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Society's nature: Ecological Economics and the Combined Challenge of Environment and Distribution

The paper introduces the emerging field of ecological economics and evaluates its potential for addressing some of the concerns within development studies. It takes as its point of departure the study of the relationship between nature and society that emerged in the wake of the environmental discourse in the 1960s. In the first section, a new perspective in the study of the interaction between society and nature is briefly outlined. Thereafter, the field of ecological economics is discussed as a specific example of this new perspective, followed by its potential link to the development debate, in particular the combination of the environmental and distributional issues and the challenges therein. Finally, the paper reflects on the persuasive potential of ecological economics in relation to politics.

1. The breakthrough of a new perspective

In the wake of the environmental discourse that emerged in the 1960s, a new research perspective began to take shape. Whereas researchers from natural sciences, foremost biologists, were instrumental in encouraging environmental discourse, the social sciences tended to be rather more reactive. The most obvious reaction was to apply well-known theoretical approaches with which they were already familiar to the new phenomena: sociologists started to study environmental movements as they studied other social movements, economists studied environmental externalities as they studied other welfare economic disturbances, psychologists studied how people reacted to environmental risks as they studied reactions to other stresses, and so on (Pearce 2002; Dunlap 1997). However, the new problematic relationship between society and nature also inspired some researchers – from both social and natural sciences – to apply a different perspective, as they began to consider social processes in the way that natural sciences do, for example by analysing flows of energy and matter, or applying the notion of metabolism to social systems. This biophysical perspective had a number of forerunners dating back to the nineteenth century, but the real breakthrough did not come until the late 1960s (Martinez-Alier 1987; Fischer-Kowalski 1998; Røpke 2004). In the following, the perspective is mostly related to economic thinking, although it was influential in other social sciences as well.

It may seem self-evident to state that human societies are as much nature as they are culture: human societies are embedded in nature, and social processes are also always natural processes in the sense that they can be seen as biological, physical and chemical processes and transformations. However, our understanding of human societies as natural phenomena is not very well-developed. This persistent lack of understanding is related to the institutionalised division between natural sciences on the one hand, and social sciences and the humanities on the other (Costanza et al. 1997). From the time of the foundation of modern science up until the appearance of modern-day environmental problems, only a few scientists have crossed this line – such as the physiocrats, who based their description of the economy on the productivity of land,

and various individuals who made early use of thermodynamics in order to describe the economy in terms of energy. But the typical pattern has been that the economy has first and foremost been described in terms of money, prices and the flow of goods, while biologists, for example, have restricted themselves to describing ecosystems that are as isolated as possible from human influence. With the breakthrough of the new concept of 'environmental problems' in the 1960s, this pattern began to be gradually broken down. Some systems ecologists began to apply their analyses of the flows of energy and materials in ecosystems to human societies as well, while a number of physicists began to establish an energy perspective on the economy, just as some economists began to work with thermodynamic concepts and analyses of material flows (Daly 1968; Ayres/Kneese 1969; Georgescu-Roegen 1971; Odum 1971; Røpke 2004). The concept of metabolism also began to be applied to human societies (Fischer-Kowalski/Weisz 1999).

The fascinating – and environmentally problematic – characteristic of human societies seen as natural phenomena is the ability of human beings to utilise far larger amounts of energy and materials than they need from a somatic point of view. The term 'endosomatic energy consumption' refers to the energy consumption necessary to keep a person alive under given climatic conditions, while 'exosomatic energy consumption' refers to all the extra consumption that follows from our way of life. A particular characteristic of human beings is that they may have an exosomatic energy consumption that is many times larger than their endosomatic energy consumption. If one compares a human society with an anthill, this metaphor is limited by the fact that the human 'anthill' is not required to comply with a set form, but can be constructed in numerous different ways which may increase the use of energy and materials as well as greatly multiplying the appropriation of land, water and air per person. This becomes even more problematic if most of this exosomatic energy as well as materials are obtained from non-renewable geological stocks (fossil fuels, minerals, ores, metals, etc.), leading to sustainability problems on the input side (eventual resource scarcity) as well as on the output side (creating wastes that cannot be effectively absorbed by nature).

