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THE SUSTAINABILITY PRINCIPLE

The idea that Earth has unlimited capacity to provide for human desires and absorb human wastes was undermined when the first pictures of the planet from outer space were published. The US Ambassador to the United Nations, Adlai Stevenson, stated in 1965:

> We travel together, passengers on a little spaceship, dependent on its vulnerable reserves of air and soil; all committed for our safety to its security and peace; preserved from annihilation only by the care, the work and, I will say, the love we give our fragile craft. (quoted in Hardin 1977)

In 1966 Kenneth E Boulding (1966), a professor of economics, used the same analogy in his classic essay, 'The Economics of the Coming Spaceship Earth'. In it he described the actual economies of industrialised countries as 'cowboy' economies, 'the cowboy being symbolic of the illimitable plains and also associated with reckless, exploitative, romantic, and violent behavior, which is characteristic of open societies'. He wrote of the need for a 'spaceman' economy which recognised the planet has limited supplies and a limited capacity to extract wastes. In this economy people would have to find their place 'in a cyclical ecological system which is capable of continuous reproduction of material form'.

While a cowboy economy maximises production and consumption as desirable goals, and success is attained by continually increasing the throughput of materials and energy, a spaceman economy tries to minimise throughput in a closed economy. In such an economy the aim would be to:

- limit extraction and pollution
- decrease consumption

- continuously reproduce the material form
- increase stock maintenance – goods would be built to last as long as possible.

Economic success in a spaceman economy would be measured by the 'nature, extent, quality, and complexity of the total capital stock, including in this the state of human bodies and minds'.

LIMITS TO GROWTH

Early warnings

In the late 1960s and early 1970s many scholars and thinkers observed that continual economic growth was causing environmental decline, and argued that it could not be sustained forever. One of the most famous studies done at this time was commissioned by the Club of Rome, which was formed in 1968 by scientists, educators, economists, humanists, industrialists and civil servants under the leadership of Italian businessman Aurelio Peccei. The study was undertaken by a team of scientists at the Massachusetts Institute of Technology (MIT) in the USA and published as a book called *The Limits to Growth* (Meadows et al. 1972). The study used a computer model of the world economy to show that the existing exponential growth rates of population and economic activity could not continue indefinitely on a planet that had only limited natural resources and limited ability to deal with pollution. It found that:

> If the present growth trends in world population, industrialization, pollution, food production, and resource depletion continue unchanged, the limits to growth on this planet will be reached sometime within the next one hundred years. The most probable result will be a rather sudden and uncontrollable decline in both population and industrial capacity. (Meadows et al. 1972: 23–4)

Although this has often been characterised as a doomsday scenario, the study was optimistic in its assertion that it 'is possible to alter these growth trends and to establish a condition of ecological and economic stability that is sustainable far into the future'.

The Limits to Growth 'made headlines around the world and began a debate about the limits of the Earth's capacity to support human economic expansion' (Atkisson & Davis 2001: 165). It was translated into 29 languages, and 9 million copies were sold. While the idea of limits to growth appealed to the layperson's common sense, it 'seriously perturbed Western intellectuals' and angered economists, conservatives and politicians alike, who viewed any criticism of economic growth as a direct attack on capitalism. Socialists, who were also attached to economic growth as essential for progress, disliked it as well (Ekins 1992: 270; Norgaard 2001: 167; Suter 1999).

In the same year as *The Limits to Growth* was published, the magazine *The Ecologist* (Editors 1972) devoted an entire issue to arguing that economic growth could not continue into the future without disaster. Their argument was supported by 33 eminent academics. The issue was also published as a book – *A Blueprint for Survival* – which stated:

> The principal defect of the industrial way of life with its ethos of expansion is that it is not sustainable … By now it should be clear that the main problems of the environment do not arise from temporary and accidental malfunctions of existing economic and social systems. On the contrary, they are the warning signs of a profound incompatibility between deeply rooted beliefs in continuous growth and the dawning recognition of the earth as a space ship, limited in its resources and vulnerable to thoughtless mishandling.

In 1973 economist Herman Daly (1973) published a book of papers entitled *Towards a Steady-State Economy.* Daly, like Boulding, argued for an economy in which the numbers of people and goods were stable and the throughputs of materials and energy were restrained.

Backlash

These publications and others unleashed a wave of controversy. There was a major counter-attack on the whole idea of limits to growth. Economists and others argued that technological change and the invisible hand of the market meant that there were no limits or, if there were limits to particular resources, humans could outsmart them by finding alternatives.

