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FOR PEOPLE, NATURE, AND THE ECONOMY

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ECOLOGICAL FOOTPRINT OF NATIONS DECEMBER 2001 UPDATE

HOW MUCH NATURE DO THEY USE? HOW MUCH NATURE DO THEY HAVE?

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This *Ecological Footprints of Nations* report compares the ecological impact of 52 large nations, inhabited by 80 percent of the world population. It also shows to what extent their consumption can be supported by their domestic ecological capacity. These accounts document that humanity has already exceeded the Earth's biological capacity by over a third. Many nations run even more significant ecological deficits. The United States' ecological deficit is over 50 percent. A growing human population, with a growing appetite for resources, increases these ecological deficits and liquidates the Earth's natural capital. After introducing the rationale and assessment method for these ecological accounts, the report explains how such analysis can help build a sustainable future. These accounts are based on the most current usable United Nations statistics (1997).

THE ECOLOGICAL FOOTPRINT MEASURES HUMAN IMPACT ON NATURE

Because people consume the products and services of nature, every one of us has an impact on the Earth. This is not problematic as long as the human consumption stays within the ecological capacity of the biosphere. But does it? The latest Ecological Footprint Accounts, based on 1997 United Nations data (the most recent publicly accessible information), provide an answer.

The "Ecological Footprint" concept has been designed to respond to this question and estimate people's impact on their environment. It does this by measuring how much nature people use today to sustain themselves.[1]

Ecological Footprint calculations are based on two simple facts: first, we can keep track of most of the resources we consume and many of the wastes we generate; second, we can measure these resource and waste flows in terms of their corresponding biologically productive area.

Thus, the Ecological Footprint of any defined population, from a single individual to a whole city or country, is expressed as the area of biologically productive land and water required to produce the resources consumed and to assimilate the wastes generated by that population using prevailing technology.

Since people use resources from all over the world and pollute far away places with their wastes, Ecological Footprints sum up the size of these ecological areas wherever they may be located on the planet.

THE SEA AND LAND-USE TYPES OF THE ECOLOGICAL FOOTPRINT

The common unit used to compare areas with different biological productivity is called a global acre, a measure equivalent to one acre with world-average productivity. (One acre is approximately the size of an American football field without the end zones.)

Our accounts include six mutually exclusive uses of the planet's bioproductive surface, uses which compete for biologically productive space. These uses correspond to our planet's major ecosystems:

- **Agroecosystems** cultivate crops for food, animal feed, fiber, oil crops, and rubber
- **Grasslands and pasture** raise animals for meat, hides, wool, and milk
- **Forests** provide timber, wood fiber, and fuel wood;
- **Forest sinks** also sequester carbon dioxide (CO_2) emitted from the burning of fossil fuels
- **Coastal and marine systems** nurture fish and other marine products
- **Urban land** accommodates infrastructure for housing; transportation; industrial production; and for capturing solar, wind, and hydro energy

THE AMERICAN ECOLOGICAL FOOTPRINT

HOW MUCH DO WE USE?

The 1997 Ecological Footprint Accounts show that the average American required approximately 30.8 global acres to provide for his or her consumption, or over four times the 7.1 global acre world average.

These 30.8 global acres correspond to about 30 football fields without their end zones. How big is your Ecological Footprint? Visit the Redefining Progress Web site to find out: (www.RedefiningProgress.org/ecologicalfootprint/).

In comparison, the average Canadian lived on an Ecological Footprint that was one-third smaller (21.5 global acres), while the average German lived on an Ecological Footprint that was half the size (14.9 global acres).

While the Ecological Footprint is a comprehensive assessment of major land and sea uses, it is only a partial assessment of all environmental pressures. Important environmental pressures such as ozone depletion, toxic waste, and greenhouse gases apart from CO_2 are not included in the accounts.

These accounts document that humanity has already exceeded the Earth's biological capacity by over a third. Many nations run even more significant ecological deficits. The United States' ecological deficit is over 50 percent.

How Much Do We Have?

Dividing all of the biologically productive land and sea area of the United States by its 1997 population (over 270 million) results in a biocapacity of 13.6 global acres per person. Due to the United States' abundant natural resources, vast land area, and highly productive agriculture, this per capita capacity is over twice the 5.3 global acres available per capita worldwide.