When this perspective had its modern breakthrough, several sub-disciplines were influenced in turn and new interdisciplinary fields emerged, such as social and human ecology, ecological anthropology, environmental history, environmental sociology and ecological economics. I concentrate here on ecological economics.

2. Ecological economics

Although this new perspective was formulated in its modern version in the late 1960s, it took about twenty years before it was institutionalised through the creation of The International Society for Ecological Economics in 1988. In the meantime, the welfare economic approach to the study of environmental problems had become well established as environmental economics and during the following years, ecological economics developed to some extent in a critical dialogue with environmental economics. There is no authoritative version of the research programme of ecological economics, but it makes sense to talk about a core of basic ideas. Different authors present ecological economics in different ways (e.g. Martinez-Alier 1987; Costanza et al. 1997; Costanza, Perrings/Cleveland 1997; Söderbaum 2000; Common/Stagl 2005; Daly/Farley 2004; Martinez-Alier/Røpke 2008; Eriksson/Andersson 2010), but almost all agree that the same idea is fundamental: the human economy is embedded in the biosphere, which is a closed system. This is what Herman Daly calls the preanalytic vision of ecological economics (Daly/Cobb 1989). Related to this idea is the presupposition that the human economy can take up

more or less ‘space’ in the biosphere, or in other words, it can appropriate more or less of the biosphere. This ‘size’ of the human economy is what Daly refers to as the scale of the economy. Furthermore, it is agreed that the larger the scale of the economy the greater the risk of destroying the conditions for human life on earth in the long run. The basic ethical challenge is thus to consider the interests of future generations.

This perspective differs from the focus on externalities in mainstream environmental economics. Externalities are usually conceptualised as exceptions to the rule – as disturbances in relation to the well-functioning markets. When the economy is considered to be a metabolic organism embedded in the biosphere, then all outputs from economic processes influence the inputs to future processes. ‘Externalities’ are thus pervasive and inevitable to such an extent that the concept loses its meaning. Of course, some economic processes are more harmful to the environment and human future than others, but the biophysical perspective also emphasises the importance of the sheer size of the economy.

When the scale of the economy has to be limited in the common interest of humanity, the question of distribution within the present generation comes to the fore. This question can be avoided more easily when it is possible to argue that the poor can be provided for through economic growth and so a redistribution is not necessary. However, if the economy has already reached or exceeded the maximum sustainable scale, the need for redistribution becomes pressing. Here ecological economics includes an ethical principle within the basic axioms of the programme: all human beings have the same right to be able to fulfill their basic needs, so it is not ethically defensible to appropriate so much of the biosphere that others are left without the possibilities of fulfilling basic needs. This formulation thus endorses the idea of basic needs – needs are not just a question of individual preferences which cannot be used as a basis for moral obligations (Max-Neef 1992). Some ecological economists will go further than this proposition and argue that all human beings have a right to an equal share of the biosphere (in practice this difference is not very important, as we are so far from fulfilling the most basic needs for everybody).

These basic ideas imply some fundamental research questions. First of all, the idea of the scale of the economy has to be operationalised: what is the present ‘size’ of the economy, and is this ‘size’ sustainable – and if sustainable, in which sense? This question has led to much fruitful research over the last 15-20 years. Not surprisingly, the research question and some of the answers more or less preceded the formulation of a research programme for ecological economics and thus constituted an important input into the formulation of the programme. The results comprise such concepts as the human appropriation of the product of photosynthesis (HANPP) (Haberl et al. 2007, 2008), ecological rucksack or hidden flows (Matthews et al. 2000), Material Input per Service Unit (MIPS) (Schmidt-Bleek 1993), ecological footprint (Wackernagel/Rees 1996), environmental space (Spangenberg 2002), different forms of energy accounting (Haberl 2001, 2002), industrial metabolism (Ayres/Simonis 1994; Ayres/Ayres 2002), and social metabolism (Fischer-Kowalski/Haberl 2007, Singh/Eisenmenger, this issue).

