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ENVIRONMENTAL SCIENCE

A Baltic University Publication

DISCOVERING THE ENVIRONMENTAL DILEMMA

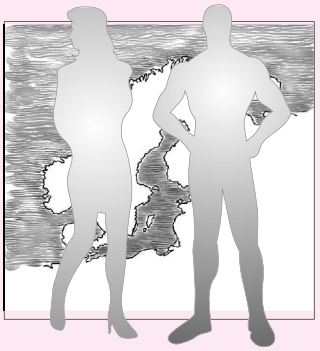
1

St Petersburg, January 2000. Large cities with polluted water and air dramatically illustrate the environmental impact of urbanization and industrialisation. (Photo: Lars Rydén.)

”The mechanistic world view which has dominated since the beginning of the scientific revolution, which looks for large scale solutions, and has economic growth, dualism, and an instrumental and exploitative view on nature as core values – this world view is no longer possible to maintain. It has to be replaced by a world view in a different key... We need new rules for how man should deal with nature.

A view … characterized by an insight that natural resources are limited and that nature has a multitude of values, already starts to emerge. Concern for the environment has in a few decades grown from almost nothing to become a key issue in today’s societies.”

Sverker Sörlin
(Sörlin, 1992)



We all live with a complex environment around us, an environment that provides us with all we need: air, water, food and land. We, just as all life forms, also influence the environment, intentionally or unintentionally. This influence has taken place as long as humans have existed, when settlements grew up, and forests and fields were turned into agricultural land. Although many changes were not negative, others were: sizeable areas were burnt, and animal species became rare or extinct in areas where they previously were abundant.

Even if the impacts have been very visible, and often obviously damaging, it was not until the 1960s that they grew to such a scale that “the environment” became an established point on political agendas. There were several reasons for this change of perspective. One was *population increase*; as the number of humans increased, the environment became a more scarce resource. Another reason was the *changed character* of the impact, especially the increased impact of chemicals. Due to the *improved economic conditions*, there was room to reflect on the environment and to be concerned about it. Further, *the role of science* contributed to a more thorough analysis of environmental change and its consequences, which influenced the general understanding and policy making.

Environmental impacts were originally mostly local, as seen around mines and factories, and also illustrated by the drainage of lakes, or the destruction of forests. In the 1960s, regional environmental impacts became obvious. We saw eutrophication of lakes, coasts and large seas including the Baltic Sea, and the acidification of large forest areas. Later, global impacts were identified. It was discovered that the Earth’s atmosphere was changed by greenhouse gases and ozone-depleting substances. Problems on both the regional and global scales triggered in the early 1970s, the first international measures to protect the environment.

In this first chapter, environmental science is introduced in three ways. First, from the perspective of natural science, the concept of the environment and the contexts in which it can be studied are defined, This includes environmental protection, sustainable development, and human ecology. Second, from a political perspective, the environment is placed in a societal context that involves political change, that is political, economic, and legal action. Third, from the perspective of historians, the environment is seen as part of how humans perceive nature, themselves and their lives both in the present and in the past. All three perspectives are equally relevant in understanding what is meant by ”the environment”, and which basic assumptions are present when we attempt to manage, protect, and restore it.

Authors of this chapter

Tage Sundström, introduction and the section on new strategy for man and the environment; Magnus Andersson, environmental policy and the part on central and eastern Europe.

DISCOVERING THE ENVIRONMENTAL DILEMMA

MAN AND THE ENVIRONMENT

ENVIRONMENTAL PROBLEMS

FACING ENVIRONMENTAL DECLINE – THE DEVELOPMENT OF ENVIRONMENTAL POLICY

ENVIRONMENTAL POLICY IN CENTRAL AND EASTERN EUROPE

A NEW STRATEGY FOR MAN AND THE ENVIRONMENT

Man and the environment

The long history of the human environment

Environmental impact by man is as old as human civilization. In biblical Mesopotamia, irrigation caused salination that turned vast areas into desert. All over the world nomads and farmers alike have caused changes in the soil, plants and animals. In ancient Greece, deforestation was widespread and in ancient Rome household waste was an everyday nuisance (Sörlin, 1997). However, the most dramatic deterioration in the global environment has taken place since the industrial revolution.

The origin of the history of the human environment is thus to be sought far back in time. Our human species, *Homo sapiens,* meaning "the wise man" – an epithet that may be questioned – originated in Africa some 150,000 years ago. Most likely humans stayed in Africa until some 70,000 years ago when they migrated north and slowly began to colonise the Eurasian continent. Over much of southern Europe there are signs of civilisation found from at least 35,000 years ago. Already at this stage there are indications that man caused serious environmental impact. Biodiversity was reduced as groups of people hunted animals to extinction, e.g. the mammoth and other very large animals which otherwise lacked natural enemies. These early events are echoed in the extinction of defenceless birds such as the flightless moa in New Zealand in the 18th century.

When the human population was still very limited, any large impact on the environment only took place locally, e.g. in areas where there was a higher density of people, such as at the mouth of the large rivers in the Middle East – the Nile, Euphratus and Tigris. At the time of the birth of Christ, there were probably about 5 million people on the planet.

A steep increase in human population began in the 1700s. This coincides with early industrialisation in England and a reorganisation of agriculture, e.g. in many countries in Northern Europe. Improvement in living conditions led to better survival rates and families began to have many children. The increasing populations in Europe could not be supported and many were forced to leave, primarily to North America. During a period in the 19th century about 30 million people left Europe, not least from the Baltic Sea region, to the USA.

Population increase, industrialisation and environmental decline

The requirements for improved food production, better jobs and improved health became primarily a task for science and technology. At the end of the 19th century the development of chemical industries, coal and oil technology, and industrial nitrogen fixation for agriculture, were all achievements that led both to enormous improvements in the living conditions of people, and to the beginning of an environmental crisis that appeared much later.

Clusters of people in cities and at industrial sites were then enough to have considerable impact on the local environment. England was one of the first countries to experience the drawbacks. For example, sewage from cities was recognised as a problem in mid-19th century London, where a cholera epidemic was traced back to polluted drinking water. The accumulation of waste, in so called pits, and wastewater created terrible stenches throughout English cities. Waste management and wastewater treatment began at this time with the instalment of sewage pipelines, with the development of water closets (flush toilets), and finally much later, wastewater treatment plants.