One well-known response to the limits to growth thesis was *The Doomsday Syndrome* by John Maddox, the editor of *Nature*, a leading science journal. Maddox (1972: 21–2) argued that there was no forthcoming crisis, that environmental and associated problems could be and were being fixed through legislation and through scientific and technological innovation:

> Tiny though the earth may appear from the moon, it is in reality an enormous object. The atmosphere of the earth alone weighs more than 5,000 million million tons, more than a million tons of air for each human being now alive … It is not entirely out of the question that human intervention could at some stage bring changes, but for the time being the vast scale on which the earth is built should be a great comfort.

Another well-known refutation came from economist Julian Simon, professor of business administration and senior fellow at the libertarian think tank, the Cato Institute. Simon (1981) wrote a book entitled *The Ultimate Resource*, in which he argued that human resourcefulness would ensure that resources would never run out because, if a particular resource became scarce, either new sources would be discovered, people would learn to do more with less, or substitutes would be found.

A team of scientists at Sussex University re-ran the model used in *The Limits to Growth* but with the assumption that instead of there being absolute limits on food and resources, resources could be increased exponentially through discovery of new resources, recycling and pollution controls. Not surprisingly, they did not come up with the pessimistic results of the original model (cited in Ekins 1992: 270).

One analyst noted that neither outcome was certain, and that what separated the resource optimists from the resource pessimists was that

> [the] optimist believes in the power of human inventiveness to solve whatever problems are thrown in its way, as apparently it has done in the past. The pessimist questions the success of those past technological solutions and fears that future problems may be more intractable. (Lecomber quoted in Ekins 1992: 270)

The pessimist also believes there are certain physical constraints that mean that resources cannot continue to grow exponentially, no matter how much recycling is achieved or how clever technology becomes (Ekins 1992: 272).

Complete recycling, in fact, is not possible, since some materials are always lost through wear and tear, and corrosion and energy are required to make the transformation from waste product to new product. Moreover, according to limits-to-growth advocate Ted Trainer (1985), even if the pollution generated by manufacturing could be cut by 30 per cent, this gain to the environment would be soon lost if more manufacturing was undertaken as the result of economic growth. If the manufacturing sector grew at 3 per cent per year, it would only take 13 years before there was just as much pollution as before the cuts, and 23 years for there to be twice as much.

The merits of economic growth

The debate was not only over the question of whether human ingenuity, the market and technological change could overcome the physical limits of the planet but also over the merits of economic growth. Herman Kahn (1989: 178–9), and the US Hudson Institute, argued that while economic growth might not be able to continue indefinitely, there was too much to gain from economic growth to attempt to reduce it in the shorter term:

> In our view, the application of a modicum of intelligence and good management in dealing with current problems can enable economic growth to continue for a considerable period of time, to the benefit, rather than to the detriment, of mankind. We argue that without such growth the disparities among nations so regretted today would probably never be overcome, that 'no growth' would consign the poor to indefinite poverty and increase the present tensions between the 'haves' and the 'have-nots'.

Economic growth was put forward as the solution to problems such as poverty: the poor would be better off as the economy grew. Without such an argument politicians would have little answer to demands for more equitable redistribution of wealth (Norgaard 2001: 167). But economic growth does not necessarily eliminate poverty. The economic growth that has occurred worldwide over the last three decades has not decreased the poverty within developing nations; and the richest nations in the world still accommodate some of the poorest people. Much poverty results from distributional problems rather than from a nation's lack of wealth. This was already evident in 1973 when the president of the World Bank, Robert McNamara, said that although the world had just experienced ten years of unprecedented economic growth, 'the poorest segments of the population have received relatively little benefit … the upper 40 per cent of the population typically receive 75 per cent of all income' (Sachs 1992a: 6)

The need for growth in high-income countries was even more controversial. US economists Paul Barkley and David Seckler (1972: 18) wrote that:

> the more developed nations of the world have now reached a state where all reasonable and rational demands for economic goods have been or can be satisfied. As a result, the virtues of added economic growth may be an illusion because growth does not come free. In fact, the costs of added growth are climbing quite rapidly as the pressures against certain resources, and on the environment as a whole, increase. The developed countries may have reached a level at which the costs of additional growth in terms of labor and loss of environmental quality exceed the benefits …

Similarly, economist EJ Mishan (1967) argued that the costs of economic growth outweighed the benefits:

> The uglification of once handsome cities the world over continues unabated. Noise levels and gas levels are still rising and, despite the erection of concrete freeways over city centres, unending processions of motorised traffic lurch through its main thoroughfares. Areas of outstanding beauty are still being sacrificed to the tourist trade and traditional communities to the exigencies of 'development'.

