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COMMENTARY

FORUM: THE ECOLOGICAL FOOTPRINT

Ecological footprints and sustainable development

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1. Introduction

The concept of the ecological footprint is well known amongst ecological economists. It represents the human impact on the Earth in a clear manner. As its originators note, the ecological footprint calculations have reinforced the view that if everyone enjoyed a North American standard of living then globally this would require three earths — although finding two other planets would be difficult (Wackernagel and Rees, 1996). Simply stated, we are living beyond our biophysical means.

The ecological footprint is one attempt at developing a biophysically-based ecological economics, which approximates reality better than many economic expansionist models. This paper examines the ecological footprint as one contribution to the overall goal of making human development sustainable for current and future generations living in harmony with the rest of the biosphere. The following section briefly describes the advantages and limitations of the ecological footprint methodology. Section 3 then suggests ways in which some of these limitations can be overcome so as to make a useful contribution to the transformation of societies onto paths of equitable, ecologically sound and economically sensible sustainable development.

2. Advantages and limitations of the ecological footprint concept

The ecological footprint methodology and results are well documented and need not be repeated here (Rees and Wackernagel, 1994; Wackernagel and Rees, 1996). The most important message emerging from the analysis of the Lower Fraser basin and of Vancouver City was that to maintain the lifestyle of these communities they would require 12 and 207 times the geographical area of the home territory (Rees, 1999). Similar studies in Scotland and the Netherlands have shown that the land mass required to support the population is six and 15 times, respectively (Moffatt, 1996).

There are several advantages and limitations associated with the development of the ecological footprint concept (Table 1). The major advantage of the ecological footprint concept over some other indicators like environmental space (Moffatt, 1996; McLaren et al., 1998) is that the former concept gives a clear, unambiguous message often in an easily digested form. The clarity of the message is an important function of any indicator for both policy makers and the general public. Next, the calculation upon which the ecological footprint is based is relatively easy to undertake and much of the data is available at different

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Table 1
The advantages and limitations of the ecological footprint

Advantages	Limitations
	Is an areal unit a suitable measure?
Unambiguous message	A static analysis
Simple to calculate	Ignores technological change
Includes trade	Ignores underground resources
It is a stock	Ignores flows
	Lacks measures of equity
	No policy prescriptions

spatial scales. Third, more detailed calculations do include trade within the ecological footprint. If world trade were included then, under the assumption of all areas maintaining their inhabitants' standards of living, there would be some losers as well as winners. A glance at the Human Development Index gives some empirical support of the increasing numbers of poor within the Third World as well as pockets of poor and a growing underclass in rich Western democracies. Fourth, the measure is simply stated as a stock, for example, x units of land per capita. It is obvious that each areal unit can also supply a flow of goods, information, natural and manmade capital as well as pollution into and out of the region.

As with most measures of sustainable development there are several limitations to the ecological footprint. First, as a bald statement of the magnitude of the problem facing humankind it is clear that the simple statement of the ecological footprint is not in itself anything more than an important attention grabbing device. Some writers like Selman note "that it is pointless to argue for a direct equivalence between a region's area and its ecological footprint" (Selman 1996, p. 38) and others have argued for the need to consider spatial flows of trade in the derivation of indicators of sustainable development (Van den Bergh and Verbruggen, 1999). Second, as currently constructed, the ecological footprint is a static measure. It is possible to examine the dynamics of this measure by recourse to viewing the ecological footprint through historical time. Such historical studies may unearth the processes leading to unsustainable practices at different spatial scales. More important, however, is the need to develop a dynamic approach for exploring different scenarios of development (Moffatt, 1996; Lange, 1999) into the early years of the next millennium, at least if we wish for development to be made sustainable — as in the Brundtland Report (World Commission on Environment and Development, 1987) and the Local Agenda 21 agreements emerging since the Rio Conference in 1992. Third, as in many studies of sustainability the role of technological change is ignored, but it would be worth exploring. Presumably, the ecological footprint could be substantially reduced by several practices. These would include using environmentally friendly technologies, using current technologies more efficiently or reducing the throughput of resources. Fourth, at present the ecological footprint does not consider the oceans and underground resources including water. Fifth, the ecological footprint represents a stock measure. It would be useful to integrate the stock measure with the flows into or out of an area. The use of material flows or integrated economic and environmental accounting (United Nations, 1990) linked to a dynamic model of sustainable development would help. As Daly has suggested in many publications, reducing the throughput is an important aspect for achieving sustainable development (Daly, 1977). Sixth, even if the throughput was reduced and sustainable development was achieved, the thorny ethical problem of an equitable distribution for current and future generations needs to be examined. At present few measures include this aspect of equity in the structure — the index of sustainable economic welfare (ISEW) being one exception (Daly and Cobb, 1989). Finally, it offers no policy suggestions apart from either including more land, reducing population, or reducing consumption per head. The policy instruments required to achieve such desirable goals are not stated.

