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Ecological Footprint Accounting: Comparing Resource Availability with an Economy's Resource Demand

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Abstract:

The management of natural capital, including its ability to renew itself, represents a core aspect of sustainability. Hence reliable measures comparing the supply of natural capital with human demand on it are indispensable for tracking progress, setting targets and driving policies for sustainability. This paper describes one such resource measure: the Ecological Footprint. After explaining the assumptions and describing some representative findings, it provides examples of how this resource accounting tool can assist governments in managing their ecological assets, and can support their efforts for advancing sustainability.

Key words: Ecological Footprint, Resource Accounts, Sustainability, Regional Governance

*The **Global Footprint Network** is advancing the science of sustainability. It increases the effectiveness and reach of the Ecological Footprint by strengthening the Footprint community, standardizing the tool, and building wide support for bringing human demands in line with Earth's limited resources. More on the science behind the Ecological Footprint and examples of how it has been used to advance sustainability can be found on the website www.FootprintNetwork.org.*

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Why Track Resource Consumption and Natural Capital?

Sustainability promises rewarding lives for all, now and in the future. Natural capital—nature's goods and services-- is not the only ingredient in this vision. But without this type of capital – without healthy food, energy for mobility and heat, fiber for paper, clothing and shelter, fresh air, and clean water – sustainability is impossible. This is why careful management of natural capital is central to current and future human well-being. Sustainability thus depends on protecting natural capital from systematic overuse; otherwise nature will no longer be able to provide society with these basic services.

How well are we using natural capital? Without measurements, we are blind and cannot effectively manage these essential natural resources. To take care of our natural capital, we must know how much we have and how much we use. This is no different from any financially responsible household, business, or government using accounts to keep track of its income and spending. To protect our natural assets, we need accounts that keep track of humanity's demands on nature and nature's supply of ecological resources.

Ecological Footprint Accounts: Capturing Human Demand on Nature

Ecological Footprint accounts are such balance sheets. They document for any given population the area of biologically productive land and sea required to produce the renewable resources this population consumes, and to assimilate the waste it generates, using prevailing technology. In other words, Ecological Footprints document the extent to which human economies stay within the regenerative capacity of the biosphere, and who uses each portion of this capacity.¹

Such biophysical resource accounting is possible because resources and waste flows can be tracked, and because most of these flows can be associated with the biologically productive area required to maintain them. Thus, the Ecological Footprint of a population is the area of biologically productive land and sea required to produce the resources this population consumes, and to assimilate the wastes it generates, given prevailing technology. This area is expressed in global hectares—adjusted hectares that represent the average yield of all bioproductive areas on Earth. Since people use resources from all over the world and pollute far away places with their wastes, the Ecological Footprint accounts for these areas wherever they happen to be located on the planet.

Ecological Footprint Results:

For each given year, Ecological Footprints compare human demand on nature with nature's regenerative capacity. Recent calculations, published in WWF's *Living Planet Report 2002*,² show that the average Canadian required over 8.8 global average hectares to provide for his or her consumption. If everyone on Earth consumed at this level, we would need four additional planets. The average Italian lived on a Footprint less than half that size (3.8 global hectares). The average Mexican occupies 2.5 global hectares, the average Indian lives on about ¼ of that. The global average demand is 2.3 global hectares per person. (For more countries see table 1).

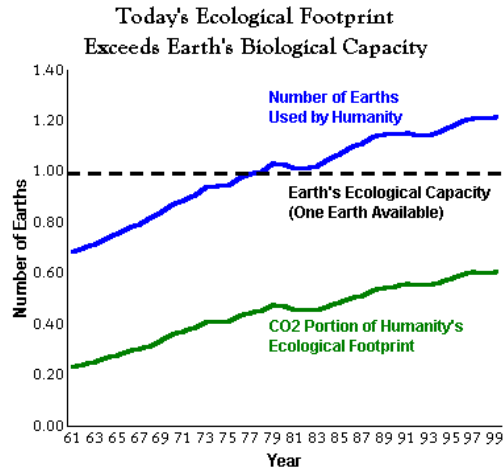
TABLE 1: Comparison of the Ecological Footprint and the Biological Capacity of selected countries.

