Centre for ISA Information Sheet 9
Ecological Footprint (EF)

The term Ecological Footprint was coined by William Rees in 1992[1]. It has proved to be a powerful metaphor, lending itself to illustration with vivid depictions of trampling on the earth and taking up more space than is available. As a result the use of Footprint has become wide-spread with people now talking about a Water Footprint, Social Footprint or Carbon Footprint.

The Ecological Footprint (EF) can be used alone or in Triple Bottom Line reports as one indicator of the sustainability of an organisation. As part of the TBL it can sit along side indicators such as employment, imports and exports, or contribution to government revenue (see Information Sheet 7 for an explanation of Triple Bottom Line and Information Sheet 6 for the full range of ISA indicators).

What does it measure?

The Global Footprint Network (GFN)[2] says that the Ecological Footprint is a resource management tool that "measures the extent to which humanity is using nature's resources faster than they can regenerate. It illustrates who uses how much of which ecological resources, with populations defined either geographically or socially". Also, they say, "it shows to what extent humans dominate the biosphere at the expense of wild species"[3].

The Footprint is not designed to be a complete sustainability measure. While it documents the ecological outcome – the demand on nature resulting from human activities that occurred at a given time – it does not, for example include any measure of social well-being. Neither does it evaluate the long-term viability of social and economic structures or political systems[4]. And while the EF is said to "describe how much of the regenerative capacity of the Earth is being used by humans, to re-generate the biosphere requires more than the regeneration of biological matter; it requires the regeneration of ecosystems, and the species relationships therein. Therefore, a more precise description [of what the EF measures] would use the term bioproductive capacity"[5].

What does it mean?

The WWF's Living Planet Report (2006, p. 16)[6] says that a "country's Ecological Footprint is determined by its population, the amount consumed by its average resident, and the resource intensity used in providing the goods and services consumed.

"It includes the area required to meet people's consumption from cropland (food, animal feed, fibre, and oil); grassland and pasture (grazing of animals for meat, hides, wool, and milk); fishing grounds (fish and seafood); and forest (wood, wood fibre, pulp, and fuelwood).

1   Rees, W.E. (1992). Ecological footprints and appropriate carrying capacity: what urban economics leaves out. Environment and Urbanization 4(2). 121-130; see also Wackernagel, M. & Rees, W. (1995). Our Ecological Footprint: Reducing Human Impact on the Earth. New Society Publishers Philadelphia, PA, USA.

2   http://www.footprintnetwork.org/gfn_sub.php?content=footprint_overview (retrieved from the web 29/11/07)

3   http://www.footprintnetwork.org/gfn_sub.php?content=footprint_overview (retrieved from the web 29/11/07)

4   University of Sydney ISA & Global Footprint Network (2005). The Ecological Footprint of Victoria: Assessing Victoria's demand on nature. EPA Victoria. P. 66.

    Also http://www.footprintnetwork.org/gfn_sub.php?content=standards Ecological Footprint Standards 2006, Global Footprint Network "Policy decisions regarding biodiversity, resource management, social well-being and other sustainability dimensions require consideration of factors beyond the Footprint. Footprint reports need to state clearly that Footprints are not complete sustainability measures." (p. 26).

5   On the bioproductivity and land-disturbance metrics of the Ecological Footprint. ISA Research Paper 03/06, in collaboration with WWF. Manfred Lenzen, Carina Borgstrom Hansson and Stuart Bond. http://www.isa.org.usyd.edu.au/publications/documents/ISA&WWF_Bioproductivity&LandDisturbance.pdf

6   http://www.panda.org/news_facts/publications/living_planet_report/lp_2006/index.cfm (retrieved from the web 29/11/07)

CARBON FOOTPRINT

"It also estimates the area required to absorb the CO_2 released when fossil fuels are burned, less the amount taken up by the oceans."

Using the original concept and methodology this area of productive land or sea is translated into a common unit of biologically productive area called a 'global hectare' (gh). Thus a five hectare footprint would mean that five 'global hectares[7]' are in constant production to support the average individual of that country. According to calculations based on the above, in 2006 WWF reported that humanity's Footprint was 14.1 billion global hectares, which exceeded the Earth's biological capacity by about 25 percent[8] (up from 20% reported in 2004). This translates to an average of 2.2 global hectares per person[9]. However the productive area available to support the global population of 6.3 billion in 2003 was 11.2 billion global hectares, which is an average of approximately 1.8 gh each. We are considerably overshooting our planet.

The 'overshoot' is said to indicate the extent to which humanity's consumption exceeds nature's ability to regenerate (Wackernagel et al, 2002[10]). To explain this concept: in a perfectly sustainable system, human waste products would be re-used in nature at the same rate that they were produced. Waste products from human activities would not build up on land, in the sea, or in the atmosphere. Greenhouse gases, which make up about 48% of our global footprint, would be re-used at the same rate that they are produced. The fact that they have accumulated indicates that some 'overshoot' has occurred. One role of the Ecological Footprint (EF) is to provide a concrete method for visualising the 'overshoot', as an area of land.