3. Indicators: moving towards sustainable development

One of the key aspects of sustainable development is that it makes us consider the problems of intergenerational and intragenerational equity. As currently reported the ecological footprint merely shows that current human development is unsustainable — we only have one Earth (Ward and Dubos, 1972). Yet, if we are to actively engage in the processes of making development sustainable we need to establish indicators so that we know if we are moving towards or away from a sustainable future. We also need to consider which trajectories are equitable, economically and ecologically desirable and achievable.

There is a plethora of indicators attempting to capture the economic, environmental and social aspects of sustainable development (Moffatt, 1996; Hanley et al., 1999). Some researchers have relied on a set of indicators covering environmental, social and economic aspects of reality. Others have attempted to develop a unified framework. The former suggests that integrating indicators of economic, environmental and social aspects of sustainable development in one framework is useful, although it could be argued that such integrative indicators hide more than they reveal. Only a few have examined current and future impacts on the life support systems such as long-term environmental damage in the ISEW (Daly and Cobb, 1989; Moffatt and Wilson, 1994). Very few indicators have examined inequalities within and between generations (ISEW and the environmental space concepts are the exception).

Imagine, then, that a single index of sustainable development was produced. It would be clear, from the ecological footprint arguments, that some of the Earth's ecosystems should be set aside (like some form of safe minimum standard). Determining such a minimum amount of the ecosystem is difficult, but for the sake of this argument let us assume that this is agreed. Then a set of different trajectories of unsustainable and sustainable development could be 'forecast' using dynamic modelling and GIS (Moffatt, 1996; Moffatt et al., 2000). We could also assume that the sustainable trajectories are equitable (although neo-classical economists have a different view on equity, usually Pareto optimality, than many ecological economists). Given this hypothetical situation decision-makers would still have the problem of choosing the right mix of policy instruments to ensure that the chosen path was sustainable (Ma et al., 1996). Unfortunately, making such a choice is shrouded in uncertainty. This uncertainty would be present in any system of indicators used for forward planning and management. Accepting that there are uncertainties in any scenario then there is a need for careful monitoring of the major indicators of sustainable development to ensure that the implemented policies are having the desired effect. Unfortunately, it is at this point where many of the indicators of sustainable development, including the ecological footprint, are at their weakest.

4. Conclusions

This brief paper has described the advantages and limitations of the ecological footprint concept. It has been suggested that as a method for raising awareness of our impact on the earth it is strikingly clear. The fact that there is a minimum amount of land per capita to support all life including humans is important. Beyond the striking message, however, there is a need to explore in depth the flows into and out of the area and the equally important problems of intra- and intergenerational equity. It is this crucial part of the ongoing debate that the ecological footprint or other methods need to address.

It has been argued that by combining ecological footprints with more detailed methods, such as input/output or natural resource accounting, further detailed work of relevance to policy makers will become available. Such static approaches would still need to be made dynamic and the thorny issues surrounding intergenerational equity would have to be addressed. To develop an internally consistent theory of economic ecological interactions requires a fundamentally new theory and associated new measures of sustainable development. It has been suggested that one way of advancing the concept of sustainable development

is to develop a dynamic simulation model and integrate this with GIS so that the spatial and temporal problems of the unsustainable nature of practices can be measured.

If such research were pursued in an holistic, integrated manner then the ecological footprint concept would be greatly extended and deepened. More importantly such research could offer policy makers and members of the public some direction in their heartfelt quest to make development economically sound, socially just and ecologically sustainable.

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