Environ. Sci. Technol. **2010,** *44,* 4843–4844

Environmental Science & Technology
Viewpoint

On the Policy Relevance of Ecological Footprints

JEROEN VAN DEN BERGH*
Universitat Autònoma de Barcelona & ICREA, Spain
VU University Amsterdam, the Netherlands

FABIO GRAZI*
International Research Centre on the Environment and Development, CIRED, ENPC/ParisTech & EHESS/CNRS, France

Authors' Viewpoint

RHONDA SAUNDERS

Searching for indicators of sustainability is a recurrent theme in environmental science and policy. The "ecological footprint" (EF) has emerged as a popular concept and method for measuring sustainability (*1*). For example, ISI web of knowledge delivers over 500 journal articles for "ecological footprint"—with an increasing trend from 2001 to 2008—while Google delivers more than 2 million and Google Scholar more than 14,000 hits for "ecological footprint". This is partly due to the online "Footprint Network" putting much effort in diffusing the EF method.

The EF converts the flows of energy and matter to a specific economy or activity into corresponding land area needed to support these flows, using seven land use categories. The outcome, expressed in area units, is suggested to capture use of biologically productive land (and water) to generate resources and absorb wastes. Footprints can be calculated for individuals, activities, technologies and spatial units—cities, regions, countries or the world as a whole. In addition, the method entails the calculation of an "ecological deficit" of a region or country, equal to the difference between its ecological footprint and its available ecological capacity. Countries can then be ranked on the basis of a total or per capita footprint, while they can be judged as (un)sustainable if the ecological deficit is negative (positive). The footprint approach has given rise to the related notions of energy, carbon, and water footprints, with an explosion of studies devoted to the latter.

Is it useful to spend so much intellectual energy, time, and research money on EF studies? We believe not. The quantitative EF method suffers from a number of shortcomings, which cause it to be a weak, even unreliable, tool for public policy, despite all good intentions of its inventors and users. Many of them seem to be unaware of its methodological shortcomings as identified by various economists and environmental scientists (*2*). A recent assessment of imperfections of the method by the most important EF proponents (*3*) identifies 26 minor shortcomings but surprisingly neglects the most important defects identified in earlier publications.

Six Concerns

We raise six main concerns about the EF method. These relate to the calculation method, applications, and interpretations.

Although the EF denotes hypothetical land area, there is a danger that it is interpreted as realistic or, worse even, actual land use. This may be referred to as "false concreteness". In fact the EF method calculates the land area used by an activity as if it were sustainable. The transformation of an unsustainable to a sustainable situation requires a number of assumptions, which make the result hypothetical. This is the reason why the world's EF can exceed its "bioproductive" land area in hectares. Of course, real land use could never exceed available land area. The EF measures something unreal as land surface that is not literally occupied for such activities. Very likely the EF would have been much less popular if its units had been less concrete and familiar to reflect the "unrealness" of the measurement.

A second concern is that reducing environmental problems to land area represents an implicit land value theory, suggesting that scarcity of land overrules all other concerns. This value theory assigns dominance to one production factor (land) which is reminiscent of Marxian labor value and energy value theories, both of which have received a fair amount of criticism. Related is the problem that aggregation of different environmental problems in the EF involves arbitrary and fixed implicit weights. These weights do not correspond to physical or chemical logic, or to social values.

Third, for most rich countries about half of the footprint results from translating the problem of enhanced global warming into land area. This translation requires the assumption of a "sustainable energy scenario" in which carbon dioxide is captured by forestation. This scenario

* Please address all correspondence regarding this Viewpoint to jeroen.bergh@uab.es or grazi@centre-cired.fr.

10.1021/es1003582
Published on Web 05/04/2010

means assigning an implicit weight to the problem of climate change, which is however arbitrary and meaningless from both environmental and economical angles. There is simply insufficient land available to create an amount of forests to compensate for CO_2 emissions causing enhanced global warming. Moreover, such a large demand on land would increase its price dramatically, making other, less land-intensive solutions attractive. Many alternative strategies to compensate or reduce CO_2 emissions will produce a very different estimate of "energy land" than the default strategy in the EF method. But neither of them provides a relevant indicator for, or weight of, the importance of climate change risks.

