the MA, is the omission of Supporting Services such as nutrient cycling and food-chain dynamics, which are seen in TEEB as a subset of ecological processes. Instead, the Habitat Service has been identified as a separate category to highlight the importance of ecosystems to provide habitat for migratory species (for example, as nurseries) and gene-pool 'protectors' (for example, natural habitats allowing natural selection processes to maintain the vitality of the gene pool). The availability of these services is directly dependent on the state of the habitat (habitat requirements) providing the service. If commercial species are involved, such as fish and shrimp species that spawn in mangrove systems (= nursery service) but for which the adults are caught far away, this service has an economic (monetary) value in its own right. Also the importance of the gene-pool protection service of ecosystems is increasingly recognized, both as 'hot spots' for conservation (in which money is increasingly invested) and to maintain the original gene-pool of commercial species (which are increasingly being imitated through the creation of botanic gardens, zoos and gene banks).

In the past few years an additional classification of ecosystem services has been developed named CICES (Common International Classification of Ecosystem Services, see www.cices.eu), which aims at a hierarchical consistent classification for accounting purposes (Haines-Young and Potschin, 2013). Table 10.1 shows the relationships between the different classifications in the MA, TEEB and CICES (from Maes et al., 2013).

Table 10.1 *Ecosystem services categories in MA, TEEB and CICES*

MA categories	TEEB categories		CICES v4.3 group†
Food (fodder)	Food	**Provisioning services**	Biomass [Nutrition]
			Biomass [Materials from plants, algae and animals for agricultural use)
Fresh water	Water		Water (for drinking purposes) [Nutrition]
			Water (for non-drinking purposes) [Materials]
Fibre, timber	Raw materials		Biomass (fibres and other materials from plants, algae and animals for direct use and processing)
Genetic resources	Genetic resources		Biomass (genetic materials from all biota)
Biochemicals	Medicinal resources		Biomass (fibres and other materials from plants, algae and animals for direct use and processing)
Ornamental resources	Ornamental resources		Biomass (fibres and other materials from plants, algae and animals for direct use and processing)
			Biomass based energy sources
			Mechanical energy (animal based)
Air quality regulation	Air quality regulation	**Regulating services (TEEB)**	[Mediation of] gaseous / air flows
Water purification and water treatment	Waste treatment (water purification)	**Regulating and supporting services (MA)**	Mediation [of waste, toxics and other nuisances] by biota
			Mediation [of waste, toxics and other nuisances] by ecosystems

Table 10.1 (continued)

MA categories	TEEB categories		CICES v4.3 group†
Water regulation	Regulation of water flows Moderation of extreme events	**Regulating services (TEEB)**	[Mediation of] liquid flows
Erosion regulation	Erosion prevention	**Regulating and supporting services (MA)**	[Mediation of] mass flows
Climate regulation	Climate regulation		Atmospheric composition and climate regulation
Soil formation (supporting service)	Maintenance of soil fertility	**Regulating and maintenance services (CICES)**	Soil formation and composition
Pollination	Pollination		Lifecycle maintenance, habitat and gene pool protection
Pest regulation Disease regulation	Biological control		Pest and disease control
Primary production Nutrient cycling (supporting services)	Maintenance of life cycles of migratory species (incl. nursery service)		Lifecycle maintenance, habitat and gene pool protection Soil formation and composition [Maintenance of] water conditions
	Maintenance of genetic diversity (especially in gene pool protection)		Lifecycle maintenance, habitat and gene pool protection

Spiritual and religious values	Spiritual experience	**Cultural services**	Spiritual and / or emblematic
Aesthetic values	Aesthetic information		Intellectual and representational interactions
Cultural diversity	Inspiration for culture, art and design		Intellectual and representational interactions
			Spiritual and / or emblematic
Recreation and ecotourism	Recreation and tourism		Physical and experiential interactions
Knowledge systems and educational values	Information for cognitive development		Intellectual and representational interactions
			Other cultural outputs (existence, bequest)
MA provides a classification that is globally recognized and used in sub global assessments.	*TEEB provides an updated classification, based on the MA, which is used in on-going national TEEB studies across Europe.*		*CICES provides a hierarchical system, building on the MA and TEEB classifications but tailored to accounting.*

Note: † http://cices.eu/.

Source: Maes et al. (2013).

Following the TEEB 3-step procedure, before economic valuation can be applied, the performance or availability of ecosystem services has to be mapped and measured in biophysical terms. The progress in the state of ecological knowledge and in data availability increasingly makes more direct measures of services possible but in most decision-making situations it is still necessary to make use of proxies (De Groot et al., 2012). Actual measurements of ecosystem services should be split into: (a) the capacity of an ecosystem to provide a service (for example, how much fish a lake can provide on a sustainable basis); and (b) the actual use of that service (for example, fish harvested for food or for use in industrial processing). Measurement of the importance (value) of that fish in terms of nutritional value, a source of income and/or way of life is then part of the 'human value domain'.

When applying valuation, it is necessary to clearly distinguish between potential and actual use of services which have direct use value (notably provisioning and some cultural services), and services that have indirect use value (notably regulating, habitat and other cultural services). Since most ecosystems provide a bundle of services, and the use of one service often affects the availability of other services, (economic) valuation should consider not only (marginal) values from the flows of individual services but also take due account of the 'stock or asset value' (that is, the entire ecosystem) providing the total bundle of services. In this context the ecosystem can be seen as the 'factory' providing (a bundle of) services. It is common practice that, for example, car factories include the costs of maintaining the machines and buildings in the price of the car but for fish taken from a natural lake the maintenance costs of the natural capital (the lake and its food web) providing the service is not included. In the timber industry the cost of replanting and soil maintenance are included, comparable to agriculture, although the negative effects of use of pesticides is usually not part of the analysis. If the actual management cost of the ecosystem (which is determined by the institutional arrangements) is taken into account, this will influence the expected value of future flows of services, which will differ depending on whether it leads to sustainable or unsustainable uses (Maeler et al., 2008).

3.3 Human Well-being: Typology of Benefits and Values

The TEEB framework (Figure 10.2) makes a distinction between benefits and values. The reason for separating benefits and values is because people have needs which, when fulfilled, are translated into (more or less objectively measurable) benefits. For example, catching fish from the ocean gives us food (health), but also cultural identity (as a fisher) and income. How we value these benefits is subjective: some people will value the income much more highly than their cultural identity (social ties and so on) and may be willing to give up one aspect of their well-being (cultural identity) over another (for example, material wealth). Thus, different values can be attached to a particular benefit. Although the TEEB study focuses primarily on the measurement of economic values and the assessment of costs and benefits in a welfare economics approach, it includes equity considerations in particular for the aggregation of benefits over time and over groups of people. It specifically analyses the relationships between ecosystems and poverty ('GDP of the poor'), because of the higher direct dependence of the poor on ecosystem services for their livelihood (TEEB, 2010). Of course, it should also be acknowledged that many native communities ('ecosystem people') still entirely, and directly, depend on ecosystems and their services for their survival, as well as the importance of ecosystems for providing people with the ability to choose certain ways of life that they may value.

The three main types of benefits (well-being aspects) and related values and valuation metrics are briefly introduced below:

Ecological benefits and 'values'

The importance of components and processes in ecosystems to maintain life support systems (at all scales, from local to global) has sometimes been called ecological value. It has been articulated by natural scientists in reference to the causal (dose–response) relationships between parts of a system such as, for example, the role (function) of a particular tree species to control erosion, or the importance of one species to the survival of another species or of an entire ecosystem (Farber et al., 2002). Although it is tempting to use the term 'value' for this type of relative importance, we advise against it because it may easily be confused with the utilitarian concept of value which relates ecosystem structure and processes (via information, matter and energy flows) to human needs and wants. At a global scale, different ecosystems and their constituent species play different roles in the maintenance of essential life-support processes (such as energy conversion, biogeochemical cycling, and evolution) (MA, 2003). Ecological measures of a well functioning (healthy) ecosystem are, for example, integrity, 'ecosystem condition' or resilience, which are important indicators to determine critical thresholds and minimum requirements for ecosystem service provision. So, indirectly, the link to human use, utility and economic valuation is made, which is the background of the term 'ecological value'. Now, with the TEEB (cascade) framework it is much clearer that the social and economic benefits of and assigned values to ecosystem services do not have to be labelled as 'ecological values'.

The ecological measures of ecosystems and their services can thus be used to calculate the relative contribution, next to human inputs, to economic values. The related value paradigm could be formulated as the importance people attach to a healthy, ecologically stable environment, both as a contribution to human survival (instrumental value) and for intrinsic reasons (values). This in fact is similar to the concept of Supporting Services in the MA and ecosystem functions in TEEB. If these so-called ecological values are monetized, double-counting of value is unavoidable. Therefore, because the notion of ecological value is still used frequently without realizing the above implications, we suggest that the 'value' of natural ecosystems and their components to humans should be recognized and measured in terms of their contribution to maintaining life on earth, including human survival in its own right (Farber et al., 2002).

Socio-cultural benefits and values

For many people, biodiversity and natural ecosystems are a crucial source of non-material well-being through their influence on mental health and their historical, national, ethical, religious and spiritual values. While conceptual and methodological developments in economic valuation have aimed at covering a broad range of values, including intangible ones (see the concept of Total Economic Value below), it can be argued that socio-cultural values cannot be fully captured by monetary economic valuation techniques and have to be complemented by other approaches in order to inform decision-making. These are now being denoted with the term 'non-monetary valuation' (see Gómez-Baggethun et al., 2014). This is notably relevant where some ecosystems and their services are considered essential to a people's very identity and existence.

To obtain at least a minimum (baseline) measure of importance of socio-cultural benefits and values, several metrics have been developed, such as the Human Wellbeing Index.

Economic benefits and values

As indicated above, biodiversity and ecosystem services are important to humans for many reasons. In economic terms, this can be considered as contributing to different elements of the notion of human well-being (including material welfare) measured best by 'Total Economic Value', which comprises both use values (including direct use such as resource use, recreation and indirect use from regulating services) and non-use values, for example, the value people place on protecting nature for future use (option values) or for ethical reasons (bequest and existence values). The economic importance of many of these values can be measured in monetary terms, with varying degrees of accuracy, using various techniques (including market pricing, shadow pricing and questionnaire based). In some cases the economic value (and a context-dependent price) has to be estimated by comparing the ecosystem services to alternative services via technological processes (for example, water purification), or alternative sources of the same service, but obtained (from) elsewhere.

4. GOVERNANCE AND DECISION-MAKING

In making decisions at any level (private, corporate or government), decision-makers are faced with the dilemma of how to balance (weigh) sustainable use of ecosystem services and production of socio-cultural and economic values. We first discuss some of the prominent methods for decision-making and illustrate how the European Union implements the TEEB approach following the recommendations in its Biodiversity Strategy 2011–2020.

4.1 Methodology for More Balanced Decision-making

Preferably, the importance of each of the value-components attributed to ecosystem services should be weighted in its own (qualitative and quantitative) dimension, for example, through Multi-Criteria Decision Analysis. However, since decisions are usually focusing on the economic, notably monetary, consequences, aggregation issues (1) and use of ecosystem services in trade-off analysis (2) and awareness raising and positive incentives (3) are essential tools for better decision-making.

1. Aggregating monetary values: Aggregation involves bringing together all the information on the monetary values of ecosystem services by ecosystem type into a single matrix to attain an aggregate monetary value of all delivered ecosystem services. Key issues requiring consideration include:

    - *Accounting for uncertainties in the monetary valuation of individual services*, including possible biases due to the use of different valuation methods.
    - *Interdependencies between ecosystem services at the ecosystem scale*, including issues of double counting, competing services, bundled services, etc.
    - *Aggregation of values over individuals and groups of people*: the relative importance of ecosystem services will vary between different groups of people, for example, regarding income level or dependence on ecosystem services. To integrate such

considerations some adjustments can be applied, such as equity weightings (Anthoff et al., 2009).

- *Aggregation of values over spatial scales*: different ecosystem services may be best considered at different spatial scales. For example, water regulation is best considered at a watershed scale, pollination at the site scale (1500 metres), while carbon sequestration should be considered at the global scale. Aggregation should take these differences into account.
- *Aggregation of values over time*: protecting biodiversity today may have costs and benefits to future generations. In economics, discounting is a common practice to compare these future costs and benefits with current values. An important issue is the selection of the most appropriate discount rate in different decision-making contexts.

2. Trade-off analysis: A trade-off occurs when the actual use of an ecosystem service (for example, harvesting timber) has a negative impact on the provision of other services. For example, timber extraction from a forest will affect, among others, vegetation structure and composition, visual quality and water quality, which will preclude or at least affect the continuous provision of other services (for example, wildlife harvesting, carbon sequestration, recreation) over time, since loss of structure implies loss of function, and consequently of other services and their derived benefits. Approaches to trade-off analysis include: multi-criteria (decision) analysis, cost–benefit analysis and cost-effectiveness analysis. The foundational strength of *Cost–Benefit Analysis (CBA)* is finding the 'net' benefit of an activity. Since the costs and benefits of an activity (or scenario) have different functional relationships in different circumstances, utilizing a 'benefits only' approach could greatly mislead decision-making (Naidoo and Ricketts, 2006). This benefits-only approach was common in early ecosystem service assessments (Balmford et al., 2002). A notable early exception is research on the fynbos in South Africa, where researchers enumerated the benefits and costs of both an invasive species eradication campaign and a do-nothing approach (Van Wilgen et al., 1996). An understanding of costs is also crucial in ecosystem service research since the complexity of benefit delivery might preclude a full understanding of service delivery. In these cases a *cost-effectiveness approach* can be highly informative, especially where the costs vary more than the benefits (Ando et al., 1998; Balmford et al., 2003; Naidoo and Ricketts, 2006; EEA, 2009).
3. Awareness raising and positive incentives: An important step towards the conservation and sustainable use of biodiversity and ecosystem

services lies in accounting for the positive and negative externalities associated with human activities. Rewarding the benefits of conservation through *payments for environmental services* (for example, Landell-Mills and Porras, 2002; Wunder, 2005; Muradian et al., 2010) or ecological fiscal transfers (Ring, 2008) is as important as the realignment of perverse subsidies that all too often incentivize unsustainable behaviours.

A growing societal awareness of the need for research and development, and for changes in policy, practice and law, can help us pursue sustainable ecosystem management and resource use, and engage in eco-regional planning and large-scale restoration and rehabilitation of renewable and cultivated natural capital (Aronson et al., 2007; Braat and De Groot, 2012).

4.2 Ecosystem Services in the EU Biodiversity Strategy 2011–2020

The TEEB study has put the issue of the economic importance of ecosystems, their services and associated biodiversity firmly on the policy agenda, especially via the launch of its key reports in 2010 at the CBD COP 10 in Nagoya (the Aichi Targets) and the EU Biodiversity Strategy 2011–2020. The 20 Aichi targets have selectively been translated into six targets in the EU strategy, and a number of actions are identified, many of which are using and further developing the concept. In the US, the US Environmental Protection Agency and US Geological Survey use the concept in policy assessments, and in many other countries around the world the concept is slowly being accepted as (potentially) useful (see, for example, Cox et al., 2013).

Here we illustrate the approach of the European Union, which adopted the EU Biodiversity Strategy 2011–2020 in December 2011. The strategy distinguishes six targets, of which Target 2 especially is dedicated to the ecosystem services (see Figure 10.4).

To achieve the targets, a total of 20 actions have been defined, three of which are focused on Target 2 (see Figure 10.5 below).

Action 5 de facto follows the TEEB approach and defines three major steps in which the European Commission and the Member States operate together to: (1) map and assess ecosystems, including their condition (= level of degradation) and their services (action to be completed by the end of 2014); (2) based on these biophysical assessments the Member States must evaluate their natural capital and ecosystem services by 2020; and (3) integrate the values into accounting and reporting systems.

Actions 6 and 7 of the EU Biodiversity Strategy introduce elements of TEEB step 3: 'capturing the values' via analysis of restoration potential

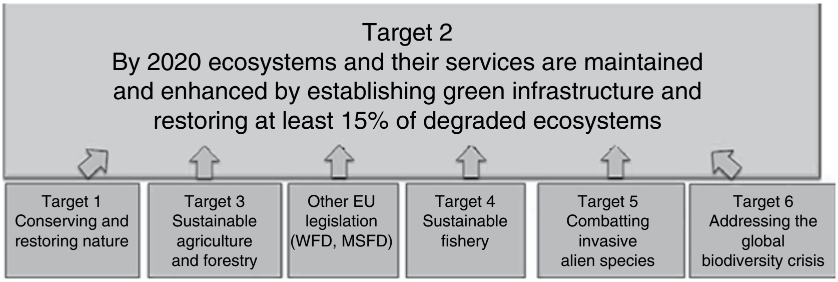


Figure 10.4 *EU Biodiversity Strategy Target 2 on ecosystem services*

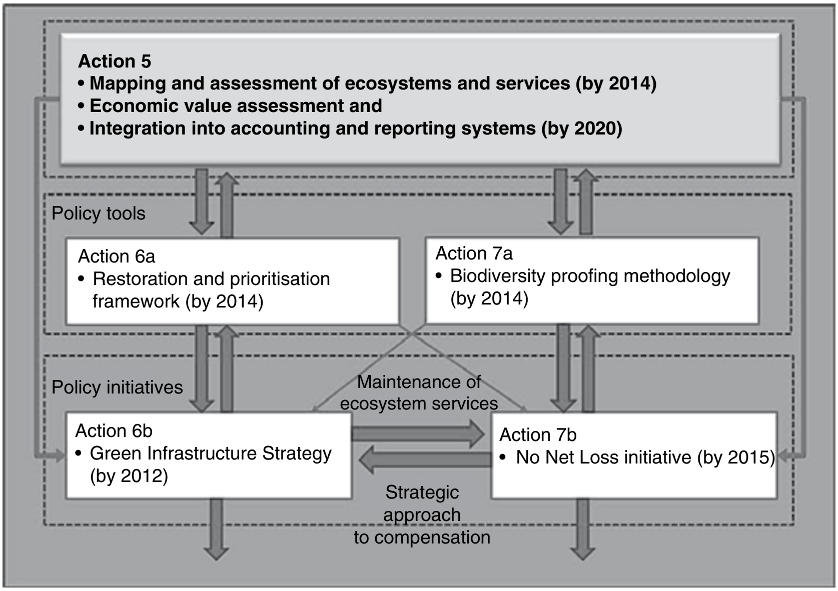


Figure 10.5 *EU Biodiversity Strategy Action 5 to map and value ecosystem services*

and 'no net loss' instruments and policy proposals for developing green infrastructure.

Many of the EU countries have started to collect the relevant material to develop the biophysical assessments, some are building on previous work in sub-global assessments of the Millennium Ecosystem Assessments (UK, Spain), some do TEEB country studies (the Netherlands, Scandinavian countries, Germany), and several have sets of maps developed based on ecological assessments of ecosystems (France, Czech Republic, Belgium, Austria, and others) (see Braat et al., 2013).

The newly constituted Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) has begun to implement its workplan and is developing many working groups on the most urgent issues (see www.ipbes.net). The WAVES[2] project (World Bank) and Inclusive Wealth Report[3] (UNEP) initiatives aim to integrate Ecosystems and Ecosystem Services better in National Accounting procedures and GDP calculations.[4] Also the business community is beginning to take the concept seriously.[5]

To provide access to all these initiatives and associated information, and stimulate collaboration between researchers, policy-makers and practitioners, the Ecosystem Services Partnership (ESP) was established in 2007, which has now over 60 institutional members and a large community (over 1800) of active participants distributed over 45 working groups. The ESP website (www.es-partnership.org) gives much information and many links to the ongoing research, policy and implementation activities aimed at using the ecosystem services concept to enhance both conservation of biodiversity and sustainable use of ecosystems while maintaining the underlying natural capital as a vital asset to our economy and well-being.

5. CONCLUSIONS

The economic importance of ecosystems and biodiversity seems to be becoming accepted step by step by national and international governments and is receiving increasing attention in the business community as well. The TEEB publications (www.teebweb.org) and the MA studies (www.maweb.org) have contributed considerably and in fact the process has only just begun to affect policy and planning at the regional level. The TEEB database of valuation studies (see De Groot et al., 2012), for example, contains information from more than 230 studies from all over the world. Interestingly, the problems some people have with the somewhat technical term 'ecosystem services' is beginning to lead to the development of popularized versions of the concept, such as 'nature-based solution'.

A challenge that remains, in spite of the increasing popularity of the

[2] https://www.wavespartnership.org/en.
[3] http://www.ihdp.unu.edu/article/iwr.
[4] https://unstats.un.org/unsd/envaccounting/seea.asp.
[5] http://www.wbcsd.org/work-program/ecosystems/cev/background.aspx.

ecosystem services concept, is to make structural changes in economic theory and practice based on the 'full value' of ecosystems and their services in business practice and accounting procedures. Although the theory and empirical basis for ecosystem service assessment and valuation are rapidly developing, real change in our practice and institutions is lagging behind. It is therefore essential that the concept and the discipline of ecological economics becomes accepted as part of mainstream economic curricula to achieve the necessary fundamental changes, otherwise we will continue to only treat the symptoms (spending, or better wasting, huge sums of money on damage and restoration costs) and not deal with the causes of the ongoing loss of biodiversity and degradation and disappearance of natural ecosystems.

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11. Ecological economics perspectives on ecosystem services valuation

Erik Gómez-Baggethun and Berta Martín-López

INTRODUCTION

Interest in ecosystem services valuation has grown steadily since the 1990s and gained renewed attention after the launch of the international initiative The Economics of Ecosystem Services and Biodiversity (TEEB). *Ecological Economics* is the journal that hosts the largest number of papers on ecosystem services valuation (Abson et al., 2014) and yet this topic remains a highly divisive question among ecological economists (Spangenberg and Settele, 2010; Baveye et al., 2013; Kallis et al., 2013).

Costanza et al.'s (1997) study on the monetary value of the world's ecosystems divided ecological economists between those who accept valuing nature in monetary terms as a pragmatic choice, and those who reject it on methodological, ethical or political grounds (Toman, 1998; Spash, 2008). After years of polarized debates, the *impasse* in the valuation debate is slowly giving way to discussions that aim to define specific conditions under which monetary valuation may or may not be appropriate. This includes considerations on whether valuations are scientifically sound (Baveye et al., 2013), socially just (Martínez-Alier, 2002; Boeraeve et al., 2015), or ethically fair (Jax et al., 2013; Luck et al., 2012).

Another important development in the ecosystem services literature is that the prominence of monetary valuations has declined over recent years (Abson et al., 2014) as scientists pay attention to other valuation languages (Martínez-Alier, 2002; Pascual et al., 2010; Gómez-Baggethun and Barton, 2013; Martín-López et al., 2014). The edited volumes of the Millennium Ecosystem Assessment provide rich information on different values of ecosystems and biodiversity (MA, 2003) and even the economically focused TEEB study concedes the existence of multiple, conflicting and non-commensurable values (Pascual et al., 2010, p. 193; TEEB, 2010). The Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) embraces this perspective even stronger and has made from the outset a plea for value pluralism to comprehend the multiple ways in which different human societies understand the importance of ecosystems and biodiversity (Díaz et al., 2015).

Despite these opening trends, monetary valuation remains the hegemonic valuation language (Nieto-Romero et al., 2014). Recent contributions (for example, Chan et al., 2012a; Jax et al., 2013; Dendoncker et al., 2013) note that much of the literature on ecosystem services keeps using the term 'value' in a narrow monetary sense, often presenting money values of ecosystem services as *the* value of ecosystems and biodiversity (Ghermandi et al., 2010). Similarly, Wikipedia refers to 'ecosystem valuation' as 'a widely used tool in determining the impact of human activities on an environmental system by assigning an *economic* value to an ecosystem or its ecosystem services'.[1] Economists are not solely to blame for this value reductionism. Seduced by the alleged persuasive power of the money language, many natural scientists have endorsed monetary valuation as a pragmatic short-term strategy to communicate the societal value of ecosystems and biodiversity in a language that resonates with dominant political and economic views (Daily and Ellison, 2002; Skroch and Lopez-Hoffman, 2010; Costanza et al., 1997, 2014). 'New environmental pragmatists' (Spash, 2009) may have contributed as much as economists to the hegemony of the money metric in environmental valuation.

Dominance of valuation by a narrow market-oriented understanding have led some critical ecological economists to oppose valuation as a whole. We share the concerns that motivate this scepticism and are aware of the limits of any anthropocentric approaches to nature protection (Kronenberg, 2014; McCauley, 2006). We contend however, that there are important reasons why ecological economists should engage in the debate on ecosystem services valuation. First, as a growing share of contemporary people live in cities alienated from nature (Miller, 2005), metaphors that highlight societal dependence on ecological life support systems may be more necessary than ever (Odum, 1989). A core premise in ecological economics is that ecosystems and biodiversity are not only a matter of ethics and aesthetics but the very material foundations of human societies (Gómez-Baggethun and de Groot, 2010). Second, despite the leading role ecological economics have played in developing the ecosystem service approach, its mainstreaming has resulted in applications of the concept in directions that diverge significantly from the original purpose for which it was introduced (Norgaard, 2010). An approach originally introduced to *ecologize economics* is at risk of being demeaned by a market

[1] http://en.wikipedia.org/wiki/Ecosystem_valuation. Accessed 24 September 2014.

environmentalism that *economizes ecology* by turning ecosystem services into fictitious commodities (Gómez-Baggethun, 2010).

Aware of the growing importance of ecosystem services in the environmental science and policy agendas, this chapter delineates an approach that is aligned with the principles and vision of ecological economics. This is an approach where different valuation languages can be consistently combined to elicit the importance humans attribute to ecosystems and biodiversity as the basis for life and long-term economic viability. The text is structured in three main parts. First, we present the case for value pluralism. Second, we examine and describe essential value dimensions in ecosystem services and associated valuation techniques. Next, we outline the approach of integrated ecosystem services valuation and discuss valuation languages, knowledge systems, data sources, and value articulating institutions for developing an ecological economics perspective on ecosystem services. We end up with a summary of our main conclusions.

THE CASE FOR VALUE PLURALISM

The Oxford Dictionary defines 'value' as 'the regard that something is held to deserve; the importance, worth, or usefulness of something' or as '[. . .] one's judgment of what is important in life'.[2] The key word here is *importance*. Following these definitions and sidelining influential contributions to the literature on ecosystem services valuation (for example, Costanza, 2000; de Groot et al., 2002; 2010; MA, 2005), here we endorse this broader understanding of value as *importance*, and refer to valuation accordingly as the act of assessing, appraising or measuring value or importance (Dendoncker et al., 2013).

The question that follows is how importance can be quantified or qualified. The search for a common substance in 'value' has long been the philosopher's stone of value theorists. Classical economists like Ricardo and Marx searched for it in labour. For moral philosophers of classical utilitarianism like Bentham or Stuart Mill, the fundamental value is pleasure (defined as utility), and all the other objects we think valuable are only so in the extent they contribute to pleasure. Neoclassical economists brought this principle into economic analysis suggesting that utility could be measured by means of the preferences people express in markets through their willingness to pay to satisfy a need or want. Finally, some authors from the natural sciences sought to find a common substance of

[2] http://www.oxforddictionaries.com/definition/english/value.

value in energy (Hannon, 1973) or other related concepts (such as *exergy* or *emergy*) (Odum, 1996). Despite the large epistemological differences that are apparent in these perspectives, all of them share an important common characteristic: they all endorse a monist theory of value.

Monist approaches are appealing for their synthetic power and mathematical tractability, and may be especially attractive for policy-makers avid for decision support tools that inform trade-offs and facilitate choices. However, many ecological economists think along with Georgescu-Roegen (1975, 1983) that monist theories of value – be they monetary, biophysical or other – are forms of value reductionism that can capture only one of the several relevant dimensions of nature's value (O'Neill, 1996; Paterson, 1998; Martínez-Alier, 2002; Gómez-Baggethun and de Groot, 2010; Martín-López et al. 2014). Today there is a growing consensus on the view that monistic approaches cannot capture a comprehensive picture of nature's importance for informed decisions (O'Neill, 1996; Beckerman and Pasek, 1997; Martínez-Alier, 2002; Pascual et al., 2010).

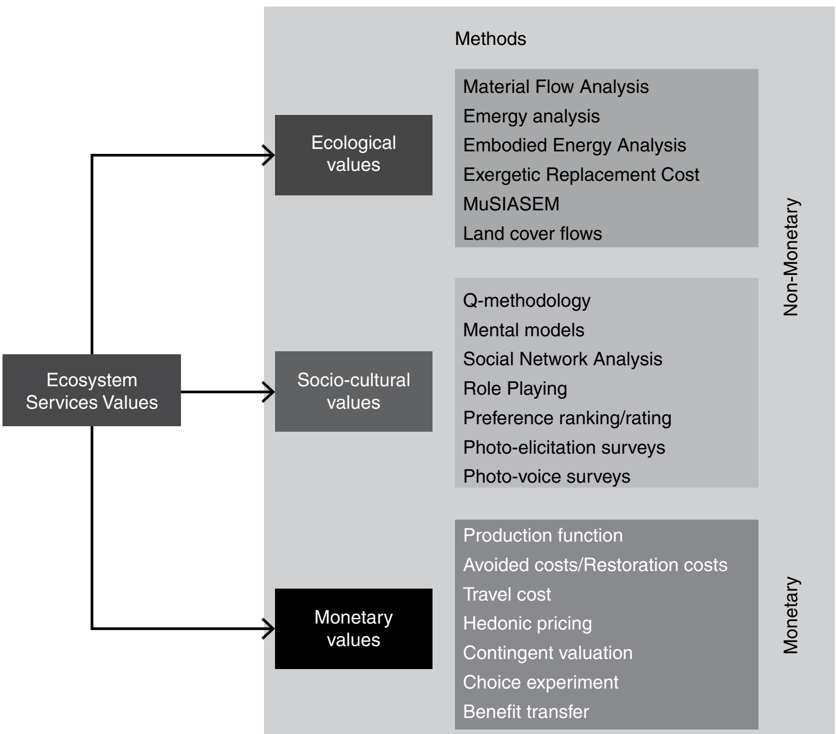
Value pluralism rests on the idea that multiple values deserve in principle distinct recognition and may be in conflict with each other (Mason, 2011; 2013; Norton and Noonan, 2007; Gómez-Baggethun and Barton, 2013; Martín-López et al., 2014). It thus departs from the assumption that different values are required to capture the multiple ways in which ecosystem services contribute to fulfil human needs and wants. These include physiological and subsistence needs, safety and protection, affection and sense of belonging, esteem and identity, and other important aspects of quality of life (Max-Neef, 1992; MA, 2005; Zorondo-Rodríguez et al., 2014).

Value pluralism stems from the assumption that valuation of ecosystem services involves dealing with multiple and often conflicting valuation languages, whereby different values deserve distinct attention in decisions and yet may not be reduced to a single metric (Martínez Alier et al., 1998). Consequently, the perspective of value pluralism postulates that some values may be weakly comparable (Martínez-Alier et al., 1998), or even incommensurable along a single rod of measurement (Neurath, 1925; Kapp, 1983; O'Neill, 1996; Gómez-Baggethun and de Groot, 2010; Chan et al., 2012a).

Despite formal recognition of multiple values in ecosystems services (for example, de Groot et al., 2002; Farber et al., 2002; TEEB, 2010; Jax et al., 2013; Dendoncker et al., 2013; Reyers et al., 2013), the bulk of the empirical literature addresses single values from disciplinary approaches (Vihervaara et al., 2010; Abson et al., 2014; Nieto-Romero et al., 2014).

ESSENTIAL VALUE DOMAINS IN ECOSYSTEM SERVICE ASSESSMENTS

The literature on ecosystem services valuation refers to multiple values, including ecological, economic, social, cultural, spiritual, symbolic, therapeutic, insurance, relational and place values. For consistency with previous typologies in the ecological economics literature on ecosystem services (for example, Farber et al., 2002; Howarth and Farber, 2002; Limburg et al., 2002; Wilson and Howarth, 2002; de Groot et al., 2010; Dendoncker et al., 2013; Martín-López et al., 2014; Castro et al., 2014a), here we group values into three broader families or value domains: ecological, sociocultural and monetary (Figure 11.1).



Note: MuSIASEM = Multi-Scale Integrated Analysis of Societal and Ecosystem Metabolism.

Figure 11.1 Methodological toolbox for integrated valuation of ecological, socio-cultural and monetary values of ecosystem services

In practice, the boundaries of these domains are blurred and these value categories should therefore be understood as ideal analytical types in a Weberian sense (Weber, 1949). Next, we examine each of these values in a sequence that follows the ecological economics framework of the three nested systems of sustainability: ecological, socio-cultural and economic (Daly and Farley, 2004; Martínez-Alier, 2002) (Figure 11.1). We further present a range of methods, embedding both qualitative and quantitative techniques, to elicit each of these values (Table 11.1).

Ecological Values

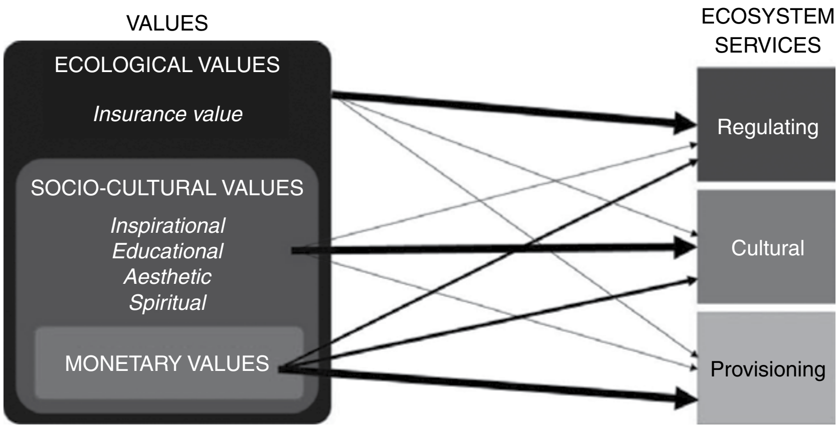
In the ecosystem services literature, ecological values relate to the ecosystem functions, processes and components on which ecosystem service delivery ultimately depends (de Groot et al., 2002). They measure the ecological health and integrity of an ecosystem and its capacity to perform regulation and habitat functions as measured by ecosystem parameters, such as complexity, diversity, productivity and stability (de Groot et al., 2003; Gómez-Baggethun et al., 2014). For the sake of our discussion, ecological value can be related to the integrity of the biotic and abiotic components that contribute to ecosystem service provision, including populations, communities, functional groups, functional traits and habitat types (Luck et al., 2003; Elmqvist et al., 2003; Kremen, 2005; Harrington et al., 2010; Kontogianni et al., 2010; García-Llorente et al., 2011).

Ecological values have been linked to the notion of 'insurance value' (Armsworth and Roughgarden, 2003), related to ecosystem resilience and capacity to sustain ecosystem services over time in the face of disturbance and change (Pascual et al., 2010). Securing such capacity involves maintaining critical levels of ecological function and structure – sometimes referred to as 'critical natural capital' (Deutsch et al., 2003) – and keeping ecosystems away from ecological thresholds (Limburg et al., 2002; Gómez-Baggethun et al., 2011). Critical natural capital and related insurance values can be secured by adopting a strong sustainability approach to preserve ecosystem stocks and funds (Farley et al., in press) (for example, through caps on emissions and resource extraction) and by defining safe minimum standards or safe operating spaces for human activity (Rockström et al., 2009). Ecological values relate most directly with habitat/supporting services and with regulating services (Figure 11.2). Some authors consider these categories represent *intermediate services* and alert against double counting problems (Turner et al., 2008; Fisher et al., 2009) but others suggest that ecological values require distinct analytical treatment and should not be compressed into monetary or socio-cultural values (Pascual et al., 2010; Gómez-Baggethun, 2013).

Table 11.1 Tools for valuing ecological, socio-cultural and monetary values of ecosystem services, spatial scales at which they can be applied, and quantitative vs. qualitative nature

Values	Methods	Spatial scale			Methodological approach	
		Local	*Regional*	*Global*	*Quantitative*	*Qualitative*
Ecological values	Material Flow Analysis	●●	●●	●●	×	
	Emergy analysis	●	●●	●●	×	
	Embodied Energy Analysis	●	●●	●●	×	
	Exergetic Replacement Cost	●	●●	●●	×	
	MuSIASEM	●●	●●	●	×	
	Land cover flows	●●	●●	●●	×	
Socio-cultural values	Q-methodology	●●	●		×	×
	Mental models	●●	●			×
	Social Network Analysis	●●	●		×	
	Role playing	●●			×	×
	Preference ranking / rating	●●	●		×	
	Photo-elicitation surveys	●●	●		×	×
	Photo-voice surveys	●●	●			×
Monetary values	Production function	●	●●	●●	×	
	Avoided costs / Restoration costs	●●	●●	●●	×	
	Travel cost	●●	●		×	
	Hedonic pricing	●●	●		×	
	Contingent valuation	●●	●		×	
	Choice experiment	●●	●		×	
	Benefit transfer		●	●●	×	

Notes: MuSIASEM = Multi-Scale Integrated Analysis of Societal and Ecosystem Metabolism. (●● good fit with the spatial scale; ● partial fit with the spatial scale).



Notes: The left-hand side of the figure represents the ecological–economic perspectives on the three nested systems of sustainability (i.e. ecological, socio-cultural and economic systems). The width of arrows represents the level of association.

Figure 11.2 Associations between major categories of values (i.e. ecological, socio-cultural and monetary values and major categories of ecosystem services (i.e., provisioning, regulating and cultural services)

Some ecological economists link the notion of ecological valuation with biophysical measurements of metabolic requirements (Martínez-Alier, 1987, 1993; Naredo, 2001). Biophysical valuation includes methods to quantify flows of materials such as Material Flow Analysis or Life Cycle Analysis (Daniels and Moore, 2002); methods to quantify surface requirements or changes therein such as ecological footprint (Wackernagel and Rees, 1997) or land cover flows (EEA, 2006); and the broader family of methods based on the calculation of energetic requirements or entropic costs of human activity, including Embodied Energy Analysis (Costanza, 1980), Exergetic Replacement Cost (Naredo, 2001), Emergy analysis (Odum, 1996), Human Appropriation of Net Primary Production (Vitousek et al., 1986) and Multi-Scale Integrated Analysis of Societal and Ecosystem Metabolism (MuSIASEM) (Giampietro et al., 2009) (Table 11.1).

Sociocultural Values

People hold material, moral, spiritual, aesthetic and other values regarding the environment, all of which influence their attitudes and actions toward ecosystems and the services they provide. These include emotional, affective and symbolic views that in most cases cannot be captured in any meaningful way by commodity metaphors and monetary metrics (Norton and Hannon, 1997; Martínez-Alier, 2002; Bryan et al., 2010; Gómez-Baggethun and Ruiz-Pérez, 2011; Daniel et al., 2012; Chan et al., 2012a, 2012b).

The ecosystem services literature has variously defined cultural values as 'aesthetic, artistic, educational, spiritual and/or scientific values of ecosystems' (Costanza et al., 1997), which is quite similar to the definition given to cultural services, that is, 'non-material benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experience' (MA, 2005). Cultural values include intangible things such as the place values that emerge from people's emotional and affective bonds to nature (Altman and Low, 1992; Feldman, 1990; Shamai, 1991; Williams et al., 1992; Basso, 1996; Norton and Hannon, 1997; Brown et al., 2002), spiritual values (Stokols, 1990; Milton, 2002), heritage value (Throsby, 2001), sense of community (Doolittle and Macdonald, 1978; Chavis and Pretty, 1999), and social cohesion (Lin, 2001; Sable and Kling, 2001; Doolittle and Macdonald, 1978). All these values are created in the mind of the ecosystem service beneficiaries and therefore the same flow of ecological information may be differently labelled in inspirational, educational, therapeutic or spiritual benefits, depending on who is the observer (Gómez-Baggethun et al., 2014). Sociocultural values relate mainly to the category of cultural services but not exclusively, since people can also perceive therapeutic, educational or inspirational benefits related to regulating and provisioning services (Figure 11.2).

Recent research has made progress in the quest to better integrate social perspectives and cultural valuation techniques into the ecosystem services framework, enabling a wider representation of cultural values in ecosystem service assessments (for example, Chan et al., 2012a; Hernández-Morcillo et al., 2013). In the context of ecosystem services, socio-cultural valuation has been used in reference to a heterogeneous collection of valuation approaches and methods whose only shared characteristic is not relying on monetary or biophysical measurement (Christie at al., 2012; Milcu et al., 2013; Kelemen et al., 2014) (see Figure 11.1). Some of the labels used within this family of methods and techniques include 'psycho-cultural valuation' (Kumar and Kumar, 2008), 'social valuation' (James et al., 2013; Casado-Arzuaga et al., 2013), 'deliberative valuation' (Howarth and Wilson, 2006; Kenter et al., 2011), 'qualitative valuation' (Zendehdel et al., 2008) and 'subjective assessment' (Aretano et al., 2013). Recently, 'socio-cultural valuation' has been applied as an umbrella term for methods that rank preferences towards ecosystem services in non-monetary terms (for example, Gómez-Baggethun, 2010; Calvet-Mir et al., 2012; Castro et al., 2014b; Martín-López et al., 2012, 2014; Oteros-Rozas et al., 2014). Table 11.1 identifies qualitative and quantitative methods to estimate socio-cultural values.

Monetary Values

Monetary valuation of the environment has its origins in the 'externality' concept (Pigou, 1920 [2006]; Pearce and Turner, 1990). The initial focus was on negative externalities, like pollution or resource depletion, but was thereafter extended to cover environmental amenities (Clawson, 1959; Krutilla, 1967) and ecosystem services (Costanza et al. 1997; Balmford et al. 2002; TEEB, 2010).

Since Krutilla (1967), the literature on monetary valuation often divides values into use and non-use values, each subsequently disaggregated into different value components that are generally added up to the so-called Total Economic Value (TEV) framework (for example, Heal et al., 2005; Turner et al., 2003, 2008). The TEV framework often divides use values into: (1) direct use; (2) indirect use; and (3) option values. Direct use values are derived from the use and enjoyment of ecosystem services, either extractive or non-extractive. Extractive direct use values have been traditionally related to provisioning services such as agriculture or fishing, while non-extractive direct use values have been mostly related to cultural services recreational activities, nature tourism, and aesthetic enjoyment. Indirect use values are traditionally associated with regulating services (for example, soil fertility, water purification, climate regulation, pollination, and so on). Finally, so-called option values are associated with the satisfaction humans derive from ensuring that an ecosystem service will be available in the future (Faith et al., 2010). An example of option value is bioprospecting, which involves the question of whether or not any particular organism will prove to be of commercial use in the future.

Non-use values relate to the satisfaction that individuals derive from the knowledge that biodiversity and ecosystem services are and will be available for other people and other species (Kolstad, 2000). In the first case, non-use values are usually referred to as altruistic values (in relation to intra-generational equity concerns) or bequest values (when concerned with inter-generational equity). In the second case non-use values are usually referred to as existence values.

Many techniques have been developed to measure monetary values of ecosystem services (TEEB, 2010). When markets exist (as with many provisioning services), monetary values are derived directly from market prices. In their absence, monetary values are estimated from shadow prices in parallel markets. When not even parallel markets exist, monetary valuation typically relies on expected consumer behaviour in hypothetical markets. The three situations described above correspond to a common categorization of valuation techniques: (a) direct market valuation approaches; (b) revealed preference approaches (travel cost and hedonic pricing method; and (c) stated preferences approaches (contingent valuation and choice modelling) (Figure 11.1; Table 11.1). Values from original studies are sometimes applied to other sites through benefit transfer (Barton, 2002) and aggregated values are often incorporated into extended cost–benefit analysis (Balmford et al., 2002; Barbier et al., 2009).

Some economic valuation methods may fit better than others with an ecological economics perspective. For example, methods that measure 'hidden' yet real economic costs (for example, avoided and replacement costs) or benefits (for example, production functions or hedonic pricing), provide more reliable information than valuations based on stated preferences in abstract market simulations. Lumping together real, hypothetical and potential values into aggregated figures that are thereafter used in extended cost–benefit analysis is bad economics (Spash, 2011; Boeraeve et al. 2015).

INTEGRATED VALUATION OF ECOSYSTEM SERVICES

Integrated valuation of ecosystem services may be defined as the process of synthesizing, interpreting and communicating knowledge and data about the ways in which people conceptualize, understand and appraise the values of ecosystems services to facilitate deliberation and agreement for informed decision-making and planning (Gómez-Baggethun et al., 2014). It operates primarily at the science–policy interface and should ideally render information in formats that are compact enough for practical problem solving by stakeholders, practitioners, decision-makers and planners. The scope of its application can range from purposes of awareness raising, to design of policy instruments, priority setting, and liability litigations, among others.

Integrated valuation of ecosystem services rests on the basis of at least four premises: (1) consistent combination of different valuation languages; (2) interdisciplinarity and methodological pluralism; (3) integration of different forms of knowledge; and (4) consideration of values across various levels of societal organization (Gómez-Baggethun et al., 2014).

Articulation of Valuation Languages

Integrated valuation endorses value pluralism as a core foundation. Integration means combining one thing with another to form a coherent whole. While accepting that some values may not be measured in common units, integrated valuation should not merely recognize a battery of values assessed independently, but should also examine how conflicting values stand in relation to each another. This involves addressing questions like: what are the trade-offs among different value domains (Martín-López et al., 2014), which values stand in conflicting or reinforcing relation to each other and whether some values may have power of veto over other values (for example, the sacredness that an animist society may attribute to an ecological site over the commercial value of exploiting its forests for exporting timber) (Temper and Martínez-Alier, 2013).

Defining conditions and contexts where different values may (or may not) be aggregated to a certain degree, and defining epistemological boundaries within which different valuation approaches can be consistently combined, are critical tasks for the research agenda in ecological economics (Spash, 2012) as much as for integrated approaches to ecosystem services valuation (Gómez-Baggethun and Barton, 2013).

Interdisciplinarity and Methodological Pluralism

Because ecosystem services crosscut various ecosystem components (soil, water, biodiversity) and societal domains (stakeholders, value systems, distributive conflicts, power asymmetries, institutions), integrated valuation demands expertise from both the social and the natural sciences (Vila et al., 2002). Interdisciplinarity is therefore a core element of integrated ecosystem services valuation. A corollary of interdisciplinarity is the recognition of methodological pluralism (Norgaard, 1989). Methodological pluralism should be orchestrated to avoid unstructured eclecticism, minding internal consistency and epistemological contradictions (Spash, 2012).

Integrated ecosystem services valuation covers both qualitative and quantitative methods (Table 11.1; Patton, 2001; Zendehdel et al., 2008). Many ecosystem services may be quantified with high degrees of precision. However, some ecosystem services render themselves better for qualification than for quantification. For example, direct measurement can be difficult for cultural ecosystem services, which usually lack any obvious biophysical or monetary counterpart (Hernández-Morcillo et al., 2013). In some cases, tools have been developed to quantify cultural services and related values using scores and constructed scales as in the cases of place values (Williams and Roggenbuck, 1989; Shamai, 1991) and aesthetic values (García-Llorente et al., 2012; López-Santiago et al., 2014). In other cases, however, quantifying cultural services may be too difficult (Chan et al. 2012a) and demands holistic approaches that may include qualitative measures or even narration (Patton, 2001; Chan et al., 2012b). Forcing measurement into ecosystem services that do not render themselves for quantification may even be detrimental for their protection when the elicited values fail to capture in any meaningful way how stakeholders understand their importance (Turnhout et al., 2014) or when it may create metrical technology for undesirable commodification of ecosystem services (Gómez-Baggethun and Ruiz-Pérez, 2011).

Knowledge Systems and Epistemic Communities

Integrated valuation of ecosystem services feeds on different knowledge systems (Tengö et al., 2014). Knowledge systems are the agents, practices and institutions that organize the production, transfer and use of knowledge (Cornell et al., 2013). Relevant knowledge systems for ecosystem services valuations include: (1) formal scientific knowledge; (2) lay knowledge from practitioners and stakeholders affected by a given decision over ecosystem services; and (3) local, indigenous and traditional ecological knowledge (TEK) held by indigenous and peasant communities (Reid et al., 2006).

Over the last decade, the scientific community has called for the recognition of local, indigenous and TEK systems as critical knowledge sources to enhance our understanding of ecosystem services (Turnhaut et al., 2012; Gómez-Baggethun et al., 2013; Tengö et al., 2014; Reyes-García, Chapter 12 in this volume). The Convention on Biological Diversity's call to recognize the role of TEK in the conservation and sustainable use of biological diversity (CBD, 1992, art. 8) has been taken up by major international initiatives for the protection of ecosystem services, such as the Millennium Ecosystem Assessment (MA, 2005; Reid et al., 2006) and the Economics of Ecosystems and Biodiversity (Brondizio et al., 2010) and the Intergovernmental Platform of Biodiversity and Ecosystem Services (IPBES) has put a major emphasis on the importance of TEK in sustaining ecosystem services worldwide (Gómez-Baggethun et al., 2013).