> Pollution of air, soil and oceans spreads over the globe … The upward movement in the indicators of social disintegration – divorce, suicide, delinquency, petty theft, drug taking, sexual deviance, crime and violence – has never faltered over the last two decades. (quoted in Ekins 1992: 273)

The limits to growth debate did cause more conservative economists 'to incorporate natural resources and pollution' into their growth models. Such models had completely ignored the ecological basis of production before this time. However, the technological optimism of the 1980s came to dominate economic thinking, and faith in the ability of markets and technological change to overcome natural limits was reaffirmed in economic circles (England 2000: 425–6).

In 1980 the administration of US President Carter published a report entitled *Global 2000* which predicted that 'if policy everywhere continued unchanged, the world in 2000 would be more crowded, more polluted, less stable ecologically and more vulnerable to disruption than the world in 1980'. As one of the report's authors noted at the end of 2000, 'this conclusion has, unfortunately, met the test of time' (Barney 2000).

Initially, however, the trend seemed to be more hopeful. The oil crisis of 1973 provided a large incentive for companies, governments and individuals to use energy more efficiently, and between 1973 and 1985 the intensity of energy use declined in most developed nations while economic growth continued. This was taken as proof that economic growth and resource use were not linked (Ekins 1992: 275).

The limits-to-growth argument was readily dismissed during the 1980s, even by many environmentalists. This was partly due to the exaggerated pessimism of some of the early writers, who had prophesied imminent disaster that did not occur (at least in the short term); partly due to their focus on the depletion of resources such as oil and minerals rather than environmental degradation; and partly due to the success of well-financed think tanks in refuting their arguments. The debates over whether there were limits to growth were no longer found in the mainstream discourse of the 1980s.

SUSTAINABILITY IN THE 1980s

Sustainable development

In the 1980s the idea that continuous economic growth could not be ecologically sustainable was replaced by the notion of 'sustainable development', which argued that ways could be found to sustain economic growth without creating too much pollution or environmental degradation. The gloom and doom scenario was replaced with one of optimistic faith.

The environmentalists of the 1970s had used the term 'sustainability' to refer to systems in equilibrium: they argued that exponential growth was not sustainable, in the sense that it could not be continued forever because the planet and its resources were finite. In contrast, sustainable development sought ways to make economic growth sustainable, mainly through technological change. In 1982, the British government began using the term 'sustainability' to refer to sustainable economic expansion rather than sustainable use of natural resources.

Many of the ideas associated with sustainable development were articulated in the 1980 World Conservation Strategy (cited in the Introduction), which argued that while development aimed to achieve human goals through the use of the biosphere, conservation aimed to achieve those same goals by ensuring that use of the biosphere could continue indefinitely. National conservation strategies based on this World Conservation Strategy were adopted in 50 countries. The Australian National Conservation Strategy, like many others, argued that development and conservation were different expressions of the one process and that economic growth could be achieved through a more appropriate use of resources. It called for sustainable modes of development, a new international economic order, a new environmental ethic and population stabilisation (DHAE 1984) – but the World Conservation Strategy and its national equivalents had little impact on the wider public or on national policies.

In the mid-1980s, however, the World Commission on Environment and Development (WCED 1990) rejuvenated the concept of sustainable development in its report *Our Common Future* (also referred to as the Brundtland Report, after the commission's chair, Gro Harlem Brundtland, who was prime minister of Norway at the time). In October 1987, the goal of sustainable development was largely accepted by the governments of one hundred nations and approved in the UN General Assembly.

The Commission defined sustainable development as 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs'.

Promoting economic growth

In the foreword to the report Bruntland said, 'What is needed now is a new era of economic growth – growth that is forceful and at the same time socially and environmentally sustainable' (WCED 1990: xvi). This call for economic growth was made in the name of the developing countries, but the notion that affluent nations might reduce their own growth to make room for the growth of poorer nations was not entertained. Jim MacNeill (1989: 106), secretary-general to the Brundtland Commission, argued that:

> the most urgent imperative of the next few decades is further rapid growth. A fivefold to tenfold increase in economic activity would be required over the next 50 years in order to meet the needs and aspirations of a burgeoning world population, as well as to begin to reduce mass poverty. If such poverty is not reduced significantly and soon, there really is no way to stop the accelerating decline in the planet's stocks of basic capital: its forests, soils, species, fisheries, waters and atmosphere.

