Ecological Footprints

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Professor Berman, Green Design & the City, Fall 2009

Shortly after its publication, ecological footprints have become almost ubiquitous among the environmentally-minded general public. They are among the first to fit all the criteria for effective indicators: ecological footprints are relevant, easy to understand, reliable, and based on accessible data.[1] In addition they are quantifiable; and quantifiable metrics are highly important for changing attitudes, establishing baselines, and creating goals for sustainability. Ecological footprints were one of the first to define the "affordability of sustainability" based on empirical facts, and are still effective indicators despite inherent limitations and criticisms.

Origin

Ecological footprints (EF) have unique beginnings as a topic of Mathis Wackernagel's graduate school dissertation under Professor William Rees at the University of British Columbia. This dissertation idea came about in the early 1990's after Professor Rees had argued with economists about whether the concept of carrying capacity (a.k.a. the limited population size that the environment can sustain indefinitely within natural resource limits) could or could not be applied to humans. The economists contested that "if [humans] run out of one resource we will simply find a substitute [using technology], so there was no need to be concerned." In response, Rees and Wackernagel hypothesized that a limit of resources does exist, and one could quantify it in a universal and accessible way.[2] Their process compared human consumption with Earth's ecological capacity to regenerate, resulting in one value (generally measured as hectares or global hectares per capita).

This project was novel in that it aligned with the thinking of 'One Planet Economics' (versus the idea of infinite available resources), while adding a visual, quantitative, and easy-to-grasp element. Rees and Wackernagel concluded that a person in a developing country can get everything he or she needs from less than a third of a hectare per person. But citizens of rich countries like Canada and the U.S. have an EF of about eight to ten hectares per person. They also concluded that with technology comes with productivity and stronger energy dependence, meaning per capita demand on the earth generally does not decrease with growth. Technologies that come with productivity and stronger energy independence lead to true development, which increases livability while maintaining the same size / decreasing an EF. However, unsustainable technologies and the desires to achieve the same level of consumption as North America create fears of a forthcoming exponentially large global environmental footprint.[3]

Methodology

The first step in creating an EF metric is establishing the target audience. The population unit in question can vary from an individual, groups of people, or even activities. For calculating the EF of people assumptions are made concerning a population's consumption levels. Consumption is divided into 5 categories: food, housing, transportation, consumer goods, and services. Consumption measurements are converted into land area

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[1] "Characterisitics of effective indicators." Sustainable Measures. <http://www.sustainablemeasures.com/Indicators/Characteristics.html>

[2] Foss, Kelly. "Originator of the ecological footprint to lecture at Memorial." *The Gazette.* Memorial University. <http://www.mun.ca/gazette/issues/vol41no8/originator.php>

[3] Ibid.

equivalents. This value comes from where the act of consumption was derived or where its waste material was absorbed. Also, the total land on Earth is measured to give perspective to the consumption value. Land can be categorized as energy land, degraded or built land, gardens, crop land, pastures and managed forests, and 'land of limited availability' – untouched forests and 'non-productive areas,' which are not included further in the analysis. Anything else is sea area.[4] All conversion figures are calculated in advance through reasoning, physical measurements and process analysis.[5] Ecological footprints for activities, like producing goods or performing a service, are calculated similarly.[6]

Generally EF makes the following assumptions: (1) deserts and ice caps are unproductive lands, (2) yield factors can be determined with adequate accuracy, (3) two pieces of similar land with the same yield factor have the same biocapacity, regardless on what is grown on them, and (4) the majority of resources people or activities consume and the wastes they generate can be tracked.[7]

The following images were taken from some websites that showcased their own version of an EF calculator. The ones available online have simplified formulas since general assumptions are made and usually target individual or household populations. Quickness and ease are the goals for these designs. Calculations for larger populations – done offline – make fewer assumptions, are more complex, and gather more accurate data than the ones shown below.