Values across Levels of Societal Organization

Integrated valuation covers values emerging at different levels of societal organization, from individuals, to communities, to larger societies (Gómez-Baggethun et al., 2014). Sagoff (1998) and others have noted that the values we express as consumers are very different from the values we express as citizens. The shared values of a community differ from the sum of values held by their constituting individual members (Vatn, 2005). The choice of a meaningful level of organization to conduct valuations should be informed by the institutional nature of the ecosystem services at stake. For ecosystem services with a private good character, valuation techniques based on market-valuation or surveys to assess individual preferences may be appropriate (see Table 11.1). For ecosystem services with common or public good character, value articulating institutions that appeal to individual rationality can be ill-suited. The question here is not what an individual wants as much as what she or he is entitled to (Pitkin, 1981; Vatn, 2005). In such cases, deliberative valuation through workshops, focus groups, or citizen juries aimed at eliciting societal willingness to pay can render more meaningful values (Spash, 2007; Vatn, 2009; Zografos, Chapter 4, in this volume).

For ecosystem services with a public good character governed at the level of nations or intergovernmental organizations, deliberation by small groups may not deliver values that are representative of society at large. In such cases it can be useful to examine values embedded in norms, conventions and formally sanctioned rules such as laws, constitutions and multilateral agreements. For example, the constitutions of Bolivia and Ecuador recognize rights to nature, and the latter declares ecosystem services as public goods not amenable to private appropriation.

Finally, integrated valuations should be able to accommodate different value articulating institutions. Valuation methods are not neutral instruments that merely reveal previously existing values. Rather, they are *value articulating institutions*, that is, frames that guide the process of expressing values (Jacobs, 1997; Vatn, 2009). They regulate and influence which values come forward, which are excluded, and what sort of conclusions can be reached (Vatn, 2005). Because there are multiple rationalities other than utilitarianism through which humans choose courses of action – such as rights-based approaches (Martínez-Alier et al., 1998; O'Neill, 2001; Spash and Hanley, 1995), integrated valuation makes an epistemological plea, not only for plural values, but also for plural value articulating institutions.

CONCLUSIONS

The ecological economics literature on ecosystem services valuation has traditionally focused on: (1) reproducing valuation techniques from neoclassical environmental economics on the basis of an alleged pragmatism (Costanza et al., 1997; 2014); or (2) deconstructing monetary valuation technics questioning their validity on the basis of ethical, political and methodological concerns. To date, however, few contributions have discussed what an ecological economics perspective on ecosystem service valuation may look like (but see Martínez-Alier, 2002; Martín-López et al., 2014; Dendoncker et al., 2013; Boeraeve et al. 2015, for progress in this direction).

This chapter advances an approach of integrated valuation of ecosystem services aligned with the principles and vision of ecological economics, accommodating a plurality of valuation languages, knowledge sources, methodologies and value articulating institutions. Even when it comes to *monetary* valuation, we argue with Kallis et al. (2013) that 'to value or not to value' is not the question. Such dichotomist framing misses the more important question of what are the specific contexts where monetary valuation can serve goals that are in line with the ecological economics vision of an ecologically sustainable, socially just and financially viable economy. Monetary valuation can be useful for calculating the economic gains that corporations make by outsourcing costs of their private economic activity in the public sector (Kapp, 1983; Rodríguez-Labajos and Martínez-Alier, 2012a), but is unlikely to provide meaningful figures when attempting to capture the cultural, symbolic or spiritual importance that societies attribute to ecosystems and biodiversity (Chan et al., 2012a). In particular cases, monetary valuation is not only meaningless but also counterproductive. For example, using hypothetical markets to value ecosystem services that are not intended for sale nor expected to be governed by market values and norms can provide discursive framings and metrical technology for undesirable commodification (Robertson, 2006; Gómez-Baggethun and Ruiz-Pérez, 2011).

While monetization should be one more resource in the toolset for ecosystem services valuation, an ecological economics perspective differs from valuation approaches rooted in neoclassical microeconomic analysis. First, ecological economists distrust the conception of externalities as 'market failures' amenable to technical fixes through externality pricing and market-based instruments (Muradian and Gómez-Baggethun, 2013). Instead, many of us think with Kapp (1950) that environmental impacts of private economic activity are not market failures but cost-shifting gains that are outsourced to other regions and future generations. As other ecological economists have noted before, ability to grab or degrade ecosystem services at zero price does not indicate a market failure as much as an asymmetric power relation (Rodriguez-Labajos and Martínez-Alier, 2012b).

Second, because different values of the environment are weakly comparable or incommensurable (Martínez-Alier et al., 1998), ecological economists critically apprise valuation frameworks that reduce ecosystem service values to single measuring rods – and show a predilection for deliberative and multi-criteria approaches that are able to accommodate a plurality of values (Munda, 2004; Kallis et al., 2013). Third, the boundaries of monetary valuation should be informed by considerations of strong sustainability and environmental justice. From a strong sustainability perspective it makes little or no sense valuing in monetary terms ecosystem services for which adequate substitutes do not exist. From an environmental justice perspective, ecological economists discourage market valuation for ecosystem services that cover essential needs (Farley et al., in press) or where choices about willingness to pay and accept compensations are coerced by need and asymmetric power relations (Martinez-Alier, 2002).

As ecosystem services shape the environmental policy agenda and the scientific community discusses what the green economy looks like, we believe that abandoning the valuation battlefield risks surrendering to those who reduce it to chrematistics. How we value vitally critical ecosystem functions and services to sustain long-term conditions for life and prosperity may be too important in its implications to be left in the hands of those who attempt to reduce it to a market logic and the profit calculus.

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12. The values of traditional ecological knowledge

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1. INTRODUCTION

As other living elements of the natural system, over time, we humans have developed strategies to use and modify our surrounding environment in a myriad of ways in order to satisfy our subsistence needs and our cultural needs and greeds. Culture – or the socially transmitted and accumulated system of shared knowledge, beliefs and practices – has allowed us to adapt to different local environments, modifying them to solve adaptive problems such as producing food, mating, caring for children, or managing social interactions (Tomasello, 1999; Henrich and McElreath, 2003). Because all humans share the same basic genetic endowment, mostly cultural adaptations can explain a range of locally adapted subsistence behaviors that range from Arctic foraging, to tropical horticulture and desert pastoralism (Henrich and McElreath, 2003; Boyd and Richerson, 2005). In that sense, culture can be seen as part of the adaptive strategy of human societies to dwell and survive in a variety of environments.

In interacting in different ways with different – or the same – environments, humans have not only generated different adaptive strategies, or cultures, but they have also modified ecosystems. The interrelations between ecological and social systems are well acknowledged by the nascent field of social-ecological systems, which emphasizes the integrated concept of humans in nature and stresses that – given the numerous feedback mechanisms that link them – separating social and ecological systems is necessarily artificial and arbitrary (Gunderson and Holling, 2002; Berkes et al., 2003).

Thus, social-ecological systems theory, as cultural evolution theory, acknowledges that in societies with historical and intergenerational continuity in resource use and management, people have developed knowledge of natural resources and of ecosystem functions and dynamics, as well as associated management practices, beliefs, traditions and institutions, or what is known as traditional ecological knowledge (Berkes et al., 2000; Toledo, 2002). Traditional ecological knowledge (hereafter TEK) is a dynamic knowledge system that emerges from people's interactions with their environment and that is embedded in local institutions and organizations (Gómez-Baggethun and Reyes-García, 2013). To remain effective, it requires well connected social networks and supporting institutional frameworks (Berkes et al., 2003) and that communities have integrated formal and informal mechanisms for flexible and rapid decision-making that evolve through institutional learning (Ruiz-Mallén and Corbera, 2013). It also requires that communities interact with ecosystems on a daily basis and over long periods of time (Gómez-Baggethun et al., 2010) and that local people remain close to the production of knowledge (Gómez-Baggethun and Reyes-García, 2013).

For an increasing number of societies around the world, these social conditions have greatly changed since the advent of the industrial revolution and economic globalization, and as a result, TEK seems to be eroding in many parts of the world (Gómez-Baggethun et al., 2010; Reyes-García et al., 2013a). In a recent study estimating changes in the traditional knowledge of wild plant uses among an Amazonian indigenous society ($n = 1151$), researchers have found that, between 2000 and 2009, adults experienced a net decrease in the report of plant uses equivalent to between 1 per cent to 3 per cent per year (Reyes-García et al., 2013a). While acknowledging that over the broad course of human history particular cultural traits (such as plant uses) will inevitably change and eventually disappear as cultures adapt to new socioeconomic and environmental conditions (Boyd and Richerson, 2005), the high rate of change observed is nonetheless surprising, as it surpasses estimates of change derived from the study of past societies (Reyes-García et al., 2013a). It is also interesting to notice that the process parallels the observed phenomena of rapid erosion of linguistic (Harmon and Loh, 2010) and biological diversity (Sutherland, 2003; Thomas et al., 2004).

Drivers of the current erosion of TEK are complex and multifaceted. Some of the current drivers of TEK change include:

1. the influences of schooling, loss of local languages (Maffi, 2005; McCarter and Gavin, 2011; Reyes-García, 2013) and religious conversion (Cook and Offit, 2008; Tang and Tang, 2010);
2. changes in land use (Gray et al., 2008; Paneque-Gálvez et al., 2013; Pérez-Llorente et al., 2013);
3. integration of local communities into market economies (Godoy et al., 2005; Reyes-García et al., 2005);
4. loss of access to resources through conservation programs and other management regulations (Gómez-Baggethun et al., 2010; Ruiz-Mallén and Corbera, 2013);
5. development aid work and mechanization (Stone, 2007);

6. climate change (Eakin, 2000; Morton, 2007) and, more generally, industrialization and globalization processes (Turner and Turner, 2008; Gómez-Baggethun, 2009).

Given that those forces have been stronger in the industrialized world, nowadays, by and large, most bodies of TEK are found in non-industrial societies. Researchers have found, however, that some TEK remains in industrial societies (Beaufoy et al., 1994; Olsson and Folke, 2001; Emanuelsson, 2010; Calvet-Mir et al., 2011). Barthel et al. (2010) use the term *pockets of social-ecological memory* for those places that having captured, stored and transmitted through time the knowledge and experience of managing a local ecosystem and its services, keeping them alive despite drastic changes in the surrounding environments (see also Barthel et al., 2013; Barthel and Isendahl, 2013). For example, agricultural landscapes in Europe evolved through thousands of years of interaction between social and ecological systems (Grove and Rackham, 2001), but drastically changed in the last century with the mechanization of agriculture and accompanying societal transformations (Emanuelsson, 2010). Despite this general change, some places still preserve locally evolved experiences of farming (Beaufoy et al., 1994; Emanuelsson, 2010; Calvet-Mir et al., 2011). Recent research suggests that when such pockets of TEK persist in contexts of high interaction with the market economy and modern technologies and lifestyles, they usually do so accommodating new forms of knowledge and technologies (Reyes-García, 2013).

Thus, our current understanding of TEK depicts it as threatened and eroding, but – at the same time – as dynamic and adaptive. In this chapter, I analyze those apparent contradictions and explore the issue of the *value* of TEK as the main cause of its endurance. To do so, in the second section I provide a brief review of the change of status of TEK both in academia and international policy. From being perceived as a vestige of the past bound to disappear with economic development and market integration, over the last two decades TEK has been redeemed and reshaped. The change can be related to two lines of thought relatively new in the academic arena: on the one hand, TEK's resilience and ability to adapt to change, and on the other the myriad of values associated to TEK, which I discuss in the third and fourth sections of this chapter. The last section puts TEK in a larger epistemological perspective and elaborates on other potential contributions of TEK for the 'knowledge society'.

2. THE FALL AND RISE OF TEK

While the knowledge, practices and beliefs that compose TEK systems are constituent of human evolution, and while the interaction between traditional knowledge systems and Western knowledge can be traced back to at least the fifteenth century (Agrawal, 1995), the scientific interest in the study of traditional knowledge systems in themselves dates back only to the 1950s. Interest in traditional knowledge systems originally arose from a sub-discipline within anthropology namely ethnoecology. The first studies of TEK were largely descriptive and focused on single species, resources, or user groups. At that time, the landmark studies documented how and why indigenous groups classified environmental features (Berlin et al., 1974; Hunn, 1977) and studied indigenous systems for natural resources use and management (Conklin, 1954; Parker et al., 1983).

Despite the fact that those studies illustrated the complexity of TEK well, at that point of time and outside the specialized circles, TEK was largely perceived as rudimentary, a vestige of the past which held, at best, folkloric interest and which was bound to disappear with economic development. This perception is clearly embedded in the assumptions governing approaches to development during the twentieth century (Scott, 1998; Dove, 2006). We find an example of the academic mainstream perception regarding TEK in the literature on diffusion-of-innovations, a theory that seeks to explain how, why, and at what rate new ideas and technology spread through cultures (Rogers, 1962). This theory, which dominated research on the adoption of technological innovations in the developing world, is largely based on the assumptions that: (1) the adoption of innovations and the maintenance of traditional practices are mutually exclusive, as it implies that everybody will eventually adopt innovations (Gilles et al., 2013); and (2) those who adopt innovations will have an economic advantage over those who do not adopt them (Saltiel et al., 1994), thus achieving the much desired development. Overall, the approach conceives the disappearance of traditional practices as the inevitable and beneficial consequence of modernization and development.

The status of TEK started to change in the 1980s. Drivers of this change include the transnationalization of the indigenous rights movement, a growing body of research highlighting the potential value of TEK for conservation and development, and, as a quick response to those, the growing consideration of indigenous peoples and their TEK in international politics. First, although indigenous peoples' fights for the recognition of their rights are much older, the 1980s saw the growth of the international movement to advance and defend the rights of indigenous peoples (Yashar, 1998; Hodgson, 2002; Jackson and Warren, 2005). New technologies and cheaper transportation provided the opportunities to indigenous peoples across the world to engage in a communication that allowed them to recognize the similarities in their historical experiences and contemporaneous fights. This led to the transformation of local disputes into international claims and to the emergence of a transnational indigenous movement (Hodgson, 2002), which not only resulted in the inclusion of indigenous peoples as political actors, but also gave visibility to the existence of their knowledge systems.

Since the 1980s, there has also been a growth in the academic interest in traditional knowledge systems, which constitutes the second driver contributing to the TEK status change. From this decade, research on TEK extended the number of subjects encompassed and became more analytical in its approach, aiming more at understanding complex relations and causalities between the different components of TEK systems, and between TEK, policy and management, than to describe those knowledge systems per se. Outside anthropology, an increasing number of disciplines, including conservation biology, forestry, ecology and landscape management, developed an interest in TEK (see, for some examples, Berkes et al., 1998; Thrupp, 2000; Pitcher, 2001; Altieri, 2004; Douterlungne et al., 2010).

At that point, one of the most powerful arguments emerging from this new TEK research was that indigenous peoples possess unique systems of knowledge that can serve as the basis for more successful development and conservation interventions, especially in areas where indigenous peoples and high biodiversity overlap (Becker and Ghimire, 2003; Altieri, 2004; Nazarea, 2006). The concept, which explicitly countered the dominant development discourse, quickly became very powerful, started to dominate the scientific research on TEK, and permeated international policy-making.

Thus, the third driver of the change of TEK status has been in the political area, which quickly reacted both to the indigenous rights movement's struggles and to the idea that TEK could potentially contribute to successful development and conservation. During the 1980s, the United Nations (1986) and the International Labor Organization (ILO, 1989) revised their definitions of 'indigenous' to reflect some achievements of indigenous rights organizations. The 1989 ILO Convention represents an important international step in the recognition of indigenous rights. During the 1990s, TEK was specifically recognized by the Convention on Biological Diversity, which encouraged national governments to protect it and promote its wider application (CBD 1992, art. 8). The recognition of TEK was reaffirmed in 2010 at the Conference of the Parties in Nagoya. Other international legislation aiming at the protection of TEK includes the Convention for the Safeguarding of Intangible Cultural Heritage

(UNESCO, 2003). Recently, major international initiatives for the protection of ecosystem services and biodiversity, such as the Millennium Ecosystem Assessment (MA, 2005), The Economics of Ecosystems of Biodiversity (TEEB, 2010) and the Intergovernmental Platform on Biodiversity & Ecosystem Services (IPBES), have also stressed the importance of TEK for biodiversity protection and the worldwide maintenance of ecosystem services (Reid et al., 2006; Brondizio et al., 2010; Vohland et al., 2011). In essence, then, the status of TEK has been increasingly upgraded among policy-makers.

It is worth noting that, despite wider recognition of TEK, there are some skeptical voices. Some authors doubt that TEK can persist (Cox, 2000). The increase of the scale and pace at which global change has been operating since the mid-twentieth century, or the so-called 'great acceleration' (Steffen et al., 2004), together with the generalized decline in traditional lifestyles has raised the question of whether TEK would adapt or disappear. There are also those who have questioned the value of TEK in the current situation of pervasive environmental change and globalized societies (Kameda and Nakanishi, 2002). In this context, it is still relevant to emphasize two of the most important aspects of current research on TEK systems: its adaptive nature and its value.

3. THE ADAPTIVE NATURE OF TEK

Several researchers have emphasized that traditional knowledge systems should neither be considered static (Berkes et al., 2000; Gómez-Baggethun and Reyes-García, 2013), nor in isolation from other knowledge systems (Agrawal, 1995; Dove et al., 2007; Leonti, 2011). Rather, traditional knowledge systems should be understood as being in constant change, in a dynamic process that encompasses a complex mix of knowledge replication, loss, addition and transformation. For example, social-ecological systems theory conceives TEK as an evolving body of knowledge, practices and beliefs that develops over time from long-term observation and monitoring of the system functioning (Berkes et al., 2000), but also from learning from crises and mistakes (Olsson and Folke, 2001; Berkes and Turner, 2006).

There is, then, an increasing research interest on the changing nature of TEK. It is acknowledged that change in traditional knowledge systems can be triggered by multiple factors that include, but are not limited to: (a) learning and experimentation; (b) diffusion and adoption of new ideas and technologies; (c) the production of new knowledge due to adaptation to new social or ecological conditions; or (d) the co-production of knowledge arising from the interactions with other knowledge systems, such as scientific knowledge (Olsson et al., 2004; Plummer and Armitage, 2007; Sillitoe, 2007; Mesoudi and Lycett, 2009; Davidson-Hunt et al., 2013).

Then, the idea that there is a neat divide between TEK and other forms of knowledge is being replaced by something more complicated: TEK has a dynamic nature that allows both for the removal of those components that become obsolete or less useful (Reyes-García et al., 2013b) and for the creation and integration of new forms of knowledge (Reyes-García et al., 2014). For example, empirical research among the Tsimane', a horticulturalist and foraging society in Amazonian Bolivia, suggests that – despite the general eroding terms – different domains of TEK experience different types of changes (Reyes-García et al., 2013b). Data collected among 651 Tsimane' men indicate that knowledge about medicines and wild edible foods is vulnerable, whereas knowledge on canoe building and on firewood sources seems to remain constant across generations. Interestingly, house-building knowledge seems to experience a slight secular increase, probably related to increasing sedentarization of this previously semi-nomadic population. Thus, changes in specific domains of TEK seem to respond to the particular needs of a society at a given point of time.

TEK is also dynamic in that it allows for the creation and integration of new forms of knowledge. For example, Reyes-García et al. (2014) document persistence of agricultural TEK among garden tenders in Spain. The study analizes how TEK is combined with the adoption of modern practices and technologies resulting in a combined form of knowledge. Several authors have previously documented similar trends regarding coexistence of traditional and modern agricultural knowledge and practices (Nygren, 1999; Dove, 2002). For example, a finding highly consistent with the previous example has been presented by Eyssartier et al. (2011) in a case study in north-western Patagonia where local people maintain traditional practices in vegetable gardens but are also adopting greenhouses, as those improve the conditions for certain crops. Likewise, though in a different domain of knowledge, Giovannini et al. (2011) document the coexistence and complementarity of medicinal plants and pharmaceuticals knowledge among an indigenous population in Oaxaca, Mexico.

There is, however, a constituent element that ensures the maintenance of TEK systems: the mere existence of TEK requires maintaining the conditions that allow local people to continue developing, testing and updating knowledge (Gómez-Baggethun and Reyes-García, 2013). What explains the persistence of TEK in managing Spanish domestic gardens is that – differently from most other agricultural systems in Europe – domestic garden tenders retain an important degree of autonomy. This autonomy is given by the fact that domestic gardens are mainly devoted to household consumption and are often grown as a leisure activity, which makes the gardeners less dependent on market dynamics for this particular activity. Gardeners' knowledge and management techniques should then be understood in a context in which there is no penalty for experimentation failures, mainly because as maximizing profit is generally not the ultimate aim. However, ubiquitous mechanization of other agricultural systems throughout Europe might not give farmers the same degree of autonomy, with eroding effects on their TEK.

In sum, in recent years researchers have been updating their perception of TEK, from a decaying body of knowledge to one having a dynamic nature that can help societies adapt to new ecological and socioeconomic conditions. A common trend in those studies is to highlight the importance of hybridization: traditional knowledge, practices and beliefs merge with exogenous forms of knowledge and technologies to face changing circumstances (Dove, 2002). A second common trend is to bring to analytical focus the importance of the social system capacity to regenerate, transmit and apply knowledge.

4. THE VALUES OF TEK

As mentioned, one of the most powerful arguments behind the current revalorization of TEK systems comes from the discourse that emphasizes that TEK can potentially contribute to meet basic needs in a sustainable way. The dominant trend in the literature on TEK underlines the benefits that these knowledge systems provide to TEK holders and to society at large. In this section, I review TEK contributions to (a) local livelihoods; (b) the conservation of biodiversity and ecosystem functions; and (c) the resilience of social-ecological systems.

First, there is a growing body of research suggesting that TEK can be critical to the well-being and survival of indigenous and rural societies (Parrotta and Agnoletti, 2007; Thomas et al., 2009). For example, recent research by von Glasenapp and Thornton (2011) found that TEK among Swiss Alpine farmers was of vital significance for households' capability to deal with socioeconomic changes. Specifically, maintaining the traditional diversification of farm products (milk, meat, biodiversity credits, and so on) made farmers less vulnerable to external changes as diversification insured farmers against disturbances.

One of the topics receiving most attention regarding the benefits of TEK for local livelihoods relates to health and nutritional status, with growing empirical work finding that these are positively related. For example, a study investigating the association between traditional plant knowledge and nutrition status conducted among the Tsimane' found an association between these two variables: doubling the stock of an adult's TEK was associated with an improvement in body-mass index that ranged from a low of 4.3 per cent to a high of 7.8 per cent (Reyes-García et al., 2008). The association was stronger for unschooled adults and for those living far from the market town. The analysis suggests that TEK also bears a positive association with other indicators of short-run nutritional status. The associations are not trivial, and interestingly – for this population with low levels of schooling – they are higher than the association between schooling and nutrition status. Similar results were found in another study among the Tsimane' investigating the association between parental TEK and child health: McDade et al. (2007) found that maternal TEK increases the likelihood of good child health. Researchers collected anthropometric data and capillary blood samples from 330 Tsimane' children aged two to ten and interview data to construct individual measures of parental ethnobotanical knowledge and skills. Child health measures (including C-reactive protein, skinfold thickness and height-for-age) were associated with maternal TEK: each standard deviation of maternal TEK increased the likelihood of good child health by a factor of >1.5.

Why would traditional knowledge be related to better health and nutritional status? There are several plausible mechanisms. First, more knowledgeable people may be more efficient exploiters of local natural resources being able to provide themselves and their children with diets that are superior both in qualitative and quantitative terms. Better diets supply the macro- and micro-nutrients that build body fat stores, fuel linear growth, and bolster immune defenses against infectious disease (Bogin, 1999). Second, some plants have pharmacological properties that help prevent or treat common ailments, which in turn may play a particularly important role in protecting health, especially in situations in which commercial medicines are difficult to procure and afford. These results underscore the importance of considering TEK as key contributors to health and nutritional status.

Second, researchers have also argued that TEK can provide insights for the management of valuable species, habitats, ecosystem services, protected areas, and, in general, human-shaped landscapes. This line of research is of critical importance in the face of current environmental problems, as it increases our understanding of alternative ways in which humans have related – and still relate – to the environment without necessarily having a negative impact on it. This line of research has mainly focused, on the one side, on environmental management and biodiversity conservation, and, on the other, on agricultural sustainability.

As evidence grows that the landscapes and the biodiversity that we currently observe result not only from natural phenomena, but also from centuries of human management (Heckenberger, 2003), researchers debate the effects of traditional management on tropical biodiversity (Chazdon et al., 2009). Some researches show that TEK systems are not always protective, and that – despite having developed TEK – there are societies that have destroyed their habitats and collapsed (Henrich, 2004; Diamond, 2005). But more researchers have emphasized the virtues of TEK-based management. TEK can potentially enhance environmental conservation by shaping local norms. For example, local norms might allow species reproduction through periodic ecosystem closures (Cinner et al., 2006; Dominguez et al., 2010) or reduce hunting pressures through taboos (Puri, 2005; Jones et al., 2008; Lingard et al., 2012). Some well-known examples of TEK contributions to resource management include watershed management of salmon rivers by the Amerindians of the Pacific Northwest (Swezey and Heizer, 1993) or biodiversity enhancement through the creation of forest islands by the Kayapo of Brazil (Posey and Balee, 1989). A recent meta-analysis of published case studies focusing on the long-term maintenance of forest cover in the tropics finds that working forests (defined as forests managed by local communities for multiple uses) presented lower and more stable annual deforestation rates than officially protected areas (Porter-Bolland et al., 2012), providing further evidence that TEK-based management of natural resources can contribute to the goal of biodiversity conservation.

Research on tropical and temperate areas also shows that TEK can potentially contribute to a more sustainable form of agriculture. Thus, researchers argue that agricultural systems – as practiced by small-scale societies – can lead to an increase in landscape biodiversity through the creation of a mosaic of different habitats (Wiersum, 2004). TEK also seems to contribute to *in situ* conservation of crop varieties (Altieri and Merrick, 1987; Jarvis and Hodgkin, 1999); to play a key role in explaining the efficiency in slash-and-burn agricultural systems (Pascual, 2005); and to lessen the clearance of old-growth forest for subsistence agriculture through increased labor efficiency (Reyes-García et al., 2011). For example, this later work suggests that, with little access to modern agricultural technologies, the Tsimane' rely on their TEK to make decisions regarding agricultural production. People with greater TEK seem to be better at selecting soils or forest types suitable for farming. They also have a greater likelihood of getting right the best timing for different tasks (for example, felling trees, burning), and have more ability at selecting, storing and planting seeds, all of which improve labor efficiency and result in a reduction in area of old-growth forest cleared for agriculture.

Regarding the role of TEK in contributing to resource management in the European agricultural sector, the literature suggests that traditional agricultural practices can play a remediating role in highly polluted soils (Madejón et al., 2011) and can provide alternative control mechanisms to address potential threats for sustainable grassland management (Winter and Kriechbaum, 2011). Such literature also highlights the relevance of farmers' knowledge to collecting information on past and present cultural landscapes (Calvo et al., 2007; Calvet-Mir et al., 2012).

While evidence accumulates on the role of TEK in contributing to the sustainable management of natural resources, the debate on the agency of local people, and especially indigenous peoples, on this outcome remains open. Several authors (Stearman, 1994; Smith and Wishnie, 2000) have long questioned the accuracy of claims regarding the sustainability of TEK-based resource management in the absence of conscious awareness, arguing that, in those systems, biodiversity conservation could be just a by-product of a lack of technology and low population density, rather than an intended outcome. The debate, which has been coined '*the noble savage debate*', is important because – in the absence of conscious conservation awareness – changes such as population growth, greater market access, increasing sedentarization, and changes in the traditional belief systems might also result in increasing pressures on ecosystems (Stearman, 2000; Godoy et al., 2005).

The third domain where TEK seems to be of value relates to the resilience of social-ecological systems, or the system's capacity to absorb recurrent disturbance so as to retain essential structures, processes and feedbacks (Adger et al., 2005). The potential contribution of TEK to build resilience into social-ecological systems has gained growing attention in the context of accelerated global change and ecosystem services decline (MA, 2005; Turnhout et al., 2012). It is argued that there are at least two potential ways in which TEK may increase the capacity of social-ecological systems to deal with crises, to cope with disturbances, to respond to global environmental change, and thus to maintain long-term resilience.

On the one side, and according to resilience theory, integrating information from several knowledge systems would increase the resilience of the system by enlarging the range of available responses in the face of different disturbances or limiting factors (Houde, 2007; Armitage et al., 2009; Gómez-Baggethun et al., 2012). Indeed, scientists working on conservation acknowledge the role of TEK in providing insights to their work (Ferguson et al., 1998; Huntington, 2000). Because of their adaptive nature and their ability to hybridize with other forms of knowledge, TEK systems could contribute to the management and governance of social-ecological systems (Berkes and Turner, 2006; Chapin et al., 2010).

On the other side, TEK contributes to building resilience into social-ecological systems because it provides a diverse pool of information and practices that encompasses the multiple forms of knowledge, practices, institutions and beliefs developed by human societies over millennia to cope with ecosystem dynamics and disturbance regimes (McIntosh et al., 2000; Folke, 2004). Given that TEK co-evolves with ecological and social systems, it has an advantage in coping with the major challenges raised by global environmental change (Colding et al., 2003; Berkes and Turner, 2006). The loss of TEK implies a loss of options regarding striving with uncertainty and responding to disturbance and change.

5. CAN TEK DYNAMICS CONTRIBUTE TO THE 'KNOWLEDGE SOCIETY'?

Given the reliance of the global economic system on intellectual capabilities and intellectual knowledge, scholars debate on whether or not we have now moved into a knowledge economy and/or 'knowledge society' (Carlaw et al., 2006). Some scholars have argued that the key component of such an economic system is a greater dependence on intellectual capabilities than on physical inputs or natural resources (Powell and Snellman, 2004). While qualifying the economic system as 'knowledge-based' gives the false impression that it is dematerialized, it, nevertheless, acknowledges the contribution of intellectual creativity to society. Social institutions, relations and practices are increasingly organized around the generation, storage, transfer and use of knowledge, which is also the subject of increasing political interest and support. Thus, investigating knowledge dynamics (that is, the production, storing, transmission, ownership and exploitation of knowledge) becomes key in the 'knowledge society'.

Unfortunately, but not surprisingly, most considerations on knowledge dynamics draw from the experiences of our own society in dealing with scientific knowledge, and essentially with scientific knowledge with a technical application within the premises of the market system (Tovey, 2008). Thus, in our 'knowledge society', knowledge is identified with science and technological expertise while little recognition is given to the potential role of other bodies of knowledge (Koutsouris, 2008; Tovey, 2008). However, the science-centered institutional model of the 'knowledge society' is increasingly being problematized in sociological writing. For example, in *Risk Society*, Beck (1992) presents science as the main source of risks, and particularly of environmental risks that threaten to become uncontrollable and that are at the base of many social conflicts. As the lack of public understanding and legitimacy of expert-based knowledge increases (that is, for issues such as environmental and health risk regulation) (Eyerman and Jamison, 1991; Long and Long, 1992; Irwin, 2001; Leach et al., 2005), and as the production of scientific knowledge becomes increasingly shaped and organized around economic and social interests (Gibbons et al., 1994), sociologists are calling for the need to include everyday expertise and informal, lay or local understandings in defining the relevant problems and co-producing knowledge (Gibbons et al., 1994; Hand, 2010). Understanding the dynamics of TEK could enrich the arguments in such a debate. To contribute to this goal, and with the risk of failing in overgeneralization, in the last section of this chapter I present some epistemological considerations related to TEK dynamics.

A key aspect that differentiates TEK from our scientific knowledge system refers to the production and transfer of knowledge. Scientific knowledge is typically produced by enclosed communities of academic scientists, who aim to generate objective and verifiable knowledge, and who might operate independently of social interests and goals (Gibbons et al., 1994). The production of scientific knowledge is part of a society's effort, but mostly remains in the hands of highly specialized personnel. Thus, although much scientific knowledge has been transformed into some sort of technological innovation that eventually reaches society, knowledge is mostly commodified under the form of products which hold the produced knowledge within themselves. Lay people can use the products derived from technological applications of scientific knowledge, but, since they rarely have access to the knowledge embedded in products, nor control over the production of knowledge, they face difficulties in modifying the products in ways that best suit them.

Like scientific knowledge, the generation of traditional knowledge is a social effort, in the sense that it does not depend on a single individual, but is also the additive product of contributions of many individuals over time (Laland, 2004). But, differently from scientific knowledge, the generation of traditional knowledge rests within lay members of the society. This allows members of the community to use and modify previous bodies of knowledge through own experimentation and learning (Ingold, 2000; Soleri et al., 2008). Although it is true that some knowledge systems have designated knowledge holders for specific domains of knowledge (for example, a 'shaman' or a 'guru') (Barth, 1990), and that traditional knowledge is often embedded in cultural systems and institutions that individuals do not fully understand (Thrupp, 1989; Lansing, 1991; Brodt, 2001), it is also true that communities at large keep substantial control over the production of traditional knowledge (Reyes-García et al., 2003) and have therefore some ability to experiment and modify its products in order to adapt them to changing conditions (Agrawal, 1995).

Several authors have noticed the break in the production of knowledge that comes with the application of scientific knowledge in everyday life through the commercialization of products in which scientific knowledge is embedded. For example, Fitzgerald (1993) and Stone (2007) describe the process of *deskilling*, or the process by which industrialization of agricultural work leads to the decoupling of the agricultural practice and the production of TEK, which – in turn – opens the possibility for social learning to propagate practices with little or no environmental basis and to make farmers dependent on the application of scientific knowledge and technical expertise (over which they have no control). The commodification of scientific knowledge and the de-legitimization of other ways of knowing (Kloppenburg, 1991) hamper the conditions that allow the production of TEK, and as a consequence limits the numbers of ways societies can respond to environmental problems.

Those considerations fit well with new trends claiming for major citizen involvement to help produce science, or what is known as 'citizen science' (Hand, 2010). Proponents of citizen science argue that by tapping into the public's capacity, the scientific enquiry can draw on diverse forms of knowledge and perspectives, which would allow for the more efficient building of large-scale research and experiments than could otherwise be possible. Citizen science projects range from analyzing the logic and mechanics of computer gaming to the mapping of the retina, or the observation of celestial objects. Through the active participation of individuals, citizen science offers a chance to engage with local contexts in a way that can lead to local ownership and adaptability. Some innovative projects bring together TEK and citizen science. For example, indigenous peoples have joined scientists to track the impact of activities such as logging (http://uclexcites.wordpress.com/) or oil extraction (Orta-Martínez et al., 2007). Indigenous peoples collect information on irregularities that they observe during their daily activities, or record negotiations with companies, so when breaches of the regulations are reported, local NGOs intervene in support of the communities.

A second critical consideration in the analysis of TEK dynamics involves the issues of ownership and exploitation of knowledge, an important locus of debate since the 'rediscovery' of TEK. Several authors have claimed that, in Western views, TEK is mostly valued only in order to be appropriated and exploited (Takacs, 1996). The focus on plant knowledge and uses, coupled with the development of interest in the conservation of biodiversity in general and plants with commercial value in particular, has resulted in debates on the assignation of market-oriented intellectual property rights to indigenous peoples for their TEK (Greaves, 1995; Brush and Stabinsky 1996), on how benefits from commercial development of TEK-based products should be shared with local communities (ten Kate and Laird, 1999), and to many conflicts over biopiracy (Shiva, 1997).

Claiming for equity in intellectual property ownership, cultural protection, and economic development, developing nations have pushed to expand intellectual property regimes to protect traditional knowledge (Hansen, 2011). But the idea of assigning intellectual property rights over TEK has proved complex and controversial (Dove, 1996). On the one side, lawyers argue that – under international agreements such as Trade Related Aspects of Intellectual Property Rights (TRIPS) – there are legal incompatibilities that do not allow for the extension of property rights to traditional knowledge (Hansen, 2011). On the other side, intellectual property rights – as we know them – seem to be an inappropriate way of defending indigenous communities (Brown, 1998). Many authors have argued that TEK should be left in the public domain, rescuing this form of knowledge from what has been labeled as the new 'enclosure movement' in the domain of ideas (Chander and Sunder, 2004). Still others have claimed that leaving TEK in the public domain would just add to TEK exploitation by commercial companies, as there are circumstances – including knowledge, wealth, power, access and ability – that render companies from the global North better able to exploit such commons than any initiative from the global South (Carlaw et al., 2006).

Overall, actual attempts in the international arena to enlarge the concept of intellectual property rights so as to include TEK have been less than successful (Berlin and Berlin, 2004; Greene, 2004). This has led many states to adopt *sui generis* legislations and to reclaim traditional knowledge from the global public domain, the most common method being the creation of traditional knowledge databases (TKDs). Many states, from India, China, Brazil, Tanzania (Alexander et al., 2004; Alikhan and Mashelkar, 2004) or even Spain (Pardo de Santayana et al., 2012) have started to develop national TEK inventories, with international organizations such as UNESCO and the World Bank joining the effort. Because novelty is a criterion of patentability, the demonstration of 'prior art' to a patent office – for example, a published description of the medicinal properties of a plant – should lead to denial of a requested patent. By offering up TKDs to patent offices worldwide, states hope to prevent privatization of traditional knowledge.

But while the debate revolves around the convenience and feasibility of applying Intellectual Property Rights to TEK, bioprospecting and biopiracy, and about the sharing of the potential benefits obtained from commercial products derived from TEK applications, there is much less attention given to the epistemological issue of TEK ownership and exploitation. The focus of the discussion reflects, again, our inability to depart from the experiences of our own society in dealing with scientific knowledge to consider alternative ways of knowing and of owning and using knowledge.

Knowledge can be considered a public good, or a shared resource from which every member of a group may benefit, regardless of whether or not they personally contribute to its provision (Olson, 1965). Furthermore, the availability of knowledge does not diminish with use (that is, one does not lose the idea as a result of sharing it), so, unlike tangible resources, knowledge is not exhausted by use, and does not suffer from the familiar tragedy of overuse. There are different ways in which societies could deal with the distribution of such a public good. In our society, scientific knowledge is protected with IPR under the argument that, since access to public goods is not restricted to contributors only, there is a temptation for individuals to free-ride, that is, to enjoy the resource without contributing to its provision (Kollock, 1998). By protecting knowledge and warranting the benefits of innovations, our society attempts to incentivize innovation and thus knowledge generation, at the cost of privatizing knowledge.

But at least some pieces of evidence drawing on the study of TEK ownership and use led us to wonder whether there are alternatives ways of owning and using knowledge that would provide greater social benefits. There is some empirical evidence that knowledgeable individuals often contribute to the group sharing either their knowledge (for example, information on resource location) or the resources they have obtained through this knowledge (for example, meat from good hunters), thus making a more communal use of knowledge. For instance, among the Tsimane', knowledgeable individuals (that is, a better hunter) provide important services to villagers both by sharing meat from hunted animals, sharing hunting stories that encode important information on hunting, or providing information on other matters, such as the location of medicinal plants in the forest. By sharing their knowledge and resources, an important transfer of material or non-material resources from the knowledgeable to the rest of the population occurs. Research suggests that this transfer of resources results in tangible benefits, not only for the knowledgeable individual, but for the whole group (Reyes-García et al., 2009).

The examples previously given do not aim at presenting fixed or unique characteristics that define the dynamics of TEK systems, as probably there are as many dynamics as TEK systems. But those examples highlight that there is not a unique and standardized process that leads to the production, transfer and use of valuable knowledge. Rather, there are multiple ways to deal with knowledge dynamics. In that sense, understanding issues related to the dynamics of TEK could be as insightful for our 'knowledge society' as the specific bodies of TEK themselves.

Having said that, and from the examples just provided, I do draw two main conclusions that might be valuable to our 'knowledge society'. First, understanding the importance of the fact that local people remain close to the production of knowledge (Gómez-Baggethun and Reyes-García, 2013) can contribute to the debate on the inclusion of lay users of natural resources in knowledge generation, which appears to have become a central issue not only in citizen science, but also in environmental sustainability projects, especially in situations of high uncertainty and complexity (Berkes et al., 2003; Jasanoff and Martello, 2004). Second, understanding the social benefits of sharing knowledge and its outcomes can contribute to current debates over the use of the growing amount of information available in our society. Thus, the 'knowledge society' would benefit from examining the contributions of TEK to create the conditions that allow (and recognize) people's active participation in the production and co-production of knowledge and that allow (and recognize) the importance of sharing knowledge for the public benefit. Those considerations will hopefully make the generation of knowledge more democratic and participatory.

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13. From conventional economics to complexity in social dilemmas: lessons from CPR experiments in the lab and the field

Juan Camilo Cárdenas[1]

1. INTRODUCTION

Ecological systems and social systems interact primarily through decisions taken by humans, determining on the one hand both private and collective outcomes perceived by these individuals, but also affecting the natural and social environment around them. However, the benefits and harms created by these individual actions are not captured only by those who caused it but also by the rest of society and those in future generations, none of whom were consulted about these impacts. Moreover, these human decisions affect the possibility that this ecosystem will continue to be able to provide more environmental goods and services for those individuals and others over time.

This chapter focuses on the analysis of human decisions and how they determine – and are determined by – these interactions between social and ecological systems. The progress made by behavioral sciences over the last decades and the tools provided by experimental economics offer us a much better picture today about the decision-making process of individuals who, surrounded by their natural and institutional environments, respond to various material and non-material incentives.

Schematically we can illustrate these interactions in Figure 13.1.

According to this simple scheme, human decisions aim at producing an increase in the welfare of those who make them; sometimes that welfare could be based only on the material conditions of that individual in the short term, but the evidence suggests, as we will see, that the motivations of individuals sometimes involves affecting the welfare of others (pro-social preferences) or affecting the natural environment (ecosystem preferences).

[1] An earlier version of this chapter was published in Spanish in a volume titled *Las Rutas de la Complejidad* edited by Edmundo Bustos, Pablo Marquet and Adrian Palacios at the Instituto de Sistemas Complejos de Valparaíso, Chile.

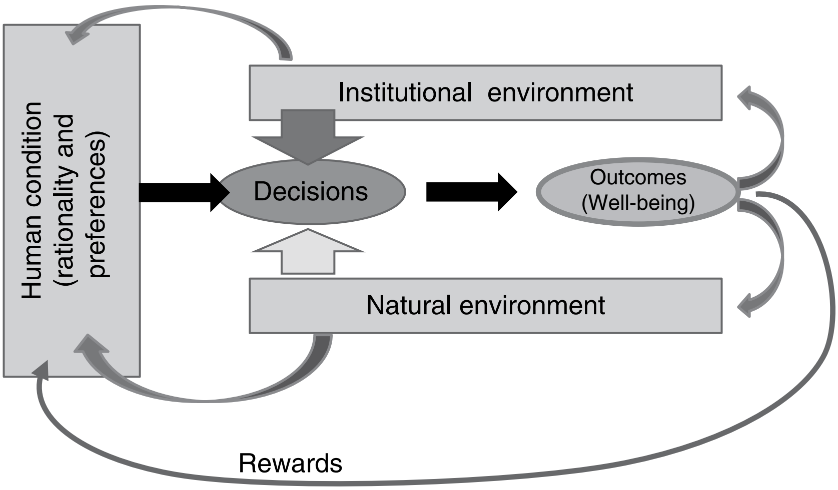


Figure 13.1 The co-evolution between institutions and ecosystems through human decisions

By affecting their own well-being, that of others, or the natural environment, individuals are ultimately also affecting the environment of rules and regulations that govern the decisions themselves (endogeneity of institutions). Thus, in a later step of the cycle, the new conditions of the natural and institutional environments will shape the incentives for individuals to make their decisions and action opportunities for the same agents (endogeneity of preferences).

These endogeneities are a central part of the discussion in this chapter. The socio-ecological systems (Ostrom, 2009) are by definition complex adaptive systems and an important part of their analysis will require an understanding of how individual decisions using ecosystems are shaped by individual, social and ecosystem-based preferences. The conventional model that we have from environmental economics (Hanley et al., 1997) in which a *homo economicus* decides on the use of resources motivated only by their individual material being derived from short-term private consumption of these goods and environmental services, has already been sufficiently refuted by ethnographic and experimental evidence (Gintis, 2000). Humans respond to additional motivations such as justice or fairness and non-utilitarian preservation of the environment, in addition to being bounded rationally by a number of biases and heuristics associated with risk, the status-quo, losses and gains (Kahneman and Tversky, 2000).

The challenge that lies ahead is to build better decision models of individuals-in-community and in turn individuals-in-ecosystem that allow us to understand a central paradox of history, reflected in the abundant evidence in the field and laboratory: human groups have been able to overcome the tragedy of the commons (Ostrom, 1990; Ostrom et al., 1994) despite the incentives against the common interest (Hardin, 1968). However, and this is the reason for the paradox, it has not been explained why these same groups of people fail to achieve socially optimal levels of use of ecosystems, sometimes even threatening their sustainability. Unfortunately, the linear models with causalities only in one direction that we have from conventional economics have not been up to this challenge.

Possible explanations of why human groups do not end up trapped in the tragedy but also do not achieve socially optimal levels of use and conservation of ecosystems will be in the analysis of socio-ecological systems as complex adaptive systems. The purpose here is to provide some thoughts and findings over the last few decades about human behavior in such situations in which natural systems interact with social systems through human decisions. The evidence presented is also derived from 15 years of field research by the author using experimental methods in the field in contexts where human groups use natural resources for their livelihoods.

A Tribute to Elinor Ostrom (1933–2012)

This chapter is also a tribute to the work of Elinor Ostrom who, over decades of work, built the foundations of the analysis of social dilemmas associated with the use of natural resources from the perspective of integration of natural and social systems. Her seminal book *Governing the Commons* (1990) attracted the attention of those who argued that not all situations where individuals can take advantage of the other individuals in the use of shared resources end with the famous tragedy of the commons that Hardin (1968) had offered as a prediction decades ago. This work created the basis for an analysis from local individual actions or decisions in the collective and constitutional arenas, within a neo-institutional approach. The impact of this approach was enormous and led to the explosion of theoretical (see, for example, Sethi and Somanathan, 1996; Baland and Platteau, 1996) and ethnographic investigations (see Ostrom et al., 1994; Baland and Platteau, 1996) that served to empirically and theoretically validate the propositions in Ostrom's groundbreaking book. In a subsequent expedition with her colleagues (Ostrom et al., 1994), she embarked on a strategy of experimental research that marked the agenda of the next decades in the analysis of human behavior in the laboratory and then in field experiments on these issues of common pool resources (Falk et al., 2002; Cárdenas, 2000; Cárdenas and Ostrom, 2004).

This effort continued through dialogue with the natural sciences to contribute to the concept of socio-ecological systems (SES) (Ostrom, 2009) as a framework for integrating the analysis of biophysical, institutional and behavioral relationships between humans and their environment variables.[2] Likewise, the efforts to integrate different research methods continued on the agenda of Elinor Ostrom, who managed to consolidate them with colleagues Poteete and Janssen to produce a book (Ostrom et al., 2010) that combines methods and disciplines in understanding these transdisciplinary problems. During these years, Ostrom and her husband Vincent Ostrom also made enormous contributions to the institutional analysis of organizations and rules governing the problems of public goods and common resources, in what they called polycentric systems (Ostrom, 1999). The analysis of polycentricity in the governance of public policy transcends the simplicity of the study of hierarchical systems within the state and its relation with the public, and includes other dimensions and levels of governance that interact with the state, civil society and the private sector.

It is along these lines of thought that this chapter is generated. The road, especially cultivated by Elinor Ostrom, raises a number of methodological and conceptual challenges for the study of common pool resources from a complexity perspective both in the behavioral and ecological dimensions.

Take the example of the Latin American context. It is worth noting that it took more than a decade for *Governing the Commons* to be translated into Spanish and that rather few works in this line are available in this language. The tradition of building the 'state' in the Spanish-speaking context in the last two centuries has explained the role of the imbalance between state and central apparatus and civil society organizations as possible complements in the provision of local public goods. It is only recently that attention is being paid to the role of various forms of self-government[3] as

[2] The concept of Common Pool Resources (CPRs) appeared in response to the concept of open access resources and the concept of pure public goods; CPRs share with public goods the characteristic that neither are excludable goods; however, CPRs involve rivalry, while public goods are not rival by definition. The concept of socio-ecological systems (SES) is another step in the progression of these conceptual constructs. An SES may involve a CPR problem but includes many more analytical elements regarding the resource and its users. The SESs have, in addition to the resources, resource users and systems of rules and regulations governing the provision and use of goods and services derived from the SES.

[3] A few exceptions to this simplistic state-or-market view in the Latin American context can be read in the works of Leticia Merino Perez and Robson (2006), Andersson et al. (2008), Stefen Gelcih et al. (2010) and Cárdenas (2009).

an alternative to the market and state solutions that have guided the public policy debates in Latin America and the Caribbean.