Secondly, the question of distribution has to be phrased in ecological terms. Thus some of the concepts mentioned above have been used to conceptualise, for instance, unequal exchange between nations in new terms, and new expressions have been coined to elucidate distributional aspects, such as ecological debt (Martinez-Alier 2002).

These efforts to ‘calculate in nature’ instead of calculating in money terms have been accompanied by a widespread awareness that there are no true answers to the questions raised – and that also the questions themselves are framed in terms that can be discussed. Even though the efforts to ‘calculate in nature’ can appear to be extreme expressions of philosophical realism, they

have been accompanied by discussions on post-normal science, basic ignorance, etc. (Funtowicz/Ravetz 1991). Thus the limits to the scale of the human economy cannot be defined by natural sciences. Each science provides a selective (more or less narrow) perspective that must be supplemented with other perspectives, including some that highlight aspects not taken into account by the natural sciences in a given period of time (Wynne 1992, mainly discussed in relation to risk). Furthermore, there is a component of valuation in assessing limits, so that limits are a matter for negotiation as well.

Ecological economics includes the discipline of economics in the name. This implies that the research programme inherits the basic concern of that discipline: that is, the question of how different resources should be allocated to achieve specific social aims. As Daly (1992) argues in his seminal article on allocation, distribution and scale, ecological economics emphasises the importance of dealing with the scale issue instead of focusing only on allocation and distribution, although of course these issues have to be dealt with as well. The core question in relation to allocation concerns valuation: the resources should be allocated to the most valuable ends – and the ends should be achieved in the most cost-effective way. The main idea of ecological economics related to valuation is a basic theorem of incommensurability: essentially we have to choose between alternatives that are not comparable in any unambiguous way (Martinez-Alier et al. 2001). Values are not necessarily best represented through monetary prices, as prices result from the market with all its imperfections (power concentrations, political interventions, externalities), its historically and culturally determined wage structures, technologies, social institutions, distribution of income and wealth, etc. (Røpke 1999; Hornborg 2001, and also this publication). However, other alternatives to establish the values of different means and ends are not perfect either (values based on energy content, labour time, etc.). Therefore, we cannot escape from political decisions in relation to many issues of allocation.

The theorem of incommensurability leads to a number of research questions (O'Connor 2000). Firstly, different valuation parameters have to be developed. Which parameters should be included? Which parameters can be reduced to other parameters, and which cannot be reduced? Secondly, methods must be developed to improve the basis for decision-making in cases where several criteria have to be taken into account, that is, different kinds of multicriteria analysis. Thirdly, recognition of the political character of economic and environmental priorities implies a need for developing social institutions for democratic participation in decision-making. The study of value-articulating institutions has evolved considerably (Vatn 2005).

The formulations given above summarise the basic ideas regarding allocation, distribution and scale and the related research questions (it may be added that many ecological economists are aware of the interdependence between these aspects). This account of the research programme focuses on the conceptualisation of environmental problems, the ethical challenge related to these problems and the question of how to set priorities. In addition, the topic of the causation of environmental problems should be mentioned. Since the field of ecological economics has attracted many scholars with a socio-economic background (institutional and evolutionary economics etc.), it is widely held that the over-exploitation of the environment is rooted in basic features of the economic system – not in minor deviations from a fundamentally sound development (Røpke 2005; Paavola/Røpke 2008). Socio-economists argue that the human economy is embedded in a broader social and cultural framework that has to be included in analyses of the background of environmental problems (the idea of co-evolution) (Norgaard 1994; Jacobs 1996; Gowdy/Erickson 2005).

The socio-economic approach is critical towards the basic assumptions of welfare economics and tries to develop alternatives to conventional environmental and natural resource

economics. Whereas welfare economics concentrates on short-term, static explanations of environmental problems in narrow economic terms, such as the lack of private property rights and market failures at a given point in time, the socio-economic perspective considers that environmental problems are constructed by irreversible and path-dependent historical processes where social, economic and cultural aspects are all relevant. Environmental problems thus require much wider institutional responses than establishing private property rights and 'setting the prices right' (elaborated in Paavola/Røpke 2008).