Figure 1.1. Svante Odén. In 1967, the Swedish scientist Svante Odén placed acidification on the political agenda through a key article in the major Swedish newspaper *Dagens Nyheter*. He had been able to relate acidity of rain to sulphur containing emissions from combustion of fossil fuels, especially coal in continental Europe and England. Using measurements of precipitation from the Hydrometeorological Institute over a 10 year period he could corroborate the results to convince his readers and get political support. It took another 20 years to reach an international agreement to reduce acid emissions. (Photo: Ellis Cowling, 1976.)

Figure 1.2. The American biologist Rachel Carson became a leader in the early environmental movement through her book "Silent Spring" published in 1962. Her book describes the devastating effects of indiscriminate use of pesticides at a lake in California. As the mosquitoes disappeared so did the birds. Although she was criticised by colleagues for being emotional, all of the pesticides she mentioned are forbidden today. (Photo: Pressens bild.)

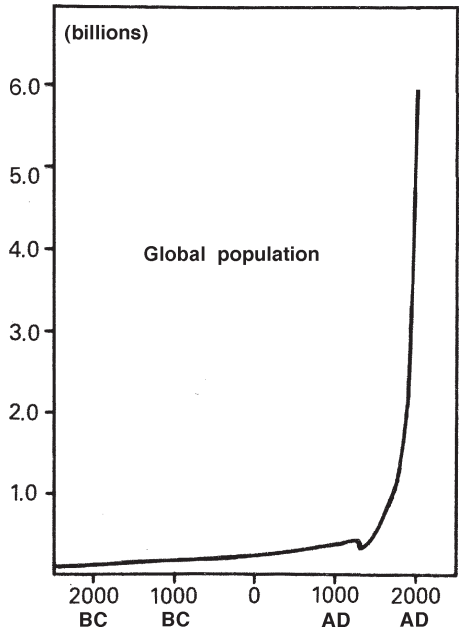


Figure 1.3. Human population of the Earth over time. Population explosion is one the major factors behind the dramatically increased environmental impacts. At the start of the 21st century, the human population just passed six billion. In the Baltic Sea Region, population increase has stopped, but in the world as a whole it is predicted to continue at least to 12 billion by the end of next century. It is still an open question if the planet will be able to support such a population. (Source: United Nations.)

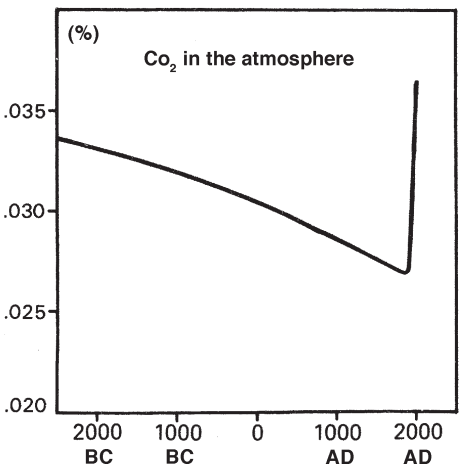


Figure 1.4. Carbon dioxide in the atmoshere over time. Detailed measurements on carbon dioxide levels in the atmosphere exist since the 1950s, and earlier values can be deduced from fossils. The increased level of carbon dioxide is mainly attributed to human activity, especially the burning of fossil fuels. The curve illustrates in one glance the impact of man on the environment. (Source: Bohlin, 1984 updated.)

During this time air pollution also became problematic. The heating of homes with coal-fired furnaces in London caused terrible smoke which, during bad weather, stayed trapped in the streets. In the early 1950s the London smog problem was finally improved after coal furnaces were outlawed.

After the Second World War the situation changed dramatically. Western society became affluent as resource consumption increased three to fourfold over the time span of one generation, from the early 1950s to the oil price shock in 1973. This was also the time when large-scale effects on the environment were first perceived as a problem. The history of the human environment entered a dramatically new phase. As the impact became more and more alarming and large-scale, the environmental interest grew and environmental issues entered the political arena.

Discovering the environmental dilemma

Deep concern about the environment arose fairly recently, only during the last three or four decades A hundred years ago, in the early 1900s, the first associations for the conservation of nature were formed in several countries in Europe. The first national parks were created. Nearly 50 years later, from the 1950s, many naturalists became worried about the effects of chemicals on nature and on humans. The background included the discovery of effects of biocides, first on bird fauna and occurring later on many other levels in the ecosystem, e.g. on the grey seals in the Baltic Sea. Scientists were pioneers. The Danish chemist Sören Jensen, working in Stockholm, discovered in 1962, after fascinating detective work, that a common industrial chemical, PCB, was the substance that killed birds of prey. At the same time, the Swedish researcher Svante Odén proved beyond doubt that acid rain, turning thousands of lakes into lifeless "wet deserts," was caused by industrial emissions of sulphuric oxides. The environment became a political issue and the environmental movement was born. At the same time in the United States, the publication of the book "Silent Spring" by oceanographer Rachel Carson, put environmental issues on the political agenda.

In many cases, the state of the environment in the Baltic Sea region, as in other densely populated areas of the world, is still alarming, in spite of all the actions taken over the last 40 years. News of polluted air, contaminated water, deteriorated soil, and depleted land have become common. The environmental debate includes serious concern about reports on the depletion of the ozone layer, global climate change, acidification, eutrophication, forest damage, declining water tables, desertification, and the loss of biodiversity. For many people, all these issues are well known. They provide both food for thought and arguments for action and work among scientists, business and state officials, politicians, and people in general. However, society itself needs to change. Human habits need to change on many levels, both on the individual and collective levels, in order to develop a society which can exist in harmony with the environment.