The context of the region is interesting for this analysis for several biophysical, historical and cultural reasons, with eventually valuable lessons for other contexts with similar historical patterns combined with particular ecological conditions. To start with, we have the diversity associated with multiple coastal ecosystems, and the extensive Amazonian, Andean and tropical territory that constituted a particular and unique biodiversity. On the other hand the pre-Columbian history and then the process of conquest and colonization in the region, evolved into a process of weak appropriation or control of land by what we call 'state' institutions, threatening the possibility of continuation of the existing forms of government by indigenous communities upon the arrival of European settlers. This process, however, has witnessed a counter proposal in the more recent history, with indigenous and Afro-descendants seeking to defend their rights to their ancestral territories, which has meant a growth, or rather, re-emergence, of collective forms of land ownership and massive social movements (Yashar, 2005). In cases like Colombia these social movements have led to the titling of 30 million hectares to indigenous groups, and more than 5 million hectares to Afro-Colombian community councils (together totaling 32 percent of the country). Added to that, about 12 million hectares have been declared national parks, many of which provide key environmental goods and services to rural communities that surround or live within them, and thus it can be argued that 43 percent of this country consists of collective spaces with obvious social dilemmas associated with the use of common pool resources (Cárdenas, 2009). The rest of the territory, both on the continent and in coastal areas, has similar situations regarding many of these dimensions, namely local claims for ancestral rights to their collective territories, and conservation areas under private, NGO and state ownership, and overall, a state with limited opportunity to enforce conservation laws.

2. THE PROBLEM OF COMMON POOL RESOURCES

In a conceptual framework of a single resource that is exploited by a group of users with common access to the same source (a fishing area, a forest, a water source), material incentives indicate that each user must operate individually until the point at which the private cost of extracting the last unit is just offset by the benefits received by that individual. If each resource user assumed this rationality and the natural resource was dependent on the pressure exerted on it, the sum of the individual extractions would lead

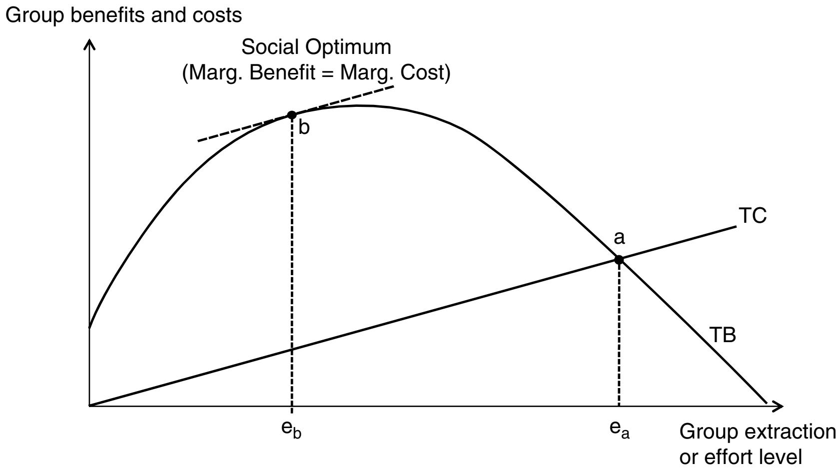


Figure 13.2 The conventional approach to the problem of common pool resources

to a level of extraction higher than socially desirable, dissipating the possible rents or social surplus in addition to an excessive level of pressure on the resource, threatening its sustainability. This is point (a) in Figure 13.2, where the total benefits (TB) and total costs (TC) for the group of users are plotted. Clearly, at point (b) the group could maximize its profits, which if distributed among users could generate a positive income or surplus for each – which is impossible at point (a).

The model in Figure 13.2 has dominated the conventional analysis of the problem of the commons, providing the basis for predicting the depletion of resources and to defend the need for intervention of a third party, usually the state, and pushing for the need to define individual property rights or, pecuniary incentives to discourage over-exploitation through the alignment of individual and social interests. A summary could be as follows: Left to their free choice and seeking self-interest, individuals will end at point (a). Through a coerced solution they will have to move from point (a) to point (b) to maximize social efficiency. That solution could include the regulation of the extraction technology allowed for each user, or limiting the amount of effort or harvest for each user, or taxing the benefits or costs to align these individual incentives with the group outcome.

The complexity of reality could force those of us interested in using this simplified model to rethink its relevance and usefulness. The model, however, is very useful as an intellectual exercise for discussion and reference regarding the most pessimistic and optimistic scenarios of the problem. For instance, the shapes of the two main functions (benefits and costs) are directly linked to the production function technology and to the properties of the ecosystem. Thus, the primary value of the model in Figure 13.2 is not its predictability but its potential to generate a healthy debate about the ecological and economic forces driving the possibility of a sustainable use of a common-pool resource.

Regarding the benchmarks, there is ethnographic evidence that some individuals in groups are often able to avoid this prisoner's dilemma without resorting to privatization of property rights or use of an external agent imposing state incentives or limits to extraction. As Ostrom rightly said in her presidential address (1998):

> You would not be [here] if it were not for some of our ancestors learning how to undertake collective action to solve social dilemmas. Successive generations have added to the stock of everyday knowledge about how to instill productive norms of behavior in their children and to craft rules to support collective action that produces public goods and avoids 'tragedies of the commons'.

This evidence has been corroborated in laboratory studies that have confirmed that individuals can build and honor non-binding agreements during an experiment in which there are clearly substantial monetary incentives to exploit the trust of others and increase one's income.

This does not mean that the general rule is universal and unconditional cooperation among humans. It simply means that the tragedy of the commons or of prisoners is not the universal rule and that it is avoidable. Indeed there are cases in which the behavior of individuals or firms has driven common-pool resources close to extinction, as in the case of some emblematic species attractive to poachers or fishing companies.

However, sufficient evidence from field and laboratory, and subsequent theoretical explanations (see Sethi and Somanathan, 1996; Ostrom, 1990; Baland and Platteau, 1996) suggest that human groups reach levels away from the two extremes (that is, universal cooperation and the universal tragedy) or, to put it graphically, those points between (a) and (b) in Figure 13.2, which deserve to be explored and explained in more detail. To do this, an approach from complex adaptive and socio-ecological systems seems more appropriate, which brings me to the next section.

3. COMPLEXITY IN THE ANALYSIS OF COMMON POOL RESOURCE USE

A Complex Adaptive System (CAS) involves a number of properties that allow us to enrich the analysis of common pool resources building on the conventional economics approach presented in the previous section.

One of the essential features of the CAS is to have structures and processes of interaction between the lower levels to generate emergent properties at higher levels or scales (Janssen, 2002), which leads us to infer that it is essential to understand the micro motivations of the CPR (Common Pool Resource) users to understand why cooperation or a tragedy could happen as an emerging phenomenon, usually against the interest of the users themselves. This also means that to understand how these phenomena of ecosystem depletion or preservation occur, one must understand the properties of the social and ecological structures around it. In the conventional model, where open access and freedom of action are the governing system of property rights and regulations, the individuals are not bound by social structures that stop them from extracting at the zero-rents solution explained in Figure 13.2.

A second point from the complexity analysis is the dynamic and adaptive nature of these systems. Many of the relationships within its components are not linear and involve feedbacks. Complex adaptive systems are often out of balance and are highly sensitive to changes or shocks, and sometimes involve stable cycles revolving around certain focal points. This allows CAS to converge to equilibria or steady states, as suggested by Limburg et al. (2002), which does not eliminate the possibility of multiple equilibria, some of which may be more robust than others to external shocks, and which would allow a CAS to jump from one equilibrium to another. Permanent change is another feature of CASs, which allows evolutionary processes to occur and some behavioral norms to emerge or disappear over time, depending on the composition of strategies chosen by the agents. Part of the reorganization and adaptation of CAS is also derived from high levels of stochasticity and therefore the role that randomness plays in generating innovations within them (for example, new rules or standards among resource users). The structures that govern these CAS usually involve hierarchical systems where there is no node that controls or plans the whole system, and the available information is partially dispersed among agents so that no single agent can know the entire system's information. These properties lead to emerging patterns that result from the processes between the components but cannot be explained from the sum of the properties of the components themselves. Levin (1999) summarizes these in three characteristics: (1) the diversity and individuality of components; (2) competitive or cooperative interactions between components; and (3) the autonomous processes that use the results of these local interactions to replicate or reinforce a subcomponent of the system. This heterogeneity of the components is essential, according to Levin, to generate the variability associated with natural selection. The non-linearity and feedbacks in the relations between the components of a CAS partly define the hierarchical structures that govern it.

This approach to complexity has not been absent in the economics discipline. Since the late 1980s we have seen these discussions at the Santa Fe Institute (see Arthur et al., 1997). The economic approach to complex systems has parallels with those already mentioned. Interactions occurring in an economic system are scattered by definition and there is no central control system that concentrates all the information needed to plan the economy as a whole. Though some of the control or regulation is achieved by the state, much of the real control is a complex economic system of rules or even decentralized rules governing interactions (for example, trust, betrayal, respect, handshakes). This need for a multiplicity of levels of government is also part of how the economic system constantly adapts to changes and technological innovations that create new markets (for example, Uber and Airbnb) leading to processes outside of stable equilibria.

It is for these reasons that it would be too limited to reduce the analysis of the problem of common pool resources to a unique solution of the tragedy at point (a) in Figure 13.2, and opens the need to involve other elements in it. In Table 13.1 we can identify the elements that are part of the conventional model of CPRs and new elements that could be included in the analysis from the perspective of CAS.

4. ADDING TO THE COMPLEXITY, DYNAMIC RESOURCES, BIODIVERSITY, SOCIAL PREFERENCES AND POLYCENTRICITY

From the first simple model presented above (Figure 13.2) and the review of the essential elements of a perspective of CPRs from the complexity in the previous section, we could then add some additional elements to a model of economic behavior in using and preserving CPRs, and thus walk in the direction of a complex adaptive systems approach.

The first and most obvious of these is the *dynamic problem* of a natural resource stock. Bioeconomic models have been around in the resource economics literature for some time now (see Clark, 1985; Clark and Munro, 1975). Ecosystems are immersed in inter-temporal

Table 13.1 Conventional vs. Complex Adaptive Systems approach to common pool resources

Characteristics of the model	Conventional model of CPRs (Figure 13.2)	CPRs as Complex Adaptive Systems (CAS)
Rationality of agents	*Homo economicus* (individuals maximize their short-run individual material pay-offs)	Individuals show other-regarding preferences, preferences towards fairness and for ecosystems' existence. They have heuristic biases and systematic errors regarding self-control, attitudes towards uncertainty and towards future pay-offs
Production function (benefits and costs)	Linear and non-linear Deterministic	Linear and non-linear More stochastic
Equilibria	In the absence of institutions and regulations, the unique equilibrium is the tragedy of the commons (point (a) in Figure 13.2)	Multiple equilibria
Stochasticity	Rare	Uncertainty in the benefits, costs and actions of players. The environment imposes global shocks on the CPR system
Social norms	Norms do not affect the utility function of individuals	Norms alter the perceived benefits and costs through shame, guilt, ostracism, sense of belonging, pride
Ecosystem (resources and interactions among them)	One species, unidirectional and predictable	Stochastic, multi-species, with feedbacks and interactions among species or resources
Government hierarchies and regulations	Perfect hierarchies and private property rights. Two extremes: (Point a): Tragedy of the commons. *Homo economicus* agents extract all the rents possible seeking their own well-being. (Point b): A central planner with perfect control can achieve the level of group effort to take the CPR from point (a) to point (b); or a perfectly enforced system of private property rights consolidates the decision in one single manager over the entire CPR	Polycentricity: co-existence of external regulators with partial capacity for monitoring and sanctioning, and self-governed organizations and rules at the community level

dynamics generated in the renewability of their components. Using the same scheme from Figure 13.2, the curve of total benefits (TB) can shift up or down, depending on the dynamic path that the ecosystem takes. If in previous years the effort has been very high, it is possible that for a later period the TB curves shifts downwards or that the total cost curve TC shifts upwards or its slope increases since ecosystems under more stress would imply more difficulties for users to appropriate their benefits.

A second element of complexity is *biodiversity* as an inherent element of ecosystems. Users often take advantage of these ecosystems by exploiting more than one resource and therefore it is possible that the multiplicity of goods and environmental services derived from these collective spaces imposes additional challenges when analyzing the possibility of a self-governing social dilemma of this solution. It is possible that not only does the value of the stock of a resource represent well-being for a user or group, but the interaction between these species or stocks of resource services generates additional economic benefits, then generating an additional coordination problem between group members when deciding the optimum extraction levels of each of the species (think of the interaction between forests and water resources in ecosystems where the supply of the latter depends on the preservation of the former). In addition to this, the coexistence of multiple species in the ecosystem is accompanied by interactions between them, which adds complexity to the problem of user decision CPR. Another example comes from predatory or invasive species. At the time that two species with commercial value or self-consumption have a predator–prey relationship, when making a decision the user must consider the possibility that exploiting one alters the stock of the other.

A third element to be added to the problem is *social preferences*. Conventional models were essentially based on an assumption of rationality based on the maximization of an individual's utility from her material consumption of goods and services. There is insufficient space here, but it is worth reminding the reader of the evidence from multiple disciplines and from different methods of collection suggesting that humans have a tendency to include in their interests the welfare of others, or discomfort from emotions such as envy, and are willing to sacrifice material payoffs for the benefit of others, including non-kin (see Bowles and Gintis, 2011).

The fourth and final component to add to the complexity of the problem is the analysis of *polycentric governance* systems that govern the management of common pool resources. Almost all local ecosystems are now governed by a mixed system that includes international agreements, national laws and constitutions, regional and local rules and regulations and rules often generated from the communities of users and their local organizations. In a view from polycentricity (Ostrom, 1999) multiple levels of government exercise power in the provision and distribution of public goods which can create breaches or redundancies. Some of those vacuums open up for opportunism and inefficiencies, but sometimes they are filled with non-binding mechanisms like trust and social norms. Some of the redundancies can be seen as tax inefficiencies and waste of public resources, but could be seen as a system of checks and balances so that absolute power does not corrupt. At its best, polycentric systems have a distribution of power between the different levels so that there is no total concentration of control, and there are redundancies that create resilience in the system of government.

The study of common pool resources has shown significant progress in recent decades since its inception in bioeconomic models of the 1950s (Gordon, 1954), the debate generated by the seminal article by Hardin (1968) in the late 1960s, the development of game theory from the prisoner's dilemma during the 1980s and the possibility of cooperation in works in biology by Maynard Smith (1982) and in economics and mathematics from Axelrod (1984) showing the role of reciprocity. This continued in the 1990s with the work by Ostrom (1990), along with other seminal works such as Wade (1988) and Baland and Platteau (1996).

The arrival of experimental economics to the CPR problem with the groundbreaking work of Ostrom et al. (1994) triggered a research agenda that continues to fuel the discussion on the possibilities and limitations of cooperation in these social dilemmas. However, there still appear to be gaps and voids to be filled within this literature. Although behavioral economics has contributed greatly to understanding human motivations and determining the willingness of individuals to contribute to the common good despite the incentives for free-riding and opportunism, the vast majority of economic systems (or production functions) being used in these experiments are still within the domain of static models as the one shown in Figure 13.2 and formally expressed in equation (13.1) below. In these static models there are N number of players, where Y_i represents the income of player i, and x_i the individual extraction effort by the same player i. The interaction of these variables is given in the following manner:

$$Y_i = f\left(x_i, \sum_1^N x_j\right) \text{where} \frac{\mathrm{d}Y}{\mathrm{d}x_i} > 0, \frac{\mathrm{d}^2Y}{\mathrm{d}x_i^2} < 0, y \frac{\mathrm{d}Y}{\mathrm{d}\sum x_j} < 0. \tag{13.1}$$

That is, each individual increases his or her profits with effort, although declining marginally, but their profits are reduced by the combined efforts of the group. Therein lies the paradox or social dilemma. However, most of the literature on cooperation and voluntary contributions to public goods[4] continues using simple linear models of provision of public goods which is simplified by assuming that $\frac{d^2Y}{dx_i^2} = 0$. By incorporating the nonlinearities expressed in equation (13.1), Ostrom et al. (1994) added a first dimension of complexity related to the functioning of the biological components of CPRs. This, however, is just one small step in the direction of incorporating the complexity of socio-ecological systems analysis from behavioral economics and experimental economics. The last section of the chapter is devoted to discussing different dimensions in which behavioral economics and economic experiments may contribute to the study of the problem from the perspective of socio-ecological systems and complex adaptive systems.

But first, it is important to do a quick tour of the progress that these conceptual and empirical approaches have made in the understanding of human behavior in these social dilemmas.

The Journey through Behavioral Sciences and Experimental Tools

Behavioral sciences and experimental economics have made significant contributions in the dimension of social preferences (see Bowles and Gintis, 2011; Gintis, 2000) and in studying the biases and heuristics regarding risk and uncertainty (Kahneman and Tversky, 2000), but they have still a long way to go to incorporate the other three elements (dynamics, multi-species systems and polycentricity) in their models and experimental tests. Regarding experiments with dynamics components, some progress has been made in this direction by introducing decisions involving renewable resources with dynamic effects of stock.[5] Regarding multiple species, there is a body of theoretical literature in ecological modeling (see Fleming and Alexander, 2003) but there are no models with experimental tests that tackle the problem of incorporating collective management or common access to multi-species ecosystems. Finally, on systems of government resources in common use, it is also important to note that most experimental work on forms of government has been busy testing the effects of a single system of government (for example, quotas, standards, taxes

[4] From experiments with prisoner's dilemmas, through the trust game, to voluntary contributions or public goods games, the vast majority of laboratory designs are based on linear relationships in the production function.

[5] See Alpizar et al. (2011); Cárdenas et al. (2013); Maldonado et al. (2009).

or forms of self-government as discussed in Ostrom et al. (1994), Clark (1985), Clark and Munro (1975) and Vélez et al. (2012, 2010)). However, there have been no experimental designs to test polycentric governance systems, except perhaps for experiments on co-management as in the case of forms of self-government with the presence of an environmental authority, as in Moreno et al. (2010), who implemented previous experimental designs by Cárdenas (2009) but which is still distant from what we might consider the testing of polycentric governance systems.

The overall risk of incorporating these dimensions of complexity in models of common pool resources is that you can lose the tractability of the models, that is, we cannot generate refutable hypotheses from the analytical results of the models that could be checked against the evidence from the field or from the laboratory. Notice, when moving from one to more species we increase the number of simultaneous decisions to be taken by individuals and therefore the complexity of the problem of strategic decision. Each individual must decide individually on the extraction of each species constrained by his or her ability or maximum aggregate extraction, and according to his/her beliefs about the other resource users making the same multi-species decision. The extinction of one of the species from the ecosystem could harm the group as a whole. If we add different prices for each target species or differential costs per unit extracted per species, a much more complex system would be required for a relevant analytical solution with predictions.[6]

Despite these gaps, the knowledge accumulated so far on the behavior of individuals in social dilemmas for these situations allows us to observe some relatively robust patterns that are worth summarizing. Nearly two decades of application of laboratory and field experiments on CPRs have gone by since the seminal work of Ostrom et al. (1994). From these initial experiments where assumptions about the power of self-governance, rules compliance, or response to sanctions or possible destruction of the resource were tested, until today, the explosion of experimental designs exceeds the available space here, and would not be the central goal of this chapter. However, it is worth summarizing some of the most consistent results found in recent years in these laboratory and field-lab tests.

First, it is quite common to observe that there is no majority, but a small fraction somewhere between a quarter or a third of the population behaving according to the conventional model of maximizing their material individual self-interest where the individual takes every opportunity to increase their income regardless of the impact on others. The rest of the

[6] An alternative to an analytical solution would be through simulations with agent-based modeling of these problems.

population chooses game strategies that deviate from this *homo economicus* prediction, including various types of heuristics in their behavior. For example, the tendency to reciprocate seems to be present in a significant fraction – I would say the majority – of players, where cooperative action of the other members of the group drives the player to cooperate, and by the same token to respond to opportunism by free-riding. Also within that fraction of individuals who do not choose the individualistic action, there are those who could be called altruistic contributors, that is, willing to contribute motivated by the welfare of others and at a personal cost. Overall we could then group these types into three: unconditional egoists, conditional cooperators and unconditional altruists. Replications in the field of these laboratory experiments corroborate this mixture of types of players, which explains in part why it is observed that the groups generally tend to avoid the tragedy of the commons but not to the point of approaching the social optimum of universal cooperation.

Alternative models that incorporate other types of individual preferences have shown a fair level of predictability of behavior in the laboratory. For example, Falk et al. (2002) construct a model of inequality aversion applied to common-pool resources in which players derive disutility because of the guilt you might feel from appropriating more of the resource than other players, and envy when others get more income than you. This model can predict cooperation at intermediate levels as observed, which is statistically supported by the authors. The evolutionary model developed by Sethi and Somanathan (1996) also predicts levels of CPR exploitation that do not match the tragedy of the commons forecast because social norms of restraint and punishment emerge as part of the mechanisms that communities use to avoid the tragedy. Both in the laboratory and outside, there are elements beyond the context of the material pay-offs of the game that are part of the determinants of resource use, including the experience and the social distance between players (Cárdenas and Ostrom, 2004), including social norms (Cárdenas, 2011).

Further, explaining behavior of individuals even in a baseline CPR setting, where no institutions (for example, regulations, social norms) are present to coordinate the actions of players is still in progress. Even under open access conditions we observe that resource users often refrain from extracting the maximum possible that would maximize their pay-offs. Several models have tried to explain why individuals in the laboratory do not always choose the material pay-off dominant strategy, that is, to maximize pay-offs by exerting the effort that maximizes their pay-offs when assuming that others will also operate with that logic. Using an evolutionary dynamic model, inspired by the sampling equilibrium concept developed by Osborne and Rubenstein (1998) where boundedly rational players sample the action space of different extraction levels possible, Cárdenas et al. (2014) generate predictions of behavior quite similar to those observed in various CPR laboratory experiments, where individuals choose with positive probabilities levels of extraction that are strictly dominated in a classical game-theoretical approach.

Another regularity observed in laboratory and ethnographic settings is that, when having the ability to communicate, especially face-to-face, individuals manage to reach agreements that, although not binding, are capable of committing their intentions and actions towards a common goal. Again, from laboratory experiments (Ostrom et al., 1994) to experiments in the field lab (Cárdenas, 2009), individuals are able to resist the temptation of a few extra dollars, and act according to the optimization of the group's income and hence the income of each group member. Moreover, this positive effect of communication and non-binding agreements seems to be more effective when the communication is repeated between players, providing a space for a trial-and-error discussion and feedbacks among group members (Cárdenas, 2011).

Also, when faced with the possibility of punishing other players for their unfair or selfish behavior, it has been observed in these experiments that individuals often choose to sacrifice their own resources to reduce the income of those players over-exploiting the resource. These actions lead the groups to control opportunism endogenously (Bowles et al., 2009; Bowles and Gintis, 2011), or even lead to reward, also at a personal cost, those who decide to cooperate in the provision of public goods (see Andreoni et al., 2003 for a review of the experimental evidence). In general this literature supports the argument that members of groups or communities are willing to incur private costs in order to resolve this second-order collective dilemma, that is, the dilemma of voluntarily contributing to generate a collective solution to the self-governance of the first-order dilemma of not over-exploiting the common-pool resource. Again, cooperating in maintaining a system of punishment and rewards, or cooperating in the use of CPRs involve assuming a private cost that exceeds the private benefit of such unilateral action, and only to the extent that group members cooperate sufficiently can you generate a socially efficient outcome.

This literature has an important reference in the anthropological and archaeological evidence for the evolution of institutions throughout the history of civilization. It is likely that the construction of institutional dilemmas used solutions that began tens of thousands of years ago with endogenous systems of rewards and punishments through clan and tribal systems, and only many centuries after was progress made in building systems with more complex hierarchies and ruling classes or kleptocracies (Diamond, 2005) devoted exclusively to monitoring and sanctioning more formal rules.

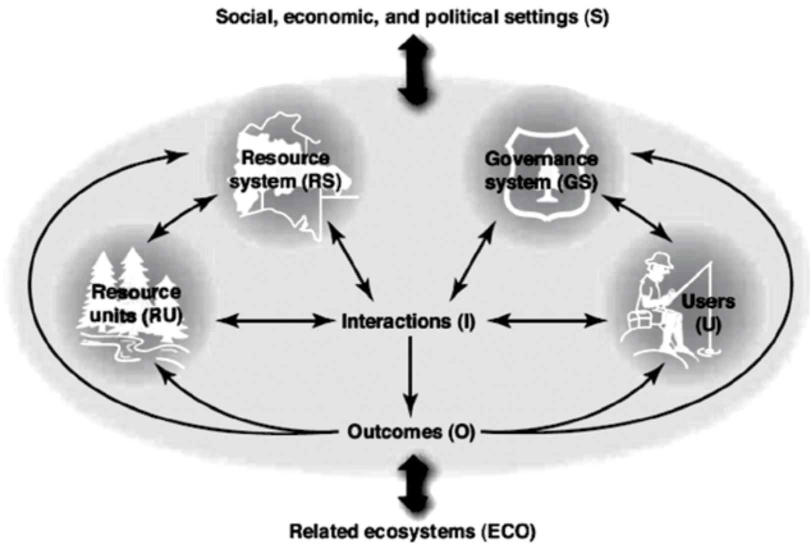
The experimental laboratory and field evidence fully supports the origin of endogenous self-governing sanction and reward systems, and from there it would be easier to explain the transition to more formal and structured systems of governance. Surprisingly, there are fewer experimental works on the behavioral effects of external sanctions or mechanisms administered by a third party in the context of common-pool resources or public goods, if compared to the usual endogenous punishment and reward experiments.

The first field experiment conducted to study the response to an external regulation system with monetary sanctions in the context of CPRs is reported in Cárdenas (2000) and Cárdenas et al. (2000). The experiment aimed to emulate a realistic situation in the current context where a regulatory state apparatus with limited monitoring capacity imposed a monetary penalty to users exploiting a CPR. The results suggested that there are risks in eroding the intrinsic motivations of the players generating an unintended consequence of regulation (crowding-out), especially given the limited capacity of the state to achieve a perfect monitoring and enforcement of the rules in the context of developing countries. After varying the severity of fines we found that although the effect was economically and statistically significant, and in the right direction, the magnitude of the difference was economically small. While individuals may respond partially to a monetary penalty for exploiting a CPR, the differences in behavior between high and low fines were very small. In fact we find that under the high fines setting, individuals were expected to show perfectly cooperative behavior, and yet a non-negligible fraction of individuals decided to violate the rule, moving away from the *homo economicus* model if they were to consider the private benefit against the expected cost of the sanction. Further, in the low fines treatment we observed levels of compliance that were greater than the theoretical prediction. It seems that these rules sent a signal not only of sanction but also a normative orientation of 'good behavior', inducing a change in incentives beyond the pure pecuniary consequences (Cárdenas, 2011; Rodriguez-Sickert et al., 2008). Similar experimental studies (Vélez et al., 2012, 2010; Lopez et al., 2010) have explored the response of individuals to external regulations, confirming that it is generally difficult to predict the behavior based solely on the *homo economicus* model. Other mechanisms associated with the formation of social norms and effects of what psychologists call social emotions seem to play an important role in explaining how individuals interact with their surrounding institutional environment.

One could summarize the patterns that appear to be common in these experiments as follows:

- Only a minority of individuals choose to maximize their material opportunities in the game through free-riding. The rest of the population opts for other strategies of altruism, cooperation and reciprocity.
- Groups achieve social efficiency levels that are far from the prediction of *homo economicus* and the tragedy of the commons, but they do not reach the levels of efficiency of universal cooperation.
- A vast majority of individuals in repeated games seem to follow a strategy of trial and error, where trying different actions instead of choosing one single strategy in the map of possible actions.
- Individuals are sensitive and responsive to the actions or pay-offs of others, sometimes through actions of reciprocity or inequality aversion.
- Participants in experiments that come from student populations are slightly closer to the prediction of *homo economicus* than other populations where participants face these dilemmas in their daily lives. However, both groups show similar patterns of behavior as listed above.
- Inequalities and social heterogeneities within a group enhance in most cases the social distance and distrust among group members, preventing the possibility of cooperation.
- When individuals are allowed to generate non-binding agreements through face-to-face communication, cooperation increases. When that communication is repeated, cooperation levels are sustained if compared to the possibility of a single period of dialogue within the group.
- Sanction and reward systems managed by the same individuals at a personal cost produce socially desirable outcomes, reducing opportunism and increasing cooperation.
- External regulations can induce positive changes but sometimes can also erode intrinsic motivation or social norms (crowding-out) associated with group interest.

The experiments that I have mentioned here somehow lead to the conclusion that in a world in which external regulations and social norms coexist for the same group, it is difficult to predict whether the self-governance, state and market mechanisms can be complementary, substitutes or even generate the mutual erosion of the desired objectives. The complexity of the institutional systems that are embedded in the CPRs



Source: Reproduced from Ostrom (2009).

Figure 13.3 Conceptual framework of socio-ecological systems (SES)

of today's reality forces us to continue this search for answers through multiple methods (Poteete et al., 2010) and dialogue between theorists and those who work in the field.

These behavior patterns offer a number of opportunities to explore the problem of socio-ecological systems and common pool resources from a complexity perspective. In this sense, the conceptual framework of the SES (Ostrom, 2009) opens a wide spectrum of relationships and components to understand these collective spaces where groups of resource users benefit from a set of their SES-based goods and environmental services. These components and relationships are synthetically described in Figure 13.3, developed by Ostrom (2009).

A more complete analysis of the CPRs will then have to consider the components described in this approach to SESs. In other words, the simple model of Figure 13.2 can be enriched with this detailed SES in Figure 13.3, at the risk of losing control or tractability. Whereas in the traditional model (Figure 13.2) we have simple assumptions about users (U) whose rationality is based on the *homo economicus* model of individuals maximizing their short-term material pay-offs, in the model of an SES one must consider a user who has social preferences for others and for fair outcomes; a user with preferences for risk or time-discounting different from the conventional model but consistent with the biases observed in the behavioral literature; or users may manifest intrinsic preferences for the mere existence of ecosystems or their components without deriving material changes in their consumption. In the new SES model the interactions (I) between users (U) and the resource (RU) would be regulated through more complex systems of governance (GS and S) emerging from problems of asymmetric or incomplete information between regulators and users, and through levels of polycentric governance distributed across different hierarchical levels. In this new paradigm the ecological relations would imply more complex relationships (RS, RU and I) between the biophysical and economic components and most likely interacting also with other related (ECO) ecosystems.

To analyze this more complex framework of relationships, Ostrom and her colleagues set out a number of factors to consider in each of the components of the SES in Figure 13.3 and summarized them in Table 13.2 (Poteete et al., 2010).

The reason for reproducing the SES framework and Table 13.2 here is to highlight the type of agenda that a next wave of experimental work needs to address to build the bridges between those in the behavioral sciences, experimenters in the lab and the field and those in the field of ecological economics.

The Experimental Approach and SES: Where to?

Given this range of factors that can affect the functioning of SES, behavioral economics and experimental methods can contribute to generate empirical evidence, furthering the construction of better SES models for the study of CPRs use. Nevertheless, strategies that combine experimental methods and the SES approach, I would say, are still in their infancy.

For some components of the SES model (Figure 13.3 and Table 13.2) there are advances in experimental economics in which these elements have been incorporated as part of the overall design, as treatments or as control variables. For example, the study of the specificity of resources (RS1 Variable in Table 13.2) has been incorporated gradually in experiments where the context (framing), the dynamics of the resource or the design of the experiment itself involve different types of natural resources (see Cárdenas et al., 2013 for distinct experiments with forests, fisheries and water).[7] However, such experiments are based on very simple ecosystems and for single species. The next step in this agenda has been to incorporate

[7] See also Janssen and Anderies (2011).

Table 13.2 Variables of importance in components of SES

Social, economic, and political settings (S)	Related Ecosystems (ECO)
S1 Economic Development	ECO1 Climate Patterns
S2 Demographic Trends	ECO2 Pollution Patterns
S3 Political Stability	ECOS Flows Into and Out of Focal SES
S4 Government Resource Policies	
S5 Market Incentives	
S6 Media Organization	
Resource Systems (RS)	**Governance Systems (GS)**
RS1 Sector (e.g., water, forests, pasture, fish)	GS1 Government Organizations
RS2 Clarity of System Boundaries	GS2 Non-government Organizations
RS3 Size of Resource System	GS3 Network Structure
RS4 Human-constructed Facilities	GS4 Property-rights Systems
RS5 Productivity of System	GS5 Operational Rules
RS6 Equilibrium Properties	GS6 Collective-choice Rules
RS7 Predictability of System Dynamics	GS7 Constitutional Rules
RS8 Storage Characteristics	GS8 Monitoring and Sanctioning Processes
RS9 Location	
Resource Units (RU)	**Users (U)**
RU1 Resource Unit Mobility [RU1a mobile RU, RU1b stationary RU]	U1 Number of Users
RU2 Growth or Replacement Rate	U2 Socioeconomic Attributes of Users
RU3 Interaction among Resource Units	U3 History of Use
RU4 Economic Value	U4 Location
RU5 Number of Units	U5 Leadership / Entrepreneurship
RU6 Distinctive Markings [RU6a natural markings, RU6b artificial markings]	U6 Norms / Social Capital
RU7 Spatial and Temporal Distribution	U7 Knowledge of SES / Mental Models
	U8 Importance of Resource
	U9 Technology Used
Interactions (I)	**Outcomes (O)**
I1 Harvesting Levels of Diverse Users	O1 Social Performance Measures (e.g., efficiency, equity, accountability, sustainability)
I2 Information Sharing Among Users	O2 Ecological Performance Measures (e.g., overharvesting, resilience, biodiversity, sustainability)
I3 Deliberation Processes	O3 Externalities to other SESs
I4 Conflicts Among Users	
I5 Investment Activities	
I6 Lobbying Activities	
I7 Self-organizing Activities	
I8 Networking Activities	

Source: From Poteete et al. (2010).

multiple species experiments and interactions and other factors described in (RU) component of SES, so that even within a controlled laboratory system, but enriched by the context in the field, we can continue the study of human behavior in these new ecological complexities.

On the role of institutional structures (especially the U and GS elements), progress has been made in the study of human behavior in endogenous and external regulatory systems mentioned above. One possible avenue of experimental research would be to study polycentric or mixed governance systems where self-governance co-exists with state-based regulatory mechanisms and to explore the complementarity or substitutability of two ways to solve the CPR dilemmas. Likewise, it would be interesting to deepen experimentally the ways in which different social network structures (GS3) affect the construction and dissemination of social norms (U6) among users of a CPR.[8]

Finally, the behavioral-experimental revolution can also bring to the table another dimension that a branch of ecological economics has embraced from its origins: the revival of the political economy of distributional issues in economics and in particular on environmental or ecological justice. Preferences for justice and fairness have been at the core of the findings from behavioral sciences over these decades, and its relations with intra- and inter-generational environmental justice and equity are part of the main concerns in ecological economics. I foresee another area of promising research in merging the study of social preferences with the study of ecological preferences to understand to what extent institutions, mechanisms and decisions are shaped by the concerns for a fair distribution of environmental outcomes within and across generations. A simple experiment in this direction can be found in Hauser et al. (2014).

These are just some examples of how we can build on the progress from recent decades in the study of the micro-foundations in the use of common pool resources, and how the socio-ecological systems approach can incorporate new categories of factors affecting the sustainability of ecosystems and among its users and beneficiaries. The journey from the simple model of the bio-economy (Figure 13.2) to the SES model (Figure 13.3) has been an enrichment of conceptual analysis of the problem. The challenge of experimental economics and behavioral sciences will be to keep up with and contribute to the sustainability of social-ecological systems existing today and those that will emerge in the future.

[8] An experimental example can be found in Cárdenas and Jaramillo (2007) and Mantilla (2015).

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14. Sustainable consumption: transitions, systems and practices

Inge Røpke

INTRODUCTION

Ecological economics has a long tradition within consumption studies. The field of ecological economics was formally established in the late 1980s, but already in the 1970s consumption issues were addressed within energy studies, which later became a key building block of ecological economics. Starting in the same period, the general discussions revolving around the IPAT equation highlighted the need to move beyond relying on technical innovation to meet environmental goals. With a growing population and increasing affluence per capita, the demands on increased technological efficiency were considered to be impossible to meet. Because increased affluence is necessary for the poor, in part to curb population growth, the consumption of the rich cannot continue to increase. The Brundtland Report made the same point by stating that 'Sustainable development requires that those who are more affluent adopt lifestyles within the planet's ecological means' (WCED, 1987: 9). A commitment to sustainable consumption was confirmed at the Earth Summit in Rio in 1992, and a number of government programmes were initiated in subsequent years. Simultaneously, the research efforts related to consumption and the environment increased, including within the newly organized field of ecological economics.

In spite of the call from the Brundtland Report, government programmes and emergent consumer policies continued to adopt the win–win perspective of ecological modernization, where environmental improvements could be reconciled with continued economic growth in rich countries, and sustainable consumption was seen as efficient consumption rather than less consumption (Fuchs and Lorek, 2005; Fuchs, 2013). Consumers should be encouraged to choose green products so that these products are profitable for businesses to provide. Much research has taken this perspective and focused on consumer choice, the impact of labelling, and the attitude–behaviour gap among consumers. This research is also reflected in the journal *Ecological Economics*, but at the same time, consumer studies in the field usually contradict the win–win idea of ecological modernization. The research suggests that to make room for increased consumption of the poor, the affluent have an ethical obligation to considerably reduce their demands on resources. The grand size of the challenge suggests that technological change and increased efficiency alone are insufficient. In ecological economics, the scene for consumption studies was set by key publications such as Daly's steady-state vision (Daly, 1977), Max-Neef's ideas of needs and satisfiers (Max-Neef, 1992), and Durning's question of 'how much is enough?' (Durning, 1992). All of these views emphasize the need for a sufficiency perspective.

The ecological economics research on consumption during the 1990s and early 2000s was concerned with five broad research questions (Røpke, 2005):

1. How can consumption be conceptualized?
2. What are the environmental impacts of consumption?
3. What are the driving forces behind growing consumption?
4. How does consumption relate to quality of life?
5. How can consumption patterns be changed?

Substantial research continues to focus on these questions, and there have been many additional contributions. However, rather than trying to survey this work, the intention of this chapter is to explore the role of consumption and consumers in relation to sustainability transition processes and wider systemic transformations. The chapter brings together a range of literature that goes beyond the dominant individualistic focus in much research on sustainable consumption and emphasizes the embeddedness of consumption activities in wider social, economic and technological frameworks. There is a need to strengthen these perspectives in ecological economics research on consumption, as this research, in my opinion, tends to be too focused on individual behaviour. This focus is paradoxical because ecological economics is strongly influenced by wider system perspectives, but with regard to consumption studies, the individualistic focus of mainstream economics seems to exert a strong influence. Even many heterodox economists consider consumption to be primarily a matter of behaviour, and these economists tend to associate consumption with psychological perspectives rather than sociological ones (Jackson, 2005; Brekke and Howarth, 2006; van den Bergh, 2008). In contrast, this chapter is more inspired by sociological and system-oriented approaches, such as practice theory and transition theory, which increasingly permeate the debate on sustainable consumption. I focus primarily on consumption in rich countries and only refer to consumption trends in poor countries in passing.

The focus on consumption in relation to wider processes of sustainability transitions acknowledges the complexity of studying consumption. On the one hand, consumption can be seen as a specific domain to be studied in its own right. No doubt the lifestyles and consumption patterns of rich people are much more resource-intensive than those of poor people, so research distinguishes between resource use that depends on ways of living among groups and resource use that relates to how goods are provided. On the other hand, the distinction between production and consumption is increasingly challenged, as the distinction is mainly an artefact of economic accounting, and production and consumption can alternatively be seen as co-evolving aspects of a whole. In this perspective, the overall organization of this whole determines the resource-intensiveness. This is consistent with the key idea in ecological economics that human society as a whole can be seen as a metabolic organism that keeps itself alive by appropriating energy and materials from the biosphere. This metaphor calls for seeing resource use as a result of the overall functioning of the metabolic organism rather than as a result of different functions in the organism (production, distribution and consumption).

In spite of this perspective, research tends to distinguish between efficiency and sufficiency, where production can be more or less efficient in terms of resource use, and lifestyles can be more or less resource-demanding. The distinction fits with a linear idea in which the efficiency concept can be applied along a chain from resource extraction to production to service provision. However, the linear thinking is increasingly challenged by the acknowledgement of interdependencies, such as when lifestyles and provision systems are considered to co-evolve. Separate efficiencies often lose meaning, for instance, when consumer preferences and lifestyles are endogenous to wider systems; when an individual link in a provision system can appear to be very energy-efficient although it contributes to maintaining an ineffective system; and when poor people are resource-consuming because they live in badly insulated houses or are forced to use marginal land. Acknowledging this complexity, the chapter on the one hand considers consumption patterns as a domain to be studied in its own right, and on the other hand includes the co-evolution of consumption, provision and distribution within wider systems, in regard to the study of dynamics and sustainability transitions.

In the following, various trends in consumption in the last twenty years are first outlined to highlight some of the challenges for sustainability transitions. Then, various theoretical contributions are applied in a discussion of how consumption patterns are shaped over time and of what should be considered in sustainability strategies. While discussions on consumption often take their point of departure in the perspective of the individual and then zoom to the wider context, the present approach is the opposite. The outline starts with the basic biophysical, distributional and economic conditions for high consumption in rich countries and then zooms in on the co-evolution of provision systems and consumption, and how consumption is shaped by practices and projects in everyday life. Furthermore, the chapter discusses whether and how transition and practice perspectives can be combined and concludes by summing up the complexity of studying the role of consumption in sustainability transitions.

CONSUMPTION TRENDS IN A SUSTAINABILITY PERSPECTIVE

Consumption and the environment have been on the agenda for policies and research for a long time, first as part of energy policies in the wake of the energy crises in the 1970s and later, after the Rio conference, as part of the ecological modernization efforts in the 1990s. Consumer-oriented environmental policies have been successful in some respects. For instance, energy labelling and subsidies for household investments in insulation have contributed to curbing the growth of energy consumption, and organic produce labelling has helped create new markets; information campaigns on waste sorting and water saving, combined with higher fees, new technologies and organizational arrangements, have also had an impact (Christensen et al., 2007). However, in parallel with these achievements, consumption in rich countries has increased.

In retrospect, the achievements have been small in relation to the ambitions that have been announced many times since the early 1990s. Some rich countries have succeeded in avoiding increased energy consumption and/or carbon emissions in spite of economic growth and higher consumption, but to some extent, this is the result of outsourcing and increased imports. For instance, territorial-based greenhouse gas emissions in the UK fell by 19 per cent from 1990 to 2008, while consumption-based emissions showed a 20 per cent increase (Energy and Climate Change Committee, 2012: 8). Stagnant energy consumption and carbon emissions are far from sufficient to make room for increased consumption in poor countries. The period leading up to the financial crisis in 2008 saw a considerable rise in consumption. While the role of the rebound effect has been much discussed (Sorrell, 2009), other factors were more decisive. Development in the financial sector as well as increased economic globalization turned out to be much more important for consumption trends than any sustainable consumption policies. The deregulation of the financial sector from the 1980s onwards allowed for increased lending through the development of new financial products, and the ensuing housing bubble enabled many people to use home equity to raise cash, which was transformed into home improvements and consumer goods. Simultaneously, globalization implied the provision of cheap consumer goods, such as apparel, electronics and toys, that were produced by low-paid workers and passed on by powerful buyers such as Walmart (Schor, 2005). The energy- and materials-intensities per dollar thus increased for some categories of consumer goods. Adding to these trends, the introduction of the euro contributed to growing consumption in Southern Europe because loans became much cheaper, and contrary to any Keynesian recipe for government intervention, many Western governments fuelled the upswing and increased public debt during the 2000s.

When the bubbles burst and the crisis set in, the growth in consumption came to a halt, which meant that the business cycle achieved what sustainable consumption policies never did. Unfortunately, this result happened in an unorganized, unprepared and unequal way that implied hardship for many people. The distribution of consumption opportunities developed in a highly unbalanced way during both the upswing and the crisis. In most Western countries, income and wealth inequality has increased since the 1980s. Particularly in the US, a small minority has become dramatically richer and the poor have become poorer, and the risk of falling into poverty has increased for the middle classes. During upswings, the rich are best positioned to exploit the advantages and opportunities related to the appreciation of assets, and during downturns, the poor are hardest hit by unemployment and reduced social welfare. A continuation of these trends may develop into what is described as an hourglass society.

Although not the primary focus here, the same period has witnessed the emergence of a large number of middle class consumers in developing countries. Myers and Kent (2004) described the consumption patterns of the 300 million new consumers in countries such as China, India, Brazil and Russia, and the number has increased since 2004. The consumption patterns of these new consumers follow in the footsteps of the rich countries. They consume more meat and dairy products and more convenience goods, such as refrigerators and air conditioners, and they travel more and increasingly rely on the car as the ultimate icon of progress (Wilhite, 2008). While many people are brought out of poverty, many others are left behind, and inequalities increase dramatically. In China, for instance, a new group of super-rich has emerged alongside a large group of dispossessed people.

Regarding the trends in consumption in the global North since the early 1990s, the picture is complex, and trends differ among countries. Some of the classic patterns have been further developed, but counter-trends have also emerged, including before the breakthrough of the economic crisis. In previous publications (for example, Røpke, 2010) I have argued that the energy- and materials-intensive lifestyles of affluent and middle class people in industrialized countries exhibit several key characteristics that can be used as a basis for considering recent trends:

- *Individual independence*: As a long-term trend, individuals have gained more personal independence from their relatives. Young people can leave their parents and establish their own home, couples can be divorced, and old people are not dependent on their children. This has led to a larger number of small households, which adds to the demand for housing and related equipment. The same trend is reflected within households, where each person increasingly has a room and personalized equipment of his or her own. From the 1990s to the crisis, this trend continued to be reflected in an increased number of second and third cars, more bathrooms per dwelling, and increased individual ownership of electronic devices. The period saw the diffusion of mobile phones, which turned the family phone into an individually owned device. The emergence of new forms of co-housing from the 1970s onwards may constitute a counter-trend, but this trend remains marginal and in some ways adds collectivity to individualization rather than replacing it (for example, by combining individual kitchens with shared facilities). During the crisis, individualization has become more difficult because it is expensive, and increasingly, young people have to stay with their parents or return home ('boomerang kids'). The crisis also seems to strengthen trends such as car-sharing and other forms of sharing and collaborative consumption, which are supported by ICT. Paradoxically, the long-term trend toward individual independence from relatives has co-evolved with the global division of labour and increased dependence on worldwide networks of economic activities. The crisis counteracts this trend by encouraging increased self-sufficiency (for example, of food, sometimes in collaboration with others in community gardens).
- *Mobility and extended space*: As a long-term trend, the spatial radius of everyday life has increased dramatically. The increased speed of transport for commuting, shopping and leisure activities is converted into longer distances rather than time savings. Holiday travelling is more frequent and exotic destinations are within reach for a growing number of families. At least in Scandinavia, this trend was important during the upswing, where prolonged weekend trips to foreign cities, holidays at distant destinations such as Thailand,

and more than one yearly holiday trip became common. The crisis curbed the development somewhat, but travelling still seems to have a high priority, and the price is kept low by the tough competition in the airline industry, the ICT-supported services for travel planning, and collaborative offers such as couch surfing. In the US and elsewhere, the super-rich set new standards for mobility with the development of personal aeromobility (Cohen, 2009), and recently, the ultimate offer of space tourism became available. With regard to everyday travelling, a potential counter-trend that has recently attracted attention is peak car use, where a decline in automobile usage has been identified in a number of countries. Many causes have been proposed, and there is debate on whether the trend is a temporary one.

- *Variation and novelty*: Across all fields of life, novel experiences, excitement and insights are made accessible and are supported by the offer of specialized and diversified goods and services. No doubt, this trend has been as vivid as ever during the upswing, especially in relation to how ICT and the internet are being integrated into various practices (Røpke et al., 2010). The use-and-throw-away phenomenon was encouraged by the speed of the renewal, and environmental concerns did little to challenge the phenomenon. The crisis has revived thrift and calls for cheaper ways of ensuring renewal, such as the collaborative exchange of clothes.
- *Convenience*: The three c's – comfort, cleanliness and convenience – imbue the arrangement of everyday life (Shove, 2003a). Heating and air conditioning provide the same temperature independent of season and local climate, and many household chores are mechanized or eased by various devices. The upswing continued this trend, for instance, with further diffusion of air conditioning in cars in countries where this was not common. ICT provided new possibilities for the mechanization of household chores, which is reflected in robot vacuum cleaners and lawnmowers. The mechanization trend may be curbed by the economic crisis by reducing labour costs relative to energy and materials.
- *Intensification of time use*: In societies with high labour productivity, slowness and relaxed attitudes tend to become socially unacceptable (Linder, 1970). The intensity of work life is transmitted to life at home and is reflected in increasing activities-intensity of time – and increasing energy- and materials-intensities (Jalas, 2002). This trend has been strong during the last twenty years, again with support from ICTs that allow people to do more things at the same time and even to initiate and manage processes without being present.