This broad, historically sensitive socio-economic approach is important for debates on the 'tragedy of the commons' (Hardin 1968) and on the conservation of biodiversity and natural resources more generally. In particular, the work of Ostrom (1990) has emphasised that it is 'open access' to resources that leads to their over-exploitation, not their common ownership. Since open access resources are owned by nobody, there is no incentive for anybody to restrain their use. While mainstream economists usually consider the establishment of private property rights to resources a solution, socio-economists emphasise that common property – under which the resource belongs to a community which maintains institutional arrangements for their ownership and management in order to avoid over-exploitation – is an alternative to both open access and private property (Gowdy 1994; Paavola 2007).

Many cases of over-exploitation have been the result of the privatisation of common property resources and may be referred to as 'tragedies of the enclosure' (Martinez-Alier 1991). Privatisation and the subsequent emergence of the market economy disrupts social patterns that have customarily emphasised social equity, and replaces them with wide social disparities. Extension of markets is particularly devastating to local biological resources because market decisions about these resources do not take into account the co-evolution of different species, the risk of destroying keystone species, the irreversibility of decisions, and the agents' fundamental lack of information. To prevent the loss of biodiversity, social control of markets is needed (Gowdy 1994).

Over-exploitation of resources also result from processes that take place far away from the actual resources. For instance, the dramatic growth in the consumption of apparel, electronics and toys since the late 1990s was encouraged by falling prices, reflecting the increased use of cheap labour in the global sweatshop. Social and political structures such as large-scale global inequalities and the American backing of authoritarian regimes are thus also decisive for environmental degradation (Schor 2005).

3. Links to the development debate

The process of decolonisation after World War II raised hopes that the newly independent countries would embark on a path of economic growth and development leading to prosperity. However, in many cases these hopes were frustrated, as new forms of domination emerged, and in some cases predatory states rather than developmental states were established (Castells 2000b). A critical stance towards these trends was formulated in the extensive literature on neo-colonialism, neo-imperialism and unequal exchange from the 1960s and especially the 1970s (see, for example, the works of Samir Amin, Arghiri Emmanuel, André Gunder Frank and Immanuel Wallerstein). This literature pointed out the transfer of natural resources from the developing countries to rich countries as an important issue and argued that this transfer could be interpreted as unequal exchange in terms of embodied labour time (Andersson 1976). However,

in general environmental issues were not at the core and transfers were not conceptualised in terms derived from the physical sciences.

Some of those who took the first steps towards the establishment of ecological economics in the 1970s and 1980s had a background in critical development studies and, for them, it was an obvious choice to use the new ecological perspective to conceptualise unequal exchange in new ways, such as material and energy flows (Bunker 1985; Muradian/Martinez-Alier 2001; Giljum/Eisenmenger 2004; Eisenmenger et al. 2007; Singh/Eisenmenger, this issue) or in terms of the appropriation of land area (Andersson/Lindroth 2001; Hornborg 2001, 2006, and this issue). Concurrently with the economic exchange of goods and money, exchanges of embodied energy, appropriated land area, quantities of mobilised materials, etc., take place. Trade might also imply environmental load displacement, when polluting industries are moved to developing countries. Later on, when ecological economics became visible as a research field in the 1990s, the field attracted new scholars with a background in the critical studies of development and of capitalist crises, since it offered approaches that were in line with their perspectives.

The fields of ecological economics and political ecology can be seen as partly overlapping given their shared interest in ecological distribution conflicts (Guha/Martinez-Alier 1997; Martinez-Alier 2002; Paulson/Gezon 2005). These conflicts occur throughout the commodity chains – at the 'commodity frontiers' where energy and materials are extracted, in relation to water and land use as well as transport and waste disposal (including carbon dioxide emissions) – and many conflicts take place in developing countries. There are separate research networks on different types of conflicts, but as argued in a recent special section of Ecological Economics (Martinez-Alier et al. 2010), it is important to bridge these conflicts and apply a systemic perspective that integrates the study of social metabolism with sociological and political analysis and that highlights the link between the increase in social metabolism and the growing number of such conflicts.