Although the Brundtland definition of sustainable development is the one that is most often quoted, there are many other definitions of sustainable development, and while it has been argued that interest groups define sustainable development to suit their own goals, they are nearly all premised on the assumed compatibility of economic growth and environmental protection.

Sustainable development aims to achieve economic growth by increasing productivity without increasing natural resource use too much. The key to this is technological change. The Australian Commission for the Future (Commission for the Future 1990: 27) argued:

> Rather than growth or no-growth, as the debate about environment and development has sometimes been cast, the central issue is what *kind* of growth. The challenge of sustainable development is to find new products, processes, and technologies which are environmentally friendly while they deliver the things we want.

Instead of being the villains as they were in the 1970s, technology and industry were now seen to provide the solutions to environmental problems. The International Chamber of Commerce (ICC 1990) launched a Business Charter for Sustainable Development that stated:

> Economic growth provides the conditions in which protection of the environment can be achieved, and environmental protection, in balance with other human goals, is necessary to achieve growth that is sustainable.
>
> In turn, versatile, dynamic, responsive and profitable businesses are required as the driving force for sustainable economic development and for providing managerial, technical and financial resources to contribute to the resolution of environmental challenges …

> Business thus shares the view that there should be a common goal, not a conflict, between economic development and environmental protection, both now and for future generations.

The conflict between economic growth and environmental protection was thus being denied, even when energy use per unit of GDP began to increase again in the late 1980s. The concept of sustainable development enabled a new breed of professional environmentalists to partner with economists, politicians, business people and others to achieve common goals rather than confronting each other over whether economic growth should be encouraged or discouraged. By avoiding the debate over limits to growth, sustainable development provided a compromise that on the face of it suited everyone.

More radical environmentalists continued to resist this win-win mentality, Wolfgang Sachs (1992b: 21), for example, arguing that by 'translating an indictment of growth into a problem of conserving resources, the conflict between growth and environment has been defused and turned into a managerial exercise' that forces development planners to consider nature.

CARRYING CAPACITY

While the concept of a limit to economic and population growth is seldom found in recent economic or political texts, it is still alive in ecology and environmental science where, rather than being discussed in terms of limits to growth, ecological sustainability is discussed in terms of carrying capacity and ecological footprints.

The idea of carrying capacity comes from animal husbandry and ecology. It refers to:

> the maximum number of a species that can be supported indefinitely by a particular habitat, allowing for seasonal and random changes, without degradation of the environment and without diminishing carrying capacity in the future. (Hardin 1977)

Resources can be renewable, conditionally renewable, fixed or non-renewable. Resources such as water, timber and food can be *renewable* if not overused. Resources such as fish and soil are *conditionally renewable*, that is, these resources are currently being overused in some cases and therefore are close to not being renewable. Resources such as land are *fixed* in quantity and once used for one purpose, often cannot be used for another. Then there are *non-renewable* resources such as fossil fuels and minerals (ECOTEC–UK 2001: 2–3).

Global human carrying capacity is generally calculated by choosing one of the limiting resources – land, energy, biota – and estimating how much there is of it in the world and how many people that it will support.

Garrett Hardin (1977) promoted the use of the concept for human populations, noting that 'carrying capacity is a time-bound, posterity-oriented concept'. He pointed out that when animals exceed the carrying capacity of their habitat the environment is rapidly degraded and the animals 'become skinny and feeble; they succumb easily to diseases. The normal instincts of the species become ineffectual as starving animals struggle with one another for individual survival'.

Hardin (1986) later argued that although carrying capacity could not be accurately determined and there were inevitably differences of opinion about it, the concept should nevertheless be taken seriously because exceeding carrying capacity results in 'serious and, more often than not, irreversible' consequences, that is, irreversible 'on the time scale of human history':

> Because transgression is so serious a matter, the conservative approach is to stay well below the best estimate of carrying capacity. Such a policy may well be viewed by profit-motivated people as a waste of resources, but this complaint has no more legitimacy than complaints against an engineer's conservative estimate of the carrying capacity of a bridge. Even if our concern is mere profit, in the long run the greatest economic gain comes from taking safety factors and carrying capacities seriously.

