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Review

Accounting for demand and supply of the biosphere's regenerative capacity: The National Footprint Accounts' underlying methodology and framework

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ABSTRACT

Human demand on ecosystem services continues to increase, and evidence suggests that this demand is outpacing the regenerative and absorptive capacity of the biosphere. As a result, the productivity of natural capital may increasingly become a limiting factor for the human endeavor. Metrics tracking human demand on, and availability of, regenerative and waste absorptive capacity within the biosphere are therefore needed. Ecological Footprint analysis is such a metric; it measures human appropriation (Ecological Footprint) and the biosphere's supply (biocapacity) of ecosystem products and services in terms of the amount of bioproductive land and sea area (ecological assets) needed to supply these products and services.

This paper documents the latest method for estimating the Ecological Footprint and biocapacity of nations, using the National Footprint Accounts (NFA) applied to more than 200 countries and for the world overall. Results are also compared with those obtained from previous editions of the NFA. According to the 2011 Edition of the National Footprint Accounts, humanity demanded the resources and services of 1.5 planets in 2008; this human demand was 0.7 planets in 1961.

Situations in which total demand for ecological goods and services exceed the available supply for a given location, are called 'overshoot'. 'Global overshoot' indicates that stocks of ecological capital are depleting and/or that waste is accumulating. As the methodology keeps being improved, each new edition of the NFA supports the findings of a global overshoot.

Contents

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1. Introduction

Economic prosperity and societal well-being depend on the planet's capacity to provide resources and ecosystem services (e.g., Costanza et al., 1997; Costanza and Daly, 1992; Daly, 1990; Daly and Farley, 2004; DeFries et al., 2004; Max-Neef, 1995). While most policy decisions are made under an assumption of limitless resources and ecosystem services, the planet has boundaries and sustainable development cannot be secured without operating within them (Rockström et al., 2009a).

Environmental changes such as deforestation, collapsing fisheries, and carbon dioxide accumulation in the atmosphere indicate that human demand is likely to be exceeding the regenerative and absorptive capacity of the biosphere. As the demands upon natural systems rapidly increase due to the swelling global economy and the need to attain better standards of living, several studies suggest that many of the Earth's thresholds are being exceeded and that, because of this, the Biosphere's future ability to provide for humanity is at risk (Goudie, 1981; Haberl, 2006; Nelson et al., 2006; Moore et al., 2012; Rockström et al., 2009b; Scheffer et al., 2001; Schlesinger, 2009; Thomas et al., 2004).

Barnosky et al. (2012) argue that a planetary-scale critical transition is approaching as a result of the many human pressures, and that tools are needed to detect early warning signs and to forecast the consequences of such pressures on ecosystems. Careful management of human interaction with the biosphere is thus essential to ensure future prosperity; systemic accounting tools are needed for tracking the combined effects of the many pressures that humans are placing on the planet (Galli et al., 2012).

The Ecological Footprint is a potential tool to jointly measure planetary boundaries and the extent to which humanity is exceeding them. It can be used to investigate issues such as the limits of resource consumption, the international distribution of the world's natural resources, and how to address the sustainability of natural resource use across the globe. Assessing current ecological supply and demand as well as historical trends provides a basis for setting goals, identifying options for action, and tracking progress toward stated goals.

The first systematic attempt to calculate the Ecological Footprint and biocapacity of nations began in 1997 (Wackernagel et al., 1997). Building on these assessments, Global Footprint Network initiated its National Footprint Accounts (NFA) program in 2003, with the most recent Edition issued in 2011. NFAs constitute an accounting framework quantifying the annual supply of, and demand for, key ecosystem services by means of two measures (Wackernagel et al., 2002):

- *Ecological Footprint*: a measure of the demand populations and activities place on the biosphere in a given year, given the prevailing technology and resource management of that year.
- *Biocapacity*: a measure of the amount of biologically productive land and sea area available to provide the ecosystem services that humanity consumes – our ecological budget or nature's regenerative capacity.

Ecological Footprint and biocapacity values are expressed in mutually exclusive units of area necessary to annually provide (or regenerate) such ecosystem services. They include[1]: cropland for the provision of plant-based food and fiber products; grazing land and cropland for animal products; fishing grounds (marine and inland) for fish products; forests for timber and other forest products; uptake land to neutralize waste emissions (currently only the areas for absorbing anthropogenic carbon dioxide emissions are considered); and built-up areas for shelter and other infrastructure.

This paper describes the methodology for calculating the Ecological Footprint and biocapacity utilized in the 2011 Edition of the National Footprint Accounts and provides researchers and practitioners with information to deepen their understanding of the calculation methodology. It builds on previous Ecological Footprint work and methodology papers for the National Footprint Accounts (Wackernagel, 1991, 1994; Rees, 1992; Wackernagel and Rees, 1996; Wackernagel et al., 1997, 1999a, b, 2002, 2005; Monfreda et al., 2004; Galli, 2007; Kitzes et al., 2007a; Ewing et al., 2010a). It also compares the most recent Ecological Footprint and biocapacity results with those from previous editions of the National Footprint Accounts.

2. National Footprint Accounts: data sources and accounting framework

Global Footprint Network releases National Footprint Accounts (NFA) annually. The NFA 2011 Edition calculate the Ecological Footprint and biocapacity of more than 200 countries and territories, as well as global totals, from 1961 to 2008 (Global Footprint Network, 2011). The intent of the NFA is to provide scientifically robust and transparent calculations to highlight the relevance of biocapacity limits for decision-making. The National Footprint Accounts measure one main aspect of sustainability only – *how much biocapacity humans demand in comparison to how much is available* – not all aspects of sustainability, nor all environmental concerns. The attempt to answer this particular scientific research question is motivated by the assumption that the Earth's regenerative capacity is the limiting factor for the human economy in times when human demand exceeds what the biosphere can renew.

The calculations in the NFA are based primarily on data sets (Table 1) from UN agencies or affiliated organizations such as the Food and Agriculture Organization of the United Nations (FAOSTAT, 2011), the UN Statistics Division (UN Commodity Trade Statistics Database – UN Comtrade, 2011), and the International Energy Agency (IEA, 2011). Other data sources include studies in peer-reviewed journals and thematic collections.

Results can be reported at the level of a product category, land use type, or aggregated into a single number (Fig. 1) – the latter being the most commonly used reporting format. Normalizing

[1] In theory, the Ecological Footprint includes all human demands that compete for space, and biocapacity all areas that provide such services. But in practice, consistent data sets for all aspects do not exist. For this reason not all human demands that compete for space are included in actual assessments, nor all areas that provide services.