Case
Box 1.1

The story of Easter Island

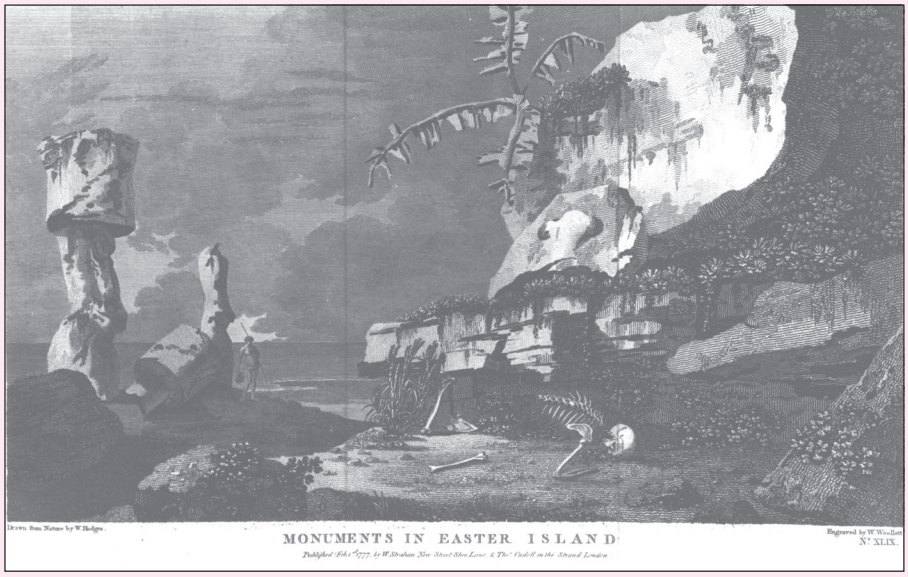


Figure 1.5. Easter Island. This is an engraving by William Woolett (after Willian Hodges) from James Cook's classical 1777 account of his expedition to the South Pole, where he describes his 1774 visit to Easter Island. On islands, the road towards disaster can be very short. But there are also islands where such a possibility was foreseen and instead foresighted naturalists took early and clear steps towards nature conservation. For example, the Seyshelles Islands that have 15% of its land area protected. The Galapagos Islands are another well known example. (Courtesy of Uppsala University Library.)

In the year 1722, the Dutch admiral Roggeveen and his men arrived at an island in the South Pacific. It was on Easter Day, so the island was called Easter Island. It was then about 1,200 years since the first Polynesians had arrived there from islands further west in the Pacific.

What the Dutch saw were a few thousand people who lived in a miserable state. They lived in caves and fought constant wars among themselves. When Captain James Cook anchored off Easter Island 50 years later, in 1774, the number of inhabitants had diminished even further and at the end of the nineteenth century lawless landowners from the South American mainland took away the few remaining inhabitants. Only just over a hundred elderly people and small children were left.

What all visitors to Easter Island were surprised to see were the gigantic stone sculptures, 600 of them, almost seven meters high on average. How could these wretched creatures have produced such marvels?

There were probably not more than 20 or 30 original Polynesians on Easter Island. The original ecosystem on the island was uncomplicated, with about 30 types of plants, a couple kinds of lizard, plus some fish in the surrounding sea. Humans brought a species of hen, the Polynesian rat, and the sweet potato which was grown for food. The human population grew and by the middle of the sixteenth century about 7,000 people lived on the island.

As the population grew, clans formed on different parts of the island. The clans competed. Growing sweet potatoes did not require much time and effort. Instead they spent their energy on arts and ceremonies, recitation and mnemotechnics, that is, training the memory. They had a cult of birds.

Most of all, they worshipped their ancestors and clan leaders at special cult sites, known under the name of ahu. Here the sculptures were raised, normally showing the stylized upper part of a man's body. It was a matter of making as many and as big and beautiful statues as possible.

The problem, however, was to transport the sculptures from the quarry to the cult site. They weighed tens of tonnes each. Animals were not available to help. Instead, they cut down trees and pulled, pushed and dragged the sculptures on them. Such wooden roads were built all across the island.

The ceremonial competition finally made the inhabitants give up making their houses of wood, because every tree was needed for the roads. Instead, they moved into caves, or built stone shelters or huts of straw. There were no trees for canoes and therefore no fishing from boats. Without trees, the soil eroded and harvests shrunk, and with no sweet potatoes the hens were in such demand that they were often stolen. Therefore, the inhabitants started building special chicken houses of stone for them.

The society could no longer sustain itself and the population decreased by 50% in a hundred years. How sudden and total the catastrophe was is evident from the several hundred sculptures that are still lying around on the ground near the Ranu Raraku quarry in different stages of completion.

The people of Easter Island did not leave any written documentation. The information available is from travelogues, objects, and their own oral mythologies and stories as they have been passed down. Most of all, our knowledge comes from a reading of nature's archives: e.g. pollen layers and biological fossils. The history of society and culture on Easter Island can only be understood as an environmental history. This is an important history as it helps us to understand that self-destructive behaviour is not unique to our own time and our part of the world.

Easter Island is an island and islands are limited. On islands the environmental situation becomes very clear. Islands are limited in size and also limited in the kind of resources they provide. They are like small models of our planet which, of course, is also limited although we do not notice it as easily.

Sverker Sörlin

Environmental problems

Global impacts

Following is a short overview of the most precarious environmental impacts facing us today. These exist on three levels: global, regional, and local. Each of the issues mentioned here are treated more in depth in later chapters.

Global environmental impacts are the most overwhelming, threatening, and difficult to address. They threaten the Earth as a whole, including humans. Two of these threats are addressed here: destruction of the stratospheric ozone layer and the enhanced greenhouse effect.

The stratospheric ozone layer (at an altitude of about 100 km and above) protects the Earth from ultraviolet radiation. In the 1970s and 1980s, it was discovered that this layer is being continually depleted. Much research is now taking place on the consequences of a thinner ozone layer and intensified UV radiation for flora and fauna, the global land masses, and the oceans.

One of the great dangers is a reduced efficiency of the photosynthetic processes – the fundamental primary production – which would substantially damage all living creatures on Earth. A small reduction of the plankton growth in the oceans might seem like a marginal factor, but researchers who began to investigate the possible outcomes of such changes have become extremely concerned. As well, the danger to human skin has already been observed through an increased rate of skin cancer, especially in the southern hemisphere.

Countermeasures involve a systematic reduction of some special chlorinated chemical substances, primarily the chlorofluorocarbons or CFCs (including the freons) used, for example, as coolants in refrigerators. CFCs react with and destroy ozone. According to the Montreal Protocol, signed in 1985, and developed further since then, a programme has been established for phasing out freons from the world market. Beginning from the year 2000, all refrigerating devices must function well without these substances.