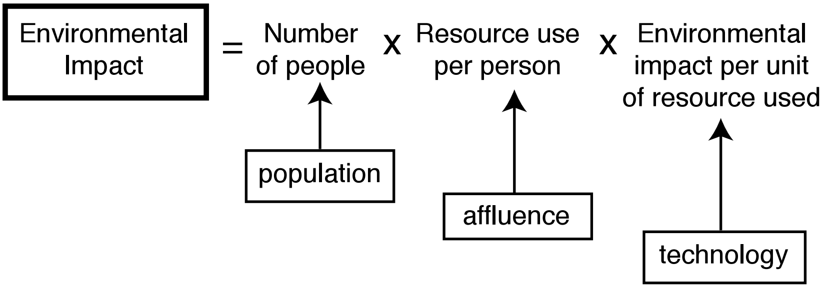
Cultural carrying capacity

For people, carrying capacity goes beyond merely populations and the resources necessary to feed them.

Humans require quality foods beyond subsistence, clothing that is more than just functional, comfortable housing, transportation, heating, and other items that constitute a reasonable standard of living. Hardin (1986) referred to this as 'cultural carrying capacity'. While many more people could be supported by the Earth if they subsisted on a minimum of food and not extras, this would be neither desirable, nor a socially stable situation (Richard 2002).

The impact of humans on the environment, as noted by Paul Ehrlich and John Holdren (1971: 1212–7), is a combination of population, resource use per person (affluence) and environmental damage per unit of resource used (technology) (see figure 1.1 on the next page).

Figure 1.1 The factors determining environmental impact



Because humans are consuming more resources per person each year, the 'world is being required to accommodate not just more people, but effectively "larger" people …' (Catton quoted in Rees 1996). The planet not only has to provide a life-support system for its human population but also has to support our industrial metabolism, which in turn requires natural resources as inputs and produces outputs that must go back into the environment. William Rees (1996) cites rising daily energy consumption as an example: in 1790 the average American used 11 000 kcal of energy compared with 210 000 kcal used by the average person in 1980, some 20 times more. Rees defines human carrying capacity as:

> the maximum rates of resource harvesting and waste generation (the maximum load) that can be sustained indefinitely without progressively impairing the productivity and functional integrity of relevant ecosystems wherever the latter may be located. The size of the corresponding population would be a function of technological sophistication and mean *per capita* material standards.

Technological solutions

The resources required to produce a reasonable standard of living have varied throughout human history. Economists still argue that technological change and international trade will ensure that there are always enough resources to meet cultural or human carrying capacity. They argue that humanity can in fact increase carrying capacity through technological innovation, for example, by increasing the food that can be obtained from a given area of land through the use of synthetic fertilisers. If a resource runs out, people will find another way of meeting their needs. In other words, 'necessity is the mother of invention'.

Technology can change the amount and type of resources that are required to produce a reasonable standard of living.

But the technologies that extend carrying capacity often come at a price. For example, the agri-chemicals used to increase crop yields have significant environmental impacts. Our ability to continue to increase the carrying capacity of the planet may therefore be limited – and there seems to be evidence that such limits are already being reached (see below). Modern advocates of the concept of carrying capacity still argue against economic growth:

> Our dominant culture continues to celebrate expansion in spite of its heavy toll on people and nature. In fact, we desperately try to ignore that much of today's income stems from liquidating our social and natural assets. We fool ourselves into believing that we can disregard ecological limits indefinitely. (Chambers et al. 2000: 47)

Rees (1996) argues that when technology makes resource use more efficient, it may encourage greater use rather than result in less use. For example, as energy use became more efficient, more energy, not less, was used because we used it for more things. Technological changes that enhance productivity often result in increased exploitation of natural resources. For example, modern fishing technologies enable catches to be increased and depletion of fish stocks to be accelerated (see chapter 14).

Biological diversity

One of the consequences of exceeding human carrying capacity is the loss of biological diversity. Biological diversity (or biodiversity) refers to the variety of ecosystems and species of plants and animals that is found in nature. There are three levels at which biodiversity is important: the gene, the species and the ecosystem. Jeffrey McNeely and his colleagues (1990: 17) describe these levels:

> Genetic diversity is the sum total of genetic information, contained in the genes of individual plants, animals and microorganisms that inhabit the earth. Species diversity refers to the variety of living organisms on earth and has been variously estimated to be between 5 and 50 million or more, though only about 1.4 million have actually been described. Ecosystem diversity relates to the variety of habitats, biotic communities, and ecological processes in the biosphere, as well as the tremendous diversity within ecosystems in terms of habitat differences and variety of ecological processes.