Nevertheless, these 13.6 global acres fall far short of the 30.8 acres needed to sustain the average United States citizen. This "ecological deficit" is realized through only two possibilities: imported ecological capacity and the depletion of domestic resources.

The first source of ecological deficit occurs when countries borrow capacity from abroad. Imports can be a legitimate means to meet domestic demand, with one caveat: *Not all countries can be net importers of biological capacity*. As population and consumption rise, moreover, the demand for imported capacity likewise increases, heightening the potential for conflict over scarce resources.

The second source of ecological deficit occurs when resource use and waste generation exceed the domestic capacity to accommodate such use and waste in a sustainable fashion. The result is a nation eating into its resource stock or accumulating waste in the environment. A nation can remove, for example, fish populations faster than they are able to regrow, cut forests faster than they are able to regenerate, or emit CO_2 more rapidly than the oceans and land are able to contain it. Eventually, however, a nation will pay for such unsustainable use of the environment.

There is also an additional complication. If we use 100 percent of the biological capacity available in our forests, oceans, pastures, and farmland, it is to the detriment of the other 10 million species sharing this planet. How much of the biologically productive area should we leave relatively untouched for these species? How much would be fair? How much would you feel is necessary to secure an ecologically stable world?

The Brundtland Report: *Our Common Future* (1987) invited the world community to protect a scientifically conservative but politically provocative 12 percent of all biologically productive space, which must be distributed strategically around the planet.

A summary of the United States's ecological footprint is included below.

SUMMARY OF THE UNITED STATES ECOLOGICAL FOOTPRINT

Ecological Footprint Component	**Global Acres per capita**
absorbing CO_2 from fossil fuel	18.8
built-up area	2.4
growing crops	3.8
grazing animals	2.6
producing wood	3.1
harvesting fish and other sea food	0.2
ECOLOGICAL FOOTPRINT TOTAL	**30.8**

Biocapacity Component	**Global Acres per capita**
land set aside for CO_2 absorption	0.0
built-up area	2.4
crop land	5.6
grazing land	2.8
managed forests	2.4
fishing grounds (in oceans)	0.2
frontier ecosystem	0.3
BIOCAPACITY TOTAL	**13.6**
ECOLOGICAL DEFICIT	***17.2***

(numbers may not add due to rounding)

WHY WOULD A NATIONAL GOVERNMENT WANT TO USE ECOLOGICAL FOOTPRINT ACCOUNTING?

Recognizing ecological limits and their implications for social equity is not just an abstract moral concern, but has practical implications for governments. Recognizing ecological constraints and being able to analyze in detail