Another link between the development debate and ecological economics is constituted by the issue of population. Ecological economics is strongly influenced by biological reasoning and thus considers humans not only in psychological, social and cultural terms, but also in biological terms as a species. The species perspective emphasises the enormous reach of humans – every corner of the earth is influenced by humans, and no other species has ever appropriated such a large part of the product of photosynthesis (Haberl et al. 2007, 2008). In socio-cultural terms this is apparent from the fact that humans have named every part of the world and established property rights for countries over all land areas. We are so used to conceiving the earth as the property of different groups of humans that just pointing out this phenomenon as an 'anomaly' in biological terms can appear surprising. From an ecological point of view, the enormous growth in the number of humans is risky, because the conditions of human life are endangered by the resulting increase in the scale of the human economy – in particular, when humans have a lifestyle commanding much more than 'the endosomatic energy consumption'.

Since the environmental agenda was first dealt with as an international issue at the UN conference in Stockholm in 1972, the population issue has been a subject of controversy between rich and poor countries. The rich blame the poor for the environmental effects of population growth, whereas the poor blame the rich for the effects of consumption growth. Ecological economists emphasise both problems and reject both the use of the population issue as an excuse for avoiding responsibility on the part of the rich countries and the playing down of the population issue by some social scientists, who only accept high consumption as a serious pressure on the environment. From an ecological point of view a high population density is problematic, no matter whether it occurs in rich or poor countries (this is not meant as an

argument against cities, if other areas remain with low population densities), and the population issue can also be relevant for countries that have passed the phase of demographic transition.

Essentially, the introduction of an ecological perspective in relation to the development debate implies that the problems we face are even deeper than they were considered to be in the traditional exploitation approach. Material and energy flow studies reveal that contemporary human society is increasingly dependent on geological stocks for its material and energy needs. On a global scale, each person presently consumes about 9 tonnes of materials each year. Of this, the share of biomass is less than a third and the rest are construction materials, minerals, metals and fossil fuels. This is a significant shift from the 1900s, when an average global citizen consumed about 4 tonnes per year, and the share of biomass was more than three-quarters (Krausmann et al. 2009). Here, the concern with respect to sustainability is two-fold: resource scarcity on the input side, since geological reserves are limited, as well as on the output side, as most of these materials after their use eventually end up in the biological system where they cannot effectively be absorbed by nature, leading to pollution problems. Moreover, country studies reveal a high discrepancy of material and energy use between industrialised and developing countries, and thus the challenge related to distribution becomes ever more important.

Although the fight over resources is of paramount interest, the importance of including an ecological perspective in the analysis of global economic and social change is still not generally accepted within sociological and economic studies. A striking example is provided by Castells' monumental and exceptionally well-informed work on The Information Age (Castells 1997, 2000a, 2000b), which includes the environmental movement, but not environmental issues.

4. The persuasive potential of the ecological economic perspective

The reasoning of ecological economics in relation to the challenge we face can be summarised as follows:

- The human species has spread so much and appropriates so many resources that it is threatening the conditions that sustain its own life.
- The industrial economy is largely based on fossil fuels and materials from geological reserves leading to sustainability problems both in terms of resource scarcity and pollution, and readjustment will be very demanding.
- The rich are essentially maintaining their high standard of living at the expense of the poor.
- The ethical challenge regarding both future generations and the poor in the present generation is immense.

This way of formulating the challenge can be and often is rejected by several different arguments. The first one relates to the description of the problems. As illustrated by the Lomborg debate (Lomborg 2001) and by the publications from a number of American think tanks (McCright/Dunlap 2003; Dunlap/McCright 2010), some argue that environmental problems are grossly exaggerated and that environmental and resource limits are not relevant for any foreseeable future. This view is often closely related to the argument that we can trust technological change: technological change can be expected to solve specific problems if they occur, so there is no reason to be modest with regard to economic growth and consumption. Within ecological economics, these arguments have been widely contradicted in relation to the prolonged controversy on economic growth and the environment.