When people talk about preserving biodiversity they generally mean that a full and diverse range of plant and animal species should be maintained. It has been argued that current human activities are causing the mass extinction of species at a rate never before experienced. Several species become extinct each day, while scientists estimate that the extinction rate in pre-human times was just a few species per thousand years. In the past, technologies were relatively harmless, and population patterns and cultural customs and taboos prevented overexploitation, so species were less likely to be under threat.

The rate of extinction of native mammal species in Australia today is particularly high compared with other countries. As in other countries, extinction has been caused by the removal of forests and bushland for agriculture, forestry and urban development; competition from introduced and cultivated plants and animals; and pollution of and changes to waterways. The state of species worldwide is shown in table 1.1.

Table 1.1 Numbers of extinct and threatened species in 2004

	Species extinct	Total number described	Species threatened	Percentage of species threatened
Birds	133	9917	1213	12
Plants	110	187 655	8321	3
Mammals	77	5416	1101	20
Insects	60	15000	559	0.06
Amphibians	35	5743	1856	32
Reptiles	22	8163	304	4
Crustaceans	8	40 000	429	1
Fish		28 500	800	3

Source (Baillie et al. 2004: 7; Worldwatch Institute 2005)

Environmentalists argue that the destruction and modification of habitats that results from economic activity is threatening the ability of life forms to evolve and therefore to survive through adaptation. They differentiate between *conservation*, which means maintaining the ability of species to evolve, and *preservation*, which provides only for the maintenance of individuals or groups of species, not for their evolutionary change. Preservation considers the setting aside of representative samples of biodiversity to be all that is required (Harris 1991: 8).

ECOLOGICAL FOOTPRINT

The ecological footprint, a different way of expressing carrying capacity, was developed by Mathis Wackernagel and William Rees in the early 1990s. Instead of working out how many people a particular area can take, the idea is to work out how much land and water is necessary to support a particular human population – a nation, a city, a company, a product, or even an individual – given their current levels of technology and consumption. This water and land – divided into categories such as arable, pasture, built or degraded – is not necessarily all in one place but may be spread all over the globe (Chambers et al. 2000: 60–3).

> The Ecological Footprint is a tool for measuring and analyzing human natural resource consumption and waste output within the context of nature's renewable and regenerative capacity (or biocapacity). It represents a quantitative assessment of the biologically productive area (the amount of nature) required to produce the resources (food, energy, and materials) and to absorb the wastes of an individual, city, region, or country. (Venetoulis et al. 2004: 7)

Such analyses highlight the way that human populations, particularly cities, are dependent on environments well beyond their political boundaries. It also shows that the area of land and water outside their boundaries necessary to support them – the appropriated carrying capacity – is getting larger and larger. To be sustainable the ecological footprint must remain within the Earth's limits. If those limits are exceeded – a situation called 'overshoot' – then resources are used faster than they can be renewed, the environment becomes degraded and the ability of Earth to sustain life and economic activity is further reduced (Rees 1996; Venetoulis et al. 2004: 7).

In 2000 a joint analysis of national ecological footprints by WWF International and Redefining Progress found that although the footprint per person had been falling over the previous 20 years because of increased efficiencies in resource use, the total footprint had been increasing (Venetoulis et al. 2004: 7–8). More recent studies show that humanity's ecological footprint had exceeded the planet's ecological limits by the 1980s and is continuing to rise. As a result there is evidence of major environmental degradation in every part of the world and land-use conflicts – for example, between agriculture, mining, urbanisation and forests – are increasing as land becomes more scarce (Chambers et al. 2000: 38–9).

Box 1.1 Glossary of ecological footprint terms

Appropriated Carrying Capacity: The biophysical resource flows and waste assimilation capacity appropriated per unit time from global totals by a defined economy or population.

Ecological Footprint: The corresponding area of productive land and aquatic ecosystems required to produce the resources used, and to assimilate the wastes produced, by a defined population at a specified material standard of living, wherever on Earth that land may be located.

Fair Earthshare: the amount of ecologically productive land 'available' per capita on Earth, currently about 2.2 hectares (2000). A fair seashare (ecologically productive ocean – coastal shelves, upwellings and estuaries – divided by total population) is just over .5 ha.