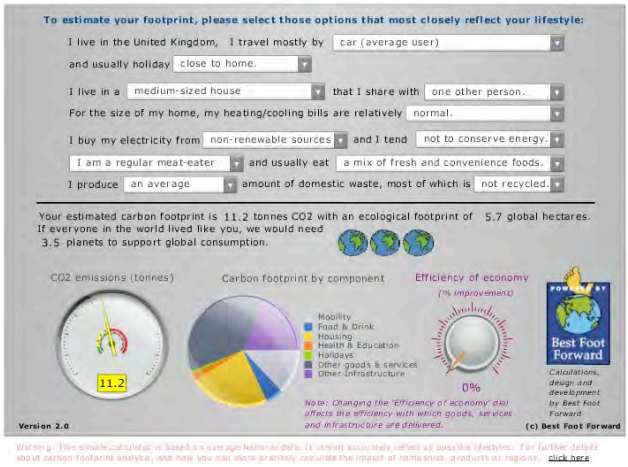

Figure 1. Best Foot Forward

[4] Lenzen, Manfred and Shauna Murray. "The Ecological Footprint – Issues and Trends." The University of Sydney. Integrated Sustainability Analysis. 2003.
[5] "Introduction to Ecological Footprints." Demesta. <http://www.demesta.com/ecofoot/eng/introd.htm>
[6] Kitzes, Justin and Mathis Wackernagel. "Answers to commong questions in Ecological Footprint Accounting." Global Footprint Network. *Ecological Indicators*. Vol. 9, pg 812-817. 21 Sept. 2008.
[7] Ferguson, Andrew. "The Assumptions Underlying Eco-Footprinting." Optimum Population Trust. *Population and Environment*, Vol. 23, No 3. Jan 2002.

Figure 2. Redefining Progress (Flash Animation)

Figure 3. University of Texas

Success

Before ecological footprints were established, environmental concerns were either too scientific for the layman or too qualitative for measurable results. EFs bridge together the two extremes and make environmental effects simple, easy-to-understand, and quantifiably acceptable to the public. Also, Wackernagel and Rees believe that this "crude" simplification will broaden appeal to both those reluctant to accept the ideas of ecological constraints and those who aren't. Because of these two reasons, the concept of EFs have been adapted by many different organizations and recreated for many different purposes. Concerns about retaining consistent and comparable EFs led the Global Footprint Network (GFN), an international think tank working to advance

sustainability via EFs, to produce methodological standards in 2006. They update those standards every year because of the increasing amount of ecological calculators.[8]

GFN has calculated individual footprints for each country in the world, and was recently awarded a $1,015,000 grant from The Skoll Foundation for Social Entrepreneurship. The organization is using that money for the Ten-in-Ten campaign, institutionalizing the ecological footprint in at least ten key nations by 2015.[9]

Limitations & Criticisms

Like all measuring devices, there are inherent kinks in EF's design. GFN identifies calculation problems as EF's main limitation, admitting, "some aspects of sustainability are excluded from its scope, some aspects of demand are hard to quantify, and errors can occur in the calculation" due to human error or erroneous assumptions.[10] Addressing the point of exclusions, EFs do not take into account non-ecological aspects of sustainability, depletion of non-renewable resources, inherently unsustainable activities (like the release of heavy metals), ecological degradation (like increased soil salinity from irrigation), or the resilience of ecosystems." This is mainly due to added computational complications. Secondly, in order to avoid data problems, double-counting in the case of multiple land uses, and significant uncertainty; calculations are made on the side of over-reporting biocapacity and under-reporting ecological footprints. Estimates were made in this direction in order to maintain EFs' conservative bias. Though, this suggests that most EF calculations are more likely to be underestimates than overestimates.[11, 12]

But outside critics mainly focused on problems with the larger concepts used in ecological footprints rather than calculation errors. For instance, in a global sample size who has the authority to determine whether or not land is or is not productive? Non-productivity is subjective. There are deserts in Australia that are habitable that are negated from the calculations. Generally, opinions on non-productivity are regionally- and culturally-based and should be recorded with this in mind.

The nature of EFs is also temporal, which means that it can be hard to update and maintain. EF data has been used in arguments about the sustainability of past, current, and future consumption; but its time-dependence only illuminates the ecological impact of people or activities during a certain time period. Calculations need to be constantly updated in order to stay accurate. And constant monitoring means ownership or political buy-in for an EF to ensure that there is consistent manpower for any modifications.[13]

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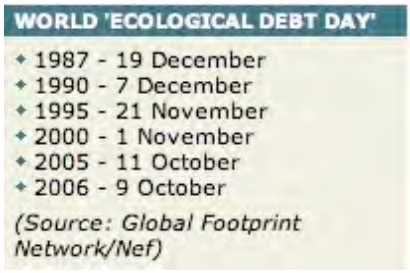
[8] Quek, Augustine. "The Ecological Footprint: Measuring Humanity's Impact on the Earth." *Environmentalism.* 2 Nov. 2008. <http://environmentalism.suite101.com/article.cfm/the_ecological_footprint#ixzz0WWkRDPJs>
[9] O'Neill, Meaghan. "Meet the Bookkeeper: An Interview with Mathis Wackernagel of Global Footprint Network." Treehugger. 26 June 2007. <http://www.treehugger.com/files/2007/06/meet_the_bookke_1.php>
[10] Ewing, Brad et. al. "The Ecological Footprint Atlas 2008." Global Footprint Network. 28 Oct. 2008.
[11] Rees, William. "Revisiting Carrying Capacity: Area-Based Indicators of Sustainability." *Population and Environment.* Vol. 17, 3. Jan 1996.
[12] Ewing, Brad et. al. "The Ecological Footprint Atlas 2008." Global Footprint Network. 28 Oct. 2008.
[13] Fiala, Nathan. "Measuring Sustainability: Why he Ecological Footprint is Bad Economics and Bad Environmental Science." University of California, Irvine: Department of Economics. 15 July 2008.