The speed has been challenged by phenomena such as slow food and other movements for slow living, but these phenomena remain marginal.

- *Diet*: As a long-term trend, increased income implies a more varied diet with a larger share of meat and dairy products and food items that are procured from all over the world. While meat consumption has increased in countries such as China, the trend no longer seems to be fundamental during upswings in rich countries. Increased diversity is still important, but food consumption seems to be influenced by a complex set of factors (from mad cow disease to obesity concerns) that are not easily captured in key trends.

Considering that people do not lack ideas for additional consumption when increases in income and credit allow for the possibility, the historically dominant trends suggest a correlation between consumption and quality of life. However, this correlation may be misleading in rich countries. Without going into the broad discussion on the issue (Jackson, 2005, 2009; Wilkinson and Pickett, 2010), it suffices here to note that preferences are endogenous. New conceptions of normality are always being constructed, and adaptation follows. For a long time, this has implied increasing energy and material use, but the initiatives that people adopt to cope with the economic crisis may lead to other kinds of normality that can become equally satisfying, although the transformation may not be easy. Even when changes are not freely chosen, a new normality may become the preferred state.

BASIC CONDITIONS FOR HIGH CONSUMPTION: THE GROWTH ENGINE

The previous section illustrates that consumer-oriented environmental policies have had little success in promoting more sustainable consumption patterns during the period of growth, and the section highlights the considerable challenges for sustainability transitions. This section takes a step back and raises the fundamental questions of what basic preconditions have made the increasingly high levels of consumption possible in the global North and of what drives the growth engine. This focus on the wider systemic conditions for consumption emphasizes the importance of cheap resources and global inequality and the functioning of the growth engine in market economies.

Cheap Resources and Inequality

The obvious starting point for discussing consumption in ecological economics concerns the basic preconditions that have made increasingly high levels of consumption possible in the global North. First, the availability of cheap and high quality energy has been decisive (Haberl et al., 2011; Ayres et al., 2003). Fossil energy is high quality in the sense that it can do useful work (the exergy, that is, the energy that is available for doing work, is high), and the high energy density makes fossil energy widely usable. While mainstream economics explains economic growth in terms of increasing inputs of labour and capital in combination with an unexplained exogenous driver known as 'technological progress' (Solow's residual), Ayres and Warr (2005) have demonstrated that Solow's residual can be explained by including exergy in the explanation of growth: much of the technical change that has resulted in significant productivity increases and has formed the basis for increased consumption is based on innovation that replaces labour with exergy. For a long time, growth has relied on fossil fuels that were relatively easy to extract. Fossil fuels had a high EROI, or Energy Return on (Energy) Input, which implies that relatively small amounts of energy are needed to extract and process resources (Hall et al., 2009). The use of fossil fuels involves considerable negative externalities, such as various kinds of pollution, but because externalities have remained largely unpaid, this has not curbed growth.

The availability of cheap exergy is increasingly at stake, partly because the energy sources with the highest EROI were extracted long ago, and partly because the risk of climate change questions the sensibility of using the remaining fossil reserves. In addition, many other resources, such as land, fresh water and minerals, are becoming increasingly scarce. Recycling may remedy the scarcity of minerals, but the process puts extra pressure on energy resources. With global population growth, the competition for resources intensifies, and the first signs are visible as relatively higher prices on energy and other resources. The American shale gas and oil adventure most likely simply postpones the problems for a short while (Campbell, 2013).

The other basic precondition for high consumption in the global North is the highly unequal distribution of economic benefits related to the use of energy and other resources. This distribution is based on power relations among nation states and among various economic actors – power relations that have emerged over a long span of time and continually change (Hornborg et al., 2007). At a given point in time, various mechanisms of distribution are effective, and these mechanisms tend to maintain inequality in more or less subtle ways. Trade may imply unequal exchange in environmental terms when embodied or indirect flows of energy, biomass and other materials are exported from poor countries in exchange for much smaller flows. Likewise, the extremely low wages in mining, agriculture and industrial sweatshops in poor countries provide rich countries with cheap products (Schor, 2005). The trade takes place within ever more complex global commodity chains where the traditional vertically integrated manufacturing multinationals are supplemented by buyer-driven commodity chains. Transnational companies organize production by shifting contracts without owning production facilities, and bargaining asymmetries that favour large buyers such as Walmart put pressure on producers in poor countries (Conca, 2002; Gereffi and Korzeniewicz, 1994; Gereffi, 2001). Supported by the liberalization of trade and capital flows, production systems become 'denationalized', and the regulatory power of states is eroded and cannot keep up with the challenges that are posed by the globally dispersed industry. Environmental regulation suffers, which contributes to keeping costs down. The distributional mechanisms not only imply that rich countries get cheap products at the expense of poor countries, but the mechanisms also influence the distribution of income and wealth within countries. For instance, local elites in poor countries may profit from granting lucrative deals to foreign companies, and the widespread organization of transfer pricing and tax evasion benefit a small group of shareholders rather than consumers as a whole in rich countries.

The question of how the historical privileges of consumers in rich countries will develop in the years to come is decisive for sustainability transitions. If China changes its economic strategy and focuses more on consumption-driven rather than export-driven growth, and if China prioritizes environmental concerns – in both cases to meet increasing popular pressure – one result may be higher prices for consumer goods in rich countries, that is, unless other countries fill the gap with new supplies of poor workers. In rich countries, political strategies that promote sustainable consumption may also call for actively phasing out the historical privileges to make way for the new conditions.

Competition and Distributional Institutions

The basic conditions of cheap resources and global inequality feed into the growth engine of rich capitalist societies. The growth engine is constituted by competition that encourages business to continuously innovate processes and products. Process innovation is directed at reducing costs and focuses on increasing either labour or resource productivity, depending on relative prices. Product innovation ensures a supply of novel goods and services that will tempt consumers, and competition supports sales through mechanisms such as advertising, deferred payment, fashion and planned obsolescence. The relative strength of employees and employers is decisive for the sharing of the benefits of productivity increases. To run smoothly, the growth engine must allow most producers to sell their products at profitable prices, which can be difficult for two opposing reasons: either employees earn too little to be able to buy the products, thereby discouraging producers from investing in extended production capacity, or employees earn too much to leave a profit that is sufficient to encourage producers to invest. The engine can encounter crises that influence the overall development of consumption and the distribution of consumption possibilities within rich economies.

As described in the section above on consumption trends, the interplay between the financial sector and the real economy is important for the functioning of the growth engine. Finance is important to fund investments, which keep the engine running, but when the financial sector succeeds in developing constructions that enable the sector to appropriate a large share of overall profits, the sector creates problems and adds to the vulnerability of the economy. Bubbles emerge, and when they crash, the real economy suffers. In the context of globalization, the deregulation of finance has played a key role in the development of increased inequality since the 1980s (Stiglitz, 2012). This affects the business cycle and challenges the classical social contract in rich capitalist economies, as acceptance of the economic system depends on its ability to deliver on social security and consumption. The situation in Southern Europe may indicate that such a challenge is underway. Both in national and global governance, corporate interests appear to be strong, and there are few indications that political regulation seriously questions increased inequality and the privileges of the financial sector.

In spite of substantial research on consumption drivers in an environmental perspective, prior to the recent crisis, there was little focus on the importance of the business cycle, the special role of the financial sector, the pro-cyclic macroeconomic policies during the upswing, and the implications of the euro for consumption trends. Credit and deferred payments were usually mentioned as drivers, but there was little awareness of how credit could boost consumption through a housing bubble. Presently, these issues are difficult to avoid in studies of consumption.

In a national economy, both the total quantity and the distribution of consumption among social groups co-evolve with several other social institutions that frame the number of working hours and the propensity to save. For instance, Schor (1991) demonstrated how labour market institutions in the US from the 1970s have complicated consumers' efforts to reduce labour time and take out productivity increases in the form of leisure, thus fuelling a work-and-spend cycle. Since then, the use of flexible and part-time labour has become more common, which could make it easier to increase leisure, but lower wages encourage large groups of working poor to struggle to get enough labour time by having more than one job. Institutions related to the labour market, pension systems and welfare differ considerably among countries, but they are important to consider in studies of consumption trends. As a general trend, the safety net of the welfare states has become eroded since the 1980s. In principle, this should encourage more people to save, but until the crisis, offers of credit counteracted this incentive in many countries, and many of the working poor have little opportunity to save. During the crisis, mainstream economists consider the increased propensity to save to be a problem for bringing the growth engine back on track.

In summary, since 2008, consumption has become deeply affected by the serious trouble of the growth engine. The impacts are unequally distributed among different countries and social groups, and there are few indications that institutional reforms will favour those who are hit the hardest. This may change if there are increases in awareness of the threat to the social contract.

SOCIO-TECHNICAL SYSTEMS OF PROVISION

If politicians in rich countries succeed in re-starting the growth engine, if American shale gas and oil companies keep energy prices down, and poor countries continue to provide cheap resources and products, the conditions may continue to allow for increasing consumption, and the classic trends may be resumed. The environmental implications may then become highly problematic, for instance, resulting in increased carbon emissions and continued deterioration of ecosystems. The systems that provide goods and services for consumption have been developed over decades with low resource prices and the availability of cheap labour in poor countries, and these systems are not prepared to function with little environmental impact. The 'false assumptions' of low energy prices have been built into the material infrastructures and social institutions of society. For example, these assumptions are reflected in energy systems based on fossil fuels, transport systems based on the automobile, suburban housing developments, large shopping centres, and energy-intensive agriculture. Lifestyles and consumption can to a large extent be seen as integral parts of the systems that frame daily life: to live a 'normal life' implies the use of available housing, the electricity system, the transport system, the communication system, the shops, and the waste handling system – and through this use the systems are reproduced. As Otnes (1988) suggested, we serve and are being served by a number of collective socio-material systems. Another early contribution emphasizing the importance of provision systems for consumption was Fine and Leopold (1993).

The need to transform provision systems in ways that would make them more environmentally sustainable has been in focus for some time (Southerton et al., 2004; Elzen et al., 2004; Princen et al., 2002) and is now central to the Sustainability Transitions Research Network (STRN, 2010). To emphasize the inclusion of broader aspects than provision, the network uses the term 'socio-technical system' rather than the concept of provision system, but transition studies continue to focus primarily on the production side and technological innovation. The concept of the socio-technical system is usually applied to describe a system that provides society with a 'function', such as energy, mobility, housing, communication, sanitation or food (Geels, 2002). The concept may also be used in relation to more delimited systems, for instance, when considering the provision of different forms of energy, such as gas, electricity or heating. The term 'socio-technical' emphasizes that the system includes infrastructural and other technical elements as well as social elements, such as rules and other institutions that are involved in the coordination of activities within the system. In early writings (for example, Geels, 2002), a system was seen to comprise several heterogeneous dimensions (technology, infrastructure, industrial networks, user practices and markets, the cultural and symbolic meaning of technology, sector policy, and techno-scientific knowledge) that have more recently been organized into three groups: (1) material and technical elements; (2) networks of actors and social groups; and (3) formal, normative and cognitive rules (Verbong and Geels, 2010).

Socio-technical systems differ from what is usually conceptualized as production sectors, as the systems include much more than production and focus on the 'function' rather than the provision of products that are technically homogeneous, the use of a particular kind of raw material or the application of relatively homogeneous skills and knowledge (such as those within the chemical, metal or electronics industries). However, in practical analyses, the perspectives overlap as a result of sector organizations, industrial regulation and the availability of data.

In much transition research, a core idea is that systems undergo qualitative shifts over time, and qualitatively different states can be identified. A state that is characterized as a socio-technical regime is seen as a relatively stable configuration of elements. The relative stability of a regime over a longer period of time owes to various lock-in processes and path-dependent developments (STRN, 2010). For instance, such mutually reinforcing processes rely on technical infrastructures and sunk costs, established knowledge and beliefs, economies of scale, vested interests and links to political power, and routinized everyday practices. In spite of these stabilizing processes, historical experience demonstrates that systems change over time. The dynamics are considered to emerge, for instance, from new technologies, tensions within the regime and key events that question the regime (such as the Fukushima event that questioned nuclear power). Some transition theorists organize their account of change by applying a multi-level perspective that describes transitions from one regime to another as the outcome of alignments between developments at multiple levels (Geels and Schot, 2007). For instance, system change may result from the build-up of radical niche innovations that challenge the incumbent regime and make a breakthrough if the regime is destabilized by changes in the external context, or what is known as the landscape level.

Both the regime concept and the multi-level perspective are widely used, but transition studies of socio-technical systems do not have to rely on these concepts. First, processes of change are always ongoing, and actors are always both reproducing and changing the elements and their configuration. Looking back, one can identify how key technologies have replaced other key technologies (Geels, 2002), but during the process, many intermediate configurations are present (Schatzki, 2011). In this ongoing process, there is really no need to select particular configurations and characterize them as regimes. However, both stabilizing and dynamic processes are important to consider at any given point of time. Second, the processes can just as well be described in terms of a flat ontology in which all elements and processes take place on the same 'level'. The elements can be 'large' or 'small', and they can be variously influential, extended in space, and stabilized, but this does not attach them to different levels (Schatzki, 2011; Jørgensen, 2012). One can analyse the emergence of new technologies and the potential threat they may pose in relation to incumbent technologies, but this does not require a concept of levels.

As mentioned, many systems are unsustainable because they are built on conditions of cheap energy and global inequalities, and as long as these conditions prevail, some system changes continue to follow an unsustainable direction (Røpke, 2012). Green innovation often refers to specific products or processes that are more resource-saving or less environmentally destructive than those they replace, but systems increasingly come into focus because the need to prepare for new conditions becomes apparent. This is especially true for the energy system in which the low carbon transition is on the agenda. In this context, there are many specific innovations related to renewable energy, and there is increased focus on their interconnections and interdependencies in wider systems, including the relationships among energy, transport and heating systems (Mathiesen et al., 2013). System changes are complex processes that involve many actors, and no one individual is in a position to manage the changes. Government interventions can influence the process, but local and central governments are dependent on the interplay with technology innovators, business interests, civil society organizations and consumers. More radical system changes emerge over a longer period of time when visions and activities are aligned (Elzen et al., 2004).

From the perspective of consumers, changes to socio-technical systems may involve far more complex processes than those that are usually considered in relation to sustainable consumption. The meaning of sustainable consumption has developed over time – from simple choices of green products, such as organic foods and energy-labelled white goods, and simple actions, such as waste sorting and turning off the lights – to a longer list of more demanding actions. In relation to provision systems, consumers are the owners and/or managers of what Shove and Chappells (2001) call 'the sensitive fingertips' of the systems, which include switches, air conditioners, refrigerators, cookers, water taps, toilets, waste pipes, radiators, televisions, routers and mobile phones. In addition to these elements that are connected to wired and piped systems, consumers own or manage cars and bicycles in the transport system and houses and apartments in the housing system. As co-managers of the provision systems, consumers play important roles in systems changes. Historically, the challenges can be illustrated by the efforts that were necessary to implement sewage systems and electricity in homes (Forty, 1986).

Just as historical challenges have involved considerable investments, adaption and learning on the part of consumers, transitions toward more sustainable systems are challenging. The low carbon transition of the energy, transport and heating systems is illustrative of the many roles that are added to the traditional role of consumers buying ready-made products. Consumers are needed as investors in insulation and other building renovations, in heat pumps and electric vehicles, and some consumers engage in energy provision with solar panels and other technologies, becoming 'prosumers' (merging the roles of producer and consumer). Some consumers learn to trade new services by selling 'flexibility' to electricity providers in relation to the development of new market constructions. Others take the role of lead users and even develop into innovators in relation to new solutions. Yet others become organizational change agents by organizing new provision systems in local areas. This variety of roles is reflected in the close affinity between studies of consumption and studies of civil society and social movements (Walker and Cass, 2007; Hielscher et al., 2013; Schor, 2010; Seyfang, 2009).

These different roles reflect the fact that socio-technical systems of provision can be organized according to different modes of provision. The concept of 'mode of provision' differs from the concept of 'system of provision' by relating to different ways in which provision can be organized. A distinction is typically made between the four classical modes: market, state, household and communal (Southerton et al., 2004). Since the 1980s, there has been a wave of marketization of service provision that was previously organized as state or communal services, and the ideological strength of this trend is still dominant. However, in relation to sustainability transitions, it is increasingly questioned whether marketization has become an obstacle and ought to be replaced by communalization, which could encourage the involvement of people in transition processes.

Much research in sustainable transitions of systems tends to primarily focus on emerging technologies and the role of business actors. A central task for research in sustainable consumption is to link to this research and elaborate on the different roles of consumers and civil society during these transitions. However, this task has to be combined with a focus on everyday life.

PRACTICES AND PROJECTS IN EVERYDAY LIFE

Although people as consumers and civil society actors are involved in the functioning of systems and in the wider reproduction of society and its metabolism, this is not a central perspective that influences how people usually manage their everyday life. In this section, I argue that everyday life revolves around practices and projects that are meaningful to people, which must be taken into account when discussing sustainability transitions. The outline summarizes some core ideas from practice theory that have become widely used in research on consumption and the environment since the mid-2000s when Warde published a seminal article (Warde, 2005). More elaborate overviews related to consumption and the environment are available (see Røpke, 2009; Shove et al., 2012). The following is mainly inspired by the practice theory perspective applied by Shove and her collaborators, but practice theories should really be in the plural, because there are several traditions (reviewed by Nicolini, 2012).

Practice theory was formulated in response to the classical structure–actor dualism. To bridge the dualism, the theory suggests focusing on social practices as the basic ontological unit of analysis. A practice is defined as an organized set of activities that people conceive of as an entity (for example, skiing or cooking), and this entity is recognizable across time and space. By performing the activities, practitioners make connections between a diverse set of heterogeneous elements that Shove and Pantzar

(2005) categorize as material (objects, tools, infrastructures), competence (skills, know-how) and meaning (images, cultural conventions, expectations). A practice can thus be seen as a configuration of elements that are held together by a set of activities. A practice only exists when it is enacted – not only by a few particular individuals, but by larger groups of people – and these enactments reproduce and transform the practice over time. Individuals face practices as entities as they are formed historically, and individuals act as 'carriers' of the practices when they perform them. In everyday life, people are foremost engaged in practices, and their actions are seen as being constituted by practices. This dissolves the structure–actor dualism, as people's actions are neither determined by social structures and institutions nor are they the result of decisions by self-contained individuals based on the maximization of utility or the construction of self-identity. At the same time, social and material structures exist through practices and form a framework for present and future practices.

Practices are social in the sense that they are shared. Although the competences needed to perform a practice are partly embodied in the practitioners, the practice perspective implies that competences are seen as part of the practice rather than as a characteristic of particular individuals. The same goes for practice-related beliefs, emotions and purposes that the practitioner 'carries'. Thus, practices logically and historically precede individuals and have to 'recruit' practitioners. The obvious question is how 'recruitment' takes place and how people manage a combination of practices in everyday life. Of course, people mostly engage in practices that they encounter in a given society, and for which they are able to acquire the necessary competences and material equipment. To some extent, the social and material structures of society frame what practices people are recruited to, such as the normalized practices related to schooling, having a job and shopping. In addition, the individual establishes a more specific framework through his or her path-dependent biography (Pred, 1981; Røpke and Christensen, 2013). Pred (1981) suggests that the combination of collective and private frameworks defines a number of 'projects' in everyday life, where a project is seen as a complex set of practices that are necessary to complete an intention. For instance, establishing a family defines the project of maintaining family relations, and this involves the performance of a large number of practices. Typically, everyday life revolves around relatively few dominant projects, and the individual manages the puzzle within time and space constraints and relies on routines and path dependencies rather than on an overall logic of optimization or self-identity.

When practices have been formed, they are stabilized by the connections that are repeatedly being made among the elements, so the elements seem inseparable. Furthermore, some practices become parts of interconnected complexes or 'systems of practice' that also contribute to stabilization (Pantzar and Shove, 2010). However, practices also change over time. Practitioners perform them in new ways, for instance, by being inspired by changes in the elements, including technical changes and the emergence of new discourses that influence the meaning of certain practices. Likewise, new practices emerge, while others die out. Many practice theorists do not aim to provide an account of practice changes in terms of qualitative shifts from one 'regime' to another, and they do not organize their accounts in terms of levels. They rely on a flat ontology and focus on continuous shifts and changing configurations over time. Qualitative shifts may be identified in a state of flux, just as stickiness and path dependency play a role in stability. However, when compared to transition theory, there is more focus on the co-existence of different versions of practices.

Relating practice theory to consumption and the environment, it makes little sense to say that people have a desire to consume. People think of themselves as being engaged in meaningful activities, and their motivations and desires are the outcome of practices (Warde, 2005). Consumption exists as an aspect of practices, as the performance of most practices requires the use of artefacts that include tools, materials and infrastructures. Although consumption as such is not in itself a key motivation, strong inclinations to consume emerge from being engaged in a practice, as practitioners often wish to be competent. Being competent provides self-respect, status and intrinsic pleasures (Randles and Warde, 2006). In general, practice theory emphasizes the multi-causality of consumption. Because different practices involve a variety of meanings and considerations, consumption is also broadly motivated and involves noble reasons, such as ensuring a good life for one's children and taking care of one's aging parents. Environmental considerations may easily conflict with other concerns, and they are seldom strong enough to counteract the interest in improving one's performance of valued practices, especially if higher income enables practitioners to achieve this through the acquisition of additional products. Likewise, the roles of consumers in relation to sustainability transformations of systems are seldom a key consideration when everyday practices and projects are performed.

The practice theory perspective has been applied as a critique of climate change policies being too reliant on a simple model of social change – a model that relies on a strand of psychological literature on planned behaviour (Ajzen, 1991). Shove calls this the ABC model, where 'social change is thought to depend upon values and attitudes (the A), which are believed to drive the kinds of behaviour (the B) that individuals choose (the C) to adopt' (Shove, 2010: 1274). Shove argues that this model 'resonates with widely shared, commonsense ideas about media influence and individual agency' and that its popularity indicates that 'responsibility for responding to climate change is thought to lie with individuals' (ibid.). In theoretical formulations of the model (for example, Stern, 2000), behaviour is the interactive product of attitudes (including related personal variables) and contextual factors that are treated as external causal variables. Context includes a long list of factors, but the theory involves no attempts at organizing these factors or making them the focus of study. Policies focus primarily on changing behaviour by influencing attitudes and values through information and labelling, while there is less focus on changing the context. In contrast, a practice theory perspective shifts the focus from the individuals toward social practices and the ways in which they can be reconfigured. For instance, it is recommended to systematically analyse and intervene in the component elements of practices, to intervene in the competition among practices for time, space and resources, and to influence how practices are interlinked (elaborated in Spurling et al., 2013). In this perspective, people's needs and aspirations as well as the context are seen as outcomes of social processes that need to be explained rather than externalized, and policy interventions are considered to occur within the processes that policy-makers seek to shape. One can argue that theorists and policy-makers applying the ABC model have increased their focus on context over the years, but the approach still differs fundamentally from a more systemic perspective, as the focus is on individual choice.

COMBINING SOCIO-TECHNICAL SYSTEMS AND PRACTICES

In recent years, combining transition theory and practice theory in sustainability research involving consumption and civil society has become increasingly popular (McMeekin and Southerton, 2012; Hargreaves et al., 2013; Cohen et al., 2013; Watson, 2013; Spaargaren et al., 2012). The fields share many interests and basic understandings: both acknowledge the considerable challenges involved in coping with climate change and other environmental problems, and both take an interest in sustainability transitions that implicate substantial systemic changes. The fields agree on the need to go beyond the traditional focus on technological efficiency at the product level and the focus on changing consumer behaviour in accordance with the ABC model. Social and technological changes are seen as interdependent, as are production and consumption, and the need for adaptive and reflexive governance is acknowledged.

At the same time, there are important differences in the focus of the analyses, which can be seen as a good reason to treat the two approaches as complementary and to integrate the perspectives in empirical analyses. Transition studies usually take the supply side as their starting point. Technological innovation and business actors play a key role, while the role of users and actors in civil society tends to be undertheorized. In contrast, most studies inspired by practice theory tend to focus on one or a set of practices in people's everyday life, and although links are made to wider systems of practice, relatively little is done to elaborate on the dynamics of related supply systems and business strategies (for exceptions, see below). The different focuses have a bearing on what is seen as key issues for sustainability transitions. With roots in innovation studies, transition theory focuses on how to promote green transformations of provision systems based on technological innovations, and the roles of users and consumption are seen mainly as issues related to market uptake and the adoption of new technologies. This perspective tends to overlook the importance of transforming the needs and desires of people rather than simply fulfilling the needs in more effective ways (Shove, 2012). In some cases, satisfying needs in a way that is more sustainable in some respects may perpetuate problematic consumption patterns. For instance, innovations to reduce local pollution from pig farms may support the maintenance of a system that is based on unsustainable imports of feed and high levels of meat consumption. From an everyday life perspective, one must consider how eating practices could be changed and what transformations this would entail in relation to provision systems. As Shove argues, the making and meeting of needs are inseparable (Shove, 2012: 85). Further complexity is added because there is no one-to-one relationship between provision systems and everyday practices: a provision system such as the energy system provides inputs to many different everyday practices, and a set of everyday practices such as those related to eating often draws on many provision systems. As demonstrated in relation to broadband developments, connections among systems can be decisive for sustainability assessments of a provision system, including which practices the system serves (Røpke, 2012).

The dynamics of sustainability transitions is thus complex: different dynamics relate to provision systems and everyday life, and at the same time, supply and consumption co-evolve and constitute each other. Provision systems have a bearing on what kind of consumption people integrate in their practices, and everyday practices are integrated in the reproduction and transformation of provision systems. This complexity was highlighted in Shove's study on 'the social organization of normality' (Shove, 2003a, summarized in Shove, 2003b), which was published before practice theory gained momentum in consumption studies and before the boost in transition studies. Shove's study can be seen as a forerunner of the combination of transition and practice perspectives, and she later applied some of the same ideas in other contributions that were formulated more strictly in practice theory terms and related to recent discussions on transition theory (for example, Shove, 2012). Hargreaves et al. (2013) draw inspiration from the formulations and illustrations in Shove's 2003 book and suggest combining 'vertical' studies of socio-technical systems in a multi-level perspective with 'horizontal' studies of practices and systems of practice, and considering the points of intersection between these two planes. Going back to previous empirical studies based on either the multi-level or the practice perspective, the authors demonstrate how these studies can be improved by elaborating on the points of intersection with the other perspective.

While I agree on the usefulness of combining transition and practice perspectives, this can be done without the application of a concept of levels. Levels are described in various ways. The classical distinction among micro, meso and macro does not make sense in relation to the multi-level perspective, as both niches and regimes consider what would usually be seen as meso-level phenomena, and the same goes for practices. Geels usually refers to levels in terms of different degrees of structuration and stability, where niches are the least structured and stable, and landscapes are the most structured. In early formulations, levels were seen to be related to each other as a nested hierarchy, and in responding to criticism, Geels agreed that this formulation may be problematic (Geels, 2011). However, it may also be problematic to abide by the idea of levels as increasing structuration and stability, as regimes have to be continuously reproduced, and reconfigurations are happening all the time (Shove, 2012: 87). Furthermore, landscape events may appear suddenly, which Geels (2011) also accepts. As mentioned above, a flat ontology and systems that differ in 'size' depending on the number and spatial extension of the connections included in the analysis may make more sense. In fact, the application of the term 'vertical' sometimes seems to imply that systems of a wider scope are included (Gram-Hanssen, 2011: 75).

With the more strict formulation of a practice theory perspective, Shove does not apply a concept of levels. She argues that the concept implies the idea of a selection environment where novelties coming from the niche level meet the selection environment of the established regime. On the contrary, she prefers to imagine systems as more flexible configurations that are constantly changing. This allows for less linear accounts of socio-technical change and more focus on the co-existence of and links between old and new systems. Older systems can also recapture strength in new ways, as was discussed by Watson (2013) in his analysis of the relationship between automobility and velomobility. Furthermore, the functions that are delivered by systems may be considered to be in a state of flux, and they may change over time in response to new challenges. For instance, multifunctionality in relation to agricultural production is increasingly discussed. This perspective illustrates that change is not always about innovation, especially technical innovation.

The combination of transition and practice perspectives can be implemented in many ways. Like Geels (2010), Hargreaves et al. (2013) prefer 'to explore the "crossovers" between these two theories' rather than trying to synthesize them; the authors argue that 'to do so would undermine the distinctive contribution that each makes alone' (Hargreaves et al., 2013: 407). In my opinion, a more integrative account based on a flat ontology would be useful. Practices compare to socio-technical systems, (practices are just much smaller entities than socio-technical systems), as both are configurations of material and social elements, and larger systems that are based on configurations of many practices have to be performed by practitioners. In this formulation, actors are not considered to be one of the elements in a socio-technical system as they are in the multi-level perspective. Instead, the system is performed by various actors who, as they conduct activities, combine the material and institutional elements involved in the functioning of the system. This formulation arguably merges transition theory into practice theory, which already covers the whole field by including concepts such as systems of practice (or complexes and bundles). However, there is a need to be more specific by conceptualizing different kinds of systems, such as provision systems, and their dynamics. In this respect, transition studies offer important insights.

Linking back to the section on the basic conditions for the high levels of consumption in rich countries, studies that are inspired by practice theory tend to leave out the wider systemic conditions and power relations that set the stage for the unfolding of everyday life (Sayer, 2013). Transition studies tend to be more inclusive, but they are also weak with regard to issues of power and inequality on a global scale. This may be part of the reason that transitions in the wrong direction get so little attention (Røpke, 2012). To redress this imbalance, the focus on distribution systems should be strengthened. While the main function of provision systems is to transform energy and resources to make them useful for final consumption, distribution systems determine what goods and services are provided and who will have access to them (distribution and allocation are considered to be intertwined, with distribution having the upper hand; Røpke, 2015). Distribution systems are performed through configurations of practices, and these systems are equally important to change in a more sustainable direction as are provision systems.

CONCLUDING REMARKS: CONSUMPTION IN SUSTAINABILITY TRANSITIONS

When studying the role of consumption and consumers in sustainability transitions, the application of various system perspectives highlights the complexity of the processes that societies need to engage in. This complexity is far more demanding than the programmes for sustainable consumption and production have hitherto reflected. Sustainable consumption is about a wide range of issues, including:

- How the global conditions for high levels of consumption in rich countries can be challenged.
  - How the prices of energy and other resources can be raised in a gradual way and maintained at a high level, and how the poor can be compensated for price increases.
  - How unionization and the development of welfare states can be encouraged in developing countries to improve the living standards of the poor and raise the prices of goods that are exported to affluent countries.
  - How the power of transnational companies can be limited, how tax evasion can be controlled, and how the systems for trade and capital movements can be transformed to change the direction of flows so they go from rich to poor.
- How the growth engine can be checked without leading to a breakdown in the economy.
  - How societal institutions can be transformed to work in a no-growth economy.
  - How the financial sector can be stopped from appropriating a large share of income and wealth.
  - How inequality can be reduced both as an aim in itself and to ensure social stability.
- How socio-technical provision systems can be transformed in more sustainable directions.
  - How the systems can be transformed to prepare for the disappearance of the conditions of cheap energy and global inequalities.
  - Which roles consumers and civil society can play in relation to the transformation of provision systems.
- How resource-demanding practices in everyday life can be transformed in more sustainable directions.
  - How practices and consumption can co-evolve with provision systems.

- How provision systems can be transformed to support more sustainable practices.
- How changes to distribution systems can encourage more sustainable practices.
- Which practices can maintain more equitable distribution systems.
- How people can prepare for lower real incomes in biophysical terms.

These aspects, and many other relevant issues, cannot all be addressed in individual studies on sustainable consumption. However, studies must consider whether these aspects are decisive for the processes and eventually the strategies in focus. Otherwise, conclusions may suffer from 'misplaced concreteness'.

When the biophysical space for consumption is reduced, hopefully in an organized and gradual way 'by design, not disaster' (Victor, 2008), people will find ways to live with lower incomes and change everyday practices accordingly; trends toward collaborative consumption, localization and peak car use exemplify this adaptability. Lower incomes can also be expected to encourage technological efficiency improvements that will serve as useful supports for managing with fewer resources rather than being sources of potential rebound effects. The process toward more sustainable consumption will surely be easier if it is continuously supported by collective policy interventions in provision and distribution systems. In particular, it is important to ensure that the burdens are carried by those who are strongest.

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15. Consumers, the environment and the new global middle classes

Alejandro Guarín and Imme Scholz

Consumption is at the same time inescapable and elusive. We consume to exist – is life anything but a sophisticated arrangement of molecules drawing matter and energy from its surroundings? And yet there is nothing simple about consuming, as anyone who has gone out to buy a pair of shoes knows. Consumption is the engine of the earth's social-ecological metabolism. Deliberately or unintentionally, we draw on nature's vast pool of resources to satisfy every single one of our material needs – and many of our spiritual ones too. Our society's appetite for things of all sorts, from bananas to mobile phones, has resulted in the exploitation of natural resources at a speed and on a scale unprecedented in human history. Some of today's major environmental problems such as climate change, overfishing and large-scale biodiversity loss are a direct consequence of our consumerist lifestyle.

The issue of consumption seems all the more urgent in light of the rise of the so-called new global middle classes, which is just another way to describe the sharp decline of poverty across the world in recent years. In Asia alone about a billion people crossed the poverty line in the last 20 years, and another billion are likely to do so by 2030 (Asian Development Bank, 2010). This means that, in a relatively short time, hundreds of millions of people now earn enough money that they can worry about things other than simply surviving. By 2030, many more middle class people are expected to live outside Western countries than inside (Kharas and Gertz, 2010). Shouldn't this be good news? As is often the case in humankind's slow march of history, it is good for people but bad for the environment. To put it simply: with greater income comes more consumption, and more consumption means more use of natural resources, more waste, and more pressure on the planet's regulation systems. So while it is unqualifiedly good news that people around the world are becoming less poor, there is a big question mark about where all the stuff they want will come from if they decide to consume in a manner similar to the West.

This is an important if. Mass consumption is a very recent phenomenon in history – and a fairly small one too. The development of large middle classes with high levels of consumption happened only within the last century or so, and in a small group of countries in North America, Europe and Australasia. So history doesn't give us many clues about what happens when a lot of people stop being poor, and certainly not at the scale that is happening today. It is quite obvious that consumption as a whole has increased with rising incomes, but this does not mean that the new middle classes – or whatever other label we use – will look anything like the old ones.

Crucial to understanding how sprawling wealth around the world will affect the environment is to know more about consumers in the developing world. While it is clear that *consumption* in the aggregate is rising in developing countries, we know relatively little about the people behind the numbers. Who are these consumers? How do they behave and what is driving their behavior? How is this behavior changing as they become wealthier? These are questions for which we unfortunately have very few answers. Intuitively we don't expect a student in Frankfurt to make the same purchasing decisions as a taxi driver in Jakarta, even if their incomes were the same. But we don't have much systematic information about how consumers – and people in general – behave in the developing world (Maheswaran and Shavitt, 2000). The bulk of what we know, or think we know, about human behavior comes from studies involving university students in a handful of rich countries – those whom Henrich et al. (2010) have called WEIRD (Western, educated, industrialized, rich, and democratic) people. But WEIRD people will soon represent a small fraction of consumers worldwide.

Addressing key environmental challenges such as climate change or the degradation of ecosystems is likely to require changes in the way that people behave (Weber and Johnson, 2012). Understanding consumer behavior is a key component of any theory of change from the current system to a more sustainable production-consumption system (Vergragt et al., 2014), and yet we know so little about those who are likely to become the greatest consumer force in the world.

This chapter is about what we know about non-WEIRD people as consumers. Our review leads us to suggest that while in some ways it is undeniable that non-Western consumers are adopting the values and behaviors of their Western counterparts, their behavior is far from being homogenized in any predictable way. We have found that there is a complex interplay between income, culture and behavior that both makes things more difficult to study and creates opportunities for change. The chapter proceeds as follows. First, we review what we know about the new global middle classes and the ecological implications of their expansion. Second, we look at the question of convergence versus divergence in global consumer behavior, and suggest that globalization does not beget Westernization.

Third, we look at the evidence about consumer behavior in the new global middle classes and identify four key patterns: (1) materialism and consumerism appear across cultures and income levels; (2) income is not a good predictor of people's wants; (3) values and culture do not automatically change as people become more affluent; and (4) the embrace of globalization / Westernization is selective. We finish the chapter by discussing the implications of these findings for sustainability.

WHO ARE THE NEW MIDDLE CLASS CONSUMERS AND WHY DO THEY MATTER?

The recent attention to the growth of the middle classes in developing countries has to do with more than rising incomes. In the West, the middle class is seen as the social and political anchor of society, a source of stability and prosperity. Its very existence reinforces economic dynamism, so that the middle class becomes simultaneously a cause and a consequence of growth (Birdsall, 2010). An established middle class is also a sign of a social contract, one that trades redistribution for stability (Easterly, 2001). In countries where the middle class prevails, people are more educated and more politically engaged, and this translates into better and more transparent institutions of governance.

This picture may be further and further from reality in many parts of Europe and North America, but this is the enticing ideal of the Western middle class. The first thing to note in our discussion of the new global middle classes is that, for the most part, they don't look anything like this. The middle classes in developing countries, even those which have experienced remarkable economic growth over the last two decades, are relatively small in number and relatively poor (Birdsall, 2010). What is 'middle' about the new middle classes is that they are neither too poor nor too rich, but they certainly do not have the same living and consumption standards of the middle classes in Europe or North America.

The actual definition of the middle classes is a matter of debate. The definitions typically applied for wealthy countries are relative, and they classify as middle class those who fall within a certain range of income distribution. For Easterly (2001) it is those who are in the second, third and fourth quintiles of the income distribution, and for Birdsall et al. (2000) it is the people who earn between 75 and 125 percent of the median income. For developing countries absolute rather than relative definitions are more commonly used. Some authors use quite a low income threshold for inclusion, usually above the official poverty line. Thus Banerjee and Duflo (2008) and the Asian Development Bank (2010) include those whose daily per capita income is between 2 and 20 USD (PPP). Using expenditures rather than incomes, Kharas and Gertz (2010) define the middle class as those who spend between 10 and 100 USD daily. Ravallion (2009) puts the floor at the commonly used poverty line of 2 USD per capita per day, and the ceiling at 13 USD, the poverty line in the USA. Using a slightly higher range, a recent study by Goldman Sachs defines the middle class as those earning between 16 to 82 USD per day (Wilson and Dragusanu, 2008).

Most of these definitions use relatively low income brackets. By way of comparison consider: the median yearly income in Germany in 2004 was just over 20000 USD, which amounts to about 54 USD per day (Atkinson and Brandolini, 2011), more than five times the lower limit of the bracket used by Kharas and Gertz. Why bother using the term 'middle class' then? In this chapter we do so mostly by convention. It is much more convenient and definitely better sounding than 'the new global no-longer-poor classes'. But it also serves to signal an important transition in world history. In 2009 about 1.8 billion people – 28 percent of the global population – lived in households in which the average daily expenditures fell within Kharas and Gertz' relatively low threshold of 10 to 100 USD (PPP). Using this expenditure bracket these authors project that, owing to both population growth and rising incomes, the group will swell to more than 3 billion people in 2020, and to 4.8 billion (almost two-thirds of the world's population!) by 2030 (Kharas and Gertz, 2010).

The scale of this phenomenon is likely to have a huge impact on the environment. Even if the purchasing power of individual consumers is relatively low, the aggregate effect of their sheer numbers is unprecedented. As a group, those who Myers and Kent (2003) call the 'new consumers' are creating a spike of demand for food and other consumer goods. Richer people not only tend to consume more, they consume differently. With rising incomes, people tend to eat fewer cereals and starchy tubers such as potato or manioc and rely more on processed food and animal-sourced proteins like meat and dairy (Weinzettel et al., 2013). In China alone, poultry consumption is expected to roughly double in the period 2000–30, while the population is only expected to increase by about 14 percent in the same time period (Heinrich Böll Foundation and Friends of the Earth, 2014). Even in traditionally vegetarian India, consumption of poultry is set to increase tenfold by 2050 (ibid.). Cheap food prices are allowing these changes to happen particularly fast and at a relatively low level of GDP (Kearney, 2010).

In addition to dietary changes, people are using their expendable income to buy non-food products and services at unprecedented rates. In China all income segments have shifted their main expenditures away from food towards housing, transport, recreation, education and clothing

(Hansakul, 2010). In India, where discretionary spending is thought to be happening at lower income levels than in other countries, food expenses dropped from 56 percent of total household expenses in 1990 to 42 percent in 2005, with a further drop to 25 percent expected by 2025 (Beinhocker et al., 2007).

Such a rise in consumption has come with a high environmental price tag. A meat- and dairy-intensive diet demands much more land, water and energy to produce than one based on cereals (Myers and Kent, 2003; Weinzettel et al., 2013); affluence therefore causes a shift towards a more inefficient food system (Gerbens-Leenes et al., 2010). Moreover, due to the connections of international trade, satisfying consumption in one part of the world can put pressure on resources and natural systems in another, distant part (Meyfroidt et al., 2013). In addition to this, the thirst for electronic appliances and vehicles is creating an ever-increasing demand for raw materials and energy (Fraunhofer ISI and IZT, 2009; Hertwich et al., 2010).

IS CONSUMER BEHAVIOR CONVERGING OR DIVERGING?

The preceding discussion refers to an economic transformation involving greater affluence and more consumption. The data points to some unmistakable trends. But there is another story to tell, which is about the transformation of people's way of thinking and of acting as they become wealthier and are able to consume more. This is a harder story to tell, and one for which the data are both scarcer and more ambiguous. In this section we turn to what we know about consumer behavior. With incomes rising, global products more readily available and media and advertising reaching further and further, can we expect people to start behaving and acting similarly around the world?

The prevailing model about consumer behavior in mainstream economics is that of a rational consumer who makes decisions to maximize utility for a given set of preferences (McFadden, 1999). The process by which choices are made is a black box that is assumed to achieve the optimal cost/benefit solution. However, the work of behavioral economists and psychologists has shown that people make systematic decision errors due to cognitive biases, subjective appreciations, and impulse (Kahneman, 2003). The interesting part, it turns out, is what happens *inside* the decision-making black box. Lacking a general, elegantly simple theory such as rational choice, economists have had to reach outside their discipline for insights about the role of more subjective things like perceptions, attitudes, affects, motives and preferences (McFadden, 2013).

Some of these insights have come from the broader social sciences, for which consumption has been a central problem from the beginning. Rather than a mere information-processing problem, consumption can be seen as a 'subjective state of consciousness with a variety of symbolic meanings, hedonic responses, and esthetic criteria' (Holbrook and Hirschman, 1982, p. 132) influenced by things like self-perception, identity and social status. What people buy and why is obviously limited by what they can afford, but many of the non-income aspects appear to be affected by culture (de Mooij and Hofstede, 2011; Luna and Gupta, 2001). 'Culture' is a tricky word; in the consumer behavior literature it is used as a convenient shorthand to refer to 'the rich complex of meanings, beliefs, practices, symbols, norms, and values prevalent among people in a society' (Schwartz, 2006, p. 139).

The key word here is 'prevalent': culture is something diffuse and multifaceted, so in order to make it a relevant construct for comparison it has to be packaged into discrete categories. One commonly used framework to study consumer behavior cross-culturally is that of Hofstede's dimensions of national culture (Hofstede, 2001). Based on how a large sample of IBM workers across the world responded to a questionnaire, Hofstede posited that five dimensions seemed to explain most of the variation in the responses: collectivism/individualism (the degree to which one's personal identity comes from one's self or from one's relation to a group); power distance (how willing people are to accept inequalities and hierarchies); uncertainty avoidance; masculinity/femininity (the relative weight of success versus caring); and long- versus short-term orientation. A similar framework was proposed by Schwartz (2006). Although the categories are slightly different, there is a lot of overlap with Hofstede's dimensions, and the explanatory power is similar. Schwartz uses a worldwide survey ($n > 75\,000$) of the seven value orientations to map out all the countries in the world, and finds that countries fall rather neatly into a small number of groups that are held together by a similar combination of cultural traits. These 'culturally distinctive' world regions are: West Europe, English-speaking, Confucian, Africa and Middle East, South Asia, East Europe and Latin America.

These frameworks are widely used and have been found to explain some of the differences observed in several aspects of consumer behavior. These include attributes of the consumer (for example, personality, identity and attitude), attributes of the processes of decision-making (for example, motivation, emotion and cognition) and different domains of consumer behavior (product ownership, brand loyalty and complaining behavior) (de Mooij and Hofstede, 2011). Whereas there are considerable supranational and subnational cultural differences, these national culture frameworks have been shown to be remarkably consistent (Steenkamp, 2001).

If these cultural attributes are relevant to explaining how consumers behave, then the big question is if and how culture is affected by income. Do the sweeping changes in income across the world mean that there is a convergence towards a particular type of consumer culture? To some, globalization – that is, the liberalization of trade and greater flow of information and people around the world – is likely to lead to the homogenization, indeed Westernization, of cultures and consumer behaviors (Levitt, 1983). This is an old idea; it is embodied in W.W. Rostow's (1960) modernization theory, according to which societies would travel a series of predictable stages towards industrialization and development – Western style of course. Such a crude characterization is no longer fashionable, but the term *globalization* is often used as shorthand to mean *globalization of Western ideas, markets and values*.

It is undeniable that certain aspects of Western culture have spread quickly across the world. George Ritzer (1996) coined the term 'McDonaldization' to refer to the pervasive rationalized type of production and consumption model which is based on efficiency, calculability, predictability and control through technology. According to Ritzer (1996), this rationalized model has been expanding through time and through space, and its growth is inevitable to the extent that globalization makes diffusion easier. Such a process, now aided by the internet, could lead to the homogenization of culture and consumer behavior so that it converges with the West (Merz et al., 2008). The social dynamic of this model of rational production favors the emergence of consumerism: modern society offers a wide range of things that we use for constructing identities, reaffirming social relations and fulfilling emotional needs. People always long to have things because they are new, because they allow us to emulate those we admire or to distinguish us from others, seeming to open a passage to an idealized perfect world of things. But things alone cannot fulfill the psychological and social needs of identity and belonging, and thus continually nurture the desire for more and new things (Jackson, 2009).

The first problem with that picture is that there is no one 'Western' consumer model. Consumer culture in the West is actually quite varied. There are significant differences in many cultural aspects between the USA, Europe and Japan, for example in relation to egalitarianism and individualism (Schwartz, 2006). Moreover, the supposed foundations of mass consumption in the West – stable jobs, good incomes, adequate health and education – can no longer be taken for granted.

The second problem is that globalization – even McDonaldization – is not automatic, as there are considerable local readjustments (Ritzer, 1996). The evidence suggests that global trends are adapted to local values and needs, even if the encounter is often unequal and corporations sometimes have the upper hand (Ger and Belk, 1996b). Moreover, as incomes rise, local cultures may be strengthened, rather than weakened, resulting in more heterogeneous global markets (de Mooij, 2000). As the interaction between cultures and global markets accelerates and becomes more pronounced, acculturation starts working in both directions. As Cleveland and Laroche put it, 'as the economic center of the globe shifts from Europe and America to Asia, cultural phenomena rooted in Asia will increasingly be exported worldwide and integrated into the global consumer culture, even as Asian cultures themselves change because of globalization' (2007, p. 257).

FOUR TRENDS IN CONSUMER BEHAVIOR IN THE NEW MIDDLE CLASSES

The above discussion suggests a rather complicated relationship between income, culture and behavior. Given these apparent tensions between divergence and convergence, what do we actually know about consumer behavior in the new middle classes? In the review below we have pieced together some of the available evidence and identified some emerging patterns. Beware: the evidence is patchy. The scientific study of consumer behavior in developing countries is scarce, and lags well behind the wealth of understanding accumulated by retail and marketing firms. Unsurprisingly, those most interested in understanding consumers are the people trying to sell things to them; alas, they don't publish in academic journals. The review below therefore draws from a hotchpotch including the academic psychology and marketing literature, industry reports and consumer surveys. Although the picture is partial, four key trends emerge:

1. materialism and consumerism appear across cultures and income levels;
2. income is not a good predictor of people's wants;
3. values and culture do not automatically change as people become more affluent;
4. the embrace of globalization/Westernization is selective.