The enhanced greenhouse effect, leading to an increased global average temperature, has been investigated by the United Nation's Intergovernmental Panel on Climate Change (IPCC). There is now a scientific consensus that several greenhouse gases produced by human activity, especially carbon dioxide, methane,

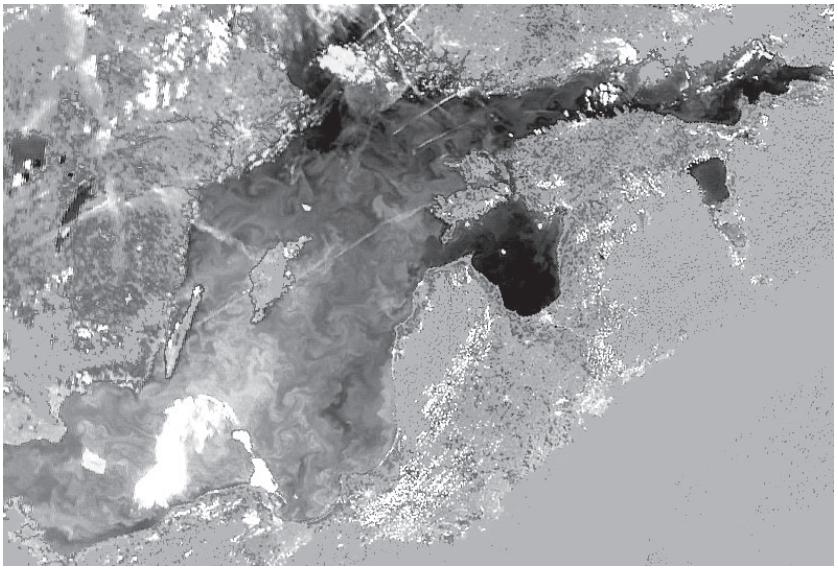


Figure 1.6. Eutrophication is one of the most obvious of the several regional and global environmental impacts, as it gives rise to very visible and annoying algal blooms, coastlines overgrown with vegetation, and dead bottoms. In this satellite image from the Baltic Sea, in July 2001, a large belt of blooming algae is seen south of Gotland. The summer of 2001 was unusually warm and there were algal blooms of record intensity in many places. (Photo: NASA. Courtesy of NASA's Earth Observatory.)

Review
Box 1.2

The changing character of environmental problems

Sources
Classical sources of pollution were *point sources*, such as air and water pollution from an industrial plant, release of toxic substances as a result of an industrial catastrophe, and leakage of toxic substances from a waste dump. Later it was realised that many environmental impacts were less concentrated. They originated from *diffuse sources*. These include run-off of nutrients from agricultural land, use of chemicals in the households, and air pollution from cars. Point sources could be taken care of by a defined and limited action, such as improving the technology in a specific industrial plant. Diffuse sources are much more difficult to deal with. They may require, e.g., substantial changes in agricultural policy, and only slow improvements may be possible.

Scale
Recently, many sources of pollution, had only a *local impact*. The area effected was around the source of pollution, e.g., a mine, a factory or a city. Later it was observed that pollution could hit a whole *region*, even spread over several countries. This is the case for acid rain and eutrophication. Today the most threatening environmental problems are *global*. Such problems are climate change and destruction of the UV-protecting stratospheric ozone layer, which affect the entire atmosphere of the Earth. The larger scale problems are the most difficult to deal with and require international co-operation.

Duration
The environmental impact from a source may in many cases be *short-term* if the source is temporary. This has been the case for air pollution from household heating in bigger cities or pollution of a local river from a small town. Many environmental problems today are on the contrary *long-term*, and do not disappear immediately even if the source is temporary. Persistent organic pollutants (POPs), heavy metals, or radioactive pollutants can effect the environment for a very long time after their release, simply because they are long lived. This is also the case for, e.g., eutrophication of the Baltic Sea which will require many decades to decrease, even if the addition of excess nutrients was stopped immediately and completely. The system responds slowly because of the slow rate of water exchange.

Complexity
Since the advent of industrial society, many environmental problems have become exceedingly complex. A factory may use hundreds of chemicals in its processes and all or many may persistently stay in the environment. Also, consumer products may have multiple effects on the environment. Many chemicals also interact with each other. Organic debris, e.g. from a paper mill or city sewage, bind aromatic substances as well as heavy metals, which are released when the organic matter is broken down. Forestry and agriculture may also have combined effects. For example, ground water depletion, space intrusion, and pollution with biocides have multiple effects on wildlife and biodiversity. In general, the more complex the environmental impact, the more difficult it is to understand and to remedy.

and the CFCs, significantly contribute to the ongoing increase in the global average temperature. At the conference in Kyoto, Japan in 1997 an agreement was reached on a systematic reduction of the carbon dioxide emissions from all 140 participating countries. For the European Union countries, the decision was taken that CO_2 emissions should be reduced by 8% from the 1990 level before the years 2008-2012; the corresponding percentage for the USA was 7%, for Japan 6%, and so on. The Association of Small Island States in the Pacific, which are immediately threatened by a rising sea level, one consequence of increased global temperature, had favoured a reduction of 20%. It can be concluded that results of this magnitude cannot be reached by technical means alone, but will also require changes in human habits. As follow-up to the 1997 Kyoto conference, the parties (negotiating countries) to the United Nations Framework Convention on Climate Change (UNFCCC) met in the Hague in the year 2000 to discuss ways to implement measures to mitigate climate change. To the great disappointment of many, no consensus was reached. The Kyoto protocol was however signed in Marrakech in 2001, although without the USA.

Regional impacts
The ozone depleting substances and greenhouse gases distribute themselves over the entire Earth and therefore have a global environmental impact. Other man-made substances have a more regional distribution. These include chemicals that cause eutrophication and acidification.

Many bodies of fresh water and large stretches of coastal waters on the Earth receive enormous amounts of plant nutrients. This leads to eutrophication.

Outlook
Box 1.3

Global concerns

Our environment not only receives our waste, it also has to produce our food, clothing, and shelter. On the global level, the most problematic environmental concerns deal as much with production as pollution. Today, productivity of the global ecosystems is decreasing at the same time as human population and per capita demands are increasing. In addition, non-renewable resources are being depleted, especially fossil fuels. As well, there is the concern of food production and distribution for the population of the world. Climate change and ozone depletion have already been mentioned.

