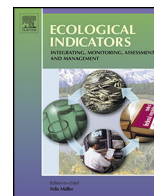




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## Ecological Indicators

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### Letter to the Editor

#### Footprint facts and fallacies: A response to Giampietro and Saltelli (2014) “Footprints to Nowhere”

#### ARTICLE INFO

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#### ABSTRACT

The Ecological Footprint is a resource accounting tool that tracks human demand on the Earth's biological resource flows, and compares it with the Earth's capacity to generate these same flows. Critical discussion of Ecological Footprint accounting contributes to the ongoing development of its methodology, comprehensibility and policy relevance as a science-based metric. Giampietro and Saltelli's recent critical article provides an opportunity to address some fundamental misunderstandings about the metric, including the research question it seeks to address, the methodology used to calculate Footprint and biocapacity results, and what the results do and do not imply. Contrary to their criticisms, it is shown that the Footprint reflects the productivity of actual rather than hypothetical ecosystems, does not claim to be a comprehensive measure of sustainability, and is not prescriptive about trade practices nor any other policy decisions, including how to respond to the finding that the world is in ecological overshoot. Despite acknowledged current limitations of Ecological Footprint accounting, including that the calculation methodology, in exercising scientific caution, might somewhat underestimate the challenge facing humanity, Giampietro and Saltelli's criticism that the results are reassuring and encourage complacency appears to be unwarranted. In addition, it is argued that the continued refinement of the metric as new scientific findings and improved data sets become available is not, as Giampietro and Saltelli suggest, a liability of the measure, but instead a strength that increases both its value as an indicator of the magnitude of human pressure on global ecosystems, and its policy relevance.

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### 1. Introduction

In their critique of Ecological Footprint accounting, [Giampietro and Saltelli \(2014\)](#) argue that the Ecological Footprint “does not serve a meaningful discussion on the modeling of sustainability” and that despite this fault, it has become widely used across the planet because it is “media-friendly,” “reassuring” and generates complacency rather than, presumably, a sense of urgency about “man's pressure on the planet and its ecosystems.” The authors support their strong claim through several lines of argument: that the Footprint does not measure what it claims to be measuring; that the metric is computationally “laborious” while at the same time “fragile;” that the most widely reported finding associated with Ecological Footprint accounting – that human demand on global ecosystems is now overshooting their capacity to meet this demand by at least 50% – is misleading as it is solely due to the way anthropogenic carbon emissions are handled by the accounts; and that Footprint accounting prescribes strategies for policy makers that could be counter-productive in terms of achieving sustainability goals.

For any indicator purporting to be science-based and relevant to decision-making, criticism plays an important role in ensuring that the indicator addresses a clearly stated research question, utilizes a methodology that is appropriate and accurate in answering that question, incorporates the most recent, reliable and robust scientific findings and robust data sets as they become available, and provides information that is useful for designing policies and

programs. But criticism can only serve this important purpose if it is pertinent to the indicator it is assessing.<sup>1</sup> In terms of Ecological Footprint accounting, one example of relevant and constructive criticism can be seen in [Kitzes et al. \(2009b\)](#), which identifies less robust or incomplete aspects of Ecological Footprint accounting, and then proposes various lines of research to improve the accounting methodology.

Unfortunately, the critique offered by Giampietro and Saltelli largely fails to meet this key criterion of pertinence, for they describe and then criticize a version of Ecological Footprint accounting that bears little resemblance to that provided annually by Global Footprint Network, which serves as the steward of the national level accounts, and is used by numerous government, business and scientific institutions. In particular, Giampietro and Saltelli begin their critique by claiming that the Footprint is designed to address a very different research question than the one it is actually intended to measure, then proceed to criticize the indicator for not effectively capturing their altered version of the research question. This is a bit like criticizing an accounting of greenhouse gas emissions for not effectively measuring biodiversity loss. As a consequence, the majority of Giampietro and Saltelli's criticisms simply do not apply to Footprint accounting as it is currently practiced. Other criticisms are based on older versions of the

<sup>1</sup> A framework for reviewing indicators is suggested in [Wackernagel \(2014\)](#).

methodology that have since been superseded, on confusions about some of the formulas utilized in calculating Footprint and biocapacity results, and on unsupported personal opinion. These criticisms are examined in more detail below.

## 2. What is the research question addressed by Footprint accounting?

If the objective is to assess how well any indicator methodology addresses its underlying research question, then that question must first be clearly and accurately defined. Ecological Footprint accounting is a way of assessing compliance with the first two sustainability principles identified by [Daly \(1990\)](#): that harvest rates should not exceed regeneration rates; and that waste emission rates should not exceed the natural assimilative capacities of the ecosystems into which the wastes are emitted. More specifically, the research question underlying Footprint accounting asks: How much biologically productive land and water area (adjusted for the productivity of this area as compared to world average),<sup>2</sup> is required to support the material consumption of an individual, population or activity, and how does this demand compare to the amount of bioproductive (productivity adjusted) area available? This includes demand for the production of living, renewable resources—that is, biological materials, such as food, fiber and timber, that are useful to society; for the hosting of human infrastructure, such as cities and roads; and for the absorption of anthropogenic waste, thus limiting its harmful accumulation. On the waste side, current National Footprint Accounts only include the primary driver of anthropogenic climate change, the carbon dioxide emissions that result from burning fossil fuels, land use changes, human-induced fires, and the chemical processes in cement manufacturing ([Borucke et al., 2013](#)).