Recent calculations published in the Living Planet Report (WWF 2006[11]) suggest that the average Australian uses 6.6 global hectares to produce the goods they consume and absorb the waste they produce. The average US resident has an Ecological Footprint of 9.4 global hectares, whereas the average Italian lives on 4.2 global hectares. The average Mexican occupies 2.6 global hectares, and the average Indian lives on about one-third of that.

Data sources and calculation issues

The Global Footprint Network has stewardship of the National Footprint and Biocapacity Accounts. These accounts provide the basis for Ecological Footprint analyses. Information that makes up the accounts is drawn largely from United Nations agencies. It documents the natural resources (e.g., cropland, pasture, forests and fisheries) available within a country as well as the country's demand on these resources. An academic license to use the accounts is available for those interested in exploring Footprint applications.

The WWF's *Living Planet* report (2006) documents national per capita footprints for all countries with populations greater than one million for which complete data are available. Each nation's footprint includes the resources embodied in the goods and services consumed (food, housing, transportation, consumer goods and services, domestically produced and imported) and the

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[7]   A 'global hectare' is the "average per hectare regenerative capacity of all the planet's biologically productive surfaces". According to the Global Footprint Network "the planet has approximately 11.3 billion hectares (27.9 billion acres) of biologically productive land and sea surfaces" (http://www.footprintnetwork.org/gfn_sub.php?content=national_footprints). A hectare is about the size of a football field

[8]   http://assets.panda.org/downloads/living_planet_report.pdf

[9]   Using 2003 data

[10]   Wackernagel, M., Schulz, N.B., Deumling, D., Linares, A. C., Jenkins, M., Kapos, V., Monfreda, C., Loh, J., Myers, N., Norgaard, R. & Randers, J. (2002). Tracking the Ecological Overshoot of the Human Economy Proc. Natl. Acad. Sci. USA, Vol. 99, Issue 14, 9266-9271.

[11]   http://assets.panda.org/downloads/living_planet_report.pdf

Centre for ISA Information Sheet 9
Ecological Footprint (EF)

associated waste. It excludes resources embodied in exports, which are counted in the footprint of the importer. Analysis is based primarily on data published by the Food and Agriculture Organisation of the United Nations and the Intergovernmental Panel on Climate Change.

In the original ecological footprint, land categories were weighted with equivalence and local yield factors (Wackernagel *et al.* 2002) in order to express appropriated bioproductivity in world-average terms. This weighting has significant implications for ecological footprint figures: For example New Zealand and Germany run cattle. New Zealand uses far more space than Germany per unit of cattle, but when adjusted to world-average yield the differences are evened out so that a kg of meat consumed in NZ is not much different to a kg in Germany. In effect, the global-averaging of agricultural land does not reward the farmer who improves yield by using less land per kg of meat, and it does not penalise the farmer who uses more land per kg.

Both countries also produce electricity. Germany generates a lot more emissions than NZ per kWh; unlike agricultural production these don't get converted to world-averages, so that a kWh of electricity consumed in Germany contributes considerably more to that country's EF than a kWh in NZ. Thus the EF methodology does penalise the electricity producer for high emissions, and rewards the electricity producer who reduces emissions. This anomaly – the conversion to world averages of agricultural production but not other production areas such as electricity – is still to be addressed.

Further, the intensity of human-induced changes to land is independent of productivity. Land converted to roads and buildings, used for mining or for intensive cropping – whether productive or not – is drastically altered from its natural state, whereas land used for non-intensive grazing or native forestry may be only slightly altered. For this Lenzen and Murray (2001)[12] suggest that a better approach is to use the condition of the actual area of land used by the respective population as a basis for the EF and suggest *landcover disturbance* as a proxy for land condition. They apportion weightings for different types of land use.

Another issue inherent in using *bioproductivity* as a measure is the suggestion that changing to higher yield monocultures can improve your Footprint. Thus replacing rain forest with palm oil plantations, for example, could be seen as a positive move. To counter this notion the *Living Planet Report* includes *The Living Planet Index*, which is "a measure of the state of the world's biodiversity based on trends from 1970 to 2003 in over 3600 populations of more than 1300 vertebrate species from around the world" (WWF, 2006). Thus the *Living Planet Report* provides the two complementary indices: Ecological Footprint and Biodiversity.

Methodological developments

The methodology developed by the Global Footprint Network[13] has continued to evolve as interest has grown worldwide. Recent work in Australia, for example, has introduced into the Footprint debate some measure of biodiversity and toxicity impact[14].

