Trumpeter (1997)
ISSN: 0832-6193

The Footprints of Consumption: Tracking Ecospheric Decline

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Focus: Assessing Progress Toward Sustainability

This essay revisits the limits-to-growth debate using ecological footprint (E-F) analysis, a novel approach to assessing human carrying capacity. Eco-footprinting reveals that contrary to conventional wisdom, carrying capacity considerations are central to achieving sustainable development. Indeed, EF analysis suggests that material consumption by the human enterprise already exceeds the long-term productive capacity of the planet. This conclusion is consistent with empirical evidence of accelerating global change.

Concepts and Methods

Carrying capacity is traditionally defined as the maximum population of a given species that can be supported indefinitely by a defined habitat without permanently damaging that habitat. However, development economists have long rejected this concept as irrelevant to human beings on grounds that trade can relieve most local constraints on population and economic growth, and that technology will overcome any others. In fact, imports can alleviate local shortages and industrial humans do have a considerable history of success in substituting technology or manufactured capital for natural capital stocks that run out (see Box 1 for definitions pertaining to "natural capital"). By this logic, it might seem there are virtually no real limits to the growth of the human enterprise.

Unfortunately, any such conclusion would be premature. Simply by inverting the standard c.c. ratio, EF analysis literally overturns the economists' objection to carrying capacity. Rather than asking how many people can be supported in a given area, the relevant question becomes: How much area is needed to support a given population *wherever* that land may be located? Thus, ecological footprinting formally recognizes, first, that trade does not actually relieve or increase carrying capacity but merely shuffles it around and, second, that all technologies have some material impact on the Earth.

EF analysis is derived from trophic ecology (food-web and energy-flow analysis) and approaches humans much the same way as we would any other large consumer organism. However, in addition to accounting for peoples' physiological demands, we also factor in the metabolic demand of the economy (i.e., the material and energy flows required to build, maintain, and operate our manufactured capital, urban and industrial infrastructure, consumer goods – all the material artifacts of industrial civilization).

From this perspective, the impact or "load" imposed by any defined human population on the Earth can be summarized as the product of population size times mean *per capita* energy/material consumption, where "consumption" includes use of the waste assimilation services of nature. EF analysis is further based on the fact that many forms of material and energy consumption can be converted to a land/water (ecosystem) area equivalent. Summing the ecosystem areas required by a given population for each major resource and waste flow provides an estimate of the total area "appropriated" by that population to maintain its current lifestyle. Thus, the true ecological footprint of a defined population is the total area of land/water required on a continuous basis to provide the resources consumed and to assimilate the wastes produced by that population, *wherever on Earth that land is located.*

A Range of Applications

Eco-footprinting can address many questions relevant to society's quest for long-term sustainability. For example, a population's *de facto* ecological footprint can be compared to the area and productivity of its home region to determine the extent to which that population has overshot its local carrying capacity (i.e., the extent to which it is dependent on imports of surplus carrying capacity from elsewhere). This particular application provides a powerful heuristic and analytic tool to the bioregional movement. A central issue in bioregionalism is the extent to which life-styles and consumption patterns must be adjusted if we are to become more locally self-reliant and better adapted to living "in place."

EF analysis can also be used to estimate the total "natural capital" requirements of the anticipated global population at any assumed material standard; to monitor progress toward sustainability at any spatial scale, and; to assess the ecological efficiency of alternative technologies, development projects, lifestyles, settlement patterns, etc.

Real-World Results and Policy Implications

The average *per capita* ecological footprint of residents of typical high-income countries is three to five hectares

Summary and Conclusions

Ecological footprint analysis shows, that contrary to conventional wisdom, trade and technology have not freed humanity from real ecological constraints. Mainstream economic analyses are simply blind to the physical flows (the appropriated "natural income") associated with rising money incomes. In fact, the high levels of consumption and waste generation made possible by modern technology and international trade have made individuals and nations *more dependent than ever* on the products and processes of nature. EF analysis also suggests that to close the sustainability gap, a minimum five-fold decrease in energy and material consumption by the rich will be necessary over the next 40 years. Little progress is being made toward this goal as the consumer ethic spreads around the world.

Notes.

*Revised from the extended abstract of a paper presented to the special symposium on Population and Consumption at the Annual Meeting of the American Association for the Advancement of Science (AAAS), Baltimore, MD, February 1996. (Original published in: *Bioline* 14:2:15-16 [Fall/Winter, 1996]).

**These published estimates are relatively conservative. More recent extended analyses suggest the ratio may be as high as 1000:1.

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Citation Format

Rees, William E. (1997) The Footprints of Consumption: Tracking Ecospheric Decline
Trumpeter: 14, 1. http://www.icaap.org/iuicode?6.14.1.1