	Population	Ecological Footprint	Biological Capacity	Ecological Deficit (-) or Reserve (+)
	[millions]	[global ha/cap]	[global ha/cap]	[global ha/cap]
WORLD	5,978.7	2.3	1.9	- 0.4
Argentina	36.6	3.0	6.7	3.6
Australia	18.9	7.6	14.6	7.0
Brazil	168.2	2.4	6.0	3.6
Canada	30.5	8.8	14.2	5.4
China	1,272.0	1.5	1.0	- 0.5
Egypt	66.7	1.5	0.8	- 0.7
France	59.0	5.3	2.9	- 2.4
Germany	82.0	4.7	1.7	- 3.0
India	992.7	0.8	0.7	- 0.1
Indonesia	209.3	1.1	1.8	0.7
Italy	57.5	3.8	1.2	- 2.7
Japan	126.8	4.8	0.7	- 4.1
Korea, Rep.	46.4	3.3	0.7	- 2.6
Mexico	97.4	2.5	1.7	- 0.8
Netherlands	15.8	4.8	0.8	- 4.0
Pakistan	137.6	0.6	0.4	- 0.2
Philippines	74.2	1.2	0.6	- 0.6
Russian Federation	146.2	4.5	4.8	0.4
Sweden	8.9	6.7	7.3	0.6
Thailand	62.0	1.5	1.4	- 0.2
United Kingdom	59.5	5.3	1.6	- 3.7
United States of America	280.4	9.7	5.3	- 4.4
A. Combined	4,048.6	2.5	1.9	-0.6

In the last column, negative numbers indicate an ecological *deficit*, positive numbers an ecological *reserve*. All results are expressed in global hectares, hectares of biologically productive space with world-average productivity.
 Note that numbers may not always add up due to rounding. These Ecological Footprint results are based on 1999 data. (WWF, *Living Planet Report 2002*)

In contrast, the current supply of biologically productive land and sea on this planet adds up to 1.9 hectares per person. Less is available per person if we allocate some of this area to the other species which also depend on it. Providing space for other species is necessary if we want to maintain the biodiversity that may be essential for the health and stability of the biosphere.

Comparing supply and demand, we see that humanity's Ecological Footprint exceeds the Earth's biocapacity by over 20 percent (2.3 [gha/pers] / 1.9 [gha/pers] = 1.2). In other words, it takes more than one year and two months to regenerate the resources humanity consumes in one year. Global demand began outpacing supply only recently, beginning in the late 1970s or early 1980s. In 1961, for example, it took only 0.7 years to regenerate what was used in that year, as shown in the figure below.³



Overshoot and Ecological Deficit

It is possible to exceed global biocapacity because trees can be harvested faster than they regrow, fisheries can be depleted more rapidly than they restock, and CO₂ can be emitted into the atmosphere more quickly than ecosystems can sequester it. With humanity's current demand on nature, ecological deficit, or 'overshoot,' is no longer merely a local but a global phenomenon. We are now consuming not only nature's interest, but also invading the principle.

Overshoot causes the liquidation of natural capital: carbon accumulates in the atmosphere, fisheries collapse, deforestation spreads, biodiversity is lost and freshwater becomes scarce. Efficiency gains have helped to some extent: humanity's Ecological Footprint has grown slower than economic activities. Still, human demand on nature has steadily risen to a level where the human economy is now in global ecological overshoot.

Applications of Ecological Footprint Accounts

The Ecological Footprint can be applied at scales ranging from single products to organizations, cities, regions, nations and humanity as a whole. It can be used to help budget limited natural capital. It also makes clear the four complementary ways in which ecological deficits can be reduced or eliminated:

- (1) Use resource-efficient technology that reduces the demand on natural capital;
- (2) Reduce human consumption while preserving people's quality of life, for example reduce on the need for fossil fuels by making cities pedestrian friendly;
- (3) Lower the size of the human family in equitable and humane ways so that total consumption decreases even if per capita demand remains unchanged; and,
- (4) Invest in natural capital, for example by implementing resource extraction methods that increase rather than compromise the land's biological productivity, thereby increasing supply.