Materialism and Consumerism Appear Across Cultures and Income Levels

One of the most basic aspects of consumer behavior is materialism, or in other words the extent to which people derive happiness from buying and owning things. Following Max Weber, Campbell (1987) suggested that the success of the industrial revolution required the development of a culture of consumption, and that such a culture draws from a Western European (specifically English) desire for pleasure-seeking or hedonism. Wealth, in the form of a large middle class, simply allowed this hedonic drive to flourish (Holbrook, 1997). Is this gratification-through-consumption a universal trait, or is it culturally specific? And how does it relate to income? The evidence suggests that consumerism shows up across cultures and levels of affluence, even if it is expressed in different ways. For example, China, the USA and Western Europe can be said to be consumerist societies, but materialist needs are fulfilled differently. In the USA owning a car is a key part of the consumer experience, but this is much less so in Europe and in China. Similarly, both Chinese and Americans find fulfillment in home ownership and improvement, but this is not so important in Europe (Stein, 2009).

The systematic study of consumerism and materialism across cultures suggests that materialism is not an exclusively Western construct. Ger and Belk (1996a) investigated different aspects of materialism in a sample from 12 countries with different income levels. For this, they used a survey which allowed them to rank people along a quantitative materialism scale. Somewhat surprisingly, (then) relatively poor countries such as Romania, Ukraine, Turkey and Thailand ranked highly alongside the USA and New Zealand. India and most other European countries ranked low, suggesting that income level is not a good predictor of how materialist a society will be. People in poorer societies may feel that they are far from having a desired bundle of goods, and could thus be more driven to acquire things. In a different study, Cleveland et al. (2007) found similarly opaque relationships between affluence, culture and materialism. Using surveys in eight wealthy and developing countries, they tested the relationship between ethnic identity, materialism and ethnocentrism. Materialism was found to be widely spread across countries rich and poor, suggesting its apparent universalism. However, more ethnocentric consumers seemed to prefer to display their materialism preferably through consuming local alternatives.

Income is Not a Good Predictor of People's Wants

One of the fundamental empirical observations about consumption in the new middle classes, as we describe above, is a shift from basic staples to meat and processed food. Such a shift could be indicative of a broader transition from basic to luxury goods. We use these terms in a general way to distinguish those goods that have a purely utilitarian or functional value from those which are consumed for pleasure and self-gratification (Wang and Lin, 2009). As we will see, this is a tenuous distinction. While it has long been clear that wants change in relation to economic conditions (Katona, 1968), income turns out to be a rather poor predictor of these changes. The evidence suggests that people with relatively low levels of income consume things that fulfill their spiritual as well as their physical needs, and that even wealthy people shop with an eye for functionality.

The notion that there is a predictable relationship between people's economic means and their wants is encapsulated in Maslow's (1943) influential idea of the hierarchy of human needs. According to this framework, people first must meet their basic material needs such as food and shelter before they can move on to spiritual and emotional – that is, 'higher' – needs. But the evidence suggests that such boundaries are arbitrary. Consumers in developing countries are spending a lot of time and money buying fashion clothing, food and other consumer goods well beyond the basics; in India at least, this is happening at lower income thresholds than would be expected (Beinhocker et al., 2007). In Brazil, a recent survey of women in several cities found that for 80 percent of them the most important attribute in clothing is fashion, not functionality; the result was consistent across income levels (Artigas and Calicchio, 2007). In South Africa, a study tried to explain why private labels (supermarket brands) were failing to catch on, even though they were cheaper. The answer? Price was a secondary consideration; even poor people were looking for quality above all (Beneke, 2010).

These results point to the fact that wealth is only one of many factors shaping people's preferences. Often specific cultural or historical variables override monetary ones. A study of fuel sources for cooking in Botswana found that the hypothesized transition from firewood to gas as a function of household income (the 'energy ladder') did not hold. In fact, relatively affluent households continue to use firewood to cook some things, even if they shift to gas for others (Hiemstra-van der Horst and Hovorka, 2008). In a different study, households in Tianjin (China) were found to use about two-thirds of the water that households with comparable incomes in Beijing used. In the absence of any economic explanation (water is even more expensive in Beijing), the cause had to be looked for in history: Tianjin has a long tradition of saving water (Zhang and Brown, 2005). Seemingly non-monetary factors were also found to override financial concerns in a study of luxury consumption in India. Despite the importance of conspicuous consumption for the country's middle classes, high-end products like Teflon pans and automatic dishwashers saw disappointing sales. Affluent people simply relied on cheap labor: why spend more on household goods if you can hire someone to clean (Dawar and

Chattopadhyay, 2002)? Once median incomes grow, however, this option might become too expensive and the purchase of a dishwasher ceases to be a luxury and turns into a necessity for a middle-class household where all adults are wage-earners and time for household chores is scarce.

Systematic, comparable studies across the developing world are infrequent, but there is some evidence that consumers in India and China are making decisions very differently. One interesting study looked at the attributes used by consumers to choose jeans in these two countries (Jin et al., 2010). The sample was relatively homogeneous: middle class university students in two large, cosmopolitan metropolises, Bangalore and Shanghai. The product, jeans, was also broadly comparable. And yet the results differed significantly. For Chinese consumers price was the most important attribute, followed by fitting, brand country of origin, design and quality; for Indians, price came only fourth after fitting, brand country of origin and design. We will explore these differences in more detail below.

Values and Culture do Not Automatically Change as People become More Affluent

Affluence and certain aspects of consumer culture often appear together. Hofstede (2001) found a positive correlation between GDP per capita and higher individualist cultures, but this correlation need not entail causation. In many developing countries, even those in which incomes are rising fast, consumers retain many aspects of their local culture: there is no automatic shift in a predictable direction. In countries like China and India, collectivist traits persist in some aspects of consumption even if in other regards consumers are becoming more individualistic. As de Mooij (2000) suggests, instead of being a homogenizing force, rising incomes might have the effect of letting people express their own cultural differences more fully.

Collectivist and individualist traits can be seen at similar levels of wealth under different cultural settings. In a survey, English consumers said they drank luxury beverages like single malt whiskey to enhance personal satisfaction (an individualist trait); for Indians, drinking is a more social occasion, and respondents said they were more concerned about how they were being perceived by their peers (Shukla, 2010). The social aspect of consumption was also evident in a study comparing the relationship between preference and choice among wealthy students in the USA and India. While American subjects chose based solely on their personal preferences, suggesting individualism, Indian respondents considered the desires and expectations of their social and family peers (Savani et al., 2008).

This contrast can also be seen within national borders. Conveniently for us, China offers an interesting laboratory for studying consumer behavior in relation to income because of its uneven regional development: broadly speaking, cities are wealthier than the rural areas, and large cities in or close to the coast are wealthier than those in the interior. These regions also vary with respect to their exposure to global markets and the adoption of Western lifestyles, and large surveys have shown important differences in consumer behavior along these geographical lines (Atsmon et al., 2010). Consistent with different regional degrees of Westernization, a study found that a sample of urban consumers in coastal cities (Shanghai and Guangzhou) are more individualistic, according to the Schwartz model, than consumers in cities of the interior (Chengdu and Harbin), who tend towards collectivism (Xin-an et al., 2008). As a result of individualist values, coastal consumers gave more importance to the functional attributes of products (comfort, warmth), while collectivist-oriented consumers gave more weight to social attributes such as fashion, color or cut.

But the picture is not so neat. Wealthier Chinese consumers – especially the younger generation – are seeking more differentiated products and showing some of the individualist consumer values typical of the West. However, two cultural traits seem to be pulling towards tradition. On the one hand, several studies suggest that Chinese consumers, even at higher levels of income, are price-conscious and care about good value and product reliability (Atsmon et al., 2010; Jin et al., 2010); this has been interpreted as being derived from the traditional Confucian value of thrift (Wang and Lin, 2009). Consistent with this, Lin et al. (2013) found that thrift, expressed in private acts like re-using plastic bags or buying water-saving dishwashers, was common across income levels.

On the other hand, however, status and social acceptability are key concerns. In China, building and maintaining public face (*mianzi*) is a very important aspect of consumption, and consumers go to great lengths to find products that earn them praise from their social peers – a typically collectivist trait. Using a web-based survey, Lin et al. (2013) found that gaining praise by building face through purchasing expensive cell phones or brand clothing was very important for respondents of all income levels. This is consistent with an earlier study (Bao et al., 2003) showing that a sample of young urban Chinese consumers was willing to pay more from brands that were approved by their peers. Using brands in this way is a means to signal graduation into the middle class and to gain prestige. Another survey of university students found that Western fashion brands were preferred to local brands, both by affluent people and by those who aspire to be so (O'Cass and Siahtiri, 2013).

The Embrace of Globalization/Westernization is Selective

The exposure to or adoption of certain Western products or brands does not mean the wholesale embrace of globalization. As we have discussed earlier, the expansion of Western brands and media into the developing world has been modulated by local needs, preferences and traditions, creating distinct landscapes of consumption (Ger and Belk, 1996b). Rising incomes put global brands within the reach of millions, but people are selective about what they reach for. In India, for example, the public display of luxury Western brands of jewelry is very important – and increasingly available to more people. However, in a survey of consumers in Delhi, Mumbai and Kolkata, affluent consumers expressed very clearly that, although global brands are a way to signal status, traditional Indian clothing was an equally important source of pride and social recognition (Eng and Bogaert, 2010).

The road to Westernization seems to be bumpiest when it comes to food. People around the developing world have readily adopted aspects of Western food consumption, as evidenced by changing diets and the expansion of Western food chains. However, there is evidence that traditional ways of buying and consuming food endure, even among the relatively affluent. A survey of over 600 young consumers in rural and urban northeastern Thailand revealed the preference for local Thai food over Western fast food due to health reasons (Seubsman et al., 2009). Another study of food-buying preferences of university students from Tianjin and Shenzhen (China) showed that, despite different levels of exposure to Western consumer values (Tianjin being more conservative and Shenzhen being more Westernized) in the two cities, students in the sample showed similar preferences for taking the time to cook at home and for buying fresh foods at wet markets (Ho and Tang, 2006).

While much has been made of the so-called supermarket revolution (Reardon et al., 2010), consumers in the developing world do not seem to be marching inexorably towards standardized retailing. Evidence from different developing countries points to the continued relevance of traditional retail outlets, and not just among the poor. Surveys among middle class urban residents in Ghana (Meng et al., 2014) and in Uttar-Pradesh (India) (Ali et al., 2010) found that, despite the fact that they like supermarkets, consumers also continue to shop in traditional outlets such as corner stores and street markets, especially for fresh fruit and vegetables. Concern for freshness seems to be the overriding explanation for this behavior. Even the relatively high-income consumers of Hong Kong – who have a wide choice of supermarkets – still prefer wet markets for fresh fruit and vegetables, because they perceive these traditional retailers as being better able to guarantee freshness (Goldman et al., 2002). Similarly, Van Hoi et al. (2009) found that Vietnamese consumers were reluctant to purchase fresh fruit and vegetables from supermarkets and other retail outlets selling 'safe vegetables' (that is, those grown using fewer pesticides and herbicides) because they did not trust these retailers as much as they did traditional ones. A similar explanation for the continued patronage of traditional vendors in Vietnam was found by Cadilhon et al. (2006).

SUSTAINABILITY IMPLICATIONS OF CONSUMER BEHAVIOR IN THE NEW MIDDLE CLASSES

Given what we know about the aggregate environmental impacts of affluence, the rise of the new global middle class does not bode well for the viability of the natural systems that support life on earth (Krausmann et al., 2009; Steinberger et al., 2010). Even though we have cautioned against making assumptions about the inevitability or predictability of particular changes in consumer behavior, it is clear that consumers have an important role to play in any transformation towards a sustainable future. What is that role, and what can our knowledge – and ignorance – about consumer behavior tell us about it?

There is a growing amount of work that seeks to establish what a sustainable lifestyle looks like, and what it takes to shift consumption patterns. Much of that discussion has focused on what is called green consumption, that is, shifting people's choices towards more sustainable alternatives. In an excellent review of the green consumption literature, Peattie (2010) shows the multifaceted nature of this concept. Green consumption covers both the decision-making processes of consumers as well as the outcome of these decisions; both the purchasing of products as well as the impacts of their production, use and disposal. However, in some way – as Peattie recognizes – the idea of green consumption is an oxymoron. In fact, focusing on consumers' choice of green alternatives is far more palatable politically than looking at the hard question of reducing consumption. As Akenji (2014) notes, green consumption is an end-of-pipe approach that does not seek to fundamentally alter the system, but just tweak it a bit, and it places the burden of change squarely on consumers. Thus, Akenji argues, green consumption should not be confused, or replaced by, *sustainable* consumption. The latter entails a much more profound change in the production–consumption system in which consumers play only a marginal role.

Whether it's green consumption or sustainable consumption, effecting any changes to consumer behavior is likely to be a challenge. This is because, as noted at the beginning, consumption behavior is not based on fuller or better information, but instead is plagued by systematic cognitive biases. Pro-environmental behavior, in particular, is affected by what psychologists call cognitive myopia, that is, the tendency to weigh short-term outcomes more than long-term ones, even if the latter are objectively better (Weber and Johnson, 2012). In addition to this and other cognitive biases, there is the well-known problem that people say (or think) one thing and do another – the attitude–behavior gap (Bray et al., 2010). While people often enthusiastically endorse environmental sustainability in their responses to surveys, when it comes to paying a little more for sustainable products – for example fair trade coffee – the enthusiasm subsides (Basu and Hicks, 2008).

Until now the debates about green or sustainable consumption have centered largely on consumers in wealthy countries, but the scope is broadening. Because sustainably produced products often carry a price premium (De Pelsmacker et al., 2005), it is often assumed that they are a luxury that only wealthy and well-informed people can afford. However, there is evidence that green attitudes, and even green behavior, occur at low levels of income as well (Martínez-Alier, 2005). This, at the very least, suggests that the relation between income and sustainable consumption is not straightforward.

What, then, are the sustainability implications of our discussion of convergence and divergence in consumer behavior, and of the four key trends identified in the previous section? We outline some of the implications, as well as areas for future research, of each of the four trends below.

First, in relation to materialism and consumerism, the outlook is not auspicious. If consumerism and materialism show up across cultures and levels of affluence, the possibility for radically reducing consumption in the new global middle classes seems unrealistic. Given that it is unlikely that people will want to consume less, or abandon consumption as a desirable goal, it may turn out that end-of-line approaches are more likely to succeed. In a review of Chinese-language literature on pro-environmental behavior Harris (2006) found that the Chinese are consumerists who in general have an instrumentalist view of nature and who appear to disregard environmental problems unless they affect them directly. While attitudes and knowledge about the environment vary widely in relation to affluence and education, actual behavior differs little between the educated well-to-do and the poor. More robust and systematic studies of the relation between income and consumerism are needed in order to establish the validity of these observations in China and in other developing countries.

Second, the indication that people's wants are not easily predicted by income suggests that there is room for pro-environmental behavior in developing countries at both current and higher income levels. Some evidence shows that pro-environmental attitudes are found both among the rich and the poor, but that price acts as a barrier to pro-environmental behavior. Using data from the world survey of values, Guarín and Knorringa (2014) found no correlation between countries' GDP per capita and the willingness to pay a higher price for environmentally sustainable products, whereas actual pro-environmental behavior was positively related to income. A cross-country study of the role of social and environmental attributes in consumer purchases (Auger et al., 2010) showed that price was a barrier for consumption of sustainably produced goods. In the choice experiment, Indian respondents were much more sensitive to price than participants of other wealthier countries, and showed little regard to environmental attributes such as the presence of hazardous chemicals or use of recycled materials.

But generalizations about the actual drivers of this behavior are difficult. Two studies of Indian consumers (Jain and Kaur, 2004, 2006) found that socio-demographic characteristics of consumers were poor predictors of their green behavior. A survey of over 200 middle class consumers in Delhi showed heterogeneity with respect to the information and knowledge that people have about environmental issues. Green consumerism was more likely to be present among wealthier and better educated respondents, but the effect was weak. Similar results were observed in a study of consumer preference for garments with eco-labels (that is, apparel claimed to be produced using environmentally textiles and dyes) among a sample of over 480 urban middle class buyers in Kolkata and Mumbai. Goswami (2008) found that consumers show different degrees of interest for these types of certification, but these differences could not be explained by income. These results are similar to those of studies in industrialized countries who find a large heterogeneity of consumption and lifestyle patterns, associated with very diverse combinations of values and attitudes which span different income groups (Reusswig, 1994).

While these studies in India are limited to environmental attitudes, two very different studies show that pro-environmental behavior is not exclusive to the affluent. Van Kempen et al. (2009) found that participants in a choice experiment in rural Guatemala actually paid a higher price for firewood that was said to be sustainably (that is, legally) harvested, but the reasons behind this behavior could not be clearly elucidated. In a survey of rural residents in China, Wang et al. (2014) found that pro-environmental attitudes were generally associated with better incomes and education. However, there was evidence of pro-environmental behavior even among the rural poor. The study found that actions such as recycling had more to do with rather short-term personal interests than with loftier environmental goals, a finding that is consistent with Harris's (2006) study of Chinese environmentalist behavior.

Third, the ambiguous relation between cultural values and income could potentially create opportunities for behavioral change, but this is a topic that requires further investigation. Both Schwartz's (2006) and Hofstede's (2001) typologies highlight the cultural importance of the relation between the individual and his or her surroundings. One could therefore expect that care for the environment would be associated more strongly with collectivist societies. If unsustainable behavior is regarded by social peers as loss of public face, collectivist values could reinforce positive consumption trends. The evidence for this, however, is slim. Consistent with the theory, a survey of pro-environmental behavior in Beijing and Guangzhou (Chan, 2001) found that the collectivist cultural traits of the respondents were associated with greater interest and sensibility for environmental issues. However, as Harris (2006) and Wang et al. (2014) found, actual pro-environmental behavior is not widely observed in China.

Finally, the persistence of traditional consumption and retailing suggests some scope for strengthening local networks and environmentally-friendly local traditions. It is true that traditional does not necessarily mean sustainable, but some aspects of traditional production systems such as small-scale agriculture or grass-fed livestock rearing have smaller environmental impacts than large-scale and input-intensive food and meat production. In addition, traditional retail networks often source their products from local farmers and stock seasonal produce. Rather than accepting the inevitability, or desirability, of standardized retailing and consumption, it is possible to imagine tapping into this diversity to build more sustainable consumption–production systems. Here too the theory would need much more data to be validated.

CONCLUSION

Consumption is one of the drivers of the coupled economic–ecological system, and therefore a central concern for ecological economics. Through history people have been quite good at using technology to substitute scarce raw materials for other more plentiful ones and to replace some natural processes by artificial means (Dietz and Neumayer, 2007). But the economic system is closed; our insatiable appetite for stuff is likely to run into physical limits, particularly as key life-sustaining natural systems are irremediably disrupted (Ekins, 2003).

Are things likely to get better or worse as people become wealthier and better educated? The hypothesis of the environmental Kuznets curve theorizes that the relation between income and environmental degradation follows an inverted U-shape: environmental quality decreases as societies become wealthier, but then things get better as people become more environmentally conscious, technology improves and regulatory institutions are strengthened. However, although elegant in principle, the empirical support for this hypothesis is at best conflicting (Dinda, 2004). Environmental sustainability does seem to improve as wealth increases, but this tends to be a rather local phenomenon – as, for example, richer communities are able to avoid the worst polluted areas. The overall consumption of materials and energy does not appear to be abated by rising incomes (Rothman, 1998), so the negative effects are either displaced in space towards those who are less lucky, or in time towards future generations.

An important part of the environmental impacts of consumption depends on structural constraints that are beyond the control of the individual. Some of these constraints – such as the availability and type of public transport or the materials that are used for building homes – are the result of inertia and path dependency. But this does not mean that consumer behavior does not matter. For example, consumers in the USA and Japan, two countries with comparable levels of affluence, have very different attitudes and preferences with regard to public transportation, and this has massive repercussions on greenhouse gas emissions and energy consumption. As we have discussed in this chapter, income is not a good predictor of people's environmental values, nor does wealth turn us all into frenetic buyers.

If we acknowledge the relevance of consumers for sustainability but accept the complexity of their behavior, then we must ask ourselves what resources are at the disposal of society – especially in emerging economies – to achieve more sustainable consumption patterns. Our review suggests that while materialism and consumerism appear to be widespread, consumer preferences are flexible to some degree. Contrary to the assumption of the environmental Kuznets curve hypothesis, people do not have to be wealthy to worry about the environment, and being rich does not guarantee sustainability. This means that there is room for both hope and despair in the rise of the new global middle classes. Questioning received assumptions of 'universal' human behavior is a first step in recognizing the potential perils and opportunities of consumer preferences across cultures. At best, such nuanced knowledge may help us search for appropriate conceptions of sustainable consumption across cultures, and to promote sustainable lifestyles in the new consumer centers of the world.

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16. Global environmental governance

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1. INTRODUCTION

Two observations form the basis for this chapter. First, environmental problems are increasingly globalized. Climate change, biodiversity loss, stratospheric ozone depletion, ocean acidification and the expansion of biogeochemical cycles like that of nitrogen are among the most important as recognized over the last decennia. The list illustrates also that the concept of 'global' means different things across the field of environmental issues. While the climate change process is driven by changes in an atmosphere that is common across the globe, biodiversity loss – while a global phenomenon – is more localized as to its dynamics. Nevertheless, Rockström et al. (2009) talk about planetary boundaries in relation to all the above examples.

Second, the existing systems for governance of the involved resources are not well adapted to the kind of problems faced. Key actors are nation states and multinational corporations. This implies that the main political decision-making power is vested in units that have jurisdictions that are highly limited with respect to the geographical scale, while those deciding about production processes so important for the creation of environmental problems operate globally. This is an uneven battle based on dogmas of free trade, creating conditions that are not favorable for establishing the necessary cooperation that a solution to global environmental challenges demands. We have certainly managed to develop a set of international organizations and treaties directing efforts into reducing the abovementioned type of problems. These are, however, weak.

From a global perspective, environmental governance must be a multi-level endeavor demanding nested action across the global, regional, national and local levels. This is in itself very challenging. Added to the spatial and political complexities, the field is also characterized by high levels of uncertainty and ignorance regarding the form and magnitude of environmental change and challenges. Hence, the structure of the decision-problems is also ill-defined.

The aim of this chapter is to offer a more in-depth analysis of the above issues. First, I will clarify the concepts of environmental governance and global environmental governance using an institutional perspective.

Second, I will characterize some of the core environmental challenges, explaining what the main governance issues are. Next, I will briefly present some of the international agreements in the field – the ones for climate change, biodiversity and stratospheric ozone depletion – and the processes behind their development and operation. I turn then to a characterization of the way these agreements are made operational at the national level – the level where the political capacity to act is mainly concentrated. I close by offering a brief description of possible ways to increase our capacity to handle global environmental problems.

2. THE CONCEPT OF ENVIRONMENTAL GOVERNANCE

2.1 Environmental Governance

Paavola (2007: 94) emphasizes that the 'literature distinguishes between "governance" and "government" by considering the absence of coercive state power as the hallmark of "governance".' Like him, I find this dichotomy unproductive. While there are many forms of governance – some where states are of very little importance – their role is often very significant, even in cases where 'self-organization' is viewed as key.

I therefore find it more advisable to define governance with respect to what governance is about and not the way it is undertaken. Hence, I define governance as the processes that shape social priorities, how human coordination is facilitated and how conflicts are acknowledged and possibly resolved. Environmental governance concerns then these issues as related to use and protection of environmental resources – see also Vatn (2011). It concerns action 'on the ground' where humans use environmental resources and may themselves define local institutions regulating access to them. While it is at this level that the direct interactions between humans using various resources take place, the actual use of resources will be very much influenced by institutions formulated at higher levels – including the national and international ones.

The above understanding implies that four key factors are important when studying environmental governance: the institutions, the actors, the environmental resources and the technologies used. It is the relationships between these four factors that are key to understanding what kind of environmental challenges will be faced and how successful one may be in remedying the problems. While technologies form the means for humans regarding their actions towards the environment, it is the institutions that regulate the relationship between humans and nature. In doing so, they also influence the relationships between humans (Bromley, 2006; Schmid, 2004; Vatn, 2005). This follows from the fact that environmental resources are interlinked systems of processes, by necessity creating a set of interdependencies among humans using or operating 'within' these resources. As the actions of one therefore must influence the opportunities for others, the institutions that structure these actions are at the core of the problem.

2.2 Governance Structures

I started by stating that it is better to define governance with respect to what governance is about and not the way it is undertaken. Nevertheless, the effectiveness of any governance depends very much on the structures in place. In relation to that, the concept of a governance structure is important. It can be specified as consisting of the following main elements:

1. Actors
   - economic actors: holding access rights to productive resources;
   - political actors: being involved in defining the rules concerning (a) access to resources and (b) interaction rules – i.e., rules for transfer of resources and products (goods/services and side-effects) between those having access to these resources.
2. Institutions
   - the resource regime: the rules governing the economic process: (a) the access to resources and (b) transfer of resources/products (i.e., goods/services and side-effects);
   - the rules governing the political process (typically constitutional rules and collective-choice rules) – i.e., rules regarding the process of forming of the resource regime.

In disentangling the above, let me start with the institutions. The resource regime encompasses first of all how access to (environmental) resources is defined. Access is here understood in a broad way. Basically it is about property and/or use rights – where one may refer to the standard categories private, common, state/public and open access (Bromley, 1989). Variations across types may be due to different degrees of formalization, but also to what elements are included in the right. Schlager and Ostrom (1992) emphasize four main elements – rights to withdrawal, management, exclusion and alienation – with withdrawal rights defining authorized users at the one end and all four categories defining full ownership at the other.

The resource regime is also defined by the rules regarding the type of interaction between actors having access to resources. Such rules can also be of different kinds – that is, as ideal types one may distinguish between trade/market exchange, command (state/public-based interaction rules), reciprocity (community-based interaction rules) and no interaction rules.

Institutions hence influence strongly who gets access to resources and under what conditions. Institutional theory[1] emphasizes moreover that institutions also influence actors' motivations – for example, the will to cooperate or compete; more generally, the kind of preferences or goals that dominate a certain context or institutionalized arena. In relation to this, one may distinguish not least between individual and social rationality – between competition and cooperation. Institutions also influence the costs of interaction between actors – that is, the transaction costs (Vatn, 2005).

Regarding actors, the main distinction goes between economic actors, for example, households and firms, and political actors, for example, parliaments, governments and NGOs (business and civil society-based). The categorization is based on the role they have in relation to the institutions – whether they are simply governed by or also participate in making these rules. Hence, while economic actors operate within a set of given institutions, political actors define these. The actions of the latter are, however, also themselves governed by institutions – that is, constitutional rules and collective-choice rules. Certainly, the rules for economic activities may not be clear or competing rules may exist – for example, legal pluralism (e.g. Merry, 1988). This may open up for so-called 'forum shopping' (e.g. Busch, 2007) where economic actors select the rules that suit them the best or try to bend them in their favor. More specifically, in the present global context, firms may move between states to 'shop' for the most favorable rules. This opportunity offers a lot of power – not least to multinationals – to not only select between, but also push for advantageous conditions.

There is a link between institutions and actors also in the sense that actors – their preferences and motivation structures – are influenced by the institutions under which they operate. Certainly, there is both individual and institutional variation. Hence, there are differences between how private firms like corporations operate. At the same time, there are differences between types of private firms – for example, corporations and cooperatives, between companies and public bodies and so on.

Given the above, one may hypothesize that the kind of challenges that could appear regarding use and protection of environmental resources – that

[1] There are different schools when it comes to institutional theory – both in general and within economics. The presentation here is based on what may be called classical institutional economics; see Vatn (2005) for a clarification. It comes close to core positions within sociology and parts of political science (for example, March and Olsen, 1995).

is, maintaining their essential functioning really – will vary according to what kind of institutions are in place. I have already emphasized that environmental resources – just by their basic characteristics – create interdependencies between humans when acting. Certainly, some resources may be abundant – meaning that human use does not affect their functioning. The environmental problems mentioned in the introduction imply that for many resources or functionalities this is not the case anymore.

The fundamental question regarding governance is then if our governance structures are well adapted to handle these pressures on the environment. To make a long history short, the main development over the last few centuries has been one towards: (1) division or separation of decision-making regarding resource use – for example, the creation and expansion of the corporation; and (2) creating wider geographical arenas for economic interaction by these separated units – that is, the liberalization of trade. Actually, this process has gained extra speed since the 1970s. This implies that the creation of global environmental agreements has happened in a political and economic context that has become increasingly difficult to operate within.

Hence, we have set in motion a system that split decision-making over integrated natural processes. Companies – with ever-increasing transformative capacities – have gained exclusive power to decide over 'pieces' of natural 'wholes', including also the 'right' to emit the waste created. Hence, there is a separation of responsibilities involved, too. This structure has been very important for the rapid economic growth we have observed over the last couple of centuries – not least after 1950. Evaluated against the dynamics of natural system, however, these separations are fundamentally arbitrary. Hence, a system has evolved that fits very badly the dynamics of the environment on which the economy so fundamentally rests. This was maybe a minor problem when economic activity was small compared to the volume of environmental processes. This is no longer the case. Through the expansion of markets, the structure of separated decision-making creates enormous challenges for the maintenance of key environmental processes.

2.3 Global Environmental Governance

Global environmental governance has been a response to these challenges. We recall that environmental problems have reached a state where they operate even at an 'earth systems' level. Hence, they extend more and more beyond the jurisdiction of the main political decision unit – the state – implying that no third party authority exists over key spaces where economic actors operate. The global becomes *inter*national in the political sphere. Certainly, issues that go beyond the level of states may in a physical sense operate at levels lower than the global – for example, regional pollution or water management problems. While important for certain governance aspects – for example, the number of involved states may be much smaller than at the truly global level – the lack of third party power is principally the same.

In relation to the policy issue, global environmental governance is characterized by three distinct features. First, there is a certain element of anarchy involved following from the above-mentioned lack of a third party. As the literature on international relations emphasizes (e.g. Jackson and Sørensen, 2012), this is a situation that may be characterized by strategic action as studied by game theory. It may, however, also open up for specific forms of dominances – that is, 'the realist' or 'hegemonic power' perspective. At the same time, there is an emphasis in the literature on the creation of institutions at the international level that goes beyond protecting the (immediate) interests of single states, for example, the institutional bargaining model (Young, 1994) and the social constructivist perspectives (Jackson and Sørensen, 2012). Despite the fact that these latter traditions point towards an understanding of the international arena that is different from an anarchy, it is undeniable that it is weak regarding the capacity to reach agreements and even more so when it comes to making what may be agreed materialize into operative policies.

This takes us to a second issue: that of multi-level governance (Cash et al., 2006; Nilsson and Persson, 2012; Young, 2002). To the extent that issues are global and an international agreement regarding what should be done is reached, it still demands action at lower levels to have effects 'on the ground'. In this respect, states play a key role in the sense that they have the formal power to formulate policies that can create (changed) action. However, lower levels than the state need also to be involved, as action will depend on local contexts and conditions. So, while problems are global, actions to combat them are typically local. The need for sensitivity and adaption to different contexts is similarly stressing the need for locally-based action – see for example, Folke et al. (2005).

Finally, the literature on multi-level governance has been emphasizing the reduced, respectively changing role of nation states (e.g. Pierre, 2000; Eckerberg and Joas, 2004). This is partly driven by effects of deregulated financial markets, but is in the environmental arena also an implication of increased emphasis on necessary cross-country coordination to solve regional issues (e.g. Kern and Löffelsend, 2004). Here we observe different types of regional policy-networks, sometimes with states and sometimes rather with cities or municipalities as key actors. Given this, the concept of polycentrism has been introduced into environmental governance (e.g. Galaz et al., 2012; Ostrom, 2009), typically noting elements of 'self-governance' in the meaning of establishing relationships between centers of decision-making that are formally independent of each other. Their role and effectiveness is nevertheless a debated issue (Galaz et al., 2012).

3. THE GLOBAL CHALLENGES

3.1 Characterizing the Environment as a System

While the physical environment used to be looked at as space and resources for human use – for example, land for agriculture; forests for timber and energy; water for drinking and energy – the focus has become much more on the environment as a dynamic system with its functioning, reproduction and change. Hence, modern ecology and the various earth sciences including studies of the atmosphere, hydrosphere, oceans and biosphere (e.g. Steffen et al., 2005) emphasize the interdependencies between different parts and processes of entire systems all the way from species through ecosystems up to earth system-level processes (e.g. Biermann, 2012; Rockström et al., 2009).

Interaction appears at different levels in space and time. Typically, local processes are quicker while global processes take more time – for example, litter decomposition vs. the global carbon cycle. While ecosystems recycle matter and energy wherein what is a waste product from one species becomes a resource for another species – such as fungi and bacteria turning litter into compounds that trees can later access – no sub-earth system is closed. While this is actually what links processes at different levels, it also implies that the parts of the earth system are not stable over time. Rather we observe a mix of stability and change.

Plants and animals are highly ordered systems containing a tremendous number of processes making it possible to live and grow. Reproduction is also a very ordered process where these capacities are inherited. We can generally say that life both is and depends on a certain level and type of order. At the same time, there is also variability and change. Species compositions change naturally; new species appear as some become extinct.

Cycling of matter and energy is creating various connectivities within the system. Through various biogeochemical processes, we observe global cycles of a series of compounds of importance for life, such as calcium, carbon, nitrogen, phosphorus and sulfur (e.g. Schlesinger, 1991). Again, we may emphasize order, change and variability. Hydrological cycles, ocean and atmospheric movements are all core elements of cycling of both matter and energy. The hydrological cycle – through rainfall, erosion, percolation through soils and movements to lakes and oceans – is a key motor in cycling of matter. Ocean currents are as important, transporting nutrients far away from where they originated and greatly influencing the opportunities for life beyond coastal areas. Similarly, these currents transport energy from equatorial zones to higher latitudes, making temperature variations across the globe much lower than they would otherwise have been. Also atmospheric movements transport energy and have similar effects on temperature variations. Wind is also important for transport of matter, causing depositions both on land and on the sea surface.

Regarding the dynamics of natural systems, one may distinguish between amplifying (positive) and stabilizing (negative) feedbacks. Systems characterized by amplifying feedbacks are destabilizing themselves. Hence, for a system to be sustained over time, existence of stabilizing feedbacks is important. In relation to this, we need yet another concept to be able to characterize complex systems. That is the concept of resilience. Chapin et al. (2009: 9) define resilience as 'the capacity of the system to absorb a spectrum of shocks and perturbations and still retain and further develop the same fundamental structure, functioning, and feedbacks'. Resilience is therefore about the capacity of a system to change and adapt, while still remaining within critical thresholds.

This seems to be the key aspect of global environmental governance – not to maintain stability – but to ensure that the system does not develop beyond important thresholds or tipping points. It is this understanding that lies behind the efforts to define 'planetary boundaries' (Rockström et al., 2009) and trying to define limits to, for example, the emission of greenhouse gases, extinction of species, and emissions of compounds that deplete the stratospheric ozone layer.

3.2 Key Global Environmental Issues

To illustrate the above, but also to indicate some of the variations regarding the different types of global environmental problems and challenges, I will offer a brief overview of the issue of climate change, biodiversity loss and stratospheric ozone depletion.

3.2.1 Climate change

Climate change includes changes in the patterns of temperature, precipitation, humidity and wind, including how these vary across seasons. It is a natural process dependent on, for example, variation in sunlight intensity and the earth's orbit around the sun, including the axial tilt – the so-called Milankovitch cycles. The composition of the atmosphere, the reflective capacity of the earth's surface and the capacity of oceans to store and transport heat are also of great importance, acting as amplifying or stabilizing feedbacks. These latter factors may themselves change as an effect of the changed inflow of sun energy. This complex interplay has resulted in climatic variations over geological time horizons that are quite substantial. Nevertheless, the last 10000 years show a stabilizing climate that may be the reason, for example, for the fact that humans shifted gradually from hunting and gathering to agriculture as their main livelihood.

We are now in a phase where human action – for the first time – influences the development of the climate. This is due to emissions of so-called greenhouse gases, largely following the industrial revolution. From about 1950, the process has accelerated substantially due to steep increase in fossil fuel use, resulting at present in the CO_2 level recently passing 400 ppm – as opposed to 280 ppm before the industrial era. Other important greenhouse gases are methane, nitrous oxide and various fluorinated gases counting for about a quarter of the total increase in radiation forcing (UNEP, 2012).

Based on various projections of future emissions of greenhouse gases, scenarios are made using global climate models to predict future developments in, for example, temperatures and precipitation. These estimates typically predict temperature increases for 'business as usual' in the range of 1–5°C by the end of the century, compared to a reference level being the mean of the period 1960–90. Most scientists see both the speed and potential level of change now observed as very worrying.

The level of emissions of greenhouse gases is strongly linked to economic development. While it is quite a good predictor of emissions per capita, other factors also count, such as the composition of fossil fuels used, access to other energy sources than fossil fuels, the efficiency of energy and transport sectors, whether the country is a large oil producer and so on. Looking at CO_2 emissions, Qatar is at the top with about 50 tons per capita. The figure for the US is 19.3, for Germany 10, while for the EU as a whole it is 8.2. It is notable that China and Sweden have about the same per capita levels of CO_2 emissions: 5.1 and 5.2 tons respectively. The level in India is 1.3, while in Tanzania it is 0.2 tons per capita (World Resources Institute, 2012).

There is much uncertainty concerning climate change and its future development. First, the development in emissions is uncertain and dependent not least on political decisions. Second, the role of various stabilizing and amplifying feedbacks is uncertain. Land and sea retains about half of the CO_2 emissions. This is a huge stabilizing factor, while there is uncertainty for the future due to complex interactions between temperature, CO_2 concentrations and nutrient cycles. It is likely that these stabilizing feedbacks will weaken during the present century (Steffen et al., 2005).

As important are the amplifying feedbacks following from melting ice and the thawing of permafrost soils. The former will reduce albedo, which next reduces reflection of sun energy back into the universe. Hence, more of the energy will be trapped as heat. The latter concerns potential release of large amounts of CH_4, which is now stored in the frozen soils. If the latter happens, there is the risk that 'a natural process' – instigated by human activities – may speed up global warming tremendously.

Consequences of global warming for the biota – humans and other species – are many and may be severe. They are also uncertain, not only because of uncertainties in expected emission levels and various feedbacks. There are also a lot of uncertainties related to how a defined increase in temperature influences the dynamics of the system directly through, for example, precipitation/frequencies of floods and droughts, erosion, severe storm events, sea level rise, ocean currents and their dynamics. These uncertainties amplify when we look at more indirect effects like the implications for food production, availability of fresh water, distribution of diseases, species adaptation, ocean acidification and so on.

The above has spurred a process of defining safety levels – what is a safe level of emissions, of atmospheric change, of temperature rise. The IPCC has defined a 2°C temperature threshold (IPCC, 2007), specified as a concentration of CO_2 in the atmosphere at about 450 ppm. There is uncertainty, and Rockström et al. (2009) specify 350 ppm as the 'safe' limit.

The structure of the climate problem raises tremendous challenges for the global 'polity'. It implies that a common limit should be defined regarding emissions and distributed across countries. Defining both limits and distribution rules is extremely demanding, as fossil fuels are so important for our economic development. The fact that some countries are rich, and may not want to lose their position, and some are poor, and demand development, is a vast challenge to overcome. Moreover, if agreements can be made, it seems demanding to ensure effective compliance.

3.2.2 Biodiversity loss

The number of known/named species is in the order of 1.5 million (Keller and Botkin, 2008). This is, however, only a proportion of all species on Earth. Keller and Botkin (op.cit.) indicate that the total number could be in the order of 3–10 million. Stork (1997) and Mace et al. (2005) offer even higher estimates, that is, 5–15 million and 5–30 million respectively.

Biodiversity richness varies across the globe. It is typically highest in the tropics. Many tropical forest areas are characterized as biodiversity 'hotspots' (e.g. Myers et al., 2000). Biological processes play a core role in maintaining the dynamics of various processes both at local and global scales. Different species fill different 'niches', that is, they maintain different processes of importance for the larger system they are part of. Moreover, variation is a kind of security. As emphasized above, no system is fully in equilibrium. There are always changes going on. External shocks may appear. Hence, diversity within a species increases the chance for it to survive if external conditions change. Similarly, an abundance of species maintaining a certain function in an ecosystem increases the chance of that system surviving despite some species becoming extinct. Therefore, variation and redundancy are important for longer-term survival of species and ecosystems' functioning.

While a certain stability of ecosystems is also of very high importance for the human species, biodiversity is important for more direct economic reasons. Certainly, food production is highly dependent on a variety of species. While only about 110 plant species provide the basis of almost all food in the world (Dolman, 2000) – which actually is a concern in itself – variation in genetic material is crucial for the long-run functioning of the food system. This is not least important for the ability to develop new crops in the face of environmental change, capacity to combat diseases and so on. As important is the role various plants play in both 'traditional' and 'modern' medicine. The whole industry of biotechnology depends on natural variation. Finally, maintenance of biodiversity is important for recreational, cultural and aesthetic reasons. Variety is a source for both cultural identity and experience. As important are moral arguments based on the view that various life forms have an equal right to exist.

While change is a natural and necessary element of living systems, the speed of change – the magnitude of species loss – may create concerns. Present extinction rates are estimated to be about 100–1000 times higher than the typical or 'natural' level (Mace et al., 2005; Pimm et al., 1995). Without action, they are expected to increase. Based on data from Mace et al. (2005), Rockström et al. (2009: 15) conclude that 'currently about 25% of the species in well-studied taxonomic groups are threatened by extinction'.

It is very demanding to combat biodiversity loss. In some respects, it is even more difficult to handle than climate change, while in others it seems easier. It is more demanding as the processes creating biodiversity loss are so diverse. 'Solving' the climate problem is mainly about changing the energy system and technically one could get far 'just by' instituting a global tax on fossil fuels. The processes behind biodiversity loss are many, for example, emission of various pollutants, land conversion and fragmentation, climate change. These processes are again fundamental to modern economic development. Hence, the whole model of development is challenged.

There are also some factors that make it easier to reduce biodiversity loss. One is the fact that problems are more local and at least issues related to land use demand regional or local action 'only'. This is, however, a conditional truth as the costs of protection reduce the competitiveness of firms operating globally. Another 'simplifying' issue is that biodiversity is also valuable in its own right. Hence, there are some incentives to protect biodiversity for more 'narrow' economic reasons.

3.2.3 Stratospheric ozone depletion

The third case I want to visit regards the depletion of the stratospheric ozone layer. While ozone (O_3) causes problems at the surface of the globe – reduces plant growth and harms health – stratospheric ozone protects the globe against damages from high levels of ultraviolet radiation. The reduction of the latter is caused by emissions of chlorofluorocarbons (CFCs) used mainly as refrigerants.

At the start of a supposed industrial adventure, the problem CFCs could cause for the ozone layer was unknown and science did not have the equipment to measure stratospheric ozone depletion. In the 1970s, scientists discovered, however, that these compounds represented a serious threat (Chasek et al., 2010). During the 1980s, the so-called ozone hole in the atmosphere in polar regions was established as a fact. Steffen et al. (2005: 236) writes:

> Stratospheric ozone depletion is an example of a powerful, non-linear feedback system, as well as a clear case of anthropogenically driven chemical instability in the Earth System. The rapidity with which the ozone hole developed is characteristic of threshold-abrupt change behavior. Luckily in this case the damage is reversible, albeit over a considerable period of time.

The structure of the 'ozone problem' seems politically less challenging than the previous two problems. It is caused by only one compound, and while important, the link to the model of development is much weaker. Moreover, few countries have been involved in producing CFCs. It is finally notable that the negative effects are largest for people in rich counties.

4. INTERNATIONAL ENVIRONMENTAL AGREEMENTS

How then have the above problems been treated politically? How have the differences in problem structures as indicated above materialized? In this section, I will respond to these questions by describing the main developments in each field of study – looking both at the policy processes and outcomes. As the above issues have international, even global dimensions, the focus in this section will be on international agreements including common goals and agreed responsibilities defined for different countries. Turning shared goals and responsibilities into action 'on the ground', is still mainly with nation states. That issue will be visited in section 5.

Studying international environmental treaties in isolation from wider political and economic factors is not a very useful exercise. Looking in depth at these issues is, however, not possible in one limited chapter. My 'solution' has therefore been just to illustrate some relations and mechanisms between the more general international economic regime and the environmental ones.

4.1 The Climate Agreements

While the greenhouse effect of atmospheric CO_2 was identified at least as early as 1859 – by John Tyndall – it took a long time before the issue became political. As noted, the use of fossil fuels increased considerably especially from 1950, but it was first in the 1980s that the topic gradually entered the political arena. The first World Climate Conference was held in 1979, but attracted mainly scientists and NGOs. The Intergovernmental Panel on Climate Change (IPCC) was established in 1988 under the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP). At the Rio conference in 1992, the UN's Framework Convention on Climate Change (UNFCCC) was signed. It emphasized that the industrialized countries had a particular obligation to reduce emissions. It was suggested that these should be stabilized at the 1990 level by the year 2000 (Cicero, 2003).

At the Rio summit, the so-called Conference of the Parties (COP) to the UNFCCC was also instituted to create a forum for specifying further the commitments to reduced emissions. The first COP was held in Berlin in 1995. The EU was pushing for a binding agreement, while the so-called JUSCANZ group (Japan, USA, Canada, Australia and New Zealand) opposed negotiations for reduced emissions (Chasek et al., 2010). At COP3 – in Kyoto in 1997 – the Kyoto Protocol was nevertheless agreed. It established a plan for reducing the emissions of greenhouse gases among the so-called 'Annex I' countries – that is, industrial countries plus Eastern Europe – to a level about 5 percent lower than that of 1990 by 2008–12. To be operative, the protocol had to be ratified by at least 55 countries, covering at least 55 percent of the total emissions of the 'Annex I' countries. The reductions were not equally distributed among them. While the EU and many Eastern European countries were asked to reduce their emissions by 8 percent, the US quota implied a reduction of 7 percent. The level for Russia was zero and Australia was allowed to increase its emissions by 8 percent (UN, 1997). Notably, there was an intense debate over the allocation of reductions. The protocol also included three 'flexibility mechanisms' to reduce costs. It opened up for trading emission quotas between the Annex I countries; it instituted joint implementation (JI) between the same countries allowing one Annex I country to pay for measures in another; and it established the clean development mechanism (CDM), enabling Annex I countries to invest in measures in developing countries.

The ensuing process was also difficult. At COP4 (Buenos Aires, 1998) the US demanded 'meaningful participation' also by core developing countries. There was little progress at COP5 and COP6. In 2001, the US finally withdrew after the Bush administration came into office. Then, at COP7 in Marrakesh in 2001, a detailed set of rules was agreed on by the states attending. This agreement was weaker than the initial Kyoto Protocol since the US did not join. Moreover, the rules themselves were made less stringent, a compromise to ensure that countries such as Japan, Russia and Canada were willing to ratify the agreement (Cicero, 2003). In late 2004, Russia finally ratified, which meant that the threshold of 55 percent of emissions had been reached, and the protocol became operative from February 2005.

The functioning period for the Kyoto Protocol ended in 2012. At the COP13 in Bali (2007), discussions about a post-Kyoto agreement started. Due to strong disagreements on levels and distribution of cuts, no agreement was reached in time. Hence, at the COP17 in Durban (2011), the parties agreed to postpone an agreement until 2015. Developments during the COP19 in Warsaw (2013) and COP20 in Lima (2014) indicate that agreeing within even this prolonged timeframe may not be achievable. It is clear that no post-Kyoto agreement will be signed if obligations are not also defined for developing countries. The discussion on overall levels of cuts, distribution of obligations to cut and the distribution of the costs thereof relate dominantly to challenges they pose to development and global hegemony.

This situation does not imply that countries do nothing. There is, however, a move from 'obligations' to 'pledges', that is, countries have stated levels of cuts they aim for by, for example, 2020 and 2050. The

IPCC (2007) concluded that cuts at the level of 50–85 percent are necessary to ensure that the 2 degrees threshold is not exceeded. According to the IPCC, serious cuts are necessary by 2020. There is to date nothing that indicates that such reductions will happen.

As already suggested, the climate change issue links to a set of serious political and economic issues. Cheap and highly concentrated energy from fossil fuels has made it possible to grow economies in an unprecedented way. We moreover observe how developed countries are afraid of losing out in international competition if they commit themselves to large cuts especially before the fast-growing economies, like China, Brazil and India, also commit themselves. This is so, despite the fact that per capita emissions are much lower in these countries. It is notable, though, that China is 'catching up' rather quickly. The difficulties are greatly magnified by the system developed for international trade. Effective climate change mitigation demands highly coordinated action to be successful. It is, however, to be introduced in a world of ever-stronger mobility, separation and competition in the economic sphere.