Population explosion

The large number of people living on Earth, now more than six billion, is in itself an environmental problem since each individual needs to be fed and also pollutes to some degree. The explosive population increase, today mostly in Asia and Africa, is diminishing. During the last 20 years, the global average number of children per woman decreased from 6 to 3.2. Still, it is estimated that the world population may double to 12 billion, or even more, before the increase stagnates. It should be added that in the poor countries, where the increase is immense, the pollution per capita is much less than in the industrial countries.

Resource depletion - the seas

The scale of harvesting the resources of the Earth has increased immensely over the last generation and new technology is too often used without concern for the long-term survival of the resource. The seas of the world have been over-fished, which is the main factor that has caused a depletion of fish stocks and the collapse of fish populations. Some international attempts are, however, being made to regulate fishing in the world's oceans, e.g. the United Nations Conference on Straddling Fish Stocks and Highly Migratory Fish Stocks.

Hunting of an animal population can lead to extinction of the species if the hunting is not regulated (tragedy of the commons). For example, large mammals in Africa are threatened, although they are now protected. Whaling is another example. Some whale species have been hunted so near to extinction that their numbers may never recover (e.g. the blue, right, and bowhead whales). The International Whaling Commission has attempted to regulate the whaling industry, and some whale populations are slowly recovering.

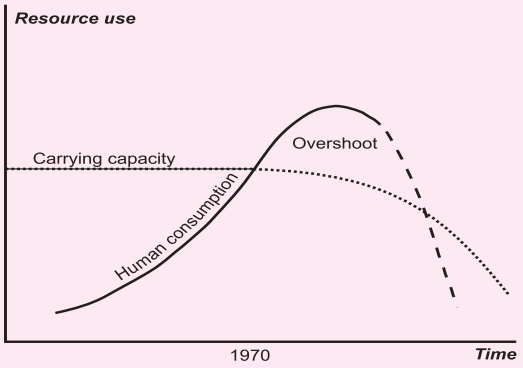


Figure 1.7. Global resource use. The graph illustrates withdrawal of natural resources from the planet. The dotted line indicating "carrying capacity" shows the maximum amount of renewable resources available. The solid line shows the amounts of resources taken. The "overshoot", growth beyond carrying capacity or renewal, corresponds to e.g. use of fossil fuel, deforestation and overfishing. This overexploitation started in the early 1970s and still increases. In the longer term it can not continue. It will lead to environmental degradation, reduced carrying capacity and population crash. (After Wackernagel and Rees, 1996.)

Land decline – desertification and deforestation

The productivity of large areas of land has been completely destroyed or severely damaged. In Africa, overgrazing and erosion has turned large areas of land into sterile desert. This process is called desertification. In Asia and South America, the logging of rain forest areas to harvest timber and create grazing areas for cattle (e.g. for the fast food industry in Northern countries), has resulted in unproductive land, badly damaged by erosion. Land reclamation and sustainable forestry practices are badly needed in these areas.

Biodiversity

All over the world, human activity has driven many species and ecosystems to extinction or near to it. This is a cause for alarm. Rain forest areas, with uniquely diverse ecosystems, have especially been severely damaged and continue to be endangered.

Today, fertilisation of farmland basically consists of adding the NPK elements – nitrogen, phosphorus and potassium. It is a common feature of ecosystems, both on land and in water, that nitrous compounds and phosphorus are limiting factors for plant growth through photosynthesis. Therefore, when these elements are added generously, they considerably add to the growth of biomass.

The Baltic Sea is a very good example of a body of water where increased growth due to eutrophication has become so excessive that it fundamentally influences the ecology of the whole body of water. The Baltic Sea is the final recipient of water from a wide area of land in Northern Europe, inhabited by about 85 million people. In general terms, cattle and fauna also add to eutrophication. Ammonia produced on farms is carried by the wind and finally ends up in the water, as do nitrous oxides from combustion and transportation. The Sea reflects the new and sometimes rather artificial methods and conditions in forestry, farming,

Figure 1.8. The local environmental impacts are sometimes easy to see, as this outlet of dirty wastewater outside Riga, Latvia. Wastewater with oil, nutrients, and chemicals may cause only local problems. However, many such sources may build up to a regional environmental impact. (Photo: André Maslennikov.)

cattle breeding, industry, and transportation in the whole of Northern Europe. The contaminated lakes, streams, and rivers all contribute their water to the Baltic Sea.

Eutrophication, which dramatically changes the conditions for many species, is mostly deleterious from the human point of view. For example, in the Baltic Sea, the numbers of cod decreased dramatically in the 1980s and 1990s. In other areas of the world, due to eutrophication, coastal ecosystems which feed billions of the world's inhabitants are threatened by the activities of these very people.

Acidification is also a world-wide problem. It is caused largely by the burning of fossil fuels, most of which contain a certain amount of sulphur, which in the end generates sulphuric acid. Nitrous oxides from various sources, mainly vehicle traffic and oxidized ammonia from animal production, also cause acidification with the same result. Soil and ground conditions vary extensively over the world, and are more or less susceptible to acidifying substances. Due to its special soil conditions, Northern Europe, especially the Scandinavian peninsula (and Scotland), is particularly susceptible to acidification. Acidification of lakes will, in the end, kill all higher forms of life, since reproduction is interfered with; the acidification of forests kills trees and also mobilizes other pollutants in soil and water.

Local impacts

Several environmental pollutants act mostly on a local level, when efficient mechanisms for their large-scale distribution are lacking. A locally important environmental threat is low level ozone and pollution from many other hydrocarbon based chemicals. Ozone is produced from hydrocarbons (petrol vapour) and nitrous oxides under the influence of sunlight. Traffic is the most important source for this ground-level ozone. During sunny days, a high concentration of ozone is reached in areas around highways, which hampers the growth in forests and fields to the extent that the cost in economic terms amounts to billions of dollars a year in the Baltic Sea region alone. The death of the forests in Europe is a paramount problem with a rather complex background, which includes ground level ozone and acidification.

Dispersion of different exogenous substances is the common denominator in a series of mostly local environmental effects. During a time span of half a century, ecosystems have been stressed by many foreign chemical elements and compounds. Several of them are quite toxic by themselves, such as DDT, PCB, PAH, and dioxine. A characteristic of these is that they do not naturally degrade or degrade only exceedingly slow. They are therefore called persistent organic pollutants, POPs. Finally, many heavy metals are toxic to animals and plants. These, primarily lead, mercury, and cadmium, are also produced in large amounts in industrialized societies.