There have been Footprint applications on every continent. Global and national accounts have been reported in headlines worldwide, and over 100 cities or regions have assessed their Ecological Footprint (see some examples in Table 2). In California, Sonoma County's Footprint project *Time to Lighten Up* has inspired all cities of the county to sign up for the Climate Saver Initiative of the International Council for Local Environmental Initiatives (ICLEI). Wales has adopted the Ecological Footprint as its headline indicator. WWF International, one of the world's most influential

conservation organizations, uses the Ecological Footprint in its communication and policy work for advancing conservation and sustainability. Government agencies, particularly in Europe, have studied the implication of Ecological Footprint results and have reexamined the significance of carrying capacity. A number of national ministers have repeatedly used the concept, including French President Jacques Chirac in his speech to the World Summit on Sustainable Development in Johannesburg. Even larger media outlets are picking up the ideas: *The Economist* titled its July 2002 insert on the global environment "How many planets?" based on a Footprint assessment that showed it would take three planet Earths if all people lived OECD lifestyles.

TABLE 2: Footprint Applications in Public Policy

Municipal Applications

There may well be over one hundred Ecological Footprint studies for cities, ranging from student projects to comprehensive analyses of a metropolitan area's demand on nature. **London**, for instance, has already gone through three rounds. In 1995, urban sustainability expert Herbert Girardet estimated that the UK capital's Footprint was 125 times the size of the city itself. In other words, in order to function London required an area the size of the entire productive land surface of the UK to provide all the resources the city uses and to dispose of its pollutants and waste.

In 2000, under the leadership of Mayor Ken Livingstone, London commissioned a more detailed Ecological Footprint study called *City Limits*. The report, sponsored by organizations including the Chartered Institution of Wastes Management, the Institution of Civil Engineers (ICE), and the Biffaward Programme on Sustainable Resource Use, was produced by Best Foot Forward and launched in September 2002. Results for this city and its 7 million inhabitants are available at: <http://www.citylimitslondon.com>.

To respond to the challenges identified by the *City Limits* report, London Remade, a business membership organization supported by over 300 of the capital's major businesses and higher education institutions, wanted to analyze possible steps for reducing London's Footprint. In collaboration with London First, a waste management partnership, it commissioned consulting companies WSP Environmental and Natural Strategies to identify the reduction potential in a project called *Toward Sustainable London: Reducing the Capital's Ecological Footprint*. The first of four reports, *Determining London's Ecological Footprint and Priority Impact Areas for Action*, is available at: http://www.londonremade.com/london_remade/download_files/Phase%201%20Final.pdf

Others have studied aspects of city living using the Ecological Footprint. For instance, the sustainable consumption unit of the Stockholm Environment Institute – York has led a number of studies of cities or regions (<http://www.york.ac.uk/inst/sei/IS/sustain.html>). They also contributed, with BioRegional, to a WWF-UK report called *One Planet Living in the Thames Gateway* which identifies Footprint saving potentials for greener urban developments. The report is available at: <http://www.wwf.org.uk/filelibrary/pdf/thamesgateway.pdf>.

Bill Dunster, UK's leading ecological architect, uses the Footprint as the context for his designs. More on his work can be found at <http://www.zedfactory.com>.

National & Regional Applications

A number of national and regional Footprint studies have contributed to policy discussions, some in close cooperation with government agencies. For example:

Wales (pop. 2,900,000). The National Assembly for Wales adopted the Ecological Footprint as their headline indicator for sustainability in March of 2001, making Wales the first nation to do so. The first report was commissioned through WWF-Cymru and executed by Best Foot Forward. This report details Welsh energy, transportation and materials management. It can be found at: <http://www.wwf-uk.org/filelibrary/pdf/walesfootprint.pdf>.

The State of Victoria, Australia (pop. 4,650,000). EPA Victoria, the lead state agency responsible for protecting the environment, established a series of pilot projects in 2002 in partnership with a wide range of organizations and businesses to further investigate the practical applications of the Ecological Footprint to promote sustainability. See <http://www.epa.vic.gov.au/eco-footprint> The campaign is expanding its reach for 2004.