Others accept that humans face serious challenges, but apply an openly cynical perspective: In this world of limited resources, environmental threats, overpopulation, etc., we are engaged in

a fight for survival. The challenge is to save oneself, not to make sacrifices to save others. The rich cannot and should not take on a responsibility for the poor (Hardin 1974). Sometimes this argument is based on biological reasoning: As with other species, humans are subjected to the 'law' of the survival of the fittest, and it does not make sense to ignore this basic condition. Another way of legitimating cynicism within the framework of social theories is to argue that the poor have only themselves to blame for their destitution – they could simply make an effort to change their situation (as Galbraith (1992) says, there is always an abundant supply of legitimating theories). This way of thinking is characterised by Sachs (1999) as the fortress perspective – the view that the rich should build their territories into fortresses to defend themselves against the hordes of the poor. Within ecological economics, this cynical approach is not accepted.

A very real worry concerns the question of whether humans are able to tackle these problems in time. The resilience of several ecosystems has already been endangered and important life-supporting mechanisms are threatened to such an extent that they may not be restored. Are we really able to change direction? It is difficult to cope with deep environmental and distributional problems, partly because the social and economic structures and related mechanisms preserve the unequal power relations, partly because of the extreme complexity of social systems. So many aspects impede a process that could reduce the human impact on the environment and improve living conditions for the poor at the same time: predatory states, the criminal economy (the huge size of which is described in Castells 2000b), the short-sightedness of politicians seeking re-election, the commercial interests of the media, etc. The challenges seem overwhelming, but there is no other option than to try, and persuading as many as possible to contribute to the process is decisive.

Ecological economics formulates the challenge we face, but can the field also provide the necessary persuasive power to encourage actions to be taken? As the discussion of critical arguments in relation to the perspective illustrates, the challenge is not generally accepted and thus persuasion is needed to achieve political backing for taking action to address this.

Ecological economists are generally aware that academic research is not simply about achieving a deeper understanding of different phenomena. This understanding is always achieved within the framework of some preanalytic vision and more specific theoretical assumptions regarding the object under study. When researchers' visions or assumptions differ, they will come up with different interpretations and ultimately with different political recommendations. However, some ecological economists, especially those with a natural science background, still find it difficult to give up a consensus perspective in relation to their research: when something is demonstrated to be rational then it should be possible to agree on the necessary action. This view underestimates the importance of both vested interests and ideology.

On the other hand, it is not simply the case that interests dictate understandings and attitudes. As Weale (1992: 58f) emphasises in his book on environmental regulation, interests have to be conceived – they cannot just be deduced from the social structures. He thus uses the concept of belief systems, stressing that such systems are not necessarily rationalisations of interests, but can also be logically prior to interests. The conceptualisation of social and economic structures as well as environmental conditions shapes how one perceives one's own interest. A topical example could be taken from the so-called 'war on terror': the rich and powerful may not be interested in sharing their riches with others and in adopting a less humiliating stance towards other cultures, but if they are persuaded to believe that a more equal distribution, better prospects for the poor and a more respectful relationship would reduce the basis for terrorism, they might find it in their own best interests to take steps in that direction. This example also illustrates how

difficult it can be for such beliefs to achieve a breakthrough, where they are at odds with another dominant belief system (or dominant ideology), e.g. the idea that terrorists will only understand the language of military power.

Academic research is a battlefield where belief systems take shape. Concurrent with the achievement of deeper insight into different phenomena within the framework of preanalytic visions and theoretical understandings we are providing worldviews, ways of conceptualising different problems in general terms and belief systems that can frame how interests are conceived. In this 'struggle for souls' the question is whether arguments really matter. Do arguments have any relevance when it comes to making a choice between different basic perspectives? Or will those who identify themselves with the fortress perspective simply be beyond the reach of ecological economic reasoning, because they have a fundamentally different way of thinking and/or because they want to safeguard their own narrow interests? It seems likely that many people will be out of reach for an ecological economic perspective, but others will have less fixed ideas and be open to revising their outlook.