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[12] Lenzen, M. and Murray S.A. (2001). A modified Ecological Footprint method and its application to Australia. Ecological Economics 37(2), 229-255, see also http://www.isa.org.usyd.edu.au/publications/documents/Ecological_Footprint_Issues_and_Trends.pdf

[13] http://www.footprintnetwork.org/

[14] http://www.isa.org.usyd.edu.au/research/EFARC.shtml

Another development has been the inclusion of the full indirect upstream production chain in calculations (see Information Sheet 2 for explanation of *full production chain*) rather than using only direct inputs. In 2004 the Global Footprint Network[15] and the ISA group joined forces in an attempt to produce a hybrid Ecological Footprint methodology that included the full upstream production chain. This improvement, while recognising the interdependence of industry sectors, makes for complex calculations. To solve this calculation problem Lenzen and Murray (2003)[16] suggest using the macroeconomic technique, *input-output analysis*. The technique was introduced by Nobel Prize laureate Wassily Leontief in 1936 since when it has been applied to numerous economic, social and environmental issues. It relies on data on inter-industrial monetary transactions, as documented for example in the Australian input-output tables compiled by the Australian Bureau of Statistics. These changes form the basis of the University of Sydney ISA methodology and are an integral part of the EF standards debate[17].

ISA was represented at the EF Standards Committee meeting at the Footprint Forum in Siena, Italy in June, 2006. This meeting issued the *Ecological Footprint Standards 2006*. These standards recognised the issue of boundary drawing when calculating the Footprint of an organisation (see ISA Information Sheet 13 for a full discussion of boundaries and double counting). For calculating the EFs of national and sub-national populations, studies usually focus on the consumption of the population as a whole. In such cases it is fairly straightforward to draw boundaries that do not overlap, so that the Footprints of all regional populations of a nation add up to the same total as the Footprint for the whole nation.

Organisations such as manufacturing companies and service providers that are in the middle of a supply chain, are more difficult to deal with. They consume goods and services in the production of other goods and services, which are either sold to a consumer, or sold to another organisation along the supply chain. These organisations are both producers and (intermediate) consumers. Defining the boundaries of such organisations so that there is no overlap is a time consuming task (see Information Sheet 8 for a discussion of boundary drawing and ISO LCA standards). Consequently the Ecological Footprint Standards Committee decided to focus on Sub-National Population studies for this first release of the Standards and take up the issue of organisations at a later date.

Meanwhile ISA has been researching the problem of system overlap and double counting when calculating the EFs of organisations. ISA's work in apportioning impacts along the supply chain has led to a consistent and quantitative framework[18] that allocates each impact – for example on a 50%-50% basis between the supplier and the recipient. This removes double-counting and solves a decades-long problem for life cycle analysis. The ISA software BL³, which can be used to calculate your EF, systematically shares responsibility along the supply chain.

In 2007 the Stockholm Environment Institute at the University of York, UK and the Centre for Integrated Sustainability Analysis at the University of Sydney, Australia, with the endorsement of

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[15]   http://www.footprintnetwork.org/newsletters/footprint_network_1-1-0.html

[16]   Lenzen M, Murray S A, (2003). The Ecological Footprint – Issues and Trends, http://www.isa.org.usyd.edu.au/publications/reports.shtml

[17]   http://www.footprintnetwork.org/gfn_sub.php?content=standards

[18]   See Gallego and Lenzen 2005; Lenzen, Murray et al. 2007

Centre for ISA Information Sheet 9
Ecological Footprint (EF)

the Global Footprint Network, developed a blueprint for a dynamic approach to forecasting the Ecological Footprint of Nations[19]. This work will complement the static EF accounts with "tools that can explore how past trends and human interactions with the biosphere might shape our future biocapacity and Footprints" (Mathis Wackernagel, Foreword p. 5). One of the major conclusions of this work confirms the Living Planet Report 2006 which suggests that humankind's demands have been exceeding the world's biocapacity since 1980.

Application

The EF provides governments and organisations with a single number that can easily be communicated. The concept of Ecologic Footprint, because of its metaphorical connotations, provides a powerful tool for education. The calculation of national EFs gives a general indication of the magnitude of human impact globally. As methodologies improve and the Global Footprint Network incorporating the ISA methodology moves towards standardisation, the Ecological Footprint will allow increasingly more accurate comparisons to be made between countries and within a country's communities and organisations over time.

Online calculators

A number of footprint calculators are available on the internet. For example:

- ISA Ecological Footprint calculator[20], developed by the University of Sydney's ISA team calculates the amount of land needed to support your lifestyle, it provides comparison with the average world citizen and the average person in India;

- Eco'tude The Power House Museum[21], Sydney, provides an online calculator for use in education – it will tell you the Ecological Footprint of your school;

- WWF Ecological Footprint calculator[22] asks questions about food, home, travel and 'stuff'.

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[19] Forecasting the Ecological Footprint of Nations: a blueprint for a dynamic approach, Lenzen, Wiedmann et al (2007) http: // www.isa.org.usyd.edu.au/publications/DEF.pdf

[20] http://www.isa.org.usyd.edu.au/

[21] http://www.powerhousemuseum.com/ecotude/calc.asp

[22] http://footprint.wwf.org.uk/