Ecological Deficit: The level of resource consumption and waste discharge by a defined economy or population in excess of locally/regionally sustainable natural production and assimilative capacity (also, in spatial terms, the difference between that economy/population's ecological footprint and the geographic area it actually occupies).

Sustainability Gap: A measure of the decrease in consumption (or the increase in material and economic efficiency) required to eliminate the ecological deficit. (Can be applied on a regional or global scale.)

Source (Rees 1996)

Partial measure

Footprint analysis is generally a conservative estimate, that is, it tends to understimate the amount of land and water required to support human populations. It does not take account of toxic pollutants; in fact, the only pollutant it generally considers is carbon dioxide. Nor does it take account of species extinctions although it sometimes includes an allowance for natural habitats. It does not take account of the scarcity of different types of land. It cannot deal with details such as whether land in a region is farmed sustainably or unsustainably, or of where in the world the impact of overshoot is felt. It includes the use of non-renewable resources only by taking account of the land and energy associated with mining, processing and consumption, but does not consider their exhaustibility. It does not address social issues such as income distribution, education or unemployment. It 'intentionally says nothing about people's quality of life' and it does not analyse who is responsible for a community's increasing footprint (Chambers et al. 2000: 31; ECOTEC – UK 2001: 17, 27; Lenzen & Murray 2001: 230; Venetoulis et al. 2004: 8; Wackernagel et al. 2002: 9268).

Ecological footprint analysis is merely a rough measure of how much land is required for particular populations, based on current management and production practices and levels of consumption, to:

- grow crops for food, animal feed, fibre, oil, and rubber;
- graze animals for meat, hides, wool and milk;
- harvest timber for wood, fibre and fuel;
- fish for food;
- accommodate infrastructure for housing, transportation, industrial production and hydro-electric power;
- absorb carbon dioxide from burning fossil fuels (Wackernagel et al. 2002: 9267).

Analysis at the national level 'uses UN data on agricultural production, forest production, area of built land and trade' and trade data to take account of what is imported and exported (ECOTEC – UK 2001: 17–8). Analysts Mathis Wackernagel and his colleagues (2002: 9266) admit:

> We recognize that reducing the complexity of humanity's impact on nature to appropriated biomass offers only a partial assessment of global sustainability. It is a necessary, but not sufficient, requirement that human demand does not exceed the globe's biological capacity as measured by our accounts.

Advocates also recognise that the measure 'provides a utilitarian view of nature – nature as a big bucket filled with resources – and measures who gets what' (Chambers et al. 2000: 31–2). In addition, ecological footprint analysis is based on current actual use of technology rather than potential use of technology. Its advocates state:

> While some technologies exist to reduce human impact, most technology has been used to gain access to limited resources at a faster rate and with more ease. In other words, while we have the technological capacity for a sustainable world, we seem to choose technologies that increase our overall footprint and increase human overshoot. (Chambers et al. 2000: 115)

The estimates of footprints for particular nations, done by different experts, vary quite considerably, although not by whole orders of magnitude. Nevertheless the simplicity of the concept enables people to easily understand it, and analysts are generally open about their assumptions and omissions. It is based on publicly available government information. As such it provides an alternative measure of human progress to economic measures such as GDP, and emphasises the principle of ecological sustainability (ECOTEC–UK 2001: 30; Wackernagel et al. 2002: 9267).

The concept of ecological footprint has been criticised for reducing the value of land, and therefore ecosystems, down to productive capacity alone, and ignoring other environmental values such as diversity and beauty. It has also been criticised for implying that environmental protection is an individual responsibility; that each person is to blame for their own footprint and can reduce it by consuming less:

> This obscures the institutional and economic factors that constrain our choices, and that make it difficult to cut our own footprint down to size, even if we wish to. The problem is perpetuated in footprint analyses of nations, provinces and cities because the products of such analyses are usually interpreted in terms of the aggregated consumption behaviour of individuals. (Bocking 2004)

Rees (2002: 276) notes in response to criticisms that it would be unrealistic to expect any single measure to 'represent the total human impact on the ecosphere'. Nevertheless, ecological footprint analysis 'is comprehensive enough to show, unambiguously, that the human eco-footprint on Earth is steadily increasing'.