Facing environmental decline

The development of environmental policy

The growing environmental movement

The pressing environmental problems discussed widely in the early 1960s caused an upsurge in the concern for protecting the environment. Scientists and others broke the silence by providing facts about what was going on, and by making philosophical and ethical arguments. Nature conservation associations often became environmental movements, or green movements. They attempted to influence and create environmental policy, and used political lobbying to influence authorities to introduce legal constraints on activities that led to environmental damage.

Environmental problems and economic activity

Environmental policy is a way to address the environmental dilemma. Environmental policies exist on all levels: local, national, international, as well as global; and on all scales. Environmental problems have appeared in both rich and poor countries and in both capitalist and socialist systems. Greater insight has been gained into the complexity of many issues. However, the long-term impacts of people on ecosystems, and the causes of impacts and what to do about them, are still far from fully being understood.

Economic activities generate several types of pressures on the environment, such as input demands (materials and energy), pollution and waste flows, and spatial intrusion in natural areas. The environment has a certain capacity to buffer these pressures. However, if the buffering capacity is exceeded environmental change or degradation will follow. More precisely, "… the limits of the Earth's assimilative capacity can be reached over time either because

Review
Box 1.4

Economic activities cause environmental problems

Economic activity	Environmental impact	Effects
Agriculture	- increased levels of nitrogen and phosphorus of water bodies	- eutrophication
	- spatial intrusion	- removal of habitat
	- use of biocides	- toxic chemicals
Forestry	- spatial intrusion	- removal of habitat
Transport	- emission of CO_2 and other greenhouse gases	- global warming
	- acid rain	- acidification
Industry	- ozone-depleting substances	- increased UV radiation
	- emission of organic pollutants	- pollution by POPs, persistent organic pollutants, e.g. PCB and DDT
	- toxic heavy metals, etc.	
Urbanization	- spatial intrusion	- decrease in biodiversity
	- emission of wastewater	- eutrophication
	- solid waste accumulation	- leakage of toxic chemicals

	Measures	Examples	First introduced
1.	Nature protection	Swedish nature reserves from 1907; Nature conservation movements in Poland before the Second World War	First half of the 1900s
2.	End-of-pipe measures to control pollution	Filters in smoke stacks to reduce air pollution, especially sulphur emissions; Improvements in waste water plants	From the 1950s and 1960s
3.	Banning chemical pollution	DDT banned in 1965; PCB banned in many countries, e.g. Japan, USA, and Sweden, in the mid-1970s.	From the mid-1960s and 1970s
4.	Waste recycling	Waste Avoidance & Management Act, West Germany, 1986	The 1980s
5.	Cleaner production and waste minimisation	An integrated technological strategy to processes and products to reduce pollution and waste, and use resources with maximum efficiency	From the 1980s and 1990s
6.	Environmental management systems	Systematic survey of processes and materials to improve environmental performance (e.g. ISO 14001 and EMAS)	The 1990s

Table 1.1. Environmental protection measures.

pollutants accumulate or because emission levels rise beyond the capacity of the relevant ecosystem to process waste" (Esty, 1994: 11).

Environmental degradation is frequently a result of the "tragedy of the commons" where actions of a small number of people have little of no effect on a public resource while the same behaviour by a larger group destroys the resource. An incentive not to act is created because any effort by an individual to address the problem has little value and may be to their own short-term disadvantage (Hardin, 1968).

Our Common Future, the final report of the World Commission on Environment and Development, underlines that unsustainable growth patterns (e.g. the increased use of land, raw materials and fossil fuels, and interventions in water cycles) have caused substantial environmental stress: "There are thresholds that cannot be crossed without endangering the basic integrity of the (eco)system. Today we are close to many of these thresholds" (WCED, 1987: 32-33). The problems presently facing mankind – overconsumption, poverty, pollution, loss of biodiversity, the diminishing resource base – may indeed constitute a threat to human civilization. The challenge is daunting for both developed and developing countries. The former must decrease their share in the consumption of global resources while assisting the latter group in its efforts to protect the environment. The latter group of countries, which has generally devoted fewer resources to environmental protection than developed countries, must utilize their modest resources to raise the standard of living and at the same time take measures to protect the environment.

Environmental policy and its achievements

Environmental policy is a relatively recent phenomenon. The British Alkali Act of 1863 is considered to be the first pollution control act. In most OECD countries, environmental management was not given systematic attention until the late 1960s and the early 1970s. It was in these decades that the concept of "environmental protection" gained currency. For instance, in Sweden, "environment protection" was explained in a dictionary for the first time in 1963. In Poland, the government began to refer to environmental protection in the 1970s.

The first responses included the adoption of laws regulating air and water pollution, the introduction of procedures for environmental management, and legislation for waste management and control of toxic substances.

However, the early strategies did not lead to sufficient improvements of environmental performance. Firstly, there was a clear-cut end-of-pipe bias which caused cross-media transfers of pollution. In the mid-1980s more than 70% of all hazardous waste in some German Länder (states in the federation) originated

The character of environmental policy

Weale (1992) argues that pollution has five characteristics:

- it concerns issues that are public goods,
- it arises as a by-product of otherwise legitimate activities,
- it has a large technical core,
- it may have long-term effects, and
- it is a policy area that cuts across the established sectors of public policy.

Dryzek (1987) claims that ecological problems are characterized by

- complexity,
- non-reducibility,
- temporal and spatial variability,
- uncertainty,
- a collective quality (manifested in the "public good" and "common property" problems), and
- spontaneity (the partial capacity of ecosystems to cope with stresses without human intervention).

OECD

OECD is an abbreviation for the Organisation for Economic Co-operation and Development. It consists of almost all Western European nations together with the United States, Canada, Turkey, Australia, and New Zealand. Recent member states are Mexico (1994), the Czech Republic (1995), Hungary (1996), Poland (1996), and Korea (1996).

from environmental process technologies. Secondly, "environmental policy was treated as a discrete policy area within its own right" (Weale, 1992: 20). In other words, environmental protection was not seen as an overall task for the government but something that could be delegated to the ministry in charge of the environment. The 1980s and especially the 1990s have witnessed a search for new approaches including recycling, pollution prevention, precaution, and the integration of environmental concerns into economic and sectoral policies.

