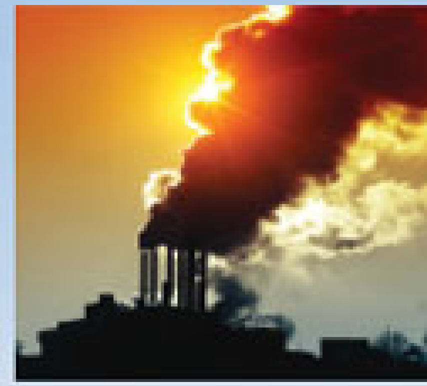


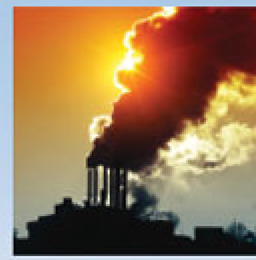


GLOBAL ENVIRONMENTAL ISSUES

SECOND EDITION

EDITOR FRANCES HARRIS

WILEY-BLACKWELL



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Part Six: Conclusion

Global Environmental Issues

Second Edition

Edited by

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For Thomas and Eleanor and their generation.

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Part One

Introduction

Chapter 1

Human–Environment Interactions

Frances Harris

1.1 Introduction

Environmental issues have been a concern for many years. Yet somehow they are problems that we have not been able to resolve, despite research, media attention, increased public awareness about environmental problems, campaigns by environmental pressure groups, and international agreements. Our environment is dynamic, constantly changing and evolving in response to stimuli. Yet in the last century it became apparent that mankind is having an increasing effect on the planet's ecosystems and biogeochemical cycles, so much so that our activities are now causing environmental change which is overriding the natural dynamism of the earth. Yet despite the evidence of environmental problems such as biodiversity loss, land cover change observable from satellite imagery, records of climate change and many examples of pollution, we still pursue activities which perpetuate the problems. As the world's population increases, and the per capita consumption of natural resources increases, we will have an even greater effect on these environmental problems, exacerbating them further.

Why are such problems so hard to resolve? There are three broad reasons: first, the science of environmental problems is complex. We are dealing with many interrelated dynamic systems, within which and between which feedback mechanisms occur. Second, there are many stakeholders involved in both the causes and the solutions to environmental problems. Organising all of these stakeholders to act in a co-ordinated manner is difficult. Third, resolving global environmental issues will require changes in our own consumption and pollution of natural resources, which will mean changes to lifestyles. This will require commitment at the personal level, which not everyone is willing to make.

Human–environment interactions involve not only the question of resource use per person, but also our ability to understand the science of the environment, our ability to regulate our impact on the environment, our beliefs in the value of the environment, our attitudes to the future, particularly risk, and our ability to negotiate solutions both at the local and the global level. This book aims to discuss environmental issues from a scientific and socio-economic viewpoint, so that they are understood not only as contested science concerning natural resources, but also as political and social issues. In this way, the reader gains a fuller understanding of the complexity of environmental issues and the challenges we are faced with in order to resolve them. ‘The science of the environment is socially and politically situated, rather than unambiguous or separable from the subjective location of human perception’ (Stott and Sullivan, 2000, p. 2).

1.2 Global demands on natural resources

Throughout the world, people earn their livelihoods through the use of whatever resources are available to them. Our livelihoods are ultimately natural resource dependent. Natural resources provide us with the land and water for agriculture (whether for subsistence needs or to serve a wider market), trees for firewood and timber, ocean and freshwater resources for fisheries, wildlife for meat, animal products, tourism, oil, gas and coal for energy, and also mineral resources (rocks, minerals, gems, coal ...). Many economies are dependent on natural resources. At the household and community level, this can be in the form of agriculture or natural resource products gathered and sold (e.g. wild foods, honey). At the national level, most countries rely on their natural resource base to meet basic needs and provide the resources for economic development, for example, through cash crops, forestry or mining. Globally we rely on natural resources for ecosystem regulation. Even where people do not rely on natural resources for their day-to-day livelihood-generating activities, the role of natural resources and ecosystem services in maintaining the environment is still crucial. The role of ecosystem services has been recognised in recent years (Millennium Ecosystem Assessment, 2005), raising the importance of the conservation of biodiversity. There is no substitute for the global climate regulation mechanism. Neither can the effects of land cover change be reversed to recreate the natural environment which existed prior to land degradation and urban sprawl. Although we can save some seeds of plants, and keep some animals in zoos, recreating ecosystems is a much greater challenge.