A fourth concern is that the EF does not, and cannot, include all relevant human impacts on the environment. This holds for such different problems like emissions of toxic substances, water pollution, noise, acid rain, the hole in the ozone layer, fragmentation of ecosystems due to infrastructure, and biodiversity loss. The reason is that their translation into land area units is not obvious. Given this incompleteness, the EF has a downward bias. Since the "EF energy scenario" may cause an upward bias, the sign of the net bias is uncertain. This is evidently an unattractive property of any environmental indicator. The fundamental problem is that land use is a too crude indicator of environmental pressure.

Fifth, the most popular application of the EF is to the level of countries, which gives rise to a ranking of countries, usually based on EF per capita. This ranking will be very sensitive to the mentioned debatable assumptions in the calculation technique while changing these assumptions is likely to alter the ranking considerably. In addition, average national footprints do not make much sense since national boundaries carry little ecological significance. Instead, application to bioregions with logical physical or ecological boundaries would be more appropriate even though more difficult.

A final concern is that the application of the EF to regions or countries and the derived "ecological deficit" as the difference between the ecological footprint and the available ecological capacity present an inherent anti-trade sentiment. The reason is that this involves a normative view that a country's consumption should be bounded by its (arbitrary) national ecological capacity. This view neglects that individuals and economic activities are historically unevenly distributed in space for good reasons, notably availability of and accessibility to resources and presence of natural infrastructure. This clustering of activities at different levels of agglomeration (cities, regions, countries) is in turn reinforced by trade among regions and countries which has its logic in comparative advantages. Moroever, trade can in principle, that is, under the right environmental policy conditions, spatially distribute the environmental burden among the least sensitive environmental systems.

The policy implication of footprint studies would be to discourage the concentration of people and their activities—which, among others, means a strong plea against cities. This methodological weakness means the EF is unable to contribute to a serious debate on optimal location patterns of activities and individuals, intensive versus extensive land use, the contribution of trade to (un)sustainability, and the potential role of cities in a sustainable development.

Part of the solution might be to make a distinction between sustainable and unsustainable land use, which is currently not done by the EF. Another improvement would be to assess the balance of "ecological capacity" in imports and exports, that is, account for unsustainability in all trade flows—not assume that trade is unsustainable by definition. Since there are very conflicting standpoints on trade and sustainability, it is very unfruitful to feed the resulting debate with indicators that represent a clear bias against trade.

Using a stylized model that integrates the most important aspects of trade, sustainability, and welfare, including local and global environmental externalities, alternative spatial economic structures (concentration versus dispersion), agglomeration externalities, and trade advantages (*4*), we have shown that a comprehensive evaluation method ranks spatial-economic configurations oppositely to the EF. This finding underpins that the EF is a biased guide to spatial sustainability and sustainable trade.

Policy Relevance

Given these various shortcomings, it is not surprising that one recent observer concluded that the EF represents both bad economics and bad environmental science (*5*). How worrisome is this? It depends on how policy relevant the EF method currently is. Some EF proponents claim as an important policy insight that we should limit consumption. But using the EF does not add any specific, useful insights about such a strategy. The question is whether we really need to aggregate different environmental problems for policy purposes, as the EF does. Concrete and scientific indicators are already available to assess most global and local environmental concerns. The EF is policy irrelevant as it represents unreal, virtual, hypothetical land about which politicians do not care.

The common defense is to say that the EF is a communication tool that turns unbelievers into believers in the seriousness of environmental problems. But a tool based on weak methodological foundations and offering false concreteness represents a fragile approach to create democratic-political support for environmental policies.

Literature Cited

(1) Wackernagel, M., Rees, W. E. *Our Ecological Footprint: Reducing Human Impact on the Earth*; New Society Publishers: Gabriola Island, BC, Canada, 1996.
(2) van den Bergh, J. C. J. M.; Verbruggen, H. Spatial sustainability, trade and indicators: An evaluation of the 'ecological footprint'. *Ecol. Econ.* **1999**, *29*, 63–74.
(3) Kitzes, J.; et al. A research agenda for improving national Ecological Footprint accounts. *Ecol. Econ.* **2009**, *68*, 1991–2007.
(4) Grazi, F.; van den Bergh, J. C. J. M.; Rietveld, P. Welfare economics versus ecological footprint: modeling agglomeration, externalities and trade. *Environ. Resour. Econ.* **2007**, *38*, 135–153.
(5) Fiala, N. Measuring sustainability: Why the ecological footprint is bad economics and bad environmental science. *Ecol. Econ.* **2008**, *67*, 519–525.

ES1003582