TABLE 1

ECOLOGICAL FOOTPRINTS, BIOCAPACITY, AND ECOLOGICAL REMAINDER (DEFICIT) OF NATIONS

Country	Population (in 1997)	Ecological Footprint per Citizen (global acres/cap)	Biocapacity per Citizen Within Country (global acres/cap)	Ecological Remainder (Deficit) (global acres/cap)
WORLD	5,848,739,000	7.1	5.3	(-1.8)
Australia	18,246,000	22.1	23.2	1.2
Austria	8,161,000	14.6	10.0	(-4.7)
Bangladesh	122,013,000	1.5	0.7	(-0.8)
Belgium & Luxembourg	10,605,000	16.3	4.9	(-11.4)
Brazil	163,132,000	5.6	27.0	21.4
Canada	29,943,000	21.5	27.1	5.6
Chile	14,625,000	8.9	4.9	(-4.1)
China	1,243,738,000	4.4	2.1	(-2.3)
Colombia	37,068,000	4.9	14.3	9.4
Costa Rica	3,575,000	10.5	4.9	(-5.5)
Czech Republic	10,237,000	15.5	6.9	(-8.6)
Denmark	5,248,000	25.5	13.9	(-11.7)
Egypt	64,465,000	4.5	1.7	(-2.8)
Ethiopia	60,148,000	1.9	1.5	(-0.4)
Finland	5,142,000	20.3	23.7	3.4
France	58,542,000	17.9	10.1	(-7.8)
Germany	82,190,000	14.9	6.0	(-8.9)
Greece	10,522,000	15.5	5.4	(-10.1)
Hong Kong	6,249,000	16.3	0.0	(-16.3)
Hungary	9,990,000	13.0	8.5	(-4.5)
Iceland	274,000	13.5	19.1	5.5
India	960,178,000	1.8	1.8	0.0
Indonesia	203,480,000	3.4	7.5	4.1
Ireland	3,559,000	23.2	16.4	(-6.8)
Israel	5,781,000	12.2	1.5	(-10.7)
Italy	57,241,000	13.8	4.6	(-9.3)
Japan	125,638,000	13.8	2.0	(-11.9)
Jordan	4,520,000	5.8	0.5	(-5.3)
Korea Republic	45,717,000	12.1	1.9	(-10.3)
Malaysia	21,018,000	8.5	9.2	0.7
Mexico	94,281,000	7.6	3.9	(-3.7)
Netherlands	15,661,000	15.5	5.4	(-10.0)
New Zealand	3,641,000	25.5	39.9	14.4
Nigeria	118,369,000	2.8	1.8	(-1.0)
Norway	4,364,000	22.6	14.6	(-8.1)
Pakistan	143,831,000	2.6	1.7	(-1.0)
Peru	24,367,000	2.9	22.1	19.2
Philippines	70,724,000	3.5	2.0	(-1.5)
Poland	38,635,000	12.3	5.6	(-6.8)
Portugal	9,802,000	12.5	5.2	(-7.3)
Russia	147,708,000	12.8	11.0	(-1.9)
Singapore	3,439,000	42.8	0.0	(-42.8)
South Africa	43,336,000	9.4	2.8	(-6.6)
Spain	39,717,000	13.5	5.6	(-7.9)
Sweden	8,844,000	20.2	19.5	(-0.7)
Switzerland	7,276,000	16.1	5.2	(-10.9)
Thailand	59,159,000	6.4	3.1	(-3.3)
Turkey	62,774,000	6.9	3.5	(-3.3)
United Kingdom	58,426,000	15.6	4.3	(-11.3)
United States of America	271,648,000	30.8	13.6	(-17.2)
Venezuela	22,777,000	6.2	13.8	7.6
Other Countries	1,173,044,000	6.3	5.8	(-0.5)

the various aspects of ecological flows, as made possible with Ecological Footprint Accounts, provides a number of benefits. Detailed national Ecological Footprint Accounts allow policy analysts to:

- **Build their country's competitiveness** by monitoring ecological deficits, since these deficits are becoming an increasing liability[2]
- **Catch up** with the business world that is preparing for sustainability in order to decrease future vulnerability (see, for example, BP or Ford)
- **Manage common assets** more effectively by providing a way to systematically assess their contribution to society, thereby allowing analysts to value these assets higher than their current implicit zero value
- **Have access to a warning device** for economic and military long-term security, recognizing emerging scarcities and overall global trends
- **Recognize (decreasing) options** by analyzing the compound effect of a number of ecological pressures such as climate change, fisheries collapse, agriculture, forestry, and urban sprawl
- **Identify local and global possibilities** for climate change mitigation and the competition between domestic sinks, joint implementation, and domestic CO_2 reduction
- **Test policy options** for future viability and possible unintended consequences

Without international and national resource accounts, countries will remain uninformed about such opportunities and threats.

EXISTING FOOTPRINT APPLICATIONS

By providing clear ways to assess potential tradeoffs, the Ecological Footprint becomes a measuring stick for assessing ecological sustainability's bottom line. Understanding this is a precondition for living satisfying lives.

The tool has provided the stimulus and foundation for many courses and thesis projects at universities all over the world.[3] More importantly, it has informed discussions and debates from the global level to the local scale by national governments, United Nations meetings, research institutes, and municipal green planning initiatives,[4] to name just a few examples.[5]

Global and national studies have compared countries' overall consumption to their ecological capacities or analyzed the ecological capacity incarnate in trade.[6] Municipal footprints have been computed and sustainability strategies evaluated with the Ecological Footprint tool.[7] At the household scale, the individual impacts have been assessed with a variety of calculators, including software programs explicitly designed for adoption in school curricula.[8] The ecological demands of specific products or the cumulative effects of consumer items have also been compared using the Ecological Footprint method.[9]

CONCLUSION

Ecological Footprint Accounts can help policy planners assess a population's ecological impact and compare this impact to nature's capacity to regenerate. In other words, Ecological Footprints contrast human load with nature's carrying capacity.