Also, the concept of sustainable development has gained currency. This concept was first coined by the International Union for Conservation of Nature (IUCN) in 1980 and later on promoted by the World Commission on Environment and Development (WCED). In WCED's report *Our Common Future* of 1987, sustainable development was defined (p. 43) in the following way: "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

In the past decade most OECD countries have accomplished considerable progress in dealing with a number of environmental problems. The most pressing wastewater discharges have been addressed through regulation of point sources and the construction of wastewater treatment plants. Emissions of sulphur dioxide and other air pollutants have diminished, partly as a result of the imposition of stricter standards. Management of municipal waste and hazardous waste have improved because of the establishment of programmes for collection and reuse/recycling of waste. Also, nature protection has become an upgraded policy area within the OECD countries.

According to the OECD, the most problematic environmental areas are eutrophication, NO_X emissions, ground-level ozone, the emission of greenhouse gases, and the generation of waste. A new approach is needed to deal with diffuse and small-scale sources and to incorporate environmental concerns into sectoral policies. Little progress has been made in areas where effective implementation depends on significant changes or reforms in economic or sectoral policies. At present, the sectors with the greatest impact on environmental conditions are energy, transport, and agriculture.

Figure 1.9. External factors. The environmental impact of traffic, especially car traffic, is indisputable as it gives rise to air pollution, carbon dioxide emissions, and large intrusions in nature through roads and other infrastructure. Still, all of this does not add to the price of transport through, e.g., taxes or charges. The costs remain external. (Photo: Inga-May Lehman Nådin.)

International cooperation

Environmental protection has emerged as an increasingly important international issue. This process was sparked off by the 1972 United Nations Conference on the Human Environment in Stockholm, attended by representatives of more than 100 countries. For the first time, the environment was placed on the international political agenda. An immediate result of the conference was the creation of the United Nation's Environment Programme (UNEP).

The United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro in 1992, attended by 179 governments, was the largest conference ever organized by the UN. The conference produced five important documents: (1) the Rio Declaration on Environment and Development; (2) Agenda 21, a document consisting of 40 chapters outlining the main tasks to be carried out for the achievement of sustainable development; (3) the Forest Principles on the sustainable management of forests; (4) the Framework Convention on Climate Change; and (5) the Convention on Biological Diversity.

Since the early 1970s, the European Union has adopted more than 200 pieces of environmental legislation and launched six environmental action programmes. The Single European Act of 1997 (Amsterdam Treaty) placed environmental protection on an equal footing with economic growth and free trade.

The role of external factors

Environmental policy-making does not take place in a vacuum, it is not a phenomenon which is isolated from other societal processes. On the contrary, it is affected by political, social, technological, and economic events which take place outside the environmental policy-making process. There are numerous examples of how environmental policy directly or indirectly has been shaped by such events. A clear-cut example is the oil price shock of 1973-74, which led to an upsurge for energy saving measures in the western world. Economic downturn, high inflation and high unemployment tend to reduce the willingness of voters to make economic sacrifices for the sake of environmental protection.

Besides these dynamic factors, there is a set of more stable factors, also external to the environmental policy-making process, that shape national approaches to environmental protection.

Geographical factors shape approaches to environmental policy in different member states of the European Union: in the northern countries, water quantity is not a pressing issue while water quality is; the Mediterranean countries tend to transfer water pollution to the sea and worry primarily about water supply.

Secondly, *historical factors* may explain why countries tend to prefer certain approaches and structures and avoid others. For example, it may be impossible to create a fully integrated environmental agency in the Netherlands because of the fact that control of watercourses and canals is vested in the Ministry of Transport, with responsibility for the historically important *Waterstaat*.

A third important aspect is *the political system and the political culture* which both affect national environmental policy styles. Vogel's (1986) comparison between environmental regulation in the USA and Great Britain and Lundqvist's (1980) comparison between clean air policies in the USA and Sweden both led to the conclusion that the characteristics of a political regime are more important than the nature of environmental policy. Weale (1992: 55) has pointed out that the room to manoeuvre for policy-makers is larger in a unitary system (for example, Sweden) than in a federal system (for example, the USA).

Fourth, *economic structure and economic situation* play an important role. Policy-makers in Sweden and the USA in the 1970s arrived at different conclusions about the adequacy of environmental policy measures, partly due to the different importance of exports to the two countries.

A last factor that may be decisive is the *distribution of natural resources*. Countries dependent on coal for supply of energy, such as Poland and Australia, may find it more difficult to implement measures to reduce sulphur dioxide and carbon dioxide emissions than countries that rely on other energy sources such as natural gas, hydro power, and nuclear power.

Important dates in environmental policy

1863	First pollution control act (the Alcali Act, UK)
1872	First national park (Yellowstone, USA)
1900	Convention for the Preservation of Wild Animals, Birds and Fish in Africa
1955	International Conference on Man´s Role in Changing the Face of the Earth in Princeton, USA
1970	Environmental Committee established within the OECD
1970	Environmental Protection Agency (EPA) created (USA)
1972	UN Conference on the Human Environment in Stockholm
1972	United Nations Environmental Programme (UNEP) established
1972	First green party founded (Values Party in New Zealand)
1973	First Environmental Action Programme of the EC
1979	Convention on Long-Range Transboundary Air Pollution
1979	World Climate Programme launched by the UN
1980	Polish Ecological Club founded (first independent environmental NGO in the Soviet bloc)
1983	Election of the Green Party in the West German Bundestag
1985	Convention on the Protection of the Ozone Layer
1992	UN Conference on Environment and Development in Rio de Janeiro
1992	UN Framework Convention on Climate Change (FCCC)
1992	UN Convention on Biodiversity
1992	Agenda 21
1997	Amsterdam Treaty of the EU
1997	Kyoto Protocol of the FCCC
2001	Kyoto Protocol signed
2002	Johannesburg Global Summit

Environmental policy in Central and Eastern Europe

The origin of environmental protection in the socialist world

The 1970s saw the birth of the modern concept of environmental protection not only within the OECD but also in Eastern Europe. Although the 1972 UN Conference on the Human Environment in Stockholm was boycotted by the socialist bloc (except for Romania) because of an argument over East Germany's voting status at the conference, this event had a tremendous impact on the environmental policy development in the eastern part of Europe. After the Stockholm Conference, the socialist countries promoted the idea of environmental protection in a more systematic way than they had done before, both on the national and international level. National environmental policy strategies were elaborated and a committee for environmental protection was set up within the Council for Mutual Economic Aid (CMEA) in 1972.