In 1798, Malthus predicted that human population growth would be checked by food supply. Although Malthus' prediction concerned specifically food, wider concerns that the human population's needs will outstrip the planet's resources have been of ongoing concern. Ehrlich (1968) argued that population growth rates at that time would exceed the world's resources. Furthermore, as most population growth, and also declining food production, were found to occur in developing countries, he advocated population control. However, these arguments assumed a steady 'carrying capacity' of the earth, whereas in reality, technological developments alter the ability of land to produce food, and rising standards of living alter the demands for food. Boserüp (1965) argued increasing populations can be the driving force for agricultural intensification, which increases food output per unit area of land. For example, the Green Revolution had an enormous impact on agricultural productivity, particularly that of rice and wheat. (Subsequently it was realised that the Green Revolution also created new social and environmental problems, as discussed in section 7.4.1, but its effect on the population–food debate remained.) Simon (1981) also argued that more people bring positive change, as this results in more ideas, more experimentation, and more technological innovation which can help resolve the problems of resource limitations. In contrast, Dyson (1996) maintains that food production increased and outstripped population growth in the last decades of the twentieth century and Bennett (2000) points out, 'There seems to be no evidence that our ability to produce food has been a lasting brake on population growth.' Michaelson (1981, p. 3) stated that 'Overpopulation is not a matter of too many people, but of unequal distribution of resources. The fundamental issue is not population control, but control of resources and the very circumstances of life itself.' Globally, sufficient food is produced to feed people. However, food shortages occur because of variations in land productivity, and also because of problems in food distribution, due to poverty, conflict and failing markets (Bennett, 2000). Problems of inequality and existing power struggles affect people's access to resources and people's entitlements to food and other natural resources (Sen, 1982; Leach *et al.*, 1997) on which their livelihoods depend.

The global population is currently estimated to be near 7 billion, and there is wide consensus that it will reach 9 billion by 2050 (Lutz and Samir, 2010). It is anticipated that the global population will reach a plateau within this century. However, anticipating food requirements of this population is a complex process, do to changing cultures, settlement patterns, and diets. Furthermore, these social changes need to be assessed in the light of changing environmental conditions, particularly the impact of climate change, and increasing land use competition, as well as rising prices of energy, which underpin all agricultural production. Since 1940, industry and services have been an equal or larger sector of the global economy than the primary sector, and since 1980, they have employed more people than the primary sector (Satterthwaite *et al*., 2010). In 2008, the global population shifted from being predominantly rural to predominantly urban (Satterthwaite *et al*., 2010). This has implications for the number of people producing food, as well as the number requiring food to be supplied to them. Urbanisation also corresponds with increased affluence and disposable income, as well as a more sedentary workplace, which affects both dietary choices and public health. For those who are on extremely low incomes, their vulnerability to food price rises is exacerbated by their move away from subsistence agriculture (Liverman, 2008). The challenges of providing food for a growing and changing population are discussed in Chapter 7.

The impact of population on the environment is determined by the size of the population, its affluence (and hence consumption per capita) and the type of technologies used. These arguments are summarised in the equation (Ehrlich and Ehrlich, 1990; see also section 10.3.3):

$$\text{Impact} = \text{Population} \times \text{Affluence} \times \text{Technology}$$

Therefore an extremely large but poor population using low impact technology could have the same impact as smaller but more affluent population using highly polluting technology. The impact depends not only on the size of the population, but also on whether the technology used is highly polluting or ‘green’ (i.e. reliant on renewable energy or non-polluting). It should also be remembered that in some cases, ‘green’ technology requires affluence, and hence is not necessarily associated with the developing world.

The rising global population will affect the environment in several ways. The sheer numbers of people may seem daunting when the need to provide food, water, a healthy environment and to cope with pollution and waste are taken into consideration. Estimates suggest that just under 15 per cent of the population do not have access to sufficient food, and an equal amount are over-fed (Godfray *et al*., 2010), therefore the distribution of food among the population is also a concern.