A crucial question of this conflict concerns the relationship between 'the crisis of nature' and 'the crisis of justice', using the terms of Wolfgang Sachs (1999). It seems that dominant social forces are rather successful in separating the two issues. One example is the watering down of the sustainability concept: increasingly it has developed into a concept of anything that is good, with no priorities and no demands – sustainable growth will solve everything so that the rich will not have to give up anything to improve the living standards of the poor and preserve the environment at the same time. A more specific example is the concept of genuine savings. It is true that this concept can illustrate how some developing countries are losing their natural riches and gaining little in terms of man-made capital, but the measure also appears to show that many rich countries have a sustainable economy. The concept does not cover the point that this 'sustainability' might be achieved through transfers from and environmental load displacement to other countries and that it co-exists with a level of consumption that could never be generalised without jeopardising the global environment.

To counter such conceptualisations, it is crucial to suggest terms that capture how 'the crisis of nature' and 'the crisis of justice' interact. An obvious way of doing this is to apply ecological economic 'calculations in nature', illustrating how much 'nature' the consumption of the rich appropriates compared to the consumption of the poor and also illustrating the transfers of 'nature' that take place. It is important to supplement the traditional focus on the environmental impact of production with a focus on the environmental impact of consumption, as this is the only way to combine environmental and distributional aspects.

Considering a few of the concepts suggested by ecological economists, some observations can be made regarding the factors that influence a concept's success. First of all, to be convincing, a concept has to be illustrative. One of the most successful proposals in this regard has been the ecological footprint idea (Wackernagel/Rees 1996). It is easy to understand the importance of the appropriation of land area, and this understanding has been supported by illustrative drawings. This success contrasts with the difficulties that have met attempts to popularise the exergy concept that is more difficult both to understand and to illustrate.

The footprint concept has been successful in relation to education, public information, NGO activities, etc., but it has had less impact in relation to bureaucratic monitoring of the environment (see Schaffartzik, this issue). One reason might be that it is difficult to provide reasonably unambiguous data as the basis for the calculations and in addition, the transparency of the concept is weakened by the mixture of the calculation of direct land appropriation (e.g. in relation to food production, housing and infrastructure) and the assessment of 'virtual' land

appropriation related to energy consumption (the area of land needed to absorb carbon dioxide emissions). This combination is probably one of the reasons why few national statistical offices have become involved in footprint calculations, which makes it difficult to obtain official recognition. A second condition for achieving success with regard to official impact might be that the concept can be operationalised by the use of data that encourage the participation of statistical offices.

The environmental space concept has had a related fate as a popular eye-opener, but has met with even less success in terms of official monitoring. The concept does not really provide a macro perspective, as each environmental problem is treated separately, but the focus on a few central issues has been informative. A core problem regarding practical application of the concept relates to determinating the 'space' for each of the problems considered – an obvious barrier for the interest of statistical offices.

The work concerned with the calculation of material flows has been more successful with regard to obtaining official recognition and plays an important role in biophysical accounting and environmental indicators of national economies (Matthews et al. 2000; Weisz et al. 2006). In this case, the statistical offices of several countries have become involved and the European Environment Agency has promoted the concept as a relevant component of monitoring the environmental situation. There are also ambiguities in the data behind the calculations of material flows but some of them can be isolated (the very complicated problems related to the so-called 'hidden flows') and others can be treated by means of established procedures used by the statistical offices. However, this approach would probably not have been proceeded with, had it not been supported by actors who knew how to lobby effectively within the system (e.g. the Wuppertal Institute, World Resources Institute, Institute of Social Ecology). Indeed, the ability to lobby in a relevant way can probably be included as a third condition for the success of a concept.

There is still a long way to go before these eye-opening concepts can have any real impact on politics and further studies are needed, not only to develop and apply the concepts, but also to consider the conditions that will ensure that they are successful in influencing political practice.

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