4.2 The Biodiversity Treaties

The development of multilateral agreements focused on the protection of biodiversity has a history dating back to the 1940s. The first example was the International Convention for the Regulation of Whaling from 1946. From the 1970s and onwards there have been more comprehensive developments, not least under the lead of the UN. The Ramsar Convention on Wetlands of International Importance was established in 1971. In 1973, after the UN Conference on the Human Environment in Stockholm in 1972, the UN Convention on International Trade in Endangered Species (CITES) was established, and the Bonn Convention on the Conservation of Migratory Species was agreed upon in 1979 (Chasek et al., 2010). A series of bilateral and multilateral agreements in fisheries around the globe – while mainly being directed at maintaining productive stocks for the world's fisheries – also has implications for species and habitat protection.

At the Rio summit in 1992, the more general UN Convention on Biological Diversity (CBD) was established (UN, 1992), and by late 1993 enough countries had signed to make it operative. The CBD is based on the precautionary principle. The underlying aim is to balance the opposing interests of economic utilization of biodiversity/genes and the need for protection. In many ways, this is a North–South conflict. In accordance with this, the CBD focuses on conserving biodiversity, sustainable use of its components, and sharing the benefits from, for example, commercial use of genetic resources.

Furthermore, it is a typical 'framework convention', implying that more specific treaties or conventions have to be developed under its 'wings' to create a basis for more concrete policies. The International Tropical Timber Agreement (UN, 1994) and the Cartagena Protocol on Biosafety (UN, 2000) are examples of such treaties. It should also be noted that at the COP 10 in Nagoya (2010), the parties to the CBD agreed on the so-called Aichi Biodiversity Targets that, among others, state that 'By 2020, the rate of loss of all natural habitats, including forests, is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced' (UN, 2010).

Chasek et al. (2010) note that it has not been easy to find ways to operationalize the CBD. They state that this reflects 'the diffuse nature of the regime's rules and norms, the absence of a strong lead-state coalition, the absence of an enforcement mechanism, and a general lack of political will to strengthen the regime' (p. 230). They note that the COPs under the CBD have been able to ensure some progress regarding the identification of global conservation priority areas and developing protocols/working programs on conservation and sustainable use. The developments regarding the issue of access to genetic resources and benefit sharing are much more conflict-ridden.

In relation to the latter, we note a rather deep cleavage between the ideas of the CBD and those governing international trade – that is, the WTO agreement. This became evident not least in the process behind the advancement of, on the one hand, the WTO Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS), and the CBD. Three issues have been addressed: the right to patent biological material, the right to trade GMOs, and the distribution of the income from the use of local species/genes in the GMO industry. These issues are interlinked. The TRIPS agreement emphasizes the importance of securing free trade and the right to use patents in the case of intellectual property – including modified genes and organisms. Certain compromises have already been made in the TRIPS agreement, implying that while micro-organisms are generally patentable, states can exempt plants and animals of a higher order through national legislation (WTO, 1994). In 1999, a process of revising the agreement started. In this process, the US claimed that the exceptions from patentability in the current agreement should be removed, while many developing countries – such as India and many African countries – favored a more restrictive policy (WTO, 1999). Because of these conflicts, the TRIPS revision is still not completed.

In the development of the Cartagena Protocol on biosafety under the CBD, some of the above disagreements resurfaced. Although the US has not signed the CBD, it was still allowed to participate in the process.

The main conflicts appeared between the so-called 'Miami countries' (Argentina, Australia, Canada, Chile, Uruguay and the United States) and 'The Like-minded Group' consisting of many developing countries. The EU took a middle position. The Miami countries wanted a solution that gave preference to the WTO rules. The developing countries wanted a Cartagena Protocol that had precedence over the WTO agreement. In WTO 'law' the core agreement here regards the so-called SPS rules – the rules for sanitary and phytosanitary measures. These rules demand risk assessments to be based on appropriate scientific evidence, that is, that potential harm is proven. The argument behind the development of the Cartagena Protocol was that in many cases such evidence cannot be delivered. Since safety hence can often not be proven, a precautionary practice should be allowed. The result was a protocol that granted more rights to regulate imports than implied by the WTO rules (Melchior, 2001), and the precautionary principle is granted a basic status in the protocol (UN, 2000). However, the protocol cannot be interpreted as changing a party's rights and duties in other areas of international law.

So regarding biological material, the situation is characterized by competing international rules. To illustrate the implications of the situation, the EU de facto ban on imports of GMOs from 1999 is interesting. It was based on the Cartagena Protocol – specifically its acceptance of precautionary action. The ban followed a process within EU where not least civil society organizations reacted to the development of the GMO sector. A panel ruling by the WTO[2] in 2006 stated that bans on GM products by individual EU member states were illegal with respect to the SPS agreement. Since the US is not a signatory either to the CBD or the Cartagena Protocol, it argued that the protocol had no power regarding trade between the US and EU countries. In relation to this, it is notable that the ruling of the WTO panel nevertheless 'sidestepped the issue' whether EU legislation on biotechnology was illegal and did not express any opinion on whether GM foods were safe for consumption. It simply concluded that the EU had breached prior commitments under the SPS agreement by disallowing market access for some 21 products (European Union Center of North Carolina, 2007). So, while the WTO system is clearly the stronger of the two, the role of the precautionary principle is still internationally not clarified.

[2] In the WTO system there is a panel procedure set up to handle disagreements between members.

4.3 The Agreements for Stratospheric Ozone Depletion

Based on a growing understanding that emissions of chlorofluorocarbons (CFCs) were a threat to the stratospheric ozone layer, a process towards establishing an international regulation started in the late 1970s. In this case, the US was the most engaged party seeking for an international agreement. This was so despite the fact that it accounted for about 40 percent of the CFC production in the world. Together with Canada and the Nordic countries, they took on a lead role. The EU opposed controls, while being an even greater producer of CFCs than the US. Chasek et al. (2010) note that developing countries such as Brazil, China, India and Indonesia were also skeptical because of the future opportunities they saw in CFC production.

The first agreement regarding protection of the ozone layer – the Vienna Convention from 1985 – affirmed the importance of protecting it, but did not mention the CFCs at all. Shortly after the signing of the Convention, new and strong evidence on the development of the 'ozone hole' was published, and in response to this, the US pushed for further negotiations, resulting in the Montreal Protocol of 1987. It mandated that industrial countries reduce CFC emissions by 50 percent (UN, 1987). Chasek et al. (2010) emphasize that the change in the EU position was a result of several factors: some EU countries were pro-regulation, the executive director of UNEP played a significant role in pushing for an agreement, pressure by the US and European NGOs, and reluctance by the EU to be the cause of negotiation failure.

In the years following the signing, there has been a substantial strengthening of the protocol through amendments. The EU shifted its position to take on a lead role. Important in that respect is the fact that in 1988 DuPont announced that they would be able to produce a substitute for CFCs. Hence, an agreement of phasing out CFCs by 2000 – the so-called London amendment – was agreed in 1990. A fund was also created to support developing countries in implementing the protocol. According to a report from the UNEP (2008), there was a steep reduction in the production of CFCs from 1989 and close to a phase-out by 2004. By 2009, all UN member states had ratified the protocol.

4.4 How to Understand the Differences?

In the above, we have hinted at several reasons why developing strong international agreements in the environmental realm is difficult. As emphasized by Underdal (2002), many of the problems are of a malign type. There are huge uncertainties involved. Hence, indisputable scientific proofs are hard to deliver. Easy technological fixes are typically not available. The structure of the economic system poses in itself serious obstructions as interests are so strongly formed around competition and economic growth. The way economic decision units are formed, the institutionalizing of the profit motive and pooling of capital through the institution of stocks have created a structure that has a tremendous force in changing the surface of the globe through the established positive feedbacks between investments, technological development and mass consumption. Politically, the problem surfaces at two levels. States are afraid of making too strict regulations for fear of losing out in the fight over attracting investments. Equally important is the 'compromise' of mass consumption. The legitimacy of the existing political system seems heavily based on the economy's ability to grow.

Comparing the climate and ozone agreements may offer some further insights into what is at stake here. The climate negotiations have really not produced much, despite the fact that they have been going on for 25 years. While less and less disputed, there are always opportunities to attack the science. The problems are expected to surface mainly (far) into the future and timing – when it is necessary to act – therefore becomes an issue. As already emphasized, climate change challenges the existing development model at its basics. The conflict between rich and poor countries is very strong and the intra-generational issue of justice creates problems for a solution to the inter-generational ones. It is also notable that the South is expected to be hit more than the North. The costs of decarbonizing the economy are substantial and the 'carbon-industry' is politically very strong.

In the case of stratospheric ozone depletion, we observed a rather quick resolution. Here the science – while disputed at the start – was soon agreed upon by all parties. The depletion of the ozone layer was very quick and countries in the North were potentially the most exposed. A technological fix was soon found, while it is worrying to observe that a single industry – a few companies really – seems to have had such a big influence on the position of the EU early on. The full 'breakthrough' came first after DuPont had developed a substitute. Maybe the shift of EU from a 'veto' coalition to a 'lead' actor came when it realized that a phasing out of CFCs could become an industrial advantage and not a handicap?

Certainly, observing the series of 'benign' conditions that seem to have to be in place to create an effective international environmental agreement in the case of CFCs may seem disappointing with regard to the future opportunities. However, before we look a bit more into that, I will turn to the issue of how the above agreements have been transformed into operative policies – that is, what kind of governance structures dominate.

5. CHARACTERIZING THE GOVERNANCE STRUCTURES

Converting treaties into action demands changes in governance structures and the power to do so lies mainly with nation states. The existing governance structures regarding resource use are primarily characterized by private property and markets/trade. Rights are defined and protected through political processes and trade is both 'regulated' and 'liberated' through political decisions. Nevertheless, while these governance structures are politically created, they are not easy to change politically. First of all, rights are rights because they are protected. So while shifting rights is often necessary when trying to reduce environmental problems, this is politically demanding. This follows simply from the logic underlying their existence. Second, governance structures support, but also create interests. Hence, the governance systems in place typically 'protect themselves' because of the interests created.

In this section, I will first offer a brief introduction to the use of legal instruments and state command. Environmental policy has historically been oriented towards using the law to change action. Over time, we observe a shift towards use of economic instruments, including markets. The larger part of the section will cover this development, emphasizing that what has been called a turn to the market, may be less so after a deeper look at what has been happening. It is important to note that environmental policies were in place before the era of international environmental agreements. When I in the following look at key (national) policies in the fields presented above, one should not infer that all of them originated due to international treaties.

5.1 Legal Regulations – Command – Forms the Basis

International treaties have been turned into practical policy first of all by defining or redefining rights. The Kyoto Protocol puts a cap on emissions of greenhouse gases for certain countries. It limits the previous unconstrained emissions. As a cap, it can, however, also be seen as a right to emit up to the cap – turning it into emission permits. The role of signatories has been to define how their part of the global permit should be allocated among sectors of the economy. Similarly, the London amendment set a cap on CFC – a strong one in the form of a phase-out. Despite the Aichi Targets, the CBD is less clear in the respect of defining quantified objectives. This certainly also reflects the much more complex nature of the problem.

So command – caps or targets on emissions – forms important bases for national policies. In the case of the ozone regime, command – the ban – has been the key solution.[3] Based on the Montreal Protocol with amendments, countries have instituted national laws ensuring a legally binding phase-out. This policy has been successful. In a report dedicated to the 20-year anniversary of the protocol, the UNEP (2007: 11) concluded that:

> today, developed countries have phased out the production and consumption of over 99 percent of all the chemicals controlled by the Montreal Protocol. With the assistance of the Multilateral Fund, by the end of 2005, developing countries had projects approved for the phasing out of 231 000 tonnes of consumption and 156 000 tonnes of production, and had achieved a reduction of 72 percent from their historic level of consumption.

Since then, further reductions have been accomplished. It is notable that an economic instrument, the Multilateral Fund, was important in supporting the reductions in developing countries.

In the case of greenhouse gas emissions, countries have chosen different strategies regarding how to distribute responsibilities for cuts between sectors. The focus has mainly been on energy-intensive industries. While regulations have been focused on defining technology standards, a main development regards the establishment of a system for tradable emission permits – see section 5.2.

In the case of biodiversity protection, we similarly observe that states have used command power to protect certain areas or habitats through national parks and various types of nature reserves. As opposed to policies on CFCs and emissions of greenhouse gases, this policy area developed long before any international treaties were formed. It was motivated by classical nature conservation ideas – for example, the establishment of the Yellowstone national park in the US in 1872 – or the interests of ensuring access to game – as not least emphasized by colonial powers in Africa through the establishment of reserved areas throughout late nineteenth century and onwards. Much of this policy has been continued by the new administrations in place after the liberation from colonialism.

Regarding the protection of habitats, we see a change in the 1990s from a 'fence and fine' strategy to more participatory processes – for example, community-based forest management (Hutton et al., 2005). This is not least typical in many developing countries. The community conservation paradigm has been highly influential and although later criticized for multiple shortcomings, it is still widely accepted as the essential way to realize effective and socially sound governance of protected areas.

[3] The US also used taxes and the EU a cap-and-trade system in the phase-out period (Hammitt, 2004).

5.2 Economic Instruments

Economic instruments include taxes, subsidies and various forms of markets, like cap-and-trade systems. From the 1980s, we observe a gradual turn towards more use of such instruments in the protection of environmental systems, typically in combination with legal regulations. We observe taxes in areas like emissions of SO_2 and NO_x (Harrington et al., 2004). The US cap-and-trade system regarding SO_2 is seen as an important step forward regarding the use of economic instruments. Regarding the areas we are looking at in this chapter, it is notable that some European countries instituted fossil fuel taxes before the Kyoto Protocol was signed (ibid.).

While there are different types of economic instruments used in the environmental areas focused on in this chapter, I will limit the presentation here to the trend towards relying more on markets. In that respect, I find it reasonable to divide the systems in two (see also Vatn, 2015). First, I will look at systems that do not depend on changes in rights – that is, non-liability-based systems. Often these are called voluntary, while as we shall see, this is not always a good categorization.

Second, we have systems based on changes in rights – that is, liability-based ones like cap-and-trade systems. These systems are based on responsibilities for cuts that are (re-)allocated through trade. While trade is introduced, the basis is nevertheless the public regulation in the form of the liability established.

Below I will offer a brief overview of these systems. It is notable that while the two types of systems are used when states operationalize international treaties, we observe them also in formats with no explicit link to international treaties. This is especially the case for some non-liability systems like certification. It seems clear that the international treaties and the debates following around their establishment and functioning are part of a raised awareness that lies behind the creation of many of these systems. They are, however, largely established as part of commercial strategies and not as part of public policies.

5.2.1 Non-liability-based systems

Payments for ecosystem services (PES) and certification systems are key examples of non-liability-based schemes. Being non-liability-based means that public authorities have not defined obligations that economic actors need to abide by. As we shall see below, this has actually implied that the state/public bodies are key actors in some of these systems.

Payments for ecosystem services (PES) Payments for ecosystem services are important for both biodiversity protection and carbon storage/

climate change. Many understand PES as a market for such services, emphasizing that it is a voluntary transaction between buyer(s) and seller(s) (e.g. Wunder, 2005). In practice, however, the money used for payments is often gathered through non-voluntary means – for example, taxes or user fees. Therefore, while PES is based on economic incentives, the role of markets is minimal. Moreover, being a non-liability-based system, rights are not changed. Payments are typically offered if somebody 'does better' than the status quo – that is, PES tend to protect status quo rights of, for example, landowners.

PES systems exist for water, landscape amenities, biodiversity and carbon. Systems for water management are by far the largest and that for carbon the smallest. Keeping to our focus, I will concentrate the presentation on biodiversity. Since systems for carbon are dominated by cap-and-trade, I will focus on climate change policies first in section 5.2.2.

Based on data from Milder et al. (2010), I have calculated that actually about 99 percent of the resources raised for biodiversity protection through PES systems in 2009 – a total of about 1.5 billion USD – come from taxes or fees (Vatn et al., 2011). Hence, the basis for PES resources is state command. The reason for this seems to be twofold. First, a market-based PES system will be confronted by a serious free-rider problem. While the cost accrues to the buyer of the service, gains are spread across many people. This reduces the motivation of private actors to do anything, while there are some voluntary actions – 1 percent of the total for biodiversity – observed through NGOs and firms that involve themselves on the basis of philanthropic motivations or use PES to position themselves in commodity markets. Public systems with taxes and fees circumvent the free-rider issue (ibid.).

Second, we have the aspect of transaction costs. Direct trade between 'buyers' and 'sellers' is typically very costly. This seems to explain why intermediaries seem to dominate. The reason why public bodies dominate as intermediaries is that they often can link 'payments' from citizens to already existing tax or fee systems. Hence, setting up and 'running' a separate system for collecting resources to protect environmental resources is not necessary.

While almost all resources for PES for biodiversity protection – actually also for water and collective landscape values related to scenic beauty and recreation – are raised through command, public agents may next use the money raised to trade with 'sellers'. While payments predominantly take the form of subsidies, trade-based systems, particularly in the form of auctions, are also observed. We finally note that PES programs may be linked to areas put under legal protection by the state, and PES programs operate de facto as a form of compensation for the loss of property or use rights.

Certification Another non-liability system is that of certification. The logic here is to set standards for products and/or production methods. They may relate to product quality – that is, private good aspects. They may, however, also be linked to environmental standards: for example, methods for organic production and environmentally friendly agriculture; harvesting practices and biotope protection in forestry; and stock management and catch practices in fishing. The idea is that 'concerned' consumers are willing to pay an extra premium for these products and in this way support more sustainable production systems.

While states may play an important role in the process of setting standards, this is nevertheless an area where voluntary action from firms and consumers is very important. According to Forest Trends and Ecosystem Marketplace (2008), about 2.5 percent of the global food market regards certified products. According to Nathaniel and Jenkins (2012), the absolute value of certified timber is almost the same as for food, implying a clearly higher percentage.

While certification may be driven by care for the environment, it utilizes the profit motive of firms and the willingness of consumers to pay voluntarily for common goods like biodiversity. While offering opportunities, the limitations are found in this mix of motivations. First, for certification to work, there must be a marketable product involved. Hence, if protection of an ecosystem demands reduced production, certification is of very limited effect, while we note that rules may demand that specific biotopes, for example, are set aside for protection. Another limitation relates to what level of extra payments consumers are willing to offer for the commodity sold. Being individual payments for common goods, the willingness depends not least on the strengths of norms regarding what responsibility consumers should take on. While the certified section concerning agricultural products is fairly low, it is increasing (Forest Trends and Ecosystem Marketplace, 2008), indicating that such norms are gradually being strengthened.

5.2.2 Liability-based systems

In the case of liability-based systems, carbon trading is clearly the most important, being also explicitly linked to the flexibility mechanisms under the Kyoto Protocol. I will look briefly at biodiversity offsets too, as one of the most important expanding 'market-based' systems in the field of biodiversity protection. In this latter field, protection by law still dominates.

Carbon trading According to the Kyoto Protocol, each country is allocated a responsibility for reduced emissions. It has then to distribute the implicit emission allowances given by this cap to sectors/firms. According to the protocol, trading is allowed to reduce the costs of operating within the limit set. There are actually several carbon markets, of which the EU emission trading scheme (ETS) is the largest. According to the World Bank (2012), the total value of the existing carbon markets in 2011 was 176 billion USD. Of this, EU ETS accounted for almost 85 percent. The next largest volume was the secondary CDM market – 22 million USD – while the primary CDM market amounted to almost 3 billion USD. It should be mentioned that the total value also includes 569 million USD from the 'voluntary' market – that is, a fraction that, while small, is outside the cap-and-trade system.

In the carbon market, buyers, intermediaries and sellers are predominantly private actors. As already noted, states define caps and turn them into emission allowances. They moreover define the rules for trading and ensuring compliance. The dominance of markets in the case of carbon as opposed to biodiversity may be explained by the fact that trading is much easier in this case. It is largely built on an already existing commodity – fossil fuels – which makes market operations much simpler than in the case of, for example, biodiversity. Hence, transaction costs are relatively low. I also note that the choice of cap-and-trade as opposed to taxes on fossil fuels may be explained by the practice of grandfathering quotas. This way costs for industry are heavily reduced. This may be especially important in this case as not all countries have reduction responsibilities, as is the situation with the Kyoto Protocol.

The ETS and the CDM have been accused of fraud (e.g. Ostrom, 2009). The motivation is to reduce costs. Especially in the case of CDM, there are many possible loopholes related not least to the problems of defining additionality. So certified emission reductions (CERs) are received in cases where the investment – for example, a hydroelectric dam – would be undertaken anyway.

There is also the issue of how just it is to trade in carbon between countries in the North and South. A key reason why things are cheaper in the South reflects the fact that people are poor. This issue has surfaced not least in the recent initiative to reduce emissions from deforestation and forest degradation (REDD+).

Biodiversity offsets with habitat banking Biodiversity offsets – while originating in US wetland policies as early as the 1970s – are first starting to expand rather recently. Again, the basis is a public regulation defining, for example, a limit for land 'development' or a restriction on species loss. To the extent that loss of nature values – in this case biodiversity – cannot be avoided locally, a compensation project somewhere else can be accepted as a way to abide by the set limit.

According to Madsen et al. (2010), there are 39 'compensatory mitigation programs' around the world. They estimate the annual market size to be at minimum 1.8–2.9 billion USD.[4] About 85 percent of the traded volumes are found in North America. The system has also been used quite a lot in Australia. Canada, Brazil and some EU countries are following.

A positive aspect of biodiversity offsets is that they may make higher levels of biodiversity protection acceptable to the extent that costs for protection are reduced. At the same time, there are challenges. One concerns the difficulty in defining what is 'equal'. For example, draining a wetland close to the sea for building purposes can be mitigated by establishing a new one, restoring or expanding an existing one upstream. How then to evaluate 'likeness'? Which aspects to include: biodiversity, water management and purification, landscape values, opportunities for people to experience wildlife? How to ensure that one system delivers the 'same' as another in a case with such compounded complexities? The closer in space the rehabilitation site lies, the larger chance of minimizing 'net losses'. On the other hand, the gains of trading will typically be lower, too. Hence, the stricter the restrictions for 'likeness' are, the lower the potential gains from trade will be.

We also need to mention again the incentive problems following the motivational structures involved, being parallel to those of carbon markets. The interest of the parties to the trade is to get the credits. The interest in the services lies mainly with the public as represented by the state, county or municipality as regulator. In line with this, Benayas et al. (2009) and Gibbons and Lindenmayer (2007) refer to different studies documenting rather high rates of non-compliance with agreed conditions in their reviews of offset schemes with habitat banking.

In relation to the above, it is notable that some level of 'envy' is observed in the 'CBD community' over the capacity of the carbon regime to create so much money for climate mitigation through establishing markets. Hence, at the COP 10 in Nagoya there was much talk about 'innovative financial mechanisms' for protecting biodiversity (COP 10, 2010). The idea that markets create resources for biodiversity protection seems, however, to be based on a misunderstanding. The carbon market does not create resources for protection. The protection is in the cap. The financial transfers just measure the volume of shifted responsibilities as defined by the markets themselves.

[4] Madsen et al. (2010: vii) emphasize quite strongly that this is a low estimate because 'about 80% of existing programs are not transparent enough to estimate their market size'.

6. IS THERE A WAY FORWARD?

Policies for environmental protection are demanding. This is so because we seem stuck in a system characterized very much by competing corporations and competing states. Moreover, intra-generational injustice at different levels makes it hard to assume that inter-generational justice can be prioritized.

The main strategy of today is in searching for technological fixes. Such solutions ensure that one does not need to attack the existing governance structures – on either the economic or the political level. My evaluation is that while technological change is a necessary element in ensuring progress, it is a far too limited strategy. Focusing also on the institutions governing economic and political processes is necessary. One element here is to push for more equal power between the global trade and environmental regimes. The proposal of a World Environment Organization (Biermann, 2000) is an example in this direction. Strengthening existing agreements regarding higher ambitions and more power to the treaties themselves to enforce the agreements is another important element of a strategy for strengthening global environmental governance.

While these kinds of changes may seem somewhat weak compared to the problems being faced, they are nevertheless politically quite challenging. At the same time, if we only think about what is realistic given present states of affairs, we will not get far. Alternatively, to think in utopian terms may actually be a better way. At least it is the only way to create an understanding of the seriousness of challenges. Limiting one's thinking to what is politically feasible implies, I think, that the 'game is lost'. The future demands that at least some are willing to think far beyond 'the box'.

So what could a utopian world regarding environmental governance look like? While this question is so huge that it demands the format of a book to be treated in any reasonable way, let me close by sketching the two most obvious elements. The challenge we face fundamentally regards our ability to operate within physical limits – within planetary boundaries. This concerns both the level of appropriation of resources and the changes in the dynamics of the system. Defining such limits is riddled with difficulties. While not being able to make any precise assessments, we know that these problems are generally greater the bigger the economy is. Hence, one step would be to develop economic and political institutions that do not demand a growing economy. This implies looking beyond the level of global environmental treaties. It rather seems to demand a change in the dynamics of the economy at its basis. It demands a shift regarding the way companies are organized and interact – whose logic its decisions are based on. It would moreover need to change the way financial risks are treated.

To the extent we manage to find solutions to this structural problem, we would need to ensure that companies are carrying direct responsibility for impacts of their actions on the environment. Hence, we would need to create firms that are willing to cooperate with political authorities in defining the limits for their actions. In that sense, the challenge is to establish a production system where cooperative will characterizes decision-making. Certainly, we do not yet know what this would mean in practice. However, institutions such as money, stocks, the bottom line, the corporation, and financial derivatives were not envisioned either before they were created through economic, political and social processes.

Next, we need to ensure a much more just distribution of resources and consumption within the limits. If there is room for economic growth, it should all be offered to the poor. This is important in itself, but would also be a necessary basis for being politically able to sustain an economy less based on growth. There is, moreover, evidence that equality offers gains for societies beyond equality itself (e.g. Wilkinson and Pickett, 2009). Finally, while the strategy of ensuring equality through growth has not been able to deliver, we have now to acknowledge that it is a locked avenue. Certainly, in rich countries, mass consumption has become the 'great class compromise'. While inequalities persist, access to mass consumption is the form of 'justice' that the present system can most easily deliver. At present consumption levels in rich countries, there seems little to gain regarding creating happy and meaningful lives through increased consumption (e.g. Layard, 2005). Rather in the utopian society, the new 'frontier' for meaningful and hence happy lives lies in making good lives within limits.

The present turn in environmental governance to the market is rather curious when thinking in terms of the above 'scenario'. It could, however, be expected, as it links up directly to the logic of the existing governance structure. It has been seen as great progress since it also has managed to engage the financial sector in environmental issues. This way of thinking, however, takes this sector for granted and accepts that the problems should be handled by using the language, and perspectives that characterize core present actors and institutions. Given the challenges that environmental governance is faced with, it is through changing these structures that solutions will be found. For that we need visions about institutions not yet created.

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17. Economic instruments in policy mixes for biodiversity conservation and ecosystem governance

Irene Ring and David N. Barton

1. INTRODUCTION

Biodiversity conservation usually builds on strategies involving a wide range of policy instruments. Policy mixes are even more important in the sustained provision of ecosystem services, however, because further sector policies come into play, be it in a synergistic way or through adverse effects. Within these policy mixes, the use of economic instruments has attracted increasing attention for biodiversity policies and the provision of ecosystem services (Vatn et al., 2011), not least in the context of the recent TEEB initiative on The Economics of Ecosystems and Biodiversity (Ring et al., 2010b; TEEB, 2010, 2011, 2012). However, economic instruments are never designed and implemented in isolation. In practice, most of them build on or complement prior regulatory approaches to conservation such as protected area regulations and conservation planning. This being so, the focus in policy analysis and design should be on policy mixes rather than on single instruments or instrument categories (for example, regulation *or* economic instruments). However, there are still many unresolved questions regarding the combination of several instruments in a policy mix. For example, what is the role of economic instruments vis-à-vis regulatory approaches in biodiversity policies? How can the various instruments be assessed when the focus is on a policy mix rather than a single instrument? Are there appropriate frameworks for policy mix analysis and the design of instruments in policy mixes?

This chapter outlines the challenges involved in assessing the role of economic instruments in policy mixes for biodiversity conservation and ecosystem governance. Rather than focusing on single instruments or categories of policy instruments, our aim in this context is to clarify the term 'policy mix' and to provide a set of rationales for a policy mix perspective. We review the available frameworks for policy mix analysis as well as important instrument categories for biodiversity conservation and the provision of ecosystem services, focusing especially on the role of economic instruments in the conservation policy mix. For further exemplification in terms of multi-level and multi-actor governance, we look specifically at two such instruments, namely payments for environmental or ecosystem services (PES) and ecological fiscal transfers (EFT).

2. WHY POLICY MIXES?

2.1 What is a Policy Mix?

According to Flanagan et al. (2010) the term 'policy mix' first emerged in the economic policy literature of the 1960s in the context of the relationship and interaction between fiscal and monetary policy. It remained largely confined to these economic policy debates until the late 1980s/early 1990s, when it began to be taken up in other areas of public policy. The most significant extension of the concept occurred in environmental policy, with early publications by Gawel (1991) and Schwarze (1995), and in biodiversity conservation and environmental policies in Australia (Gunningham and Young, 1997; Young et al., 1996; Young, 2002). More recent substantive contributions to the policy mix literature have emerged in relation to emissions-related air pollution and climate policies, where regulatory approaches in the form of technical standards coincide with various economic instruments such as emissions trading and energy taxes (Lehmann, 2012; Sorrell, 2003).

Despite the growing use of the concept, a clear definition is rarely provided. This is the case at least with innovation-related literature, where Flanagan et al. (2010) report finding, alongside loosely applied terminology, a range of normative claims involving calls for 'appropriate', 'effective' or 'balanced' policy mixes. Comparable assumptions can be found in the literature on conservation policies. To provide a more rigorous basis for analysing policy mixes in conservation policies, Ring and Schröter-Schlaack (2011b: 15) defined a policy mix as 'a combination of policy instruments which has evolved to influence the quantity and quality of biodiversity conservation and ecosystem service provision in public and private sectors'. In any specific context at a given point in time, there is usually a mix of instruments already in place. The instruments in this existing mix can be assessed *ex post* using a range of evaluation criteria to assess their specific contribution to the performance of the policy mix. Unlike *ex post* analysis, *ex ante* analysis focuses on the introduction of a new policy instrument against the background of existing instruments, with both the new and the existing ones forming the policy mix.

Individual policy instruments that are combined to form a policy mix can be classified according to their major characteristics. Various categorizations have been suggested, but the following three major instrument categories have been widely used in the literature (for example, Gunningham and Young, 1997; Michaelis, 1996; Sterner, 2003):

- Regulatory instruments (including permits, standard-setting and zoning or planning) directly control or restrict environmentally harmful activities.
- Economic instruments such as environmental taxes, charges and fees put a price on environmentally harmful behaviour, thus internalizing negative externalities, while payments for environmental services and ecological fiscal transfers reward conservation-enhancing behaviour, thereby addressing positive externalities.
- Informational and motivational instruments are aimed at shifting individual or community preferences towards more conservation and serve to inform or educate people about the links between their activities and the environment.

In the case of biodiversity conservation, we usually find instruments from all three categories forming a policy mix. Some instruments may have been introduced purposefully to enhance the outcome of another instrument. For example, informational instruments are often introduced to provide a target group with relevant knowledge that may enhance the outcome of regulatory or economic instruments. In other cases, economic instruments are introduced as compensation for the costs imposed by regulatory instruments, such as making forest conversion illegal. Some instruments may have conflicting objectives or simply be redundant in combination.

2.2 Justifying Policy Mixes in Biodiversity and Ecosystem Governance

The rationales provided for using policy mixes in the conservation and sustainable use of biodiversity emphasize the distinctive character of biological diversity as inherently complex and dynamic (OECD, 1999). Box 17.1 provides an overview on the major arguments for policy mixes in biodiversity conservation and ecosystem governance (Ring and Schröter-Schlaack, 2011b). In this chapter, we focus on the heterogeneity and multiple objectives of this complex policy field, the significance of the spatial characteristics of the public goods to be provided, and on multi-level and multi-actor governance.

Biodiversity and ecosystems provide a wealth of ecosystem services to humans, thereby supporting human well-being (MA, 2005). Policies for biodiversity conservation and the sustainable provision of ecosystem

BOX 17.1 POLICY CHALLENGES FOR BIODIVERSITY CONSERVATION AND ECOSYSTEM SERVICES PROVISION AS RATIONALES FOR POLICY MIXES

Heterogeneity and multiple objectives: biodiversity covers all life on the planet, from the genetic level and millions of species to terrestrial, freshwater and marine habitats and ecosystems.

Irreversibility: beyond certain thresholds or 'tipping points', impacts may be irreversible and cause species extinction or ecosystem collapse; appropriate policies adhere to the precautionary principle.

Information gaps: the inherent complexity of ecosystems requires policy decisions under uncertainty; adaptive management approaches.

Mix of values: biodiversity and ecosystems provide a variety of use values and non-use values, some of which are tangible and marketable, whereas others are of a public or common good nature.

(Multiple) market failures: both negative and positive externalities need to be addressed through economic instruments, regulations or the creation of new markets through property rights-based solutions.

Mix of pressures: different pressures on biodiversity and ecosystems arise from various economic sectors, calling for different responses.

Policy failures: many activities involving pressures on biodiversity are still subsidized, calling for a reform or removal of adverse subsidies, dysfunctional institutions and corruption.

Impact accumulation: small impacts persisting over a long period may create large losses with irreversible outcomes in the long term, while the costs of prevention are incurred in the present. Combinations of policies may be necessary in order to achieve sufficient cumulative impact.

Spatial externalities: whereas the benefits of biodiversity conservation accrue mainly at national and global levels, the costs are often borne at local and regional levels; costs are also distributed unequally between economic sectors and spread unevenly across administrative units.

Multi-level governance: biodiversity policies require appropriate instruments at local, regional, national and international levels.

Multi-actor governance: due to the multi-faceted nature of biodiversity loss and conservation policies, both public and private actors need to be involved in addition to the growing relevance of hybrid organizations that cross the public–private divide.

Source: Adapted from Ring and Schröter-Schlaack (2011b: 17), compilation based on Young et al. (1996), Gunningham and Young (1997), OECD (1999: 26), OECD (2007), Ring (2008a), TEEB (2008, 2011).

services differ from those applied to other environmental problems, which may need to address just one single pollutant. The *heterogeneity* immanent in the complex adaptive nature of *biological diversity* and ecosystems calls for policies with heterogeneous objectives, that is, it requires different instruments capable of addressing the multidimensional aspects of biodiversity loss and ecosystem degradation.

The need for multiple instruments has already been proposed in the context of other environmental problems. In the case of 'multi-aspect' environmental problems, the Tinbergen Rule suggests a combination of several instruments because a first-best optimum cannot be achieved with any single instrument (OECD, 2007; Tinbergen, 1952). In relation to biodiversity and ecosystem services, where *multiple problems and objectives* co-exist, Gunningham and Young (1997: 286) suggest that 'the number of instruments must be sufficient to accommodate each level of biodiversity and the web of institutions acting to conserve it'. According to this view each threat to biodiversity and each objective would require at least one instrument. But which instruments should be in the policy mix? In practice, this question is difficult to answer. Although the Tinbergen Rule is a useful starting point, it cannot be used mechanistically. The OECD (2007) recommends careful analysis of the case at hand. Furthermore, what counts as an instrument is not always clear. Below we will discuss how PES can be defined as a combination of rules, each of which acts as an instrumental variable vis-à-vis distinct policy sub-objectives.

Spatial externalities constitute a widely encountered problem in conservation policies (Perrings and Gadgil, 2003; Ring, 2002, 2008a). Whereas the benefits of biodiversity conservation accrue mainly at centralized levels of decision making, such as national and global levels, the costs are often borne by actors at local and subnational levels. Furthermore, the costs are distributed unequally between economic sectors, with the primary sector (agriculture, forestry, fisheries) bearing higher costs than others in relation to conservation and the sustainable use of biodiversity. Conservation costs are also spread unevenly across administrative units, with some municipalities and districts incurring land-use restrictions related to protected areas while others are free to attract businesses and promote economic development (Ring, 2008a). These differences in conservation costs and benefits call for compensatory measures involving economic instruments of various kinds (Perrings and Gadgil, 2003). The choice of instruments for reconciling the local costs and global benefits of biodiversity conservation depends on who bears the costs (public or private actors) and who benefits from conservation (individuals, businesses, society at large or the global community).

Biodiversity and ecosystem governance relies on *multiple levels of government*, ranging from the local, regional and national to the international level, each requiring an appropriate mix of policy instruments. The spatial externalities of biodiversity conservation mentioned above also call for instruments capable of addressing interactions between different levels of government, such as intergovernmental fiscal relations and fiscal instruments. Due to the multi-faceted nature of biodiversity loss and conservation policies, a *multitude of actors* is involved and needs to be addressed in policy making. This includes public and private actors, although hybrid organizations that cross the public–private divide, such as NGOs and semi-private organizations (agencies and research institutes, for example), are becoming increasingly prominent as well (Ring, 2008a). Thus successful biodiversity policies can only be achieved by fashioning combinations of instruments with broad stakeholder involvement and implementing them within specially designed, context-relevant institutions (OECD, 1999).

3. ASSESSING INSTRUMENTS IN POLICY MIXES

Notwithstanding the fact that generalizations can be hazardous, some authors have developed a range of generic principles for evaluating and designing policy mixes. They include criteria that have traditionally been used in single instrument analysis but can also be used to improve policy mixes as well as criteria proposed for policy mix analysis as such. Nevertheless, frameworks and criteria for policy mix analysis should be read with care given that practical recommendations always depend on the specific problem and setting.

3.1 Single Instrument Choice and Evaluation Criteria

A number of criteria have been developed for the design and evaluation of individual policy instruments. Pre-eminent criteria regarding the optimality or performance level of an instrument include environmental effectiveness and economic efficiency (Gunningham, 1998; Michaelis, 1996; OECD, 1997; Turner and Opschoor, 1994). Environmental effectiveness relates to the environmental impacts or performance of the instrument (OECD, 1997): how much does the instrument contribute to a defined policy objective? What are its effects on environmental quality? In other words, the marginal environmental benefit associated with a given instrument should be as high as possible (OECD, 2007). Economic efficiency relates to the extent to which an instrument enables policy objectives to be achieved in a more cost-effective manner. Efficiency includes both static and dynamic aspects. Static aspects cover the level of administrative costs associated with the instrument to achieve a certain policy objective, whereas dynamic aspects relate to the extent to which instruments induce technological innovation and/or diffusion (Turner and Opschoor, 1994).

Static efficiency can be further divided into a cost–benefit criterion (the marginal cost of implementing a given instrument should be less than its marginal benefit) and a cost-effectiveness criterion (the marginal cost of applying a given instrument should be as low as possible) (OECD, 2007). 'Narrow' traditional economic policy evaluation focuses on effectiveness and efficiency.

However, there are further criteria that contribute to the success of policy instruments. In his framework for assessing allocative impacts of instruments in policy mixes, Gawel (1991) mentions distributive justice, fairness, and political and administrative feasibility. Furthermore, an instrument should be coherent with the legal and institutional system, and unambiguous. In the context of biodiversity conservation policies, Gunningham and Young (1997: 252) add the precautionary principle as a criterion, suggesting that an instrument 'avoids the chance of serious or irreversible consequences, especially when there is scientific uncertainty about the outcome'. Bagnoli et al. (2008) provide an overview of methodological approaches for analysing equity issues and the distributional effects of biodiversity policies. They recommend combining institutional and procedural approaches in order to integrate efficiency and equity considerations into biodiversity policies.

To sum up, we may group single-instrument evaluation criteria into four basic assessment categories:

- Conservation effectiveness: To what extent does the instrument contribute towards achieving a conservation objective? What are its impacts in terms of biodiversity conservation or the provision of ecosystem services?
- Efficiency (cost–benefit and cost-effectiveness criteria): what are the benefits of the conservation measures achieved by the instruments in question? What are the costs of policy implementation?
- Social impacts and policy legitimacy: what are the instruments' impacts in terms of equity, fairness and legitimacy?
- Institutional fit: how do (existing) institutions constrain and enable the design and implementation of the (new) policy instruments in question?

3.2 Frameworks for Policy Mix Analysis

In her analysis of problems of institutional choice, the many complex configurations of variables that need to be addressed prompted Ostrom (1990, 2009) to present these variables in a 'framework' rather than in a single model. The same applies to instrument choice and instrument design in a policy mix: policy mix analysis can easily become extremely complex. Owing to the impact of local political and cultural traits, it is very difficult to arrive at global policy conclusions (Gunningham and Sinclair, 1999).

Frameworks for policy mix analysis often build on evaluation and design criteria used for single instrument analysis such as environmental effectiveness, cost-effectiveness, distributional impacts, administrative feasibility and institutional factors. However, for policy mix assessment, these criteria need to be developed further and additional criteria devised. When policy mixes are examined as a whole, the *relationship* or *interaction* between policy instruments becomes a focus of analysis (Flanagan et al., 2010; Gunningham and Sinclair, 1998; OECD, 2007; Sorrell, 2003). Here, the aim is not to identify the *most* effective or *most* efficient instrument compared to another, but to analyse the interaction between two or more instruments. Authors who promote policy mixes and policy mix analysis suggest that 'single instrument' or 'single strategy' approaches are misguided because all instruments have strengths and weaknesses (Gunningham and Sinclair, 1999). The task instead is to build on the strengths of individual instruments, while compensating for their weaknesses through additional or complementary instruments; in other words, the *role* of the relevant instrument in the policy mix is of pre-eminent importance (Schröter-Schlaack and Ring, 2011).

Instrument combinations building on smart regulation

'Smart regulation' involves a principle-based approach to regulatory design and evaluation of environmental policies, strongly suggesting the superiority of instrument mixes over single instrument strategies (Gunningham and Grabosky, 1998; Gunningham and Sinclair, 1999). When looking at a mix of two instruments belonging to different instrument categories, the authors distinguish four basic relationships:

- inherently complementary combinations, where two instruments enhance each other's effect;
- inherently counterproductive instrument combinations, where one instrument negates or dilutes the effect of another instrument;
- sequencing instrument combinations;
- combinations, where the outcome will be context-specific.

Building on a detailed discussion of a mix of two instruments with regard to these four relationships, Gunningham and Sinclair (1999) conclude by making two general points about multi-instrument mixes. First, additional synergies can often be derived from complementary instruments in policy mixes with more than two instruments. Second, they emphasize the sequence in which the individual instruments are introduced in policy mixes as a potentially crucial factor in their success. The smart regulation literature also provides a list of additional design criteria for instrument mixes in biodiversity conservation policies. Young et al. (1996) and Gunningham and Young (1997) include, among others, 'designing for precaution', 'preference for underlying causes', using 'financially attractive instrument mixes', and 'limiting compensation for a transitionary period'.

Specifying types of policy interaction

Drawing on smart regulation theory, Sorrell (2003) and co-authors develop a typology of policy interaction as a basis for a policy mix analysis of EU climate policy (Sorrell and Sijm, 2003). They distinguish five types of interaction but emphasize the fact that two policies may interact in more than one way:

- direct interaction involves target groups that are directly affected by two policies, while these target groups overlap to some extent;
- indirect interaction relates to overlapping instruments in terms of the target groups addressed;
- operational interaction, where two policies operate together;
- sequencing interaction, where one policy instrument is followed in time by another instrument, and both directly affect the same target group;
- trading interaction, meaning that two policies are linked by the exchange of an environmental trading commodity.

Each type of interaction may have implications for the effectiveness, efficiency, social impacts or political feasibility of the policy mix. 'Hence, the extent to which such interactions can be judged as beneficial, neutral or counterproductive requires a careful examination of the nature and consequences of the interaction and an evaluation of those consequences within a multi-criteria framework. This should lead to a judgement as to whether the combination of instruments is useful, redundant or positively harmful' (Sorrell, 2003: 44). Moving onwards to analyse policy interaction, three major steps are proposed: (1) How and why are two policies affecting each other? (2) What are the consequences of this interaction for the target groups and the organizations involved in implementing the instrument and seeking to achieve the policy objective? (3) To what extent are these consequences desirable as measured against chosen evaluation criteria? Interaction analysis can focus on existing or proposed instruments or it can analyse two or more instruments, with the ultimate aim of identifying possible conflicts or synergies between these instruments. Systematic interaction analysis requires comparing the scope of the instruments, the nature of the objectives, the timetable of the instruments, the operation of the instruments and the process of implementation (Sorrell, 2003).

From policy analysis to governance frameworks

Drawing on the strengths and weaknesses of smart regulation theory, Van Gossum et al. (2010) have put forward the concept of 'regulatory arrangements'. Their approach reduces the number of options offered by smart regulation theory by considering, for example, national policy style, adverse effects of related policies, and the structure of the policy arrangement concerned. Regulatory arrangements highlight the relevance of policy learning, institutional context and governance capacity when introducing certain instruments in a specific context.

Bressers and O'Toole Jr (2005) stress the social and political context of applying instruments and the networked character of implementation contexts. Effective governance, they say, requires policy analysis that goes beyond focusing on separate and isolated instruments. They identify a number of joint forms of influence, or 'confluence', in policy mixes (pp. 137ff.):

- increased intensity of policy intervention, meaning that 'more than one instrument can be targeted simultaneously at the same group to intensify a policy intervention';
- integration of multiple instruments into one interactive process between government and target groups, for example, to address several actors in the same process;
- instruments and actions at different levels of governance;
- competition and cooperation between different but interdependent policy fields;
- mutual strengthening or weakening of the effects of interventions at different points of action in the broader social and ecological system.

Bressers and Kuks (2003) describe instrument mixes useful for analysing policy formulation and implementation and contributing to the effectiveness of instruments in relation to target groups. They introduce 'five multiplicity aspects of governance': multiple levels of governance; multiple actors in policy networks; a multiplicity of problem definitions and other policy beliefs; multiple other instruments; and multiple responsibilities and resources for implementation. Although instrument selection and design are still important topics, these authors clearly move beyond a mere focus on instrument and policy analysis. The social and political context, in which instruments are introduced and implemented, becomes much more important. Policy analysis is shifting towards governance analysis in a multi-level and multi-actor context – or, in the authors' terms, a 'networked context'.

Similarly, Flanagan et al. (2010) analyse policy mixes in innovation policies in a multi-level and multi-actor context. They distinguish between dimensions and forms of interaction while also examining possible sources of tension between instruments in a policy mix. The dimensions of policy mix interaction refer to policy space as an abstract space in which different policy domains co-exist, to the governance-level dimension where interactions occur across different hierarchical levels of governance, the geographical dimension, policy mix interactions in real space and the time dimension. They use Bressers and O'Toole's (2005) framework as their starting point to build a more sophisticated conceptualization of interactions, ending up with three kinds of policy mix interaction in the case of unambiguously distinct instruments (Flanagan et al., 2010: 24): 'interactions between instruments targeting the same actor or group of actors, interactions between instruments targeting different actors/groups involved in the same process, and interactions between instruments targeting points of action which may seem to be far removed but which interact because the processes or actors targeted prove ultimately to be linked by other processes in a broader "system"'. An additional type of interaction relates to the interaction of 'the same' instruments across one or more dimensions, for example, between different levels of governance, or in time. Finally, Flanagan et al. (2010) include negative interactions in their framework in the form of tensions between instruments in a policy mix. These relate to conflicting rationales, goals and implementation approaches.

To where from here?

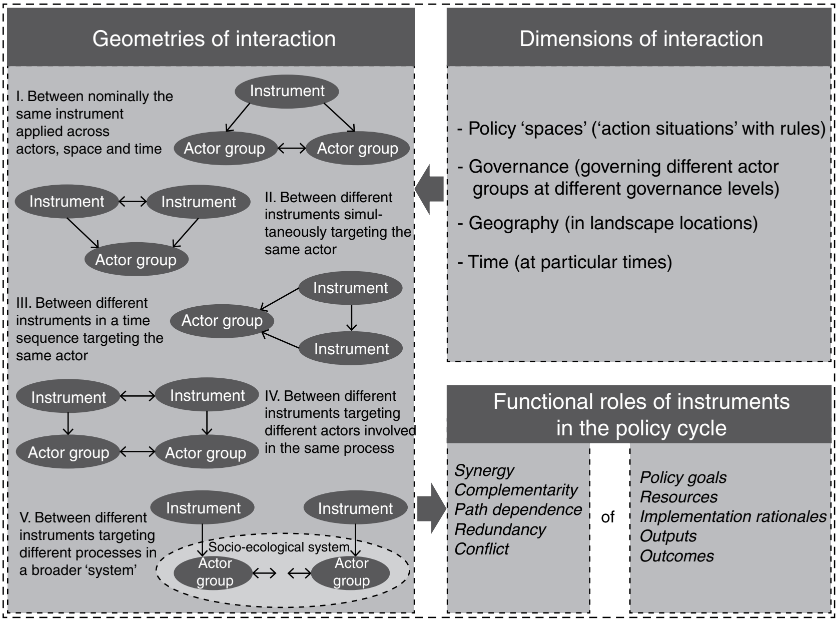
In the light of the policy mix analysis frameworks presented above, how do we move forward from here? Key lessons may be framed as following: policy mix analysis does not primarily ask whether one instrument is more effective or efficient than another, assuming only the more effective instrument should be used. The interesting question for policy mix analysis is on interaction between instruments. Are combinations of instruments complementary to each other, are they mutually reinforcing, do they involve conflicts when present at the same time, or are they suitable to be introduced one after the other in a temporal relationship to increase outcome? Furthermore, there may be situations where no general recommendation is possible at all, and the outcome completely depends on the context.