The demand for food is partly affected by absolute population numbers, but also by the diet of the global population. Rising affluence of emerging economies is resulting in increasing numbers adopting a more complex diet based on meat and dairy products. This nutrition transition (Kearney, 2010) will result in increased demands on food systems. Average grain production per capita in 1997/98 was 356 kg grain. A grain-based diet requires 180 kg grain per capita per year, whereas a meat-based diet required 930 (Millstone and Lang, 2003). Thus the implications of moving from a predominantly vegetarian and grain-based diet to the meat and dairy-based diet of a more affluent society is clear: more primary production is required. Meat-based diets required higher levels of grain as grain is needed to feed livestock. There are also implications for the amount of water required, as well as for the amount of energy. In addition, livestock production produces greenhouse gases, particularly methane, which contribute to climate change. In addition to requiring more food, the nutrition transition also results in a greater diet-related disease burden: non-contagious health problems such as coronary heart disease, diabetes, and obesity. Dealing with these health issues places an additional burden on countries, one that some predict could be crippling for emerging economies such as India (Caballero and Popkin, 2002).

Agricultural production also faces additional challenges such as the impact of climate change. Increased CO_2 levels have been linked to the concept of 'carbon fertilisation', an increased input of carbon in the system which may increase photosynthesis. However, not all crop plants are predicted to respond well to this. Furthermore, rising temperatures may increase pests and diseases, as well as increase water stress, which could limit plant growth. It is also anticipated that there may be an increase in extreme weather events, including storms and droughts, whereas agriculture requires a more regular supply of rain. Storm events result in excess water, causing erosion, floods, and increased run-off, and are therefore not beneficial to crop plants. On a larger scale, increased temperatures will affect glaciers, changing the hydrology of major catchments and rivers. Sea-level rise will impact on coastal agriculture (Godfray *et al.*, 2010). With so much uncertainty, it is hard to quantify exact effects and thus predict what will happen (Gornall *et al.*, 2010).

In addition to climate change, there are concerns about world energy supplies. The agricultural industry is heavily reliant on energy, for machinery, for agro-chemicals, for transportation and distribution of inputs and products, and especially for the production of nitrogen fertiliser. Concerns to find more environmentally sustainable forms of energy have meant that growth of biofuels has increased worldwide. Growth of biofuel production has had an impact on agricultural productivity (through diverting land from food production) and biodiversity (through clearing land of other vegetation to make space for biofuel crops) (section 8.5.5). Increasing competition for land use among urbanisation, agriculture, biofuels and recreation has had an impact on basic ecosystem services previously either unrecognised or taken for granted. The role of ecosystems in producing less obvious, non-harvestable benefits is highlighted in the Millennium Ecosystem Assessment (MEA), and it is argued that these need to be valued more clearly to ensure the long-term benefits of biodiversity are not sacrificed to immediate needs for growth and development (MEA, 2005).

Human–environment interactions are not just about meeting the global population's food needs, or even about meeting natural resource needs. The human population also affects the environment through what it leaves behind. The impact of the human population on the environment is seen as, among other things, land use change (forest clearance, reduced wildlife, changes in agricultural landscapes as farming systems intensify), urbanisation, pollution of water, seas and landscapes. In some cases, our impact is less visible, at least immediately, such as gaseous pollution and changing atmospheric composition. Harrison (1993) argues that it is the effect of pollution which will drive a ‘third revolution’ for change in the world. The arguments concerning population–environment theories range from debates based on numbers of people and food resources, more complex arguments concerning the effect of environment and technology on carrying capacity, to social and political factors affecting access and entitlement to natural resources.

1.3 Ecological footprints

The ecological footprint of a specified population or economy can be defined as the area of ecologically

> productive land (and water) in various classes – cropland, pasture forests, etc. – that would be required on a continuous basis to (a) provide all the energy/material resources consumed, and (b) absorb all the wastes discharged by the population with prevailing technology, *wherever on Earth that land is located*.
>
> *(Wackernagel and Rees, 1996, pp. 51–52)*

As such, ecological footprints are an 'accounting tool … to estimate the resource consumption and waste assimilation requirements of a defined human population or economy in terms of a corresponding productive land area' (Wackernagel and Rees, 1996, p. 9).