These analyses give us a benchmark for today's ecological performance; identify the challenges for lightening people's ecological load; and allow individuals, public sector managers, and private sector leaders to document gains as a country, region, city, or company moves toward sustainability. In this way, the Ecological Footprint becomes a tool for weighing the merits of potential policies and developing effective strategies and scenarios for a sustainable future.

For more background information, applications and links to other projects, visit the Redefining Progress Web site (www.RedefiningProgress.org), which contains descriptions and resources of Ecological Footprint projects.

FOR ADDITIONAL READING

Mathis Wackernagel and William E. Rees, 1996. *Our Ecological Footprint: Reducing Human Impact on the Earth.* New Society Publishers, Gabriola Island, BC. (www.newsociety.com/oef.html).

Nicky Chambers, Craig Simmons, and Mathis Wackernagel, 2000. *Sharing Nature's Interest: Ecological Footprints as an Indicator for Sustainability*, Earthscan, London (www.ecologicalfootprint.com).

Andreas Sturm, Mathis Wackernagel, and Kaspar Müller, 2000, *The Winners and Losers in Global Competition: Why Eco-efficiency Reinforces Competitiveness: A Study of 44 Nations*, Rüegger, Chur/Zürich, 2000 (www.rueggerverlag.ch).

World-Wide Fund for Nature International (WWF), UNEP World Conservation Monitoring Centre, Redefining Progress, Center for Sustainability Studies, 2000, *Living Planet Report 2000*, WWF, Gland, Switzerland. (www.RedefiningProgress.org/programs/sustainability/ef/lpr2000/).

Calculation files: Download summary file "EF-1993-1997 (acres).xls" or "EF-1993-1997 (hectares).xls." To receive the 6.5 megabyte workbook file with all the country calculations, contact Redefining Progress Research Associate Chad Monfreda at monfreda@rprogress.org

GLOSSARY

ACRE: is 4,840 square yards. One hectare contains 2.47 acres, or 10,000 square meters.

AVAILABLE BIOLOGICAL CAPACITY: the amount of biologically productive space that is available for human use.

BIODIVERSITY RESPONSIBILITY: the amount of biologically productive space a nation would need to set aside in order to allow the world to protect a particular percentage of the biosphere for other species. For example, if humanity decided to set aside 12 percent of the planet's surface for biodiversity preservation, as suggested by the Brundtland Report, each nation would need to become responsible for protecting biological capacity corresponding to approximately 12 percent of their national footprint. Various methods are used to allocate a country's responsibility to preserve biodiversity. One method increases the Ecological Footprint by the percent designated to biodiversity. Another reduces the potential "biological capacity" available for human use. Each method results in a slightly different estimation of amount of biological space available to a particular population. See also "ecological deficit" and "ecological remainder."

BIOLOGICAL CAPACITY: the total biological production capacity per year of a biologically productive space, for example inside a country. It can be expressed in "global acres", i.e. the equivalent area of space with world-average productivity. See also "biologically productive space."

BIOLOGICALLY PRODUCTIVE SPACE: the land and water area that is biologically productive. It is land or water with significant photosynthetic activity and biomass accumulation. Marginal areas with patchy vegetation and nonproductive areas are not included. The total biologically productive space adds up to 31.1 billion acres and hosts over 95 percent of the planet's terrestrial biomass production.

ECOLOGICAL DEFICIT: the amount by which the Ecological Footprint of a population (e.g. a country or region) exceeds the biological capacity of the space available to that population. The national ecological deficit measures the amount by which the country's footprint (plus the country's share of biodiversity responsibility) exceeds the ecological capacity of that nation.

ECOLOGICAL FOOTPRINT: a measure of how much productive land and water an individual, a city, a country, or humanity requires, using prevailing technology, to produce all the resources it consumes and to absorb all the waste it generates. This land could be anywhere in the world. The Ecological Footprint is measured in "global acres."