Positive and negative interaction between instruments may be defined differently for biodiversity conservation policies compared to general environmental policies. Regarding the latter field, OECD (2007) mentions overlap of instruments as a potential source of inefficiency and thus includes overlap in the category of 'negative interactions'. Conversely, overlap of instruments is even recommended by several authors for biodiversity policies (Gunningham and Young, 1997; OECD, 1999) and thus subsumed under positive interactions. We argue that overlap or functional redundancy of individual instruments increases the resilience of the policy mix: when there is large environmental heterogeneity and variability, as is the case for biodiversity, there will be ignorance about instrument effectiveness (as opposed to measurable uncertainty or risk underlying a portfolio philosophy). In such situations functional redundancy and policy experimentation in adaptive management may be appropriate.

What has been dealt with as the social, political or institutional context in earlier frameworks of policy mix analysis, seems to become a focus of analysis in later frameworks. In recent years, instrument choice and design as well as policy mix analysis have more and more been complemented by governance analysis, as the role of the state has continuously changed, and other actors enter stage, among them non-governmental organizations, businesses, or civil society representatives.

Functional roles of instruments: dimensions and geometries of interaction

We can compare the terminologies used in frameworks previously proposed for policy mix analysis (Flanagan et al., 2010; Gunningham and Sinclair, 1998, 1999) before trying to merge these in a single framework (Figure 17.1). Flanagan et al. (2010) describe dimensions and forms of interaction and possible sources of tension between instruments in a policy mix. Gunningham and Sinclair (1998, 1999) identify four types of relationship between instruments, including 'complementarity', 'counter-productivity', 'sequence' and 'combinations' in which outcomes will be context-specific. In order to merge the conceptual approaches in the following, we have grouped together the former authors' 'sources of tension' and the latter authors' 'relationships' under the heading 'functional roles', while at the same time differentiating between complementarity and synergy and adding redundancy as an important further category. We re-name Flanagan et al.'s (2010) 'forms of interaction' 'geometries of interaction'. Geometries are configurations of interaction and, as such, are more or less direct, while functional roles describe the nature or value of the interaction relative to policy objectives.



Source: Based on Flanagan et al. (2010), Gunningham and Sinclair (1998, 1999) and Ring and Schröter-Schlaack (2011b).

Figure 17.1 *A framework for instrument interaction geometries and functional roles*

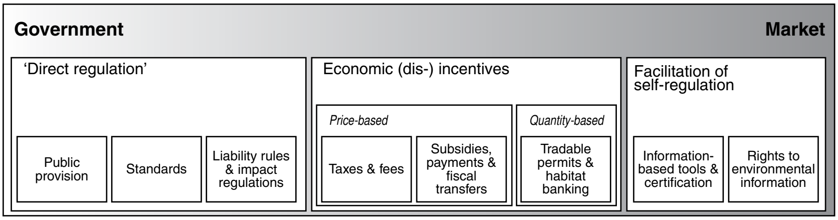
Furthermore, economic instruments have functional roles defined by 'action situations' (Ostrom, 2005). Action situations have 'dimensions' in terms of: (1) the abstract 'policy space'; (2) actors interacting at different levels of governance; (3) geographical locations in physical landscapes; and (4) occurrence in a particular time period. These dimensions can be related to the dimensions of interaction in the terminology of Flanagan et al. (2010) (Figure 17.1). The interaction dimensions and geometries define the functional roles of instruments. Instruments can have different functional roles at different stages of the policy cycle. Empirical studies of such interactions look, for instance, for instrument-to-instrument causality in historical policy analysis by cross-referencing legal texts relating to different instruments, for actors referring to multiple instrument rules that influence their decision making, or for overlapping jurisdictions of instruments in relation to specific administrative areas, land uses and actors that can be located and mapped spatially. This framing of functional roles has aspects in common with approaches that discuss the factors explaining the 'fit' between institutions and their environments and evaluate horizontal and vertical 'policy interplay' (Urwin and Jordan, 2008; Young, 2002).

Ring and Schröter-Schlaack (2011a) provide a number of examples of functional roles of economic instruments where they interact with informational or regulatory instruments. Figure 17.1 also illustrates that instrument interactions can have some basic configurations (I–V) which are synergistic, complementary, path-dependent, redundant or in conflict. We use 'complementary' in the sense that instruments do not interfere with one another in spatial targeting (or possibly that one unilaterally supports the other), while a 'synergistic' role is found when two instruments mutually reinforce one another. Functional roles are meant to describe the predominant role of an instrument in a particular period and a particular geographical area. An instrument can have several 'functional roles' over time in the 'zigzag' process sometimes observed in policy change.

Forms or geometries of interaction are increasingly difficult to study empirically as we move from (I) single instruments acting directly on actors to (V) multiple instruments acting indirectly through a socio-ecological system. The roles and basic configurations mentioned in Figure 17.1 are provided by way of example and are restricted to two instruments or rules at a time – in empirical studies this is expected to be a multi-dimensional analysis. Furthermore, in Figure 17.1 the interactions and roles of instruments are defined in terms of their effects on actors as 'targets' of policy. Functional roles must also be seen in relation to different stakeholders' own goals in the policy process.

4. THE ROLE OF ECONOMIC INSTRUMENTS IN POLICY MIXES

Against this background, what is then the role of economic instruments in policy mixes? Different instruments make use of very different mechanisms for the purpose of conserving biodiversity or sustaining ecosystem service provision. At a very general level, a basic distinction between direct regulation, economic incentives and market facilitation becomes apparent, reflecting the major instrument categories mentioned above (Schröter-Schlaack and Ring, 2011) (Figure 17.2). Whereas direct regulation operates by direct public provision of biodiversity conservation (for example, protected area designation) or standard-setting (management or pollution standards, spatial planning), economic instruments provide financial (dis-) incentives to stakeholders. Among economic instruments, a further distinction can be drawn between price-based mechanisms and quantity-based approaches. The former comprise taxes, charges and



Source: Adapted from Schröter-Schlaack and Ring (2011: 177).

Figure 17.2 A continuum of policy instruments

fees as well as payments made to different actors at different governance levels for environmental service provision or biodiversity conservation, while tradable permits are an example of the latter. The third category of informational and motivational measures provides knowledge to actors about the consequences of their behaviour, thereby facilitating intrinsic motivation for self-regulation in conserving biodiversity or managing ecosystem services. Figure 17.2 places these three policy instrument categories in a continuum stretching from direct government regulation (far left) to more indirect interventions such as facilitation of self-regulation (far right).

There are a number of different instruments within each of these major categories that may be considered for policy mixes in biodiversity conservation and ecosystem governance due to the multiple actors and governance levels involved. Table 17.1 provides an overview of the major characteristics of different instruments in terms of the incentives provided, the incentivizing actor, the incentivized actor and the relevant conditions (Ring and Schröter-Schlaack, 2011b).

In the face of multiple overlapping jurisdictions, multi-scale policy mix analysis provides concepts for understanding multiple overlapping jurisdictions and governance levels in the landscape and how they determine externalities (Figure 17.3). Different public and private governance systems have partially overlapping jurisdictions which determine a mix of conservation and development instruments at any one location. Jurisdictions do not match ecosystem and land-use boundaries, meaning that there are spatial externalities from one jurisdiction to another, with potential for policy conflict if impacts go uncompensated. Managers have a detailed knowledge of the formal instruments relevant to their jurisdiction, and a need to understand the causes of externalities affecting them from other jurisdictions.

As the focus of this chapter is on economic instruments and their

Table 17.1 Characteristics of biodiversity conservation instruments

INSTRUMENTS	INCENTIVE	INCENTIVIZING ACTOR	INCENTIVIZED ACTOR	CONDITION
Regulatory instruments				
Direct regulation and spatial planning	coercion	government	public and private resource user	various behaviours that – in general or in this instance – are *negative* for the environment
Economic instruments				
Biodiversity offsets and mitigation banking	avoiding fine	government	private resource user	project planned that involves a *negative* environmental impact
Environmental taxes	tax	government	private resource user	various behaviours that – in general or in this instance – are *negative* for the environment
Tax reliefs	avoiding tax	government	private resource user	various behaviours that – in general or in this instance – are *positive* for the environment
Ecological fiscal transfers (EFT)	payment	government	government body negatively affected by regulation	enforcement of regulation or various behaviours that – in general or in this instance – are *positive* for the environment

Environmental subsidies	payment	government	private resource user	various behaviours that – in general or in this instance – are *positive* for the environment
Government-financed payments for environmental services (PES)	payment, contract	government	private resource user	compliance with terms of contract
Market-based payments for environmental services (PES)	payment, contract	rival resource user	private resource user	compliance with terms of contract
Information-based instruments				
Certification	avoiding regulated loss of access to market or gaining good consumer reputation	government, private market operator, consumers or NGOs	private resource user	compliance with code of conduct, etc.

Source: Adapted from Ring and Schröter-Schlaack (2011b: 31).

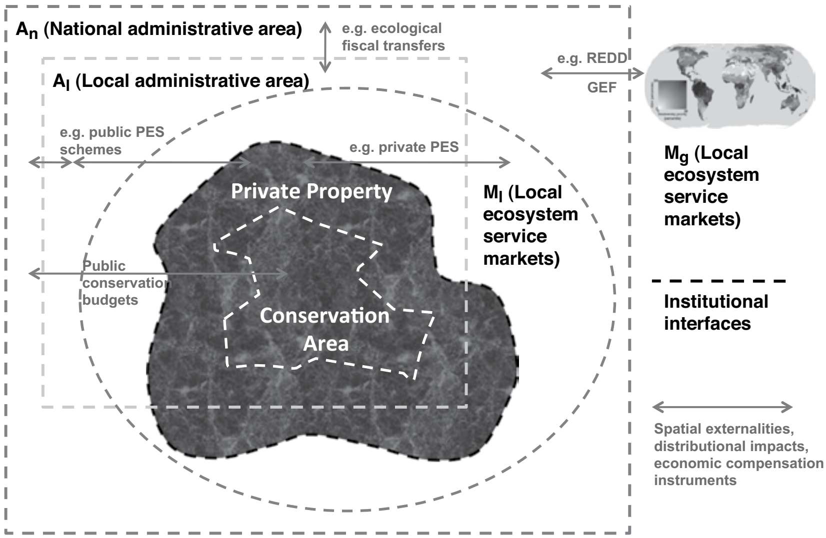


Figure 17.3 A multi-scale policy mix approach considers spatially overlapping jurisdictions and tenure rights in the landscape and the resulting functional roles of instruments

respective role(s), we highlight payments for environmental services (PES) and ecological fiscal transfers (EFT) in order to further exemplify the need for policy mixes in biodiversity conservation and ecosystem governance. By choosing these two families of instruments we can highlight, first, the relevance of multi-level governance in combination with the spatial characteristics of the relevant conservation problem (PES and EFT) and, second, the importance of multi-actor governance, addressing the interplay between private and public actors in conservation outcomes. Whereas PES can be government-financed or market-based payments made largely to land users and thus private actors at the property level, EFT represent public transfers between different levels of government, compensating state or local governments for conservation costs at decentralized levels. Finally, broad 'policy mix analysis frameworks' require articulation with more specific frameworks that address interactions at different levels, for example, at the property level of PES and municipal level of EFT.

5. PAYMENTS FOR ENVIRONMENTAL SERVICES (PES)

5.1 What is PES – a Single Instrument or a Policy Mix?

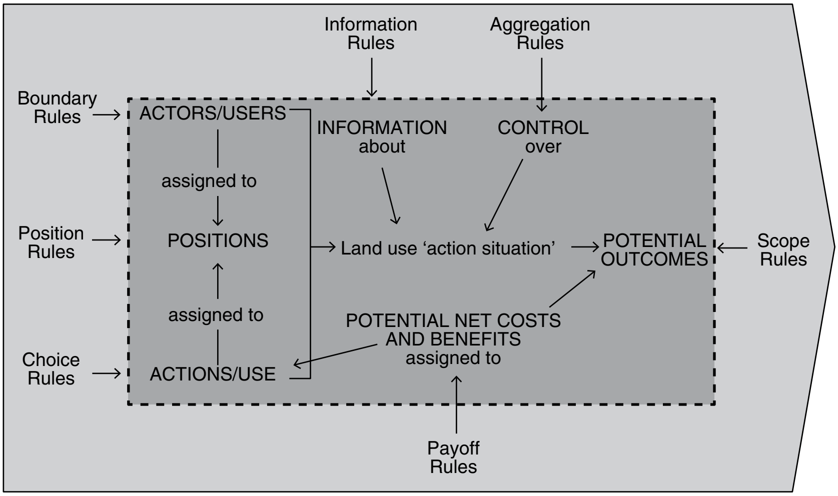
The last decade has seen payments for environmental or ecosystem services become one of the most hotly debated conservation instruments. Wunder (2005) described the simplest possible example of PES as a voluntary transaction in which a well-defined environmental service or a land use likely to secure that service is 'bought' by a minimum one service buyer from a minimum one service provider, if and only if the service provider secures service provision. Subsequent PES reviews have broadened the definition to capture a wide range of case studies and a richness of context (Engel et al., 2008; Matzdorf et al., 2013; Muradian et al., 2010; Pattanayak et al., 2010; Porras and Grieg-Gran, 2008; Sattler and Matzdorf, 2013; Schomers and Matzdorf, 2013; Tacconi, 2012; Vatn, 2010; Wunder et al., 2008). Muradian et al. (2010) offer perhaps the most encompassing definition of PES, namely, as a transfer of resources between social actors aimed at generating incentives to align individual and/or collective land-use decisions with wider social interests in the management of natural resources.

In this section we discuss how thinking of PES within a policy mix, and as a policy mix in its own right, further captures the complexity of aligning multiple incentives and social interests.

5.2 PES as a Mix of Rules-in-use

Muradian et al. (2010) call for a broader analytical approach that transcends the idea of PES being only a market-driven tool, links PES to the literature on common pool resources (CPR) and incorporates a broader range of situations and institutional arrangements. Porras and Grieg-Gran (2008) argue that a number of PES schemes are based on the reciprocity characteristics of CPR institutions rather than on conditional transactions. In case studies from Mexico and Catalonia, Corbera et al. (2009) and Prokofieva and Gorriz (2013) show how actor analysis and the institutional design of PES form the basis for evaluating the institutional interplay of PES with other institutions and their institutional performance. Both studies analyse forest incentive schemes in terms of the design and evolution of their 'rules'.

Barton et al. (2014) classify voluntary forest conservation and PES in Norway, Finland and Costa Rica using the 'rules-in-use' typology from the Institutional Analysis and Development (IAD) framework developed by Ostrom (2005). They argue that rules-in-use can be used as generic



Source: Adapted from Ostrom (2005).

Figure 17.4 Using 'rules-in-use' to characterize payments for environmental services

institutional variables to describe both PES and other instruments. Framing PES in terms of a mix of rules-in-use provides the basis for arguing that PES is in itself a policy mix: a number of the rules defining PES are defined by other policy instruments. Furthermore, rules-in-use define which characteristics of PES instruments interact with similar characteristics of other instruments in the policy mix, providing a consistent structure for evaluating institutional interplay.

Figure 17.4 illustrates the rules-in-use framework devised by Ostrom (2005). Here we use PES in Costa Rica to explain briefly how rules-in-use help define PES as a policy mix in its own right. *Scope rules* define outcome variables and their ranges, such as the maintenance of forest cover as a proxy for a bundle of environmental services. *Choice rules* define required, permitted, forbidden and guaranteed actions during the PES contract period. The land-use change ban for forest land imposed by the Costa Rican Forest Law is an example of a 'choice rule', which is a part of the mix of PES instrument rules-in-use. *Payoff rules* identify the rewards and sanctions associated with outcomes of actions. Payoff rules encompass all incentives rather than just a narrow focus on payment conditions. This broadens the scope of costs and benefits of PES participation to include *inter alia* property tax exemption, the Forest Law's guarantee of public eviction of squatters, contract termination and prison sentences for deforestation with intent. *Boundary rules* govern the entry, succession and exit of PES participation, such as forest characteristics eligible for participation, requirement of tenure rights, contract length and contract renewal criteria. As such, cadastral inconsistencies in property registers are a serious barrier to PES participation and are determined by a host of historical land-use policies. Together, boundary, scope, choice and payoff rules capture the key dimensions of PES participants' contracts.

Position rules determine decision-making positions, such as the types and roles of intermediaries in reporting, monitoring and verifying PES contracts. Costa Rica limits the transaction costs of intermediaries to 18 per cent (Porras et al., 2013), but it can be argued that this is possible because the intermediary 'forest regent' carries out almost all the transactions, including participant identification, recruiting, application, contracting, monitoring, reporting, disbursement and verification. As such, position rules are potential proxies for both transaction costs and information asymmetries in PES. *Information rules* govern information access and disclosure. In Costa Rica corporations may apply for PES, with owner structure anonymized thanks to a constitutional guarantee of equivalence between physical and legal entities. This constitutional guarantee makes it very hard to evaluate whether PES is targeted to individual small and medium-sized landowners or to large conglomerates (Porras et al., 2013). Aggregation rules refer to collective voting rules and lack of agreement rules. While they have limited relevance for individual contracts, they characterize collective responsibilities in group-based PES contracts that were once in place in Costa Rica and are common in many PES regimes.

The parsimonious PES definition by Wunder (2005) we started with can now be framed in terms of rules-in-use: a voluntary transaction (*payoff rule*), where a well-defined environmental service or a land use likely to secure that service (*scope rule*), is being 'bought' by a minimum one service buyer from a minimum one service provider (*position rules*), if and only if the service provider secures service provision (*choice rule*).

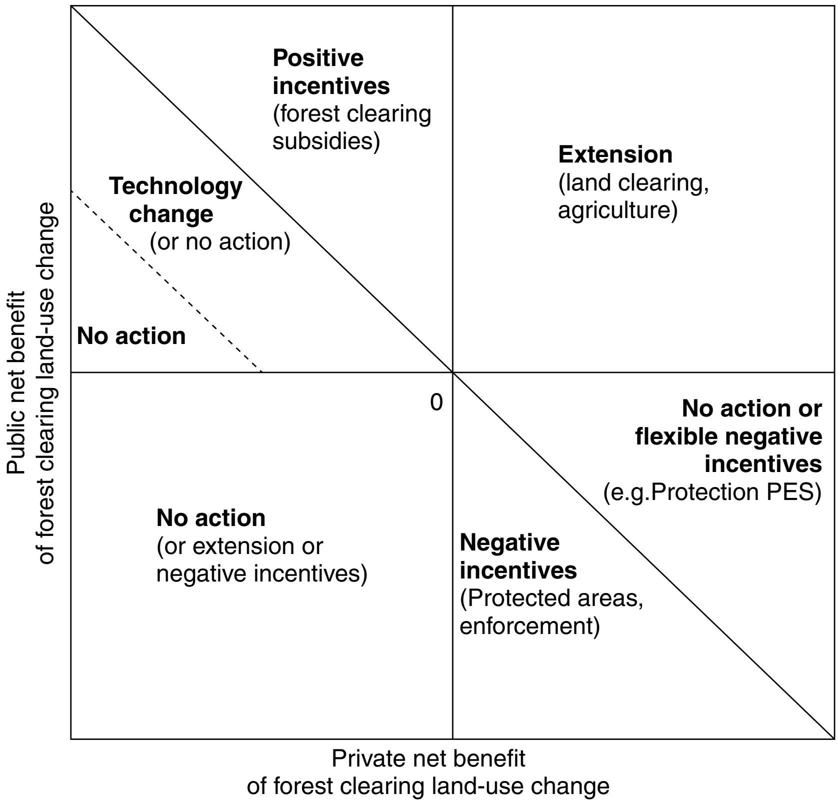
While rules-in-use are a useful framework for classifying PES design, they do not in themselves explain how PES functions with other instruments, that is, their functional role. Rules-in-use shift transaction benefits and costs between actors and are subject to contestation and conflicts of interest. Landowners' perceptions and motivational structures will depend on both formal rules that are easily identifiable and implicit informal rules (Vatn, 2010). Rules-in-use are nevertheless useful institutional 'objects' that enable us to study the dynamics of institutional interplay.

5.3 PES in a Policy Mix

PES researchers have increasingly emphasized the importance of instrument interaction or 'institutional interplay' for understanding the performance of PES (Corbera et al., 2009; Legrand et al., 2013; Prokofieva and Gorriz, 2013). Young (2002) defines 'institutional interplay' as symmetrical versus unidirectional and vertical versus horizontal. The directionality of interactions can be further divided into interaction types (Sorrell and Sijm, 2003) to determine PES 'functional roles' vis-à-vis other instruments. Vertical institutional interplay happens across local–state–national administrative levels, while horizontal interplay takes place between institutions at the same administrative level. Vertical institutional interplay can be interpreted in terms of the actual effects on land use of combinations of PES and other conservation instruments in the landscape.

Pannell (2008) proposes a 'public–private benefits framework' (PPBF) for policy mechanism choice for land-use change in order to achieve environmental benefits (Figure 17.5). Based on the ratio of public to private net benefits of land-use change, the PPBF recommends positive incentives that encourage land-use change or negative incentives that discourage land-use change. Pannell (2008) does not specify the types of negative and positive incentives that should apply, only that optimal spatial targeting should be complementary in terms of public–private benefit ratios and, crucially, that 'no policy action' is sometimes optimal for aggregate social welfare. The PPBF suggests that flexible (and, presumably, voluntary) incentives should be provided where private net benefits exceed public net costs of forest clearing – for our discussion this would translate to a form of 'protection PES'. Where public net costs exceed private net benefits of forest clearing, a negative incentive – presumably regulated and involuntary, such as public protected areas – is preferred. Interestingly, the PPBF can also be used as a framework for targeting extension and subsidies to encourage land-use change in cases where public benefits exceed private benefits.

The PPBF is a normative framework for optimal and complementary targeting. In practice we see conflicting or redundant targeting of voluntary protection PES on properties where a public protected area or extension services would be optimal from a welfare point of view (and vice versa). As examples of synergistic targeting, voluntary protection PES is implemented as one step on a policy path leading to public protection; or extension is combined with PES because private owners lack information on optimal land use and have high learning costs. In conclusion, the PPBF is a useful benchmark framework against which to compare overlapping,



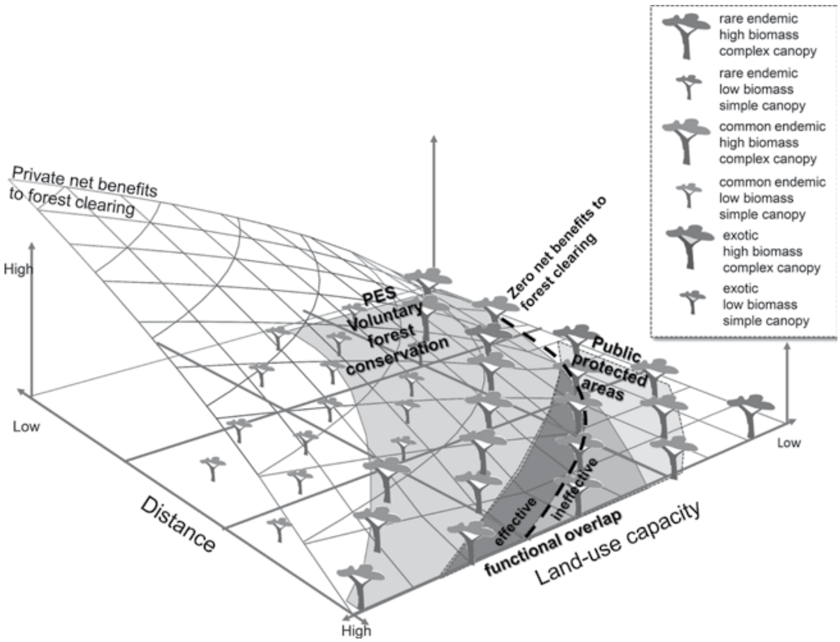
Source: Adapted from Pannell (2008).

Figure 17.5 The potential role of PES in the public–private benefits framework (PPBF)

conflicting, redundant and synergistic instrument interplay at property level in real landscapes.

5.4 PES in a Policyscape

When applying Pannell's PPBF to multiple properties facing different land-use change decisions across a landscape, it becomes a framework for the spatially explicit targeting of a policy mix. The 'policy mix' concept reminds us that assessments of the cost-effectiveness of PES may be dependent on the mix of instruments. A 'policyscape' can be defined as the spatially explicit distribution of a policy mix and its different instrument



Source: Barton and Adamowicz (2013).

Figure 17.6 Policyscape – the location of policy instruments depends on landowners' perceptions of landscape characteristics and of returns to different land uses

jurisdictions (Barton et al., 2013). The 'policyscape' concept also reminds us that cost-effectiveness is conditional on the biophysical characteristics of properties and on land users' perceptions, interacting in response to a mix of rules applied across the landscape. In Figure 17.6 we illustrate a synthetic landscape where policies are targeted according to dimensions that have been found to explain spatial patterns of policy.

A number of studies have found that accessibility/distance and biological land-use capacity significantly explain spatial patterns of rents for land conversion and location of PES and protected areas (Andam et al., 2008; Joppa and Pfaff, 2010; Pfaff and Robalino, 2012; Pfaff et al., 2009; Robalino et al., 2008). For example, national parks are typically found on low productive land, far from markets (Joppa and Pfaff, 2009). A policyscape 'state space' as shown in Figure 17.6 can help researchers communicate with managers about situations where multiple policies are implemented simultaneously on the same types of land. This in turn

Table 17.2 Subsamples for evaluating instrument interactions between PES and other conservation instruments

Subsamples	Treatments		
	PES alone	Other instrument(s)	Policy mix
Participant	$\text{PES}_{\text{participant}}$	National $\text{Park}_{\text{buffer zone}}$	$\text{PES}_{\text{participant}}$ & $\text{NP}_{\text{buffer zone}}$
Control group	Neither $\text{PES}_{\text{participant}}$ nor $\text{NP}_{\text{buffer zone}}$		

helps to spatially visualize functional overlaps of instruments. Policyscape mapping can also help identify potential instrument conflicts, that is, 'vertical institutional interplay' at the property level. By evaluating spatial locations of conservation instruments in relation to opportunity costs of alternative land uses, policyscape analysis can also help managers formulate hypotheses about whether instruments can be expected to be effective and additional (because they have opportunity costs).

5.5 Lessons for Evaluation of PES in a Policy Mix

There are few PES programmes which have been in existence long enough and with a sufficiently large and diverse set of participants to evaluate environmental impacts of PES interactions with other instruments using quasi-experimental methods (Pfaff and Robalino, 2012). Evaluating institutional interplay effects of PES increases the required sample size, because properties must be identified that are subject to PES, to the other instrument(s) hypothesized to interact with PES, to combinations of PES and other instruments, and to a control group that does not participate in any of the above (Table 17.2).

Statistical matching techniques require control groups that are frequently twice as large or even larger than the treatment groups. In practice most local and even some national PES schemes may have too few participants to evaluate such instrument interaction effects. Combining institutional design and analysis of the functional role of PES based on rules-in-use with spatial mapping of PES in synthetic policyscapes offers complementary analytical approaches when PES schemes are too small to be subject to impact evaluations with statistical power.

6. ECOLOGICAL FISCAL TRANSFERS (EFT)

6.1 EFT Foundations and Recent Experience

Intergovernmental fiscal transfers redistribute public revenue from central to decentralized levels of government. They help lower-tier governments cover their expenditure in providing public goods and services. In centrally organized countries, such as Portugal, these transfers are redistributed from the national to the local level. In federally organized countries, such as Brazil or Germany, there are fiscal transfers from the national to the state level, and various state fiscal transfer systems from each state to the local level. Comparatively new is the rationale to use ecological indicators for redistributing public monies to lower governmental levels, complementing, among others, traditionally used inhabitant or area-related indicators (Ring, 2002; Ring et al., 2011). As intergovernmental transfers are a significant source of income for public budgets, greening fiscal transfers represents a promising avenue for mainstreaming biodiversity and ecosystem conservation across other public sectors and, thus, much-needed policy integration. For example, in developing and transition economies, intergovernmental fiscal transfers represent 60 per cent of subnational public expenditure, in non-Nordic Europe and Nordic OECD countries, they account for 46 per cent and 29 per cent respectively (Shah, 2007).

Box 17.2 provides an overview of the various rationales for introducing ecological fiscal transfers (EFT) (Ring et al., 2011: 99). The choice of

BOX 17.2 DIFFERENT POSSIBLE RATIONALES FOR ECOLOGICAL FISCAL TRANSFERS

1. Compensation of expenses/supply costs for ecological public goods and services.
2. Compensation of opportunity costs:
   - Loss of land-use revenue on municipal property.
   - Loss of tax revenues from private landowners prevented from doing business.
3. Payments for external benefits to local and state governments for providing spill-over benefits beyond their boundaries.
4. Fiscal equalization/distributive fairness:
   - Vertical equalization between higher and lower levels of government.
   - Horizontal equalization between jurisdictions at the same level of government.

Source: Adapted from Ring et al. (2011: 99).

rationale(s) is highly dependent on the country's legal and institutional framework – not least the financial constitution. EFT are allocated on the basis of ecological or conservation-based indicators, for example, protected area coverage of the relevant jurisdiction. Decisions about where protected areas are to be sited are frequently taken at higher levels of government, even though the costs of losing these areas for other social and income-generating developments are borne by the local governments and communities (Ring, 2008a). Compensating for the opportunity costs of conservation has thus been a reason for introducing EFT in Brazil and Portugal (May et al., 2002; Ring, 2008c; Santos et al., 2012). Convincing reasons for greening the fiscal transfer system in other countries in line with constitutions and fiscal practices may require different arguments. In Germany, where EFT do not yet exist for biodiversity conservation, opportunity costs would not qualify as part of a jurisdiction's fiscal need. Here, compensation of above-average conservation expenses could justify ecological innovations of the fiscal transfer system (Schröter-Schlaack et al., 2013).

At the international level, financial transfers have been discussed under the term International Payments for Ecosystem Services (IPES), providing a comparable mechanism to account for conservation costs and spill-over benefits between nations (Farley et al., 2010). Whereas fiscal transfer schemes within a nation state are based on financial constitutions and highly regulated by laws, IPES have been based so far on voluntary initiatives by donating governments (Ring et al., 2011). Nevertheless, EFT that take account of biodiversity conservation in international transfers promise to play a role in the context of REDD and REDD-plus schemes on Reducing Emissions from Deforestation and Forest Degradation (Irawan et al., 2014; Ring et al., 2010a).

Practical experience with EFT exists at the national and state levels to date. In the early 1990s, the state of Paraná in Brazil was the first state to introduce EFT, in the form of the ICMS Ecológico, to compensate local governments for land-use restrictions imposed by protected areas (Grieg-Gran, 2000; Loureiro, 2002; May et al., 2002; Ring, 2008c). Since then, 16 Brazilian states have begun to use protected areas in relation to the overall municipal area as an indicator to redistribute a specified share of state-level ICMS tax income back to the local level (Ring et al., 2011; The Nature Conservancy, 2014; Droste et al., 2015). In Europe, Portugal was the first EU member state (in 2007) to consider protected areas (Natura 2000 sites as well as nationally protected areas) for redistributing tax revenues from the national to the local level (Santos et al., 2012; Schröter-Schlaack et al., 2014). France has implemented a much smaller scheme that applies to a few strict protected area categories and compensates municipalities lying within the core areas of national parks and marine natural parks (Borie et al., 2014). In a number of other countries, EFT have so far only been proposed for biodiversity conservation and, in some cases, their impacts modelled (for Germany: Czybulka and Luttmann, 2005; Ewers et al., 1997; Perner and Thöne, 2005; Ring, 2002, 2008b; Schröter-Schlaack et al., 2013; for Switzerland: Köllner et al., 2002; for Indonesia: Mumbunan, 2011; Mumbunan et al., 2012). EFT policy proposals also exist in relation to forest conservation (Kumar and Managi, 2009) and to linking REDD schemes to biodiversity conservation (Irawan and Tacconi, 2009; Irawan et al., 2013, 2014; Ring et al., 2010a).

6.2 The Role of EFT in a Policy Mix

Whereas PES schemes usually address private land users, EFT clearly address public actors at different levels of government. As such, EFT complement PES schemes in terms of the actors addressed. Only where PES also include local governments as addressees (for example, to (co-) finance certain conservation measures and associated costs) should double funding by PES and EFT be avoided. The issue of which higher and lower-tier governmental levels should be involved in EFT schemes depends on the organization of the country in question. So far, no federally organized country has implemented EFT between the national and state level on the basis of conservation indicators, although there have been proposals suggesting such schemes (Cassola, 2011; Czybulka and Luttmann, 2005; Schröter-Schlaack et al., 2013; Silva, 2000). Existing schemes address local public actors, that is, municipalities, as EFT-receiving jurisdictions, be they allocated by national (Portugal) or state levels (Brazil).

Fiscal transfer schemes are part of a country's or a state's constitution and are regulated by additional laws and decrees. As government budgets rely heavily on the relevant legal and institutional frameworks, the design of intergovernmental fiscal relations and any amendment to them are highly politicized processes involving governments and their related associations (for example, of localities and districts). Finance ministries generally assume the lead responsibility in terms of expert knowledge, design and implementation. In the case of ecological fiscal transfers, policy design, implementation and monitoring may be supported by environmental ministries and conservation or forest authorities (Ring et al., 2011).

Both existing and many proposed EFT schemes use protected area as a proxy biodiversity indicator for determining transfers. In this way, synergies are created between a regulatory instrument of biodiversity conservation and an economic instrument serving to provide decentralized governments with financial resources to fulfil their public functions. How strong these synergies are depends on the type and strength of biodiversity indicator(s) chosen in relation to other indicators for distributing fiscal transfers. In this context, it is important to note that intergovernmental fiscal transfers are first and foremost a distributive instrument, that is, one aimed at levelling off per capita differences in available public budgets at the relevant governmental levels (Schröter-Schlaack et al., 2013). Biodiversity and ecosystem conservation is not their primary aim. Nevertheless, even small percentages of tax revenues dedicated to ecological indicators may result in some steering power: (1) in localities and states with high shares of protected areas, EFT monies allocated may represent substantial amounts compared to available local or state conservation budgets from other sources, as the latter tend to be small in relation to other public sector budgets (Schröter-Schlaack et al., 2013); (2) for rural municipalities coping with comparably low local public budgets, EFT may represent a significant share of their overall finances. For example, in 2008 EFT represented 34 per cent of the total municipal budget in Castro Verde, a Portuguese municipality with (at that time) 76 per cent of its area covered by protected areas (Santos et al., 2012).

As biodiversity conservation is not the primary aim of intergovernmental fiscal transfers, it is more difficult to define the conservation effectiveness of fiscal transfers. Ring et al. (2011) have suggested relating the effectiveness of EFT to the conservation indicator considered. If the quantity (and quality, if applicable) of protected areas is the relevant indicator, the baseline for evaluating effectiveness would be the amount (and quality) of protected areas in states not implementing EFT. Declaration of new protected areas in states participating in EFT would be compared to this baseline in the control group (before–after–control–impact, or BACI methodology). In Brazil, where some of the state EFT schemes have existed for about 20 years, increases in protected area coverage have been shown for the states of Paraná and Minas Gerais following the instrument's introduction (May et al., 2002; Ring, 2008c). However, when comparing a larger number of states using BACI methodology, the results are not so clear (May et al., 2012). For example, annual average protected area created has increased for some states after the introduction of the ICMS Ecológico (for example, for Amapá, Mato Grosso, Minas Gerais and Paraná) but has decreased for others (for example, Acre, Rondônia, Tocantins and Rio Grande do Sul). The effectiveness of the Portuguese EFT scheme as an incentive for designating new protected areas or improving the management of existing areas, is not so clear, because the scheme is too recent for results to be visible (May et al., 2014). Nevertheless, an impact assessment of the Portuguese scheme has demonstrated that especially rural and poor municipalities with more than 70 per cent of their land under designated conservation status benefit financially from the new scheme, as EFT may constitute up to a third of their overall local budget (May et al., 2014; Santos et al., 2012).

6.3 Lessons for EFT in a Policy Mix

Biodiversity-related fiscal transfers are a suitable policy instrument for reconciling the conservation costs encountered at local and regional levels with the benefits of biodiversity conservation at higher levels of governance. Both Brazil and Portugal consider all protected area categories, in this way including all municipalities with any protected area type in the scheme (Ring et al., 2011). By contrast, in France very few municipalities benefit from the EFT scheme, as it applies only to core areas of national parks and marine natural parks (Borie et al., 2014). The potential synergies between protected area regulation and fiscal transfers are obviously greater if the EFT scheme is broader in scope and the potential number of beneficiaries larger (Schröter-Schlaack et al., 2014).

Thus far most Brazilian states with ICMS Ecológico as well as Portugal have chosen a quantitative indicator only, acknowledging the size of protected areas within the jurisdiction's boundaries. Only Paraná has implemented a unique and sophisticated weighting scheme based on the quality of their protected areas (Loureiro, 2002; Ring et al., 2011). However, considering both quantitative and qualitative indicators is an important requirement for generating better synergies between fiscal transfers and protected area regulation, although such a step would imply additional transaction costs related to monitoring. In Europe, where regular monitoring of the quality of Natura 2000 sites is required by law anyway, the latter costs should not constitute an obstacle to the design of EFT schemes (Santos et al., 2012).

In any event a good information policy informing local public actors about EFT schemes, their ecological indicators and allocations to municipalities is crucial. Once fiscal transfer laws are approved, intergovernmental fiscal transfers including EFT are usually allocated automatically from higher to lower levels of government, mostly in the form of lump-sum transfers to be used in any way the recipient wishes. The provision of conservation goods and services predominantly falls within the public realm but is insufficiently reflected by traditional fiscal transfer indicators. For this reason EFT schemes can only have an incentive effect towards more and better conservation if local actors are well informed about the benefits derived from EFT schemes.

Finally, EFT never exist in isolation. They are but one of the many instruments in the wider conservation policy mix. When EFT are combined with other instruments, they can potentially generate resources dedicated to reinforcing synergies between private and public conservation efforts. Recent research in Portugal and Brazil has shown that a well thought-through design of both agri-environmental measures and EFT could create new synergies for conservation on public as well as private land (May et al., 2014; Santos et al., 2015). EFT help to mainstream biodiversity and ecosystem services in public finance and fiscal transfer schemes as well as to mobilize additional financial resources for implementing biodiversity targets. In this way they constitute an important pillar of any environmental fiscal reform project (OECD, 2013).

7. CONCLUSION

The multiple objectives of biodiversity conservation and the range of different pressures at any location require a mix of regulatory, property-based, economic, voluntary and motivational instruments. Any single mechanism will have its strengths and weaknesses, so that an optimal strategy will focus on the most suitable instrument for achieving an objective while using additional and complementary instruments to compensate for its weaknesses (Gunningham and Young, 1997). Due to the complexity of all these factors, it is difficult, if not impossible 'to design a single policy instrument that will successfully provide the right incentives for biodiversity and ecosystem governance by all relevant actors. Instead, it is often preferable to employ a range of incentive measures in order to address all the pressures and actors and which, through some overlap in the measures, can provide essential backup in case any one measure fails to provide sufficient incentives' (OECD, 1999: 12).

Perhaps inspired by common pool resource management (CPRM) 'design principles' research, the PES literature has attempted to define common definitions and design principles. Muradian et al.'s (2010) wide PES definition covers most of the PES literature. However, the variety of principles defining resource transfers, relevant social actors, conditions for incentive alignment and multiple contested social interests regarding biodiversity and ecosystem services offer little hope of establishing a set of PES 'design principles'. As an example, each of the four rationales for EFT (Box 17.2) have also been interpreted as 'payments' in the PES case literature. Further complications concern the extent to which economic instruments such as PES or EFT are conditioned by existing regulatory and information instruments, thereby blurring the boundaries of PES and EFT as an 'instrument'. Rather than instrument design principles, policy mix analysis frameworks offer 'analysis principles' – variables and concepts that can be used to evaluate what characteristics of instruments interact and how.

Cross-scale policy lessons can also be drawn from our two example instruments: PES can learn from EFT how to build transfers on existing fiscal systems in order to reduce transaction costs. In fact, the longstanding PES scheme in Costa Rica has relied for roughly half of its funding on fiscal transfers from value-added tax on gasoline. EFT can learn from PES schemes on how far to push for indicators of conservation quality before transaction costs overwhelm the legitimacy of the instrument. How far have longstanding PES schemes been able to take indicators of conservation quality and ecosystem services? Such PES schemes have been able to keep transaction costs low by having very simple 'scope rules' (for example, forest cover) while achieving ecosystem service provision through 'boundary rules' (targeting land-use types) and 'choice rules' (permitted and required management actions).

To the extent that economic instruments for biodiversity conservation and ecosystem service provision evolve over time, the role of normative policy design is more limited than researchers often like to tell politicians. Policy mix analysis, rather than design, emphasizes the importance of adaptive and experimental policy development in the face of complexity.

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18. The rise of PES in Brazil: from pilot projects to public policies

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INTRODUCTION

The concept of 'ecosystem services' was suggested in the 1970s by ecologists to highlight societal dependence on ecosystems (Westman, 1977). It gained popularity among policy makers in the late 1990s, becoming associated with monetary valuation and payment schemes (Pesche et al., 2012; Gómez-Baggethun, 2010; Gatzweiler, 2006). Payments for Environmental Services (PES) were proposed as a new policy paradigm to connect those actors who benefited from ecosystem services with actors who contributed to the provision of such services, through a voluntary transaction which satisfies conditionality[1] and additionality[2] (Engel et al., 2008; Pagiola and Platais, 2004).

A wide range of models came to be grouped behind this common terminology, ranging from strictly market arrangements to national public policies. PES have been broadly defined as 'a transfer of resources between social actors, which aims to create incentives to align individual and/or collective land use decisions with the social interest in the management of natural resources' (Muradian et al., 2010: 1205). It appears to represent a good example of how a new idea is interpreted and translated into projects and policies to respond to the interests at stake (Milne and Adams, 2012). This translation occurs through a dynamic process, as policy models and practices constantly feed back into one another (Mosse, 2004): policy models require experiences to validate their

[1] Conditionality means that the payment ought to be realized 'if and only if the service provider secures service provision' (Engel et al., 2008).

[2] Additionality means 'paying for activities that would not have been conducted anyway' (Engel et al., 2008).

potential and, in turn, the experiences are put into practice to legitimize policy models.

The case of PES in Brazil is particularly interesting in illustrating how different PES models have emerged, according to different agendas, and how they have consolidated themselves. While PES in countries such as Costa Rica or Mexico were driven by national governments (Le Coq et al., 2012; Corbera et al., 2009), in Brazil, PES were initiated in the early 2000s by NGOs and local governments, making room for considerable experimentation and leading to a diversity of experiences across the country (Pagiola et al., 2012; Guedes and Seehusen, 2011). Legal frameworks and specific funds were progressively created to support the implementation of PES schemes at different governance levels (Santos et al., 2012). This led to certain tensions, as the different stakeholders negotiated their potential roles in multilevel governance arrangements.

Various trade-offs between governance levels have been identified (Larson and Ribot, 2009; Toni, 2011). At a local level, governance arrangements can be perceived as being closer to actors' preoccupations and needs, and transaction costs for monitoring may be lower. However, local governments often lack the capacity for carrying out such governance, and there is the risk of elite capture. At higher levels, though governments may realize economies of scale and limit leakage, monitoring can become more complex and resistance from local actors is more likely. Complementarities between levels can make governance more efficient (Nagendra and Ostrom, 2012), but in practice, power relations often establish the balance between levels and the dominant policy models.

Different reviews of PES in Brazil have been carried out over the past few years, providing detailed descriptions of the observed experiences and legal frameworks (for example, Pagiola et al., 2012; Guedes and Seehusen, 2011; Santos et al., 2012). Our objective here is not to add to this already exhaustive work, but rather to reveal a broader picture of the processes associated with PES experiences in Brazil, in particular the tensions and the complementarities that have arisen between stakeholders along the way. Most of the authors of this chapter have been involved in their research work in PES experiences and proposed legislation and have closely observed the dynamics at play between the stakeholders involved. Following Shi (2004), we are convinced that ecological economics has an important role to play in revealing the institutional settings of policy decision-making processes, along with the power relations and social controversies, in order to show that there is no privileged answer to political and normative questions.

Our view is that the flourishing of PES projects in Brazil corresponds to the willingness of a variety of stakeholders to experiment with the models they idealized in order to acquire the legitimacy to be key actors in defining future PES policy. This chapter undertakes a critical historical review of how PES emerged in Brazil, seeking to understand its underlying dynamics. Our primary objective is to apprehend the principal elements involved in the processes and from there contribute to support reflexive discussions on the perspectives for PES in Brazil. In the first section, we unfold the process through which PES progressively emerged in Brazil according to different agendas. In the second section, we analyze the dynamics behind this process: who were the main stakeholders involved in idealizing PES; what are the models they brought to life and experimented with; and how the different types of coordination may configure the future of PES in Brazil.

1. PROGRESSIVE EMERGENCE OF PES IN BRAZIL: MAIN AGENDAS AND PROCESSES

The present section is composed of four main parts in which we illustrate how PES emerged in Brazil in concurrence with different agendas, through intermingled processes. First, we show that among the first to idealize PES in Brazil were socio-environmental movements, launching the Proambiente pilot program to consolidate an agro-environmental transition. However, the lack of institutional support structures impeded its ongoing implementation. The second part shows that after 2005, as REDD+ brought promises of generous financial support, state governments, followed by the federal government, created structures to channel such funding and oriented the PES paradigm towards forest conservation. The third part describes how municipal and state governments consolidated PES approaches directed toward provision of hydrological services in the late 2000s. The fourth part explains how these different stakeholders and their agendas were brought together as the Forest Legislation was revised, with a view toward integrating PES into its framework.

1.1 First Steps: Idealization of Socio-environmental Incentives

The first example of direct incentives for local populations dates back to 1999 in the state of Acre, through the Chico Mendes Law.[3] This law created a program designed to provide public subsidies for rubber extraction in order to avoid massive migration of rubber tappers to urban areas.

[3] The State Law 1.277/1999 was named after the famous leader Chico Mendes, who fought for the recognition of the rights of rubber tappers. He was assassinated in 1988.

This public subsidy helped revitalize extractive activities, enabled rubber tappers to remain in rural areas, strengthened their local social organizations, and provided support for conservation of natural resources (Silva and Silva, 2006). Some 4000 families received subsidies to conserve their land, impacting a total of 1.2 million hectares (Mattos and Hercowitz, 2011).

This program thus paved the way for the rise of PES in Brazil and largely inspired civil society organizations in the rest of the country. Between 2000 and 2002, social movements from the Brazilian Amazon, in partnership with regional NGOs, formulated Proambiente, a public policy proposal to implement a new model of land use based on the management of natural resources, in which PES would play an important role in encouraging the transition (Hall, 2008). It aimed at combining different levels of management and planning, involving individual production plans, community agreements and conditionality through participatory certification, as well as territorial development plans (Mattos, 2010). This pilot project was conceived to involve more than 20000 family farmers in nine states of the Brazilian Amazon.

During the first year of President Lula's mandate, in 2003, the Proambiente proposal was included in the Pluri-Annual Governmental Plan for 2004–2007 and the first payments were implemented in 2006. The initial idea was to compensate the farmers at an amount of about USD 50/family/month for their additional labor costs pertaining to the extra effort required to establish environmentally-friendly practices. These PES encompassed all 2555 family farmers registered by Proambiente, but contrary to initial plans, they did not incorporate conditionalities or sanctions defined in the community agreements, partly because these agreements were still incomplete. After six months (January–June 2006), the payments were suspended. Some authors consider that these PES constituted merely a fulfillment of short-term political commitments by the Minister of the Environment, instead of being part of a strategic long-term plan to accomplish the conservation targets established by the program (Mattos, 2010).

Social movements expected Proambiente to become a government program but had not anticipated the need to establish conditions for payment as part of such programs. This caused a political break with the Ministry of the Environment in 2005, which widened as social movements were left out of decision making and relegated to an advisory role. Territorial plans were not implemented by municipalities due to a lack of interest and inadequate articulation with the Ministry of the Environment. Technical assistance and rural extension was implemented only in an early phase of the program (the first two years) prior to the adoption of the sustainable practices by the farmers.