Fair share

Ecological footprint analysis enables the resource use of different populations to be compared and for those that are clearly unsustainable to be identified, that is, those that use more land than they own or more than their fair share of land. By considering the footprint of each nation, the disparities between nations become evident. The USA has the largest footprint per person of all nations (9.57 hectares) and various European nations and Australia are in the top ten (see table 1.2). These figures compare with the footprints of the poorest countries at 0.5 to 1 hectare per person, an average of around 2.2 hectares per person, and a sustainable footprint of 1.7 hectares per person, a figure most nations exceed (Venetoulis et al. 2004: 12; Wackernagel et al. 1997).

Table 1.2 Ecological footprint of ten heaviest nations

Country	Footprint (global hectares per capita)
USA	9.57
United Arab Emirates	8.97
Canada	8.56
Norway	8.17
New Zealand	8.13
Kuwait	8.01
Sweden	7.95
Australia	7.09
Finland	7.00
France	5.74

Source (Venetoulis et al. 2004: 12)

Although the United Kingdom does not make the top ten, London's ecological footprint, at 5.8 global hectares per person, is amongst the highest, and means that an area twice the size of Great Britain is required to support the city (*Edie News* 2005). This is the case for all large cities: 'However brilliant its economic star, every city is an entropic black hole drawing on the concentrated material resources and low-entropy production of a vast and scattered hinterland many times the size of the city itself' (Wackernagel quoted in ISEE 1994).

Through such analysis of national ecological footprints, it becomes obvious that some countries are using more than their fair share of resources. Rees (1996) concludes that since affluent nations would need to use even more of their fair share of ecological space to achieve economic growth, to do so 'is both ecologically dangerous and morally questionable. To the extent we can create room for growth, it should be allocated to the third world'.

Other measures of human impact on the environment have been developed. One index, for example, measures the proportion of the planet's net primary production devoted to human use, where net primary production is:

> [the] net amount of solar energy converted to plant organic matter through photosynthesis … Human appropriation of net primary production, apart from leaving less for other species to use, alters the composition of the atmosphere, levels of biodiversity, energy flows within food webs and the provision of important ecosystem services. (Imhoff et al. 2004: 870)

This and other indexes also show that humans, particularly those in affluent countries, are overshooting the carrying capacity of the planet.

Consequences of overshoot

The consequences of overshoot, that is, the way humans are exceeding the capacity of the environment to sustain their impact, are evident in the UN's *Millennium Ecosystem Assessment* (Reid et al. 2005), written by some 1360 scientists from 95 countries. The Assessment found that not only are humans already consuming ecosystems at an unsustainable rate and therefore degrading them, but that consumption is likely to increase by 3 to 6 times by 2050:

> First, approximately 60% (15 out of 24) of the ecosystem services examined during the Millennium Ecosystem Assessment are being degraded or used unsustainably, including fresh water, capture fisheries, air and water purification, and the regulation of regional and local climate, natural hazards, and pests …
>
> Second, there is established but incomplete evidence that changes being made in ecosystems are increasing the likelihood of nonlinear changes in ecosystems (including accelerating, abrupt, and potentially irreversible changes) that have important consequences for human well-being.

CONTINUING DEBATE

The optimism of the 1980s that ecological limits could be overcome is as easy to refute as the predictions of imminent catastrophe of the 1970s. It is becoming increasingly clear that the environment is deteriorating and that rather than depletion of resources providing the limits to growth, it is the pollution and environmental degradation resulting from ever-increasing production and consumption that is the real threat to the planet's future.

In 1996, respected economist Robert U Ayres (1996: 117) said, 'I have changed my view radically … Today I have deep misgivings about economic growth per se.' His reasoning was as follows:

> [E]vidence is growing that economic growth (such as it is) in the western world today is benefiting only the richest people alive now, at the expense of nearly everybody else, especially the poor and the powerless in this and future generations. To those who follow us we

> are bequeathing a more and more potent technology and significant investment in productive machinery and equipment and infrastructure. But these benefits may not compensate for a depleted natural resource base, a gravely damaged environment and a broken social contract.

It is theoretically possible that economic growth could be achieved without additional impacts on the environment, but this would mean many activities that might otherwise provide economic growth would have to be forgone – which will not happen while priority is given to achieving economic growth. Whether they believe economic growth and environmental protection are compatible, almost everyone agrees that there will inevitably be situations in which the goals of economic growth and environmental protection are irreconcilable and choices will have to be made.

Also, as Paul Ekins (1992: 280–1) noted in his review of the shift from limits to growth to sustainable development, whether one is a technological optimist or pessimist, the technological changes that are necessary require 'adoption of ecological sustainability as the principle economic objective in place of economic growth'.

Further Reading

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