ECOLOGICAL REMAINDER: remaining ecological capacity, or the opposite of an ecological deficit. Countries with footprints smaller than their locally available ecological capacity are endowed with an ecological remainder—the difference between capacity and footprint. Today in many cases, this remainder is occupied by the footprints of other countries (through export production). See also "ecological deficit."

EMBODIED ENERGY: the energy used during its entire life cycle for manufacturing, transporting, using, and disposing.

EQUIVALENCE FACTOR: a factor which translates the specific land use (such as world-average cropland) into a generic biologically productive area (global average space) by adjusting for biomass productivity (see also "yield factor").

GLOBAL ACRE: one acre of biologically productive space with world-average productivity. In 1997 the biosphere had 31.1 billion acres of biologically productive space corresponding to roughly one quarter of the planet's surface. These 31.1 billion acres of biologically productive space include 7.9 billion acres of ocean and 23.2 billion acres of land. The land space is composed of 3.2 billion acres of cropland, 11.4 billion acres of grazing land, 8.2 billion acres of forest land, and 0.5 billion acres of built-up land.

NATURAL CAPITAL: the stock of natural assets that yield goods and services on a continuous basis. Main functions include resource production (such as fish, timber, or cereals), waste assimilation (such as CO_2 absorption and sewage decomposition) and life support services (UV protection, biodiversity, water cleansing, and climate stability).

OVERSHOOT: the situation when human demand exceeds nature's supply at the local, national, or global scale. According to William Catton, it is "growth beyond an area's carrying capacity, leading to crash."

PHOTOSYNTHESIS: the biological process in chlorophyll-containing cells that convert sunlight, CO_2, water, and nutrients into plant matter (biomass). All food chains which support animal life—including our own—are based on this plant matter.

PRODUCTIVITY ADJUSTED AREA: the biologically productive space expressed in world average productivity. It is calculated by multiplying the physically existing space by the yield and equivalence factors. These areas are expressed in global acres.

PRODUCTIVITY: a measurement of biological production per acre per year. A typical indicator of biological productivity is the annual biomass accumulation of an ecosystem.

WASTE FACTOR: the ratio between the quantity of prime resource compared to the quantify of output. For example in the timber calculations, it represents the ratio of cubic meter of roundwood used per cubic meter (or ton) of product.

YIELD FACTOR: a factor which describes the extent to which a local land-use category (e.g. cropland) is more productive than the world average in that same category (see also "equivalence factor").

ENDNOTES

[1] Mathis Wackernagel and William E. Rees, 1996. *Our Ecological Footprint: Reducing Human Impact on the Earth.* New Society Publishers, Gabriola Island, BC. For details on the book, see www.newsociety.com/oef.html. Translations exist in Italian (Milan: Edizioni Ambiente 1996), German (Basel: Birkhäuser 1997), French (Montréal: Les Éditions Écosocieté 1999), Spanish (Santiago:LOM 2001), Latvian, Hungarian, and Mandarin (in preparation). Also consult: Nicky Chambers, Craig Simmons and Mathis Wackernagel, 2000. *Sharing Nature's Interest: Ecological Footprints as an Indicator for Sustainability*, Earthscan, London (see www.ecologicalfootprint.com). For more details on the Ecological Footprint method and its applications, visit Redefining Progress at www.RedefiningProgress.org or www.ecologicalfootprint.org as well as the Anáhuac University of Xalapa's Centre for Sustainability Studies in Mexico (web site under construction).

[2] Sturm, Andreas, M. Wackernagel and Kaspar Müller, *The Winners and Losers in Global Competition: Why Eco-efficiency Reinforces Competitiveness: A Study of 44 Nations*, Rüegger, Chur/Zürich, 2000.

[3] In at least the following countries, we have had direct contact with academics using the Ecological Footprint concept in their teaching or their research projects: Argentina, Australia, Austria, Canada, Chile, China, Columbia, Costa Rica, Denmark, Ecuador, England, Finland, Germany, Guernsey, Greece, Hong Kong, Ireland, Italy, Japan, Lithuania, Mexico, the Netherlands, New Zealand, Philippines, Portugal, Scotland, Singapore, Spain, Sweden, Switzerland, Taiwan, Turkey, Uruguay, and the United States. Many academic papers analyzing the Ecological Footprint concept or applying it to the researchers' own region have been published. Robert Costanza has hosted a special forum on Ecological Footprints in *Ecological Economics* (Vol.32, No.3, March 2000). Also, many high school curriculums are incorporating Ecological Footprints. The Ecological Footprint has become a part of the official school curriculum in the Province of Ontario, Canada.

