



Questioning the Ecological Footprint



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ABSTRACT

In this perspective paper a critical discussion about the concept of the Ecological Footprint is documented based on 10 questions which are answered from critical and supporting points-of-view. These key questions are directed toward the underlying research objectives of the approach, a comparison with similar concepts, the quantification methodology and its accuracy, the characteristics of the observed flows, the role of scales and resolutions, the implementation of food security, the utility of the ecological footprint for society, the political relevance of the concept and the differences from other international indicator systems.

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1. Introduction

Scientific debates are focal elements of progress in research and development of academic conceptions and methodologies. According to the strong epistemological tradition which demarcates science from other endeavors, the capacity to progress by successive refutations and rectifications is a focal element of scientific discussions. Although they are sometimes executed in an obstinate and less tolerant atmosphere, the outcome can be a productive “cross fertilization”, opening the objects of research for new aspects, setting new questions, demanding for adapted concepts

and targets and widening the knowledge in the respective field of science.

Indicators provide aggregated and simplified information on phenomena which often are hardly directly determinable, and as such they are suitable objects of intensive debates: Their definitions, the relations to the indicandum, the elaborated methodology and its transparency, the respective measurements and collections, the produced results and their interpretations are often related with certain inaccuracies and uncertainties. Furthermore, the contextual extents of indicators as well as their degrees of aggregation provide a wide field of problems, challenges, potential ambiguities, normative loadings and, consequently severe discussions.

In the following, unusual article, a hopefully constructive step in the scientific debate about the Ecological Footprint is made: The paper is based on the exchange of several letters, replies and articles in which conceptual and methodological aspects of the Ecological Footprint have been discussed in this journal (see [Giampietro and Saltelli, 2014a,b](#); [Goldfinger et al., 2014](#); [Lin et al., 2015](#) and additionally [van den Bergh and Grazi, 2015](#)). To avoid a long-term sequence of papers the authors agreed to produce this joint perspective article. It aims to shed light on the roots of ongoing critical

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discussions regarding the Ecological Footprint and its methodology. This has been boiled down to ten key questions by which we identify strengths and limitations of the Ecological Footprint from different perspectives. Therefore, in this article the authors do not agree with the overall contents; In the opposite, the paper is documenting basic disagreements. One perspective is offered by Mario Giampietro and Andrea Saltelli. The other perspective is presented by researchers associated with Global Footprint Network: David Lin, Mathis Wackernagel, Alessandro Galli, Elias Lazarus, and Steve Goldfinger. Both parties suggested five questions each to frame the discussion about the validity and the utility of Ecological Footprint accounting. Each perspective is offering their particular answers for all 10 questions.

This paper starts from a common point of departure. Both parties recognize that it is fundamental for policy formulation and monitoring to have a quantitative approach capable of measuring human demand on nature against nature's ability to provide ecological services. The position of Global Footprint Network is that Ecological Footprint Accounting adds up ecological services people demand in as far as they compete for biologically productive space.³ According to this claim the Ecological Footprint can be compared against the available bioproductive area which provides these services – biocapacity for short (Borucke et al., 2013). Giampietro and Saltelli (2014a,b), on the contrary, argue that the claim of Global Footprint Network does not stand scrutiny and that the Ecological Footprint is not a quantitative approach capable of measuring human demand on nature against nature's ability to provide ecological services, and that the results generated by this methodology are not useful. This divergence of opinions led to the present paper.

The differences between the basic attitudes of the co-authors are already visible by focusing on the basic definitions:

The Footprint Network provides the following terminology: Ecological Footprint accounting answers the question: How much of the regenerative capacity of the biosphere is occupied by human demand? Humanity's Ecological Footprint is the sum of all biologically productive surfaces of the planet for which all the human demands compete. These biologically productive surfaces renew resources, provide services such as carbon sequestration, or accommodate urban infrastructure. Human demand can be a single activity, the consumption of one person, a city, a country or humanity as a whole. Ecological Footprints, or human demand (in a given year) is compared to the amount of resources and services that are generated by the biologically productive surfaces of the planet or a region (in that given year) – the biocapacity. Both biocapacity and Ecological Footprint are measured in hectare-equivalent units, namely global hectares. These are biologically productive hectares with world average productivity. Note that not only the Ecological Footprint but also biocapacity changes over time with shifting climate conditions, soil quality and management practice. As a consequence, the value of a global hectare also changes from year to year. Hence results are presented in constant global hectares, i.e., the value of a global hectare in a given year.