The concept of ecological footprints has caught the attention of many due to the simplicity of the basic concept and the ability of the ecological footprint tool to be used in an educational manner to highlight and compare individual, community, regional, or national effects on the environment. Ecological footprints link lifestyles with environmental impact. Ecological footprints are determined by calculating the amount of land and water area required to meet the consumption (food, energy, goods) of a population in a given area, and assimilate all the wastes generated by that population (Wackernagel and Rees, 1996). Obviously such a calculation relies on the accuracy of the data provided, and of the 'conversion factors' used in determining agricultural productivity of the land providing food, and the forest area required to meet energy needs. Indeed, there are those who have made serious criticisms of the method (van den Bergh and Verbruggen 1999), some of which may be valid. However, as a comparative tool, it has its value in making individuals or societies think about the implications of their lifestyle on the environment. Calculation methods have been adjusted slightly in subsequent years. For example, electricity generated by nuclear energy is no longer included in calculations as the demands and impacts (although not negative) are hard to equate with the ecological footprint accounting systems (WWF, 2008). Furthermore, methods have been refined so that ecological footprints are now also subdivided into carbon footprints and water footprints. The following discussion focuses on national ecological footprints. Urban ecological footprints are discussed in section 9.3.2, and the role of waste in ecological footprints in section 10.3.4.

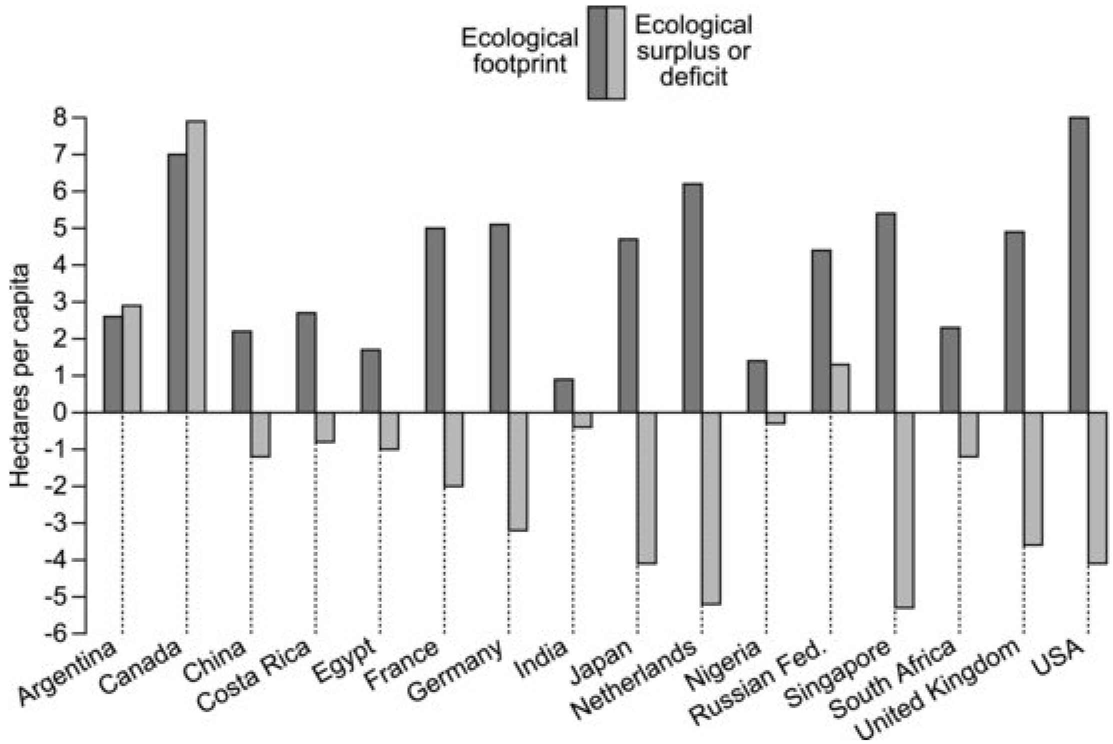
Obviously, many people are not ‘living off the land’, especially nearby land. Most people rely on some imported goods. International trade has gone on for centuries, and provides us with many of the staples we rely on. Jevons (1865) stated that:

> The plains of North America and Russia are our [British] corn-fields; Chicago and Odessa our granaries; Canada and the Baltic are our timber-forests; Australasia contains sheep-farms, and in Argentina and on the western prairies of North America are our herds of oxen; Peru sends her silver, and the gold of South Africa and Australia flows to London; the Hindus and Chinese grow tea for us, and our coffee, sugar and spice plantations are all in the Indies. Spain and France are vineyards and the Mediterranean our fruit garden, and our cotton grounds, which for long have occupied the Southern United States, are now being extended everywhere in the warm regions of the Earth.