Despite such shortcomings, a significant result of the program was its social mobilization to demand public policies which would recognize the delivery of environmental services, motivating ministerial and parliamentary debates from 2006 onwards. Coinciding with the growing international agenda on climate change, this early initiative led to a nationwide discussion on means to promote the provision of environmental services.

1.2 Expectations Linked to REDD+ and Involvement of State and Federal Governments

From 2003 onwards, Brazil pioneered within the United Nations Framework Convention on Climate Change (UNFCCC) the idea of compensations for reduced greenhouse gas emissions through forest conservation (Santilli et al., 2003). The REDD+ mechanism[4] that was configured in this process represented a marked shift in expectations linked to carbon-related finance, bringing with it expectations of opportunities to access new resources to design and carry out forest conservation policies and PES in particular.

Representatives of the federal government argued that REDD+ should not be used as a mechanism to compensate for emissions by industrialized countries, but rather that it should be financed by bilateral and multilateral donations (MMA, 2012). To consolidate this strategy, the federal government launched the Amazon Fund in 2008, with a major initial donation from the Norwegian government,[5] aiming to finance emission reduction projects related to land-use change in the Amazon region. National legislation related to REDD+ was first proposed in 2009, but is still undergoing analysis by congressional committees.

As the national REDD+ legislation advanced slowly, the Amazonian states took the opportunity to define their own REDD+ strategies. As part of the Governors' Climate and Forests Task Force (GCF),[6] the participating Amazonian states demanded autonomy to fully develop their sub-national schemes in a nested approach (May et al., 2011; Toni, 2011). Presenting a unified position to the Brazilian President in 2009, they advocated participation in the carbon market, contrary to the Federal government's position (MMA, 2011). To legitimize this position, eight Amazon

[4] REDD+: Reducing Emissions from Deforestation and Degradation, with the '+' standing for conservation of forest carbon stocks and sustainable management of forests.

[5] The Norwegian government promised to donate USD 1 billion between 2009 and 2015.

[6] GCF is a sub-national collaborative initiative by some individual states from seven North and South American countries. Six Amazonian states take part: Acre, Amapá, Amazonas, Mato Grosso, Pará, and Tocantins.

states have already created regulatory frameworks for climate change and environmental services (Pavan and Cenamo, 2012).[7]

In the meanwhile, local-scale REDD+ initiatives advanced at a rapid pace. Brazil is the largest recipient of donations for REDD+ projects so far,[8] although there is an overall lack of clarity in their definition. Existing projects include: protected areas, such as the Juma Sustainable Use Reserve, Brazil's first certified REDD+ project; Indigenous Lands such as the Suruí Indigenous Territory; and projects developed on private lands, such as the Purus Forest Conservation Project. The largest REDD+ initiative is the Bolsa Floresta Program launched in 2007 by the Government of Amazonas State, in a multi-actor partnership which encompasses 15 protected areas and benefits more than 30 000 people. Based on the experience of Juma, it offers direct payments to local populations along with other incentives to encourage the delivery of environmental services (Hall, 2008). Despite the recognition of the beneficial social impacts of these programs (for example, Börner et al., 2013; Mohammed et al., 2013), a need for improvements in monitoring deforestation and degradation to ensure conditionality has been identified (Tejeiro and Stanton, 2014).

All ongoing REDD+ labeled initiatives so far are considered 'voluntary projects', financed by firms or funds. However, some of the projects have also benefited from finance derived from the Federal Amazon Fund. To date, this fund has supported a variety of REDD-related projects: altogether 54 projects have been financed with non-reimbursable grants for a combined investment of approximately USD 390 million.[9] Despite these figures, the Amazon Fund has been subject to mounting criticism due to its bureaucracy and the difficulties in accessing resources even for approved projects. The projects funded have been coordinated by a mixture of NGOs (35 percent), states (33 percent), or municipalities (15 percent). The civil society sector has been fundamental in fostering enabling conditions for state- and municipal-initiatives, leading to a certain level of dependence on such hybrid governance arrangements to ensure project success.

The lack of a national system of regulation and crediting of forest carbon activities has been seen as a major challenge to achieving further advances at the state level. Major problems include methodological inconsistencies among the different states, the risk of double counting of the

[7] Three states have already approved laws addressing REDD+: Amazonas in 2007, Acre in 2013 and Mato Grosso in 2014, and the others states are currently in the preparation phase.

[8] Brazil received more than USD 266 million and a further commitment of more than USD 819 million, for 12 official projects (http://www.forestcarbonportal.com, retrieved 23 May 2014).

[9] Boletim Fundo Amazônia, March 2014.

same emission reductions and the need to integrate diverse sub-national programs within a broader national initiative (Pavan and Cenamo, 2012). Every REDD+ plan at state level should take into account its potential contribution to the national target of reducing Brazil's GHG emissions.[10] However, although expectations still exist regarding the potential of incentives from a REDD+ policy (Moutinho et al., 2011), it is mainly thanks to a strong federal command-and-control policy and a credit embargo on non-compliant municipalities that deforestation in the Amazon had already almost reached its target of an 80 percent reduction in relation to the 1996–2005 baseline in Amazon deforestation by 2013 (Barreto and Araujo, 2012; Assunção et al., 2012).

Thus, governance of REDD+ has been debated at length (federal, nested, market-oriented) and has led to attempts of consolidating options rapidly through legal frameworks. REDD+ appears to be in a paradoxical situation: it emerged in the domestic policy scenario with the expectation of receiving international funding; yet the global economic crisis has cast increasing doubts on the credibility of these financial expectations. REDD+-labeled projects have not sold their credits on international carbon markets, waiting for better days, and the PES promised to local populations have often not materialized. Thus, although often associated in initial discourses, PES and REDD+ have progressively become viewed to represent different agendas. However, as the federal government has advanced significantly in preparing REDD+, by setting of baselines and targets for national emission reductions and developing a reliable Monitoring, Reporting and Validation (MRV) system, this will probably have a strong influence on future PES systems.

1.3 Consolidation of PES Experiences around the Water Agenda

In the south-eastern part of Brazil, as water supply was becoming a serious problem for large cities such as Rio de Janeiro and São Paulo,[11] the World Bank, as well as NGOs, supported states and municipalities in their attempts to build PES schemes for water resources conservation. Since 1997, the Brazilian water resources legislation established charges for water use and assigned the responsibility for managing the funds raised to local and regional Watershed Committees. Nevertheless, the

[10] According to the National Climate Change Policy (Law No. 12.187/2009), Brazil has a target of reducing deforestation in the Amazon by 80 percent (against a reference period of 1995–2006).

[11] In 2014–2015, São Paulo has been facing the worst hydric crisis ever: its main water reservatory, Cantareira, was down to 5% of its capacity, threatening the water provisioning of 8.8 million people.

federal government retained an important role through the National Water Agency (*Agência Nacional de Aguas* – ANA), which supports the actions of the watershed committees and is directly engaged in managing interstate watersheds.

In 2001, ANA launched the Water Producer Program (*Produtor de Água*) to support integrated watershed management with the intention of facilitating decentralized water PES schemes (Pagiola et al., 2012). Implementation of local projects did not start before 2006, however. Through a multilevel partnership (involving ANA, governments of the states of São Paulo and Minas Gerais, The Nature Conservancy, and local organizations), two pilot PES experiments were launched in 2006. The first, named 'Water Conservator' (*Conservador das Águas*) was initiated by the municipality of Extrema (Minas Gerais), building upon several water conservation programs initiated in the mid-1990s. The second pilot project was initiated across three sub-watersheds (Piracicaba, Capivari and Jundiaí – PCJ, of which Extrema is part), which supply some of the main water reservoirs for the city of São Paulo. That same year, a private foundation, the Fundação Grupo Boticário, launched the Oásis Project, a PES scheme aimed at the protection of riparian forests in properties located in another strategic watershed for the city of São Paulo.

During the following years, PES projects proliferated rapidly in the Atlantic Forest biome of the south-southeast regions, with 80 projects identified in 2010 (Guedes and Seehusen, 2011), mainly for the conservation of hydrological resources through protection or restoration of riparian forests. As REDD+ gained visibility, firms and NGOs viewed the opportunity to supplement water management funds with funds from the carbon market. This convergence between the water agenda and forest conservation was also observed in public policies. Since 1965, the Forest Legislation has required private properties to maintain the vegetation of riparian areas (named Permanent Preservation Areas – APP), which is also a priority for water PES (Dos Santos and Vivan, 2012). Some state command-and-control programs were 'converted' into PES programs to obtain new sources of funding. An example is the PROMATA program, launched in 2003 by the state of Minas Gerais, whose aim was to control deforestation in private properties and around protected areas. In 2007, it was turned into a state PES policy called Bolsa Verde (not to be confused with a later approved federal program with the same name), whose funding is sourced mainly from water charges (Guedes and Seehusen, 2011).

Based on these experiences, municipalities and states started to build regulatory frameworks to support PES. Santos et al. (2012) identified 20 legislative initiatives at the state level and seven at the municipal level.

The sources of funds provided by these laws vary, such as donations from national or international cooperation, transfer of funds from compensation and environmental monitoring, but public funds predominate. Market-based instruments (that is, those designed to intervene in the interaction of economic actors so as to affect prices and behavior vis-à-vis externalities) are seldom involved. Most resources are managed through state funds,[12] some specifically created for PES.

The São Paulo state government, supported by the World Bank and The Nature Conservancy (TNC), played a particularly active role in the definition of a state policy to spread water-related PES schemes in the south of the country. Learning from the various PES programs with which Brazilian institutions had experimented over the previous years, it launched the *Mina D'água* program in 2009. This program is a partnership between the state Department of the Environment (SEMA), watershed committees and municipalities. The state government sets general rules (area and eligible activities), and the municipalities, according to these criteria, define the spatial targeting of the project, define actions, register landholders and monitor the project. In early 2013, the SEMA-SP had agreements with 21 municipalities. As the state could not afford to implement the projects directly with its own technical staff,[13] this approach aims at building the necessary operational capacity.

Multilevel governance was also reinforced by ANA in an attempt to upscale water-related PES. In 2011, it launched a public call to identify new initiatives to be included in the Water Producer Program. In 2013, this program had 20 projects under implementation, involving an area of 310000 ha and 1016 producers. Each project operates through a Project Management Unit generally led by a public agency (a municipality, a state water agency, a secretary of state) or an NGO. ANA does not coordinate the project, but mediates between the various entities to promote institutional and financial arrangements, technical expertise and funding when necessary (about 10–15 percent of the total value of each project).[14] Specialized entities (firms, public services or NGOs) provide the technical

[12] The State Fund for PES in Santa Catarina, the State Environmental Fund in Paraná, the Water Resources Fund (Espirito Santo, Minas Gerais, Paraná and Rio de Janeiro) and the Fund for Prevention and Control of Pollution – FECOP (São Paulo).

[13] Interview with Helena Carrascosa, coordinator of Biodiversity and Natural Resources, SEMA-SP, 18 April 2013.

[14] ANA receives an annual budget of about USD 7 million to develop the program. These 20 projects represent an investment of USD 12 million, which means additional funding sources are required (Interview with Devanir Garcia dos Santos, manager of the Sustainable Use of Water and Soil, ANA, 29 April 2013).

services, like property mapping, and extension is generally undertaken by public companies, like EMATER.[15]

Thus, in just a few years, hydrologic PES have succeeded, thanks to facilitators at various levels (ANA, state and municipal governments, NGOs), in finding other sources of funding, developing monitoring systems, building capacity, and creating legislative frameworks. The contribution of private companies generally is not included in the Watershed Committee funds. It is complementary to public funds, enabling the implementation of the project at a larger scale, an increase in the amount paid per hectare, or a prolongation of the duration of the contract (for example, the partnership between the Itaú bank and the municipality of Extrema).

The multiplication of local PES schemes in the south-southeast and, now, central parts of Brazil meets an important local demand in terms of water resource management in strategic watersheds. Pagiola et al. (2012) point out that the variety and complexity of such institutional arrangements allow the adaptation of projects to local contexts, but at the same time they consider that suitable mechanisms for upscaling such schemes are still lacking. Among the stakeholders involved, there are those who want federal legal frameworks to support local measures and raise funds, and others who fear they will lose their autonomy under such central regulations.

1.4 Towards a Federal Framework for PES: Proposed Bills and the New Forest Legislation

After 2006, with the new business opportunities in the carbon and water markets, the PES issue gained relevance for various interest groups. This fashionable theme materialized in 2007 as a veritable avalanche of proposed bills in the legislature, each one dealing with different frameworks and interests.[16] The first of these put forward the demands of the social movements that had been the driving force behind Proambiente, especially those related to family farming through the National Confederation of Agricultural Workers (CONTAG). Various related projects had the goal of creating social transfers with environmental conditions. The rural caucus (representing large landowners) proposed several bills aimed at creating funds destined for rural producers in general.

[15] Empresa de Assistência Técnica e Extensão Rural: technical assistance and rural extension company, a public entity coordinated at the state level, and dependent on state financial support, and typically hugely overextended in terms of capacity to respond to new technical demands.

[16] Eight Law Projects were submitted in 2007, and six more by 2009.

Given the delays involved in institutional coordination and mediation between the different federal sectors, the Executive branch (represented by the Ministry of the Environment) released its own bill only in 2009, presenting a national policy for PES (Draft Bill PL 5487/2009). Previous bills, including the government's, were bundled into a single substitute draft bill (PL 792/2007) which has been evolving as negotiations continue among the committees of the Chamber of Deputies in the Brazilian Congress. The current version of the proposed measure recognizes the economic value of ecosystem services and the right to remunerate social actors who provide them. However, it remains contradictory in that it relies conceptually on a market-oriented view, while at the same time putting the burden of funding the system on the provision of public funds. The proposal also seeks to prioritize the more vulnerable segments of society, but yet formalizes the buying and selling of services.

The initial excitement in the legislature about the topic was then followed by a cooling-off period, which has lasted until the present, for several reasons. First, as the PES bill was taken to the Executive, further analysis was required to decide how to treat it legally in the financial, budgetary and fiscal areas. Second, in the context of the international financial crisis, discouraging scenarios in the post-Kyoto agreements ended much of the expectations for implementing REDD+. Third, in the Brazilian domestic arena, a political battle took place around the revision of the Forest Legislation, in which PES became a strategic element. Until the debate on the new Forest Legislation was concluded, discussions on a National PES law were temporarily suspended in the Congress.

The original Brazilian Forest Legislation[17] is an important forest policy instrument, establishing protected areas on private properties, called Permanent Protection Areas – APPs (areas around water bodies, hilltops, slopes, wetlands and other sensitive areas) and Legal Reserves – RLs (a percentage of the property to be maintained under original forest cover, varying according to the region).[18] Over the decades, illegal land occupation and deforestation (especially in the Amazon region) have carried landowners increasingly far from legal compliance. With stronger enforcement of environmental policies in the 2000s, tensions increased. This led to a strong mobilization of landowners to make the Forest Code more 'flexible,' to exempt farmers who deforested from further penalties, and to incorporate measures to achieve compliance by restoring degraded vegetation.

[17] Established by decree in 1934, it became a Law (4771) in 1965.

[18] 50 percent to 80 percent in the Amazon biome, 35 percent in Cerrado areas of the Legal Amazon region, and 20 percent in the remainder of the national territory.

The different agendas previously involved in PES discussions crystallized around the Forest Legislation debate. The family farming movements highlighted their potential in delivering environmental services. Large landowners took their side, but in this process, agricultural practices became totally excluded; the focus remained only on forest cover. An unexpected alliance between the environmentalists and the rural caucus arose to defend a specific view on additionality.[19] The environmentalists wished to legitimize payments destined to support protected areas. The large landowners aimed at receiving payments for conserving or restoring APPs and LRs.

The new Forest Legislation (Law no. 12.651, signed in May 2012), established PES for the first time within a national legal framework, although in an ambiguous way. The most polemical issue is that it allows payments or incentives to be used by landholders for the maintenance or restoration of APPs and RLs (Article 41), which in principle violates the constitutional rule that one cannot receive public compensation for complying with the law. It is, however, an attempt to motivate historically non-compliant landowners to become compliant and thus provide important environmental services.

While discussions on the legal framework for PES were suspended during the polemical debate around the new Forest Legislation, the federal government sought to move forward with the socio-environmental agenda of PES by creating in 2011 the Bolsa Verde Program (Green Grant), similar in motivation to the Bolsa Floresta implemented by the state of Amazonas. The program allocates payments[20] to families who live in extreme poverty and have land use rights in an ecologically relevant area (mainly in protected areas). Using the operational structure of the Bolsa Familia program (a large federal social transfer program), Bolsa Verde had registered 59 000 families by mid-2014.[21] However, the environmental conditionality of this program has raised some concern. Families sign a contract to limit their environmental impact, but how this will be monitored is not yet clear.

Thus, confrontation of agendas at the federal level broke down the

[19] The new Forest Legislation (Article 41, §4, Law 12.651) stipulates that APPs and RLs can represent an 'additionality' eligible to be commercialized in domestic and international markets for GHG reductions. This is a contradiction in terms, since additionality is defined as an increase in the ecosystem service that would not have occurred in the absence of a program. However, there are numerous stakeholders including state government officials who support this additionality argument.

[20] Each family receives approximately USD 150 every three months.

[21] http://www.mma.gov.br/desenvolvimento-rural/bolsa-verde/item/9141 (accessed 29 May 2014).

complexity of PES into two main issues. On the one side, Bolsa Verde addressed social concerns and poor populations even though agro-environmental practices as idealized by the socio-environmental agenda were far from being made a condition for entitlement. On the other, the new Forest Legislation recognized PES as a forest conservation instrument, providing its first federal legal framework.

2. WHAT WERE THE DYNAMICS BEHIND THIS PROCESS?

In the past 15 years, many stakeholders have taken part in developing PES projects and frameworks in Brazil, and have thus become indispensable players in the design and implementation of future environmental policy. However, instead of the diversity that might have been expected, PES schemes seem to fit into relatively general models, therefore offering little insight in terms of different governance arrangements. Discussing PES policies based on such scant evidence presents a certain risk: that future legal frameworks will tend to focus on commonly encountered technical models and rules but will do little to encourage innovation or learning between stakeholders. In this section we describe the main stakeholders involved in these processes, the PES models that emerged and, finally, the main lessons learned.

2.1 Becoming Indispensable Players

The rapid dissemination of PES in Brazil has been facilitated by a few influential players who wished to set the scene for PES: NGOs, the states of São Paulo and Amazonas, and some federal institutions (ANA in particular). The promise of new funding sources for environmental policies set the rapid pace, as each player scrambled to secure his share. Although considerable public funds exist in Brazil, redirecting them towards PES was not immediately possible. Leveraging funds from international cooperation entities (international NGOs and foundations, the World Bank, the Inter-American Development Bank), as well as from voluntary carbon markets was thus fundamental in starting the different pilot projects. These international players seemed clearly interested in being part of future PES policy in such an emblematic country as Brazil, which would bring visibility to their actions.

The federal states played a particularly active role in attracting and negotiating with these international players, as PES were an opportunity to define their own environmental policies and raise complementary funds for their actions. In the case of REDD+, the Governors' Conference on Climate Change was an opportunity for Amazonian states to engage in a visible forum, with possibility of access to compensation funds. This also proved to be an excellent strategy to leverage funds from the voluntary carbon markets, through showcase experiences such as Juma, which benefited the image of private companies. In the case of hydrological PES, the partnership between the state of São Paulo, the World Bank and TNC allowed the setting up of an expert group on PES, which became the pivot for reflection on hydrological PES in south-southeast Brazil (Guedes and Seehusen, 2011; Pagiola et al., 2012). By becoming obligatory references for PES, these states indirectly made the federal government move ahead.

At the federal level, the main concern was to not be left behind on this quickly growing agenda. Several reports were commissioned by the Ministry of Environment and the Presidency: *PES in the Amazon* (Wunder et al., 2008), *PES in the Atlantic Forest* (Guedes and Seehusen, 2011), *REDD+ in Brazil* (Moutinho et al., 2011), *Lessons learned from conservation in the Atlantic forest* (Guedes et al., 2013). However, in recent years, the federal executive has become more sensitive to legal requirements, and the control by the Federal Court of Audit has substantially increased due to recurring corruption scandals. This has forced all governmental measures to be in full conformity with ethical, technical and financial requirements. There is little room left for experimenting before adequate legal frameworks are in place, as was evidenced by the Proambiente case.

These stricter requirements also have consequences for other governance levels. Indeed, although international funds and voluntary carbon markets have had a role in triggering the process, the vast majority of PES tend to be financed mainly through municipal and state policies. This imposes serious constraints compared to what can be achieved through market arrangements. For example, some projects started out by making payments to farmers from non-public sources of funding, but once they managed to integrate public funding in the PES scheme, payments had to be suspended for some time due to bureaucratic reasons (Guedes et al., 2013). Private funds have thus proved to be flexible complementary sources for PES programs, to increase their reach and finance actions that are difficult to address through public funds. Articulating public and private funds has been precisely the main goal of the ANA in recent years. For private companies, this offers various opportunities. In the case of water-related PES, they can enter as central stakeholders to guarantee water provisioning (the beverage industry, for example). They can also compensate their environmental impact or offset their carbon emissions. And finally, investing in conservation actions can confer a 'Green image' to their company.

Civil society organizations have also benefited from major complementarities with public authorities, conferring on them a key role in implementing the schemes. Their functioning is much more flexible than that of public services, enabling them to contract technicians according to the program's needs and to carry out their actions in a less bureaucratic manner (although when financed by public funds, they have to submit to very strict audits). These organizations also often present themselves as being closer to the farmers' preoccupations. In the case of Proambiente, they indeed had a strong historical legitimacy of acting with local populations. The Proambiente program was for them both a way to finance the actions they idealized with local populations and a springboard to discuss federal policies based on the legitimacy they had built.

Thus, a distinctive feature of PES initiatives in Brazil is the involvement of multiple actors, across different sectors. Such a complex configuration is closer to conventional conservation and development projects than to the simple arrangements expected from market transactions. Although many projects are derived from already existing projects, as is often the case with PES schemes (Muradian et al., 2010), the stakeholders involved clearly highlight the fact that these projects are PES schemes by using the appropriate wording: compensation of opportunity costs, additionality, conditionality, monitoring. This testifies to a desire to be part of the process of definition of a PES policy for Brazil, with the hope of designing new ways of integrating incentives into environmental policies.

2.2 What are the PES Models that have Emerged from this Experimentation?

Using a broad definition of PES, Dos Santos and Vivan (2012) have identified 116 cases of PES in the country (excluding certification schemes). Guedes and Seehusen (2011) account for 24 PES projects in the implementation phase in the Atlantic Forest. Most experiences presented state that their main objective was to offer a model for replication in other parts of Brazil (Pagiola et al., 2012).

Although a certain diversity of models existed in the initial stages of PES projects, a move towards simplification has been underway in recent years. Two factors can explain this trend: first of all, due to pragmatic reasons, projects had to scale down their initial ambitions to adopt more operational functioning (Guedes et al., 2013); second, as the new Forest Legislation was passed, expectations regarding funding linked to APPs and RLs made PES schemes converge towards forest cover (Eloy et al., 2013). This simplification has also led to the separation of the environmental and social agendas. The environmental agenda focused on forest cover, with REDD-type baselines and satellite monitoring. The social agenda turned to support families living in protected areas, with the Bolsa Floresta and Bolsa Verde.

Although the first PES schemes emerged for productive diversification and agro-ecological transition both in Amazonia and the Atlantic Forest,[22] the measures that have been ultimately the most contemplated are to set aside or restore forests. The majority of schemes (both for carbon and water) are basically devoted to preserving remaining forested areas (Dos Santos and Vivan, 2012). The new Forest Legislation has controversially opened up the possibility to pay for preservation or restoration of APPs and RLs, which are already compulsory by law. Many water-related schemes have been consolidated from this perspective, as a way of guaranteeing riparian forests. However, the latest version of the substitute bill (PL 792/2007),[23] presented in April 2014, questions this point, as it explicitly restricts the national PES program to areas outside APPs and RLs. Additionally, according to this bill the national program should prioritize critical areas for conservation in terms of biodiversity and water resources. Nonetheless, in a transition from very low compliance with the Forest Legislation, supporting legal preservation through PES may make sense.[24] However, as compliance increases, PES may well turn to reforestation additional to the legal requirements, as already planned by the Bolsa Verde in the state of Minas Gerais. Up until now, the low number of projects for forest restoration can be explained by the fact that they are much more expensive than forest preservation,[25] making it difficult for PES alone to promote this restoration.

Since current projects mainly focus on setting aside forested areas, the main differences between various PES come from the targeting of properties and the way payments are calculated. Although Proambiente suggested another way to calculate payments (remunerating the extra effort), most current PES follow the logic of land opportunity costs, usually based on an estimation of the income from other land use with a rough weighting to take into account the quality of the service provided, although payments are not meant to cover these opportunity costs

[22] Guedes and Seehusen (2011) show that in the Atlantic Forest, a third of the projects (13 out of 33) also involve measures to promote agroforestry.

[23] As we finalize this chapter (May 2014), a new substitute bill for a national PES policy (amalgamated in a revision to PL 792/2007) has just been submitted to Congress.

[24] As the new Forest Legislation was promulgated, the Ministry of Environment estimated that between 25 and 30 million hectares needed restoration to achieve compliance with the Law, 80 percent of which were occupied by pasture (Barbosa, 2012).

[25] Estimations vary between USD 2500 and USD 7000 per ha, according to the biome and the severity of degradation (Barbosa, 2012).

completely. Even if such weighting cannot be considered as a detailed assessment of the quantity and quality of the services preserved, it represents an interesting contribution in relation to most countries where payments are not related to the assessment of environmental services (Guedes and Seehusen, 2011).

Although operational aspects seem quite similar (quantity and aim of payments), PES schemes could be expected to differ mainly in their institutional arrangements, depending on the contexts in which they have emerged. However, little information is provided in the reports regarding this point. The actors and organizations involved are generally described, but their respective roles are often vague, as well as the way in which they coordinate themselves. It is unclear how the projects have involved the landholders, how they are accompanied technically, and what type of monitoring is carried out. Apart from funding difficulties, little information is provided on the challenges faced.

As PES require joint efforts of numerous actors, building these arrangements may well translate into high transaction costs. However, these transaction costs are unreported, which makes it difficult to understand the complexities involved in building such programs. Reports indicate that it is not a coincidence if the largest numbers of active PES projects are encountered in regions where public institutions function relatively well and where various environmental legal frameworks already existed (Guedes and Seehusen, 2011). Such institutional contexts can favor PES schemes through pre-existing relations between partners and well-grounded routines. Legal frameworks alone cannot make up for this pre-existing coordination. There is also an overwhelming lack of information about initiatives that have not been successful in setting up the scheme, although the proportion of cases that never reached the implementation stage is probably very high.

This knowledge gap is not a phenomenon restricted to Brazil. There is a worldwide lack of evaluations not only of PES but of conservation policy mechanisms in general (Miteva et al., 2012). Nevertheless, there are particularly few scientific assessments of PES experiences in Brazil to provide grounded evidence. Thus, the success of these schemes seems to rely more on the description of the experience and the partners involved than on the evidence of their results. In this context, the future of PES in Brazil may depend mainly on the power relations between the different stakeholders and their capacity to defend their model in the policy arena.

2.3 Lessons Learnt regarding PES in Brazil

The Brazilian Congress may be close to voting on the National Policy of Payments for Environmental Services.[26] However, NGOs and state governments are opposing the legislation as not representing the diversity of experiments underway at the regional and local levels, and warning that the policy may place shackles on a flexible tool. It is hard to predict where the discussions will lead to and what flexibility will be accorded to the different governance levels. The processes we have analyzed show that relations between governance levels and sectors can have many facets. Attribution of power, decentralization and recentralization are constant processes, negotiated between the federal government, lower governance levels and other sectors, according to the interests at stake (Andersson et al., 2006; Toni, 2011).

In the case of water, a complex polycentric governance has already been undergoing consolidation since the 1990s. Provisioning of water resources, as in other countries, is a concrete agenda which easily arouses local concerns and the willingness of lower government levels to take part in governance (Abers and Keck, 2009; Brannstrom, 2004; Lemos and De Oliveira, 2004). The key role of ANA as a facilitator enables local governments to retain autonomy of action and to experiment with new projects, while benefiting from a network of other experiences and advice. This has been highly beneficial for the expansion of PES in the south-southeast of Brazil. If the new Forest Legislation truly brings subsidies for restoring APPs, this governance based on strong coordination between levels and sectors will probably enable the expansion of hydrological PES.

In the case of the forest agenda, multilevel governance is a complex issue. Although states and municipalities are encouraged to engage in environmental management, they often lack the capacity and incentives to carry it out (Toni and Kaimowitz, 2003). As REDD+ brought promises of funding, it motivated municipalities and states to engage in national and international discussions aimed at developing this mechanism. However, as the forest issue is strategic for the Brazilian government in international negotiations, it wishes to keep control over REDD+. This is the classical REDD+ paradox (Phelps et al., 2010; Sandbrook et al., 2010), which has led to a certain recentralization of the forest agenda in some countries. In Brazil, however, states have a fair degree of autonomy and power, enabling them to build strong REDD+/PES agendas (Toni, 2011). Although NGOs stand up for their role, by defending a nested-approach to REDD+

[26] As mentioned earlier, after four years of suspension, a new Substitute Bill has just been submitted to Congress (May 2014).

to implement their own projects, they have also become important advisors to state and federal governments. They have been supporting land tenure regularization and local capacity building, two crucial issues for any progress on enforcing the Forest Legislation, but also for any future adaptation of PES to support REDD+ schemes. Thus, coordination is emerging between the different entities, but under strict rules and monitoring set by the federal government. One of the main debates regarding PES in the Amazonian context will be the landowners targeted (Börner et al., 2010): working with large landowners would be more efficient as this group is responsible for most of the deforestation, but will prove to be costly as they involve considerable forested areas and higher opportunity costs; smallholders normally involve high transaction costs for much less environmental benefit, although opportunity costs may be lower. This explains the decision to enforce strong control of deforestation on large properties, along with social transfers to the poorest populations (Bolsa Floresta and Bolsa Verde).

In the case of the socio-environmental agenda, one of the main challenges arose from the cost and complexity of PES programs linked to agro-environmental practices, rather than restricting use of native vegetation areas. Although the social organizations tried to promote participatory certification of such practices, it was impossible to proceed with this strategy within a federally supported program. As the social agenda was integrated into the Bolsa Verde program, it was drained of its potential for environmental additionality. A project approved within the Amazon Fund[27] has recently initiated PES schemes in former Proambiente areas and may succeed in establishing governance arrangements to support agro-environmental PES. However, assessments undertaken after Proambiente show that farmers mainly request technical assistance to develop their activities in an environmentally correct way rather than payments (Costa, 2008; Schneider et al., 2015). The federal government has been working on building a new organization to coordinate technical assistance, which may assume a facilitator role in a way similar to ANA. A new instrument may be reinforced in this context, the Environmentally Conditioned Credit, which would provide incentives to farmers to change their practices.

Different types of coordination have been consolidating around the PES schemes, not always smoothly, but tensions have also allowed the stakeholders to negotiate their roles and find complementarities in polycentric governance arrangements. Many stakeholders now have strong positions from which to negotiate the coming round of the National Policy for PES.

[27] The Project 'Assentamentos Sustentáveis na Amazônia', led by the NGO IPAM (Instituto de Pesquisa Ambiental da Amazônia) (http://www.fundoamazonia.gov.br).

CONCLUSION

Tracing the emergence of PES in Brazil reveals three distinct processes: one to valorize agro-environmental practices; one devoted to forests and driven by REDD+; and one to consolidate water management. These different agendas have partly influenced each other but they truly confronted each other when PES were discussed within the new Forest Legislation. This was a prelude to the discussion on the National Policy for PES, a discussion which is starting up again.

PES have initiated a debate on the possible role of positive incentives in an environmental policy. They have taken on a symbolic dimension, creating much expectation on the ways to value efforts by those who provide environmental services. The many experiences testify to the willingness of various types of actors, from private funds to civil society organizations, as well as local governments, to engage in this national debate and to advance their views for renewing environmental policies.

In fact, PES schemes are not so diverse in Brazil, having been simplified over the years to make them more operational. But what has really been at stake in the experimentation is the potential role of the different stakeholders in a polycentric governance of environmental policies. As the debate on the National Policy for PES resumes, tensions are palpable. The challenge for the federal policy is to offer more possibilities for coordination between levels. But the danger is that it may remain innocuous and relatively ineffective if it limits itself to defining basic rules that already exist at a local level, or if it merely bureaucratizes existing experiences.

Policy making is always a collective argumentative process (Bøgelund, 2007) which relies on different visions, priorities and positions. However, to enable a debate, these visions have to be supported by evidence and arguments. Although many reviews have compared Brazilian experiences, there is very little evidence technically but especially regarding institutional arrangements to support future political choices. Bøgelund (2007) considers that the key to the argumentative process is to guarantee that diverse groups of actors are engaged in the assessment process. Such a collective assessment of experiences could enable the stakeholders to go beyond a technical vision that has become characteristic in presentations of PES experiences, to really assess the governance arrangements and their limitations, according to the points of view of all those engaged in the process.

Basing policies on a lack of evidence entails some risks. Choosing policy solutions before properly understanding the problem at hand might create a mismatch between intention and actual achievement. Policy makers dealing with the interface between environment and development typically face a dilemma. On the one hand, they need to make decisions with incomplete information, and therefore to be guided by precautionary approaches. On the other, adopting an *a priori* preference for a particular policy prescription might lead to ineffective and inefficient outcomes. The rapid dissemination of PES may lead to such unexpected impacts if these policy instruments happen to be unable to meet the high expectations that practitioners have of them. It is therefore urgent to invest in impact evaluation studies, as well as to develop a research agenda dealing with the conditions under which PES can actually deliver what practitioners expect from them.

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19. Looking forward: current concerns and the future of ecological economics

Joan Martínez-Alier and Roldan Muradian

Røpke (2004; 2005) competently reconstructed the early history of modern ecological economics (until the late 1980s), as well as examining the development of the field until the mid-2000s, including aspects related to identity and conflicts within the community of ecological economists, research trends and organizational development. We do not pretend here to replicate this endeavor. In this concluding chapter to the *Handbook* we rather aim to characterize current major areas of work, to link them to the different contributions contained in this *Handbook* and to identify some significant challenges ahead.

More than 25 years after the creation of the International Society for Ecological Economics we can confidently say that it has been very successful in establishing a scientific community that has consolidated itself and has grown with time. Given the plural and inter-disciplinary profile of this 'convergence space' that has been called *ecological economics*, identity problems will always constitute a distinctive feature of the community of ecological economists (which is not only composed by economists). Despite the coexistence of different visions and approaches, we think, however, that there are also strong bonding elements, which have been able to keep this heterogeneous community alive and thriving.

1. CURRENT CONCERNS IN ECOLOGICAL ECONOMICS

During its first 10 years of existence, modern ecological economics was characterized by a 'creative explosion', generated by the many issues and concerns that neoclassical environmental economics (much older as an academic community) had not addressed. During that period, some important theoretical and methodological contributions were developed or consolidated, setting the foundations of much of the work that was done afterwards. Some of the most important of these contributions were already mentioned in the introductory chapter to this *Handbook*, such as the notion of biophysical limits to economic expansion (to see the economy embedded in the biophysical system), the acknowledgement of the plurality and incommensurability of values, the application of multi-criteria and deliberative methods for supporting decision-making, the criticism of conventional welfare and sustainability indicators, the incorporation of resilience and precautionary thinking into the analysis of economic processes, and the emphasis on inter- and intra-generational distributional issues paying attention to the relationship between globalization and the environment and to the notion of environmental justice at the local and global levels. The chapters composing this *Handbook* have addressed a number of these fundamental issues. The crucial contribution by Spash discussed the philosophical foundations of ecological economics, while pleading for a stricter delimitation of its scope and theoretical underpinning. This is complemented by the chapter written by O'Neill and Uebel, who wrote about the historical connections of ecological economics to analytical philosophy, which are not always acknowledged. They show that philosophers were concerned about four fundamental issues in modern ecological economics: (1) the limits of markets prices for guiding social decisions; (2) the incommensurability of values; (3) the challenge of rationally choosing between different social plans and outcomes, despite the multiplicity of values and social groups involved; and (4) the information loads required if we want to avoid (as we should) the use of market prices as signals for decision making (because market prices are myopic towards the needs of poor people, future generations and other species). The chapter by Zografos makes an extensive review of the contemporary debates around deliberative methods and their prospective use in ecological economics. Reyes-García stressed the plurality of values involved in traditional ethno-ecological knowledge, a subject where the links between ecological economics and anthropology, human ecology and other disciplines are evident. Fischer-Kowalski and Haberl conducted an outstanding review of the state of the art in the study of social metabolism, a key concept in ecological economics to conceive the economy–nature interaction and discuss transitions towards a sustainable economy.

After the disruptive creativity and debate of the first period, the following 15 years of ecological economics as a community of scholars have been characterized by the consolidation of theoretical paradigms and methodological tools, and therefore the 'normalization' of this scientific stream, in Kuhn's sense. Most of the publications during the period of consolidation could be grouped into the following major subjects.

Ecosystem Services

The ecosystem services approach probably constitutes the most important recent innovation in academic fields dealing with the relationship between the economy and the natural environment. What was initiated as a metaphor to describe the benefits human societies derive from ecosystems has progressively become a very influential framework with significant leverage both in academic and policy-making circles. The approach is currently widely used in a broad range of subjects, far beyond ecological economics, and it is still evolving. In the chapter elaborated for this *Handbook* by De Groot and Braat, there is a historical account, and a discussion about the scope and major trends in the ecosystem services framework. Critical voices towards the ecosystem services approach have also emerged, stressing its limitations when trying to seize the complex human–nature interactions (Lele et al., 2013). Gómez-Baggethun and Martín-López in their contribution to this book share this skepticism and are aware of the limits of any anthropocentric approach to nature protection. They contend, however, that there are important reasons why critical ecological economists may have to engage further in the debate on ecosystem services valuation, certainly accommodating a plurality of valuation languages.

Payments for Ecosystem Services (PES)

Though not intrinsically associated with the ecosystem services approach, during the past decade PES have become an attractive policy tool. Applications now abound, particularly in developing countries. Despite the fact that there has been a boom in research dealing with this subject, many issues still remain not well understood, such as the extent to which these instruments can render additional environmental changes, their cost-effectiveness in the long term and their behavioral effects, particularly on motivations for environmental protection among landholders. The contribution to this *Handbook* by Ring and Barton positions PES within the context of policy-mixes, where different sorts of policy instruments are combined in landscape management. The combination of tools is increasingly in vogue in environmental governance. The chapter by Coudel et al. undertook a review of PES in Brazil, a country where these policy instruments have been rapidly adopted by both private and public bodies. Lessons drawn from Brazil can be definitively useful in other parts of the world.

Rising Energy Demand, Climate Change and New Energy Sources

Energy demand remains as a key driver of environmental transformation, both in the places from which non-renewable or renewable energy resources are extracted or cultivated, or where new dams are built, but also where the wastes of energy consumption are accumulated (for example, in the atmosphere causing local pollution or climate change). Since there is no evidence of decoupling between income and energy consumption in absolute terms, we can expect an increase in the environmental impacts associated with rising energy inflows into the global economy. There have been strong traditions in ecological economics in the study of energy in the economy, including work by R.U. Ayres and Charles Hall (with the notion of EROI). This continues at present. New sources of energy from biomass, such as biofuels, and the search for non-renewable energy sources in ever remote and often ecologically fragile places are enhancing the pressure on ecosystems. Meanwhile, a large share of the fossil fuels cannot be taken from the ground at present speed because carbon emissions must decline. There are 'unburnable fuels'. Ecological economics has made important contributions to the debates on climate change.

A Renewed Interest in Agriculture

In part due to recent price peaks of food at the global level and the accumulated evidence about positive spillover effects on the national economy of agriculture development in low-income countries, there has been a renewed interest during the past decade about agricultural systems. These systems can be very diverse in the intensity of agrochemical use and the land-use implications of their expansion, including the effects on local biodiversity. Emerging alternative networks of producers and consumers are creating new opportunities for agroforestry and agro-ecological production systems. There have been new theoretical developments in the study of the ecological rationality of peasant production, by Victor Toledo and others (Altieri and Toledo, 2011). A major recent trend, however, has been an increasing competition (for land and investment) with mono-crops of non-food products, such as palm oil or maize (for ethanol). In South-East Asia and Latin America, the expansion of palm oil and soybeans has become a major force of land-use transformations and the intensive use of agrochemical inputs.

Socio-environmental Conflicts

The interface between political ecology and ecological economics has been very fruitful for examining and analyzing conflicts over access to natural resources or the distribution of environmental costs. The incidence of such conflicts is likely to be exacerbated by the expansion of the metabolic flows in the economy and by the declining quality of mineral reserves, which contributes to push the commodity frontiers into ecologically fragile and socially vulnerable places. The study of socio-environmental conflicts has also enabled scholars to create communication and collaboration channels with social movements and environmental activists, thus enhancing the societal incidence and dissemination of ecological economics. Notions such as 'climate justice', 'water justice' and 'ecological debt' born in activist circles have inspired research by ecological economists. The contribution of Rodríguez-Labajos and Martínez-Alier to this book deals with the interface between ecological economics and political ecology for addressing socio-environmental conflicts. They explain why such conflicts are so pervasive around the management of water, a resource increasingly threatened and scarce around the world.

Social Metabolism and De-growth

Attention to the flows of materials and energy involved in economic processes and to the notion of limits to growth (due to biophysical constraints to such flows) has always been present in ecological economics. Recently, however, there has been a consolidation of contemporary ideas about the biophysical constraints to economic growth and the concerns about how to reduce the metabolism of modern economies around the catchword 'de-growth', which has also become the name of an international social movement that is particularly strong in Europe. It has close links to Herman Daly's 'steady state' economics. The chapter by Petridis and colleagues explores the diverse linkages between academic contributions and the agenda for social transformations proposed by this movement. In addition, from the new perspective of an ecological macroeconomics without growth, Peter Victor reviews recent attempts to model a non-growing economy. From a different standpoint, while arguing that growth is a structural feature of capitalism, in his chapter Nadal discusses the environmental implications of macroeconomic policies and makes suggestions about how these policies can be changed in order to improve the environmental performance of economic processes.

Managing the Commons

Elinor Ostrom's seminal work has played a decisive role in consolidating an inter-disciplinary research agenda around the regimes of common pool resources, with applications from the local to the global scales. Issues dealing with governance and the institutional dimension of the management of natural resources (such as fisheries or water) have attracted the renewed interest of ecological economists during the past two decades, and they have constituted meeting points where different disciplines and approaches converge. Two key features of this institutional approach, namely the acknowledgement of the diversity of governance regimes and the proposition that their suitability depends on the conditions of the situation at stake (that is, no regime can be assumed a priori as preferable) are compatible with the need to accommodate equity and legitimacy concerns in decision making about the management of resources, as they are advocated by most ecological economists, drawing also on previous work by Daniel Bromley, Madhav Gadgil, Fikret Berkes, Carl Folke and others on managing the commons.

Invasive Species

The dramatic expansion of international economic transactions experienced during the last half a century has, on the one hand, accelerated the rate of species extinction and, on the other, expanded the geographical distribution of many other species. Though the term 'invasive' is relative to the timescale and social preferences, the expansion of the distribution of species can cause substantial changes in the composition of species in ecosystems, the performance of agriculture and human health, with potential significant consequences for economic processes and ecological functions. Some of the most quoted articles in the journal *Ecological Economics* are precisely on the environmental and economic costs associated with alien-invasive species, see David Pimentel et al. (2005) for instance. This is one of the issues showing more clearly the degree of inter-dependence between and co-evolution of the economic and ecological systems, along processes that take place in a relative short period of time.

Sustainability Indicators

The development of synthetic sustainability indicators is a recurrent matter in ecological economics. Despite the proliferation of indices (most of the time proposed as alternatives to GDP), there are not yet aggregated sustainability or welfare indicators that have gained universal support among ecological economists or policy makers, although some of them (for example, the 'ecological footprint') have indeed become popular. 'Multi-criteria thinking', however, has increased its influence. Beyond the many attempts to develop single and comprehensive indicators, one of the key contributions of ecological economics has been to frame decision making in many situations as the necessary deployment of a set of different criteria, each of them to be evaluated in their own units of measurement and with their own rationale (and therefore hard to aggregate). The challenge of how to communicate procedural complexity to policy makers nonetheless remains. How to reconcile the need for simplification on the one hand, and the need for quality (and therefore for considering multiple perspectives), on the other, is always present in decisions dealing with the interaction between environmental and socio-economic systems at local, national or international scales.

Experimental Approaches

During the last two decades, the field of experimental behavioral economics has thrived in a vigorous way, adding new evidence about and against the validity of key assumptions and expectations of human behavior of neoclassical economics. Experimental approaches have been used to address a wide range of issues, including time preferences, reciprocity, altruism, attitudes towards risk or equity, and propensity to cooperate in the management of natural resources. A major innovation has been the use of field experiments, with subjects that are familiar in real life with the type of social dilemmas recreated in experimental situations. The chapter written by J.C. Cardenas makes a comprehensive assessment of experimental approaches applied to decisions dealing with the environment, and it draws interesting insights about the contribution and potential use of this method in ecological economics.

2. LOOKING FORWARD

After a period of consolidation, the future performance of ecological economics will be determined by its capacity to bring mainstream economics out of its fenced enclosures, and to develop transdisciplinary approaches able to provide meaningful knowledge related to relevant and urgent socio-ecological problems.

As discussed by A. Vatn in his chapter on global environmental governance, environmental problems with a global character – such as climate change and biodiversity loss – remain very urgent, and the governance gaps to address them are striking. Goals for stopping biodiversity loss by 2010 solemnly proclaimed by governments and international agencies were simply abandoned. Due to global interdependencies of the economic and ecological systems, the resolution of many environmental problems requires global coordination, which currently seems to be increasingly problematic. This has been evident in the lack of agreements in the post-Kyoto negotiations on climate change. The probability of binding significant commitments about reductions in GHG emissions by major global emitters seems low, and therefore voices from civil society (cf. Naomi Klein's best seller of 2015, *This Changes Everything. Capitalism vs. the Climate*) claim that grassroots action to stop extraction and transport of the 'unburnable fuels' is the effective road to follow. Moreover, the deficit in global environmental governance is particularly grave in the case of the management of the oceans that confronts not only depletion of fisheries but also acidification and other risks.

For the first time in human history, currently the majority of the world's population lives in cities. Urban problems have already taken a very important position in the global environmental agenda. The problems include a variety of subjects, including water provision, air pollution, sanitation and urban biodiversity loss. They are particularly acute in emerging countries. Furthermore, unless unexpected technological innovations take place, the near future will be characterized by increasing risk of material and energy scarcity, due to the dramatic expansion of global demand. The chapter by Guarín and Scholz discusses the environmental implications of a rising huge middle class in emerging countries, and concentrated in 'emerging cities'. To meet the material and energy demand of the new middle classes at the global level would require a tremendous expansion of the extraction capacity of natural resources. The resource intensity of the economic process will then remain as a key matter determining not only economic prospects but also relations between world regions and the distribution of geopolitical influence and wealth (since the price of commodities is a major determinant of wealth distribution between world regions). The need to look for new sources of energy and materials would also be likely to enhance the chances of socio-environmental conflicts at local and international scales. Furthermore, given the recent occurrence of extremely violent confrontations, often involving the dismantling of states (particularly in the Middle-East and Africa), the social, economic and environmental implications of international conflicts, and the ecological economics of military investments and operations, are urgent research subjects at a global scale.

In order to understand the root causes of environmental problems, a systemic view is needed. Such an approach should enable us to link consumers' behavior, socio-technological systems and the geography and political ecology of resource extraction and allocation of pollution. The chapter written by Røpke addressed consumption trends from a systemic vision, aiming to draw a comprehensive account of major contemporary sustainability challenges at a macro scale. At the core of this agenda remain issues like habits of urban dwellers, resource availability, environmental fairness and policies for sustainability transitions.

We definitively need to revise some of the metaphors we use to understand the relationship between the economic and natural systems, which may in part be blamed for the massive environmental degradation experienced during the past century. A critical look at the prevailing metaphors – or pre-analytical visions as some have called them – has been at the core of modern ecological economics since its beginning (Daly, 1973). Such metaphors reflect a system of values and determine the way we cognitively interpret the world. During the past decade, the ecosystem services approach has been useful as a rising metaphor for stressing the degree of dependence of the economy on 'free of charge' ecological functions. It has been instrumental in repositioning the global environmental agenda. However, its utilitarian and compartmentalized character imposes significant constraints on its capacity to describe in a compelling way the often complex human–nature interactions (Chimello de Oliveira and Berkes, 2014). It is imperative to go beyond its limits, and to build up more comprehensive frameworks. The (re)invention of new heuristic metaphors remains then a major challenge for ecological economists during the years to come.

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