At the other side, Giampietro and Saltelli comment on the basic term of biocapacity with the following paragraph: What is called “biocapacity” in Ecological Footprint Accounting is better described as “agricultural productivity”. It measures actual yields of biomass per hectare that are due to human manipulation

of ecological processes (with no consideration for the damage to the environment) and massive injections of fossil energy based inputs (entailing the depletion of a non-renewable stock). Therefore, what is measured in the Ecological Footprint protocol under the label “biocapacity” is not an assessment of how much can be produced on this planet according to its ecological limits.

Basing upon these general contradictions, both parties suggested five questions each to frame the discussion about the validity and the utility of Ecological Footprint accounting. Both parties have answered all questions.

2. Key questions

1. What underlying research question does the Ecological Footprint address?⁴

Giampietro and Saltelli	Lin, Wackernagel, Galli Goldfinger, and Lazarus
<p>The mathematical protocol developed by the Global Footprint Network (GFN) aims to assess <i>man's impact on the planet</i> and wishes to achieve this by aggregating across scales and compartments, while at the same time focusing on a subset of the relevant dimensions of man's impact. Thus the measures arrived at by the Global Footprint Network – the quantitative assessments labeled as “Ecological Footprint” and “Biocapacity” – have a purported resemblance with the regenerative and absorptive capacity of the biosphere but no descriptive power.</p> <p>A research question on man's impact on the planet is asked and left unanswered, while a full metaphorical apparatus is developed to communicate the result of this analysis as an overall measure of man's impact, such as the ‘Earth Overshoot Day’. Stating that ‘August 13 is Earth Overshoot Day 2015’ (www.overshootday.org), and that in less than 8 months, Humanity exhausts Earth's budget for the year is a clear answer to the question of man's overall impact on the planet, but this number, precise to eight digits, is a misleading – in a sense reassuring – non-being. Depending on what dimension of possibly irreversible impact of man on the planet is looked at this number could refer to a day located decades in the past (see answer 4).</p>	<p>Ecological Footprint accounting addresses one key question: <i>How much of the biosphere's regenerative capacity do human activities demand?</i> This measure can then be compared to the biosphere's available regenerative capacity. By doing so, the Ecological Footprint framework accounts for (1) the magnitude of humanity's physical metabolism and (2) the demand such metabolism places on the Earth's ecosystems. Thus, it captures a necessary, but not sufficient, condition for sustainability.</p> <p>The Ecological Footprint framework is not a measure of total human impact but a proxy for human pressure on ecosystems. In concept, the Ecological Footprint is the sum of ecosystem services used by humans, to the extent that these services occupy mutually exclusive, biologically productive area. These services include provision of resources, housing, infrastructure, and absorption of that population's waste, using prevailing technology and management practices (Wackernagel, 1991; Rees and Wackernagel, 1994; Wackernagel and Rees, 1996; Wackernagel et al., 2002). In current National Footprint Accounts (NFA), direct tracking of waste flows is limited to CO₂.</p> <p>By tracking and adding up human demands competing for biologically productive space, Ecological Footprint accounts incorporate both of Daly's sustainability principles (Daly, 1990) which stipulate that <i>within a closed system, the harvest rate should not exceed the regeneration rate and the waste production rate should not exceed the rate of assimilation.</i></p>

³ For an introduction of the footprint methodology, see e.g. Borucke et al. (2013) and Wackernagel et al. (2014).

⁴ Question formulated by the Footprint Network.

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