[4] Outside the United States, these municipal green plan initiatives are known under the name of 'Local Agenda 21.' These local agendas represent the municipal responses to the 'Agenda 21' unveiled at the 1992 Earth Summit of Rio de Janeiro.

[5] Many Agenda 21 initiatives have used Ecological Footprints in their communications of the sustainability challenges. For example, the municipality of The Hague in the Netherlands has developed an engaging pamphlet on Ecological Footprints. Governments have also begun to refer to the Ecological Footprint in their documents. For instance, this year the Japanese government released a white-paper that talks about Ecological Footprints. Or the Dutch Environmental Minister Jan Pronk (who has mentioned Ecological Footprints in many of his speeches) has asked his advisory committee to identify the policy implications of Ecological Footprints for Holland. It also has stimulated the discussion with other initiatives to promote sustainability such as the Natural Step. See John Holmberg, Ulrika Lundqvist, Karl-Henrik Robèrt and M. Wackernagel, 1999. "The Ecological Footprint from a Systems Perspective of Sustainability," *The International Journal of Sustainable Development and World Ecology*, Vol. 6 p. 17-33.

[6] For example, Detlef van Vuuren, E.M.W. Smeets and H.A.M. de Kruijf, 1999, The Ecological Footprint of Benin, Bhutan, Costa Rica and the Netherlands, RIVM report 807005004. Bilthoven, the Netherlands: National Institute of Public Health and the Environment (RIVM); Mathis Wackernagel, Lillemor Lewan and Carina Hansson, "Evaluating the Use of Natural Capital with the Ecological Footprint: Applications in Sweden and Subregions," *Ambio*, Vol 28 No. 7, pp 604-612.

[7] Mathis Wackernagel, 1998. "The Ecological Footprint of Santiago de Chile," *Local Environment* Vol.3 No.1 (Feb); Gavin Davidson and Christina Robb, 1994. The Ecological Footprint of the Lions Gate Bridge. School of Resource Management, Simon Fraser University, Burnaby, British Columbia.

[8] Mathis Wackernagel and Dick Richardson, 1998, "How to Calculate a Household's Ecological Footprint," Anáhuac University of Xalapa and University of Texas; Diana Deumling, Ritik Dholakia, and Mathis Wackernagel, 1999. Calculate Your Ecological Footprint: 13 Simple Questions Will Assess Your Use of Nature, Excel spreadsheet available from Redefining Progress through <deumling@rprogress.org>; Best Foot Forward from Oxford has developed various footprint-based assessment software tools, including *Eco-Cal* and *Eco-Cal for Schools* (see www.bestfootforward.com).

[9] Yoshihiko Wada, 1993. *The Appropriated Carrying Capacity of Tomato Production: The Ecological Footprint of Hydroponic Greenhouse versus Mechanized Open Field Operations*. M.A. Thesis. School of Community and Regional Planning, University of British Columbia, Vancouver. Nils Kautsky, H. Berg, Carl Folke, J. Larsson, and Max Troell, 1997. Ecological Footprint for assessment of resource use and development limitations in shrimp and tilapia aquaculture. *Aquaculture Research.* 28 (10). Oct., 1997. 753-766. See also Best Foot Forward's example of footprinting Danish beverage systems.

REDEFINING PROGRESS is a nonprofit organization that develops policies and tools that reorient the economy to value people and nature first.

Redefining Progress does this by developing policies and tools to internalize the economy's hidden social and environmental costs (the **Accurate Prices Program**), to transform the human use and distribution of the Earth's natural resources (the **Sustainability Program**), and to restore the value of shared social and natural assets (the **Common Assets Program**).

These three goals come together in Redefining Progress's advocacy of fair and low-cost policies to reverse climate change (the **Climate Change Program**).

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