Sonoma County, California (30 miles north of San Francisco, pop. 495,000). Under a grant from the U.S. EPA, Sustainable Sonoma County, a local NGO, used the Ecological Footprint as the foundation of a 2002 campaign. By inviting wide public participation and comment on the study before it was released, it was able to generate strong local buy-in. As a result, the launch of the study got county-wide media coverage and built the groundwork for a subsequent campaign. The latter resulted in all municipalities of Sonoma County committing simultaneously to reduce their CO₂ emissions by 20 percent, making it the first U.S. county to do so. To meet this commitment, they established programs that track progress towards meeting their reduction goal. The Sonoma Footprint study is available at: <http://www.sustainable-sonoma.org/projects/scefootprint.html>

International Applications

The European Parliament commissioned a comparative study on the application of Ecological Footprinting to sustainability. This study included case studies exploring potential uses of the Footprint in international legislation. The study, completed in 2001, was supervised by the Directorate General for Research, Division Industry, Research, Energy, Environment, and Scientific and Technological Options Assessment (STOA). It is available at http://www.europarl.eu.int/stoa/publi/pdf/00-09-03_en.pdf or as 10-page summaries in 11 European languages at http://www.europarl.eu.int/stoa/publi/default_en.htm.

The United Nations Population Fund (UNFPA) report *State of World Population 2001 - Footprints and Milestones: Population and Environmental Change* builds on Ecological Footprint concepts. See <http://www.unfpa.org/swp/2001/english/ch03.html#5>

An Indicator for 'Strong' and 'Weak' Sustainability

By monitoring human use of renewable natural capital, Ecological Footprint accounts provide guidance for sustainability: a Footprint smaller than the available biocapacity is a necessary condition for 'strong sustainability,' a stance which asserts that securing people's well-being necessitates maintaining natural capital.

Some argue that 'strong sustainability' is too stringent since technology and knowledge can compensate for lost ecological assets. While this can be debated, even managing for 'weak sustainability' requires reliable accounting of assets. Hence, by measuring the overall supply of and human demand on regenerative capacity, the Ecological Footprint serves as an ideal tool for tracking progress, setting targets and driving policies for sustainability.

What's in It for Governments and Regions?

Ecological Footprint accounts allow governments to track a region's demand on natural capital and to compare this demand with the amount of natural capital actually available. The accounts also give regions or countries the ability to answer more specific questions about the distribution of these demands within their economic systems. For example, Footprint accounts can reveal the ecological demand associated with residential consumption, the production of value-added products or the

generation of exports, or they might be used to assess the ecological capacity embodied in the imports upon which a region depends. This can help in understanding the region's constraints or future liabilities in comparison with other regions of the world, and in identifying opportunities to defend or improve the quality of life within the region.

Footprint accounts help governments become more specific about sustainability in a number of different ways. The accounts provide a common language and a clearly defined methodology that can be used to support training of staff and to communicate about sustainability issues with other levels of government or with the public. Footprint accounts add value to existing data sets on production, trade and environmental performance by providing a comprehensive way to interpret them. For instance, the accounts can help guide 'environmental management systems' by offering a framework for gathering and organizing data, setting targets and tracking progress. The accounts can also serve environmental reporting requirements, and can inform strategic decision making for regional economic development.

In addition, monitoring demand and supply of natural capital allows governments to:

- Build a region's competitiveness by monitoring ecological deficits, since over time these deficits could become an increasing economic liability;
- Stay aligned with the business community's increasing focus on sustainability as a way to decrease future vulnerability (see for example BP or Toyota);
- Manage common assets more effectively. Without an effective metric, these assets are typically valued at zero or less and their contribution to society is not systematically assessed nor included in strategic planning;
- Have access to an early warning device for economic and military long-term security that recognizes emerging scarcities and identifies global trends;
- Monitor the combined impact of ecological pressures that are more typically evaluated independently, such as climate change, fisheries collapse, loss of cropland, forestry overharvesting and urban sprawl;
- Identify local and global possibilities for climate change mitigation, and examine the tradeoffs between different approaches to atmospheric CO₂ reduction; and
- Test policy options for future viability and possible unintended consequences.

Without regional resource accounting, countries can easily overlook or fail to realize the extent of these kinds of opportunities and threats. The Ecological Footprint, a comprehensive, science-based resource accounting system that compares people's use of nature with nature's ability to regenerate, helps eliminate this blind spot.



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