To avoid double-counting, Footprint accounts only include those aspects of human demand that compete for productive area. Because Ecological Footprint accounting is based on actual rather than theoretical productivity, it takes into account the prevalent technology and land management practices of the time period that is being assessed.

The accounting tracks how much of the biosphere's regenerative capacity humans are using and compares it with how much is available. While in an ideal world the Ecological Footprint would track all demands on regenerative capacity, in the real world limits on the availability of internationally consistent and comparable datasets—a problem that is common to many indicators—limit somewhat the completeness of the accounts. Because of these constraints, while striving for maximize accuracy, when faced with choices about including or excluding unreliable data sets, the execution philosophy is conservative in that it seeks to avoid exaggeration of human demand on the Earth's regenerative capacity ([Borucke et al., 2013](#)). Although this is interpreted by Giampietro and Saltelli as an attempt to make the accounts “media-friendly” and “reassuring”, it helps ensure that the results cannot be dismissed as hyperbole, and provides a minimum reference value for the magnitude of human demand on nature. Despite this conservative stance, the accounts point to significant biocapacity deficits for many economies and for humanity as a whole, a reality often ignored in mainstream economic assessments and development models.

<sup>2</sup> An equivalent question would be to say: how much of the planet's regenerative biological capacity is occupied by the given human activity? This fraction can be presented as the number of average hectares out of all the hectares of biologically productive surface areas. These average hectares are called “global hectares.” They are the accounting unit for both human demand on regeneration, as well for adding up the availability of productive area.

Results for both the Ecological Footprint, the measure of demand, and biocapacity, the measure of capacity to meet that demand, are expressed in a globally comparable, standardized unit called the “global hectare” (gha). This unit represents a hectare of biologically productive land or sea area with world average bio-productivity in a given year. Since the 2011 edition of the National Footprint Accounts, Global Footprint Network also anchors this measurement unit against a reference year, typically the most recent year for which complete data is available, taking into account the varying average annual resource flow per hectare of productive land. This use of a constant global hectare is similar to the use in financial accounts of a currency value from a base reference year, such as “constant 2000 USD” as their unit of comparison. As in financial accounts, the use of constant global hectares does not average out results or hide local particularities. Instead, it provides a common unit that allows researchers to compare the Footprint of different populations and the biocapacity of specific areas across time and space ([Galli et al., 2007](#)).

Ecological Footprint accounting does not by itself measure sustainability, but offers information relevant to sustainability, namely how much biocapacity exists compared to how much people use. Knowing this information is fundamental in ensuring that the development path of societies operates within the biophysical limits of the planet. Being an accounting system, it provides a snapshot of where we are today and where we have been in the past, but it does not say where we are headed; that is, Footprint accounts are historical rather than predictive. For example, they do not address ecological and other factors that may result in an increase or decrease in biocapacity, although the accounts will reflect these changes in the years in which they are reported.

Giampietro and Saltelli's description of the research question that they suggest Ecological Footprint accounting addresses differs in two key ways from the actual research question behind Ecological Footprint accounting.

First, they argue that demand must be compared with the hypothetical productivity of ecosystems that have never been subject to human intervention, rather than with the actual productivity of the real ecosystems that exist on the planet today. They claim that this was the original intent of Footprint accounting, as expressed in the early writings of the creators of the metric. Saying “...let us start again from the claims made in the 90s by the proponents of the [Ecological Footprint] analysis,” they state that there is a “lack of congruence between the original narrative of the Ecological Footprint and the protocol presently proposed for its quantification,” that “the present protocol for Ecological Footprint analysis adopted by the Global Footprint Network does not match the semantics of the original narrative.”

One could debate what the creators of the Ecological Footprint had in mind when they first proposed the analysis as well as how to interpret the semantics of a fifteen year old narrative which could arguably have been written more clearly in places. But while this may make for an intriguing historical analysis, language and sophistication evolve over time in the description of any complex indicator; this is surely as true for the Footprint as it is for any other metric that is responsive to new developments in science and the availability of more refined data sets. The intent underlying Footprint accounting has not changed since its inception. But the research question has been sharpened over the years, and the method improved. It would seem to more sense to base an understanding of the research question on how it is described in current Footprint documentation, rather than in writings from over a decade ago. The more recent literature, such as [Borucke et al. \(2013\)](#), makes it clear that Ecological Footprint accounting is designed to address the question of whether, in any given year, the actual capacity of productive ecosystems, which is influenced by

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