And the fact that an ecological footprint is only a simple aggregate indicator, means that it is not made to give social, political, or ethical recommendations after calculation, or be used to directly answer questions about trade offs between land uses.[14] Recommendations for ecologically sustainable practices have to be extrapolated from the results.

Interestingly, the creators Rees and Wackernagel noted similar concerns about EFs in separate interviews. While ecological footprints still enjoy the small-scale spotlight because of the proliferation of individualized EF calculators, their original intent was to be directed to larger entities, specifically national governments. It is actually more accurate and easier to calculate the footprint of a whole nation versus a single person because most countries have good statistics of their imports, exports, etc. [15] Additionally, "[although] individuals are becoming more interested in global sustainability and what role they can play in change, it's an error to lay the problem on individuals [alone]." Rees mentioned that individuals can regulate their own lifestyles in order to make them more sustainable, but more so, people need to become more politically engaged. Global sustainability is a collective problem that requires collective solutions such as a carbon tax or widespread pricing alterations that include the real ecological cost of producing them.[16] So according to its founders, an EF is really intended to be a warning signal on a massive scale to influence large-scale policies, planning, and development.

Effects

Although the day was initially celebrated in 1987, "Ecological Debt Day," also known as "Overshoot Day," became popular due to GFN and EFs. This date symbolized the day when people's demands exceed the Earth's resources for that year. In which case, the resulting days of the year symbolize humanity's 'ecological debt.' The date is calculated based on that year's global ecological footprint. Increases in global EFs mean an earlier Overshoot Day, with every year getting harder to recover the lost days.[17]



A series of environmentally-specific footprints have also been created as a result of EF's popularity, as well as other ideas to quantify eco-concerns. Ecological rucksacks (the total inputs of the natural material needed

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[14] Kitzes, Justin and Mathis Wackernagel. "Answers to commong questions in Ecological Footprint Accounting." Global Footprint Network. *Ecological Indicators*. Vol. 9, pg 812-817. 21 Sept. 2008.
[15] O'Neill, Meaghan. "Meet the Bookkeeper: An Interview with Mathis Wackernagel of Global Footprint Network." Treehugger. 26 June 2007. <http://www.treehugger.com/files/2007/06/meet_the_bookke_1.php>
[16] Foss, Kelly. "Originator of the ecological footprint to lecture at Memorial." *The Gazette.* Memorial University. <http://www.mun.ca/gazette/issues/vol41no8/originator.php>
[17] "Planet enters 'ecological debt.' BBC News. 9 Oct 2006. <http://news.bbc.co.uk/2/hi/science/nature/6033407.stm>

in order to generate a product, minus the weight of the product itself), energy footprints (measurements of land required to absorb the CO_2 emissions), carbon footprints (measurements of the greenhouse gases produced when performing an activity), water footprints (volume of water used), and food miles (the distance food travels from where it is grown to where it is ultimately purchased or consumed by the end user) are just a few descendants of ecological footprints.[18]

Final Thoughts

Personally, I believe that the purpose of EFs is to provide a "quick and dirty" way of quantifying environmental sustainability. The degree of accuracy in the resulting number is less important as opposed to ease of calculation and clarity of understanding. In this case, a lot of the flack that EF has been receiving can be negated. If an environmental group or other entity wants to use sustainability indicators to promote its agendas, the issue and its target audience should be considered first before arbitrarily relying on EFs to prove a point. Very specific agendas are poorly promoted with a single composite indicator. Instead of using them alone to make a point, EFs are good supplemental tools that can pair with other indicators to validate an argument. EFs also have a large following and should be used to spread general sustainability concepts to the public. Environmental footprints still have room to develop, but they should not be disregarded.

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[18] Rees, William. "Revisiting Carrying Capacity: Area-Based Indicators of Sustainability." *Population and Environment.* Vol. 17, 3. Jan 1996.