In the intervening centuries, world trade has increased, and in addition to food imports, trade also provides many non-perishable goods and commodities. Consumption, whether through trade or from local sources, creates an ecological footprint. This is then augmented by the waste generated, some of which is generated overseas in the creation of the imported goods (e.g. sugar refineries or leather tanneries). If we create demand for a waste-generating product, then we are in some way responsible for the associated waste, even if it is not produced in our country. Furthermore, some waste, such as gaseous emissions, is dumped in the atmosphere: a global ‘no man's land’ whose degradation has implications for all of us. Dumping rubbish and waste in the world's seas and oceans is another problem. Pollution of the global commons is proving hard to regulate, and where funds are required to resolve problems of pollution in this area, there can be huge disagreement concerning who should bear responsibility and pay. If resource depletion, and the pollution and waste caused by consumption are generated at a distance, the impact on the ecological footprint (via pollution in production and transportation processes) is less visible to the consumer, but ecological footprint analysis does bring it into account. Ecological footprints are a truly global measurement of the impact of people on ecosystems.

Figure 1.1 shows the ecological footprint per capita of a sample of 16 countries. What is most apparent from Figure 1.1 is that countries with ecological footprints higher than the world's ecological footprint are in the developed world, whereas those with lower ecological footprints are more likely to be in the developing world. Although the developing countries include nations with high population densities (Nigeria, China, India, Bangladesh), the number of people does not seem to be the problem; rather it is the developed countries, where affluence is greater and technology is in greater use, which have the large footprints. It is also possible to relate a country's ecological footprint to the natural resources available to that country. An ecological deficit means that the needs of a country's population cannot be met from the resources within that country. Countries such as Australia and Brazil, with large, sparsely populated areas and large forest reserves, may have large ecological footprints, but can usually meet these from their own resources. This may be partly due to the fact that the mechanism whereby ecological footprints are calculated converts energy requirements into equivalent fuel wood (van den Bergh and Verbruggen, 1999), and so countries with large forested areas are able to compensate for high energy use, whereas countries without forests do less well in the calculation, even if they could provide energy by other renewable means such as hydroelectric power. Some 50 per cent of the world's biocapacity can be found in eight countries: the United States, Brazil, Russia, China, Canada, India, Argentina and Australia, however, three of these (India, China and the United States) are ecological debtors. More than three-quarters of the world's population live in countries which are ecological debtors (WWF, 2008). Countries such as the UK, Spain, Portugal and Egypt have ecological footprints more than 150 per cent greater than their biocapacity, and emerging economies such as India, China and Mexico have an ecological footprint 100–150 per cent greater than their biocapacity. Ecological debtors survive through mining their own resources, importing resources, or assuming the atmosphere will absorb greenhouse gases, or a mixture of all three (WWF, 2008). Of course, national statistics are the result of averages, and individual household ecological footprints could vary enormously. The ecological footprint concept is useful in helping individuals or societies to think about their contribution to global environmental issues.

Figure 1.1 The ecological footprint and ecological deficit of 16 countries, compared with the global ecological footprint. (Compiled from Global Footprint Network, 2010)



The water footprint of a nation is similar to the ecological footprint, but calculations focus only on the water required to produce food and other products for consumers. The average water footprint for a country is 1240 m^3/person/year, with a range from 700 m^3/person/year for China to 2480 m^3/person/year for the USA (Hoekstra and Chapagain, 2007). India, China, the United States, the Russian Federation, Indonesia, Nigeria, Brazil and Pakistan together make up 50 per cent of the global water footprint. Water footprints are influenced by consumption (related to affluence), climate and water use efficiency in agriculture (Hoekstra and Chapagain, 2007). Rice is the crop which requires the largest amount of water, but wheat also requires significant amounts of water. There has been much discussion of the impact of vegetables imported into Europe from water-stressed countries in Africa (e.g. East African green beans). European consumers are benefitting from their scarce water supplies, leaving local people with less water to meet their own needs. Drought-prone countries can benefit enormously from importing highly water-demanding