Another landmark event was the Helsinki Conference on Security and Co-operation in 1975, at which the Soviet Union proposed to reach agreement on three pan-European problems: energy, transport, and environment. The Western countries agreed only upon an extended co-operation on the last of these themes. The new cooperation was developed within the framework of the UN Economic Commission for Europe and resulted in the 1979 Convention on Long-Range Transboundary Air Pollution.

By the mid-1970s, all countries of the Soviet bloc had incorporated the goal of environmental protection into their constitutions. The first country to do so was Czechoslovakia in 1960. Later, all the other countries followed: Romania in 1965, GDR in 1968, Bulgaria in 1971, Hungary in 1972, Poland in 1976, and the Soviet Union in 1977.

In the 1980s, experts from four socialist countries – China, Hungary, the Soviet Union, and Yugoslavia – participated in the work of the World Commission for Environment and Development.

Environmental policy in Eastern Europe before 1989 was based on national ambient quality standards which often were more stringent than western ones. Permits for use of natural resources and emission of pollution were issued by environmental agencies on the regional and local level. From the 1970s and onwards, several countries introduced economic instruments such as fees and fines. Also environmental funds, providing grants for various investments for environmental protection and water management, began to operate. For example, within the Soviet Union, the first environmental fund was established in Estonia in 1983. Furthermore, environmental protection ministries or agencies were established by several socialist states before the systems changed. Politically loyal environmental organisations, mainly concerned with nature protection, were allowed to exist, such as Brontosaurus in Czechoslovakia and the League for Nature Protection in Poland.

In the 1980s, it was revealed that the environmental protection measures taken so far had not given the expected results; industry remained in non-compliance with the environmental regulations, the environmental situation deteriorated continuously and many regions were classified as ecological catastrophes.

Despite rather well-developed environmental policies, the Eastern European countries failed to achieve satisfactory environmental results for a number of reasons.

Central and Eastern Europe

CEE, Central and Eastern Europe.

Central Europe denotes Poland, Czech Republic, Slovakia, Hungary, Romania, Bulgaria, and the Balkan countries.

Eastern Europe denotes Estonia, Latvia, Lithuania, the Russian Federation, Belarus, Ukraine, and Moldova

CEE was also often called the Eastern Block countries.

CIS: Commmonwealth of Independent States. CIS consists of all states in the former Soviet Union, in all 15, except Estonia, Latvia and Lithuania.

NIS: Newly Independent States: Often used abbreviation for the states which previously belonged to the former eastern block.

Figure 1.10. The centre of Lviv, Ukraine in 1996. Environmental impacts in Eastern Europe were and are often far worse than those in the West. Much of it is connected to energy production. In the Ukraine, this is illustrated by the Chernobyl disaster and coal mines. (Photo: Lars Rydén.)

First of all, the poor environmental performance cannot be fully understood without some reference to the ideological foundations of the socialist system. A number of scholars have emphasized that the socialist pricing mechanism, under Marx's labour theory of value, led to an underpricing of natural resources. According to Marx, value can only be created by work. Thus, natural resources have no value until they are touched by a human hand. This assumption became a typical feature of the socialist price system where the price, for instance, of water and energy was unrealistically low. Consequently, the socialist economies became highly intensive in energy and resource consumption. In general, the non-market economies in Eastern Europe required 2-3 times more input per unit of GNP in the production processes than western economies. This inefficiency was reflected by the emission of pollutants which typically were 2-3 times higher per unit of GNP than in the OECD.

Industrialization and use of natural resources

The socialist states in Eastern Europe pursued aggressive industrialization policies in which large-scale iron and steel mills, power plants, chemical plants, etc., were set up in a rapid tempo. In many cases the technologies were outdated from the outset. For instance, the Lenin Steel Plant in Nowa Huta outside Krakow, which was built in the early 1950s, was based on Soviet technology from the 1930s which, in turn, was based on American technology from the beginning of the century. The stress on heavy industry led to an under-development of the service sector which never contributed to more than 30% of the GNP of the economies in the region. This could be compared to the West where the service sector typically provides half of the share of the GNP. Another reason for the rapid industrialization was the wish to increase the military power of the Soviet bloc. In the late 1980s, the Soviet military expenditures

Figure 1.11. In Estonia, phosphorite mining, here a closed mine in the vicinity of Tallinn in September 1991, were among the environmental disasters that spurred the independence movements in the 1980s and early 1990s. Strip mining of phosphorite devastated large areas and polluted the groundwater. A major expansion of phosphorite mining was planned by Soviet authorities, but the plans were not realised due to the political situation at the end of the 1980s. (Photo: Lars Rydén.)

absorbed up to 17% or more of GNP while the world average at this time was roughly 6% (French, 1990).

The isolated position of the Soviet bloc in the world economy was not without importance for the poor environmental performance. The Eastern European countries benefited only to a very little extent from the technical development in the West. Another example is the oil crisis in the 1970s, which led to higher oil prices and an upsurge for energy-saving measures in the West while none of this happened in Eastern Europe (Nove, 1980).

The argument has been advanced that the resource allocation mechanism used in the socialist system, i.e. central planning, was not beneficial for technological innovation. Indeed, industrial technologies were often old-fashioned and inefficient. Moreover, the development of cleaning equipment was delayed in Eastern Europe compared to the West.

Environment and political transformation

Environmental concern played an important role in the political transformation of Eastern Europe in the late 1980s and early 1990s. Environmental issues played the role of political ammunition in the sense that unsatisfied demands for an improved environmental situation fuelled demands for general political and economic changes. The political dimension of environmental affairs was evident in a number of cases, such as:

- The Hungarian opposition against the construction of the Gabcikovo-Nagymaros dam on the Danube river. This joint Hungarian-Czechoslovakian project was launched in 1977. Hungarian protests against the project were led by the independent organization the Danube Circle (Dunakör) in the second part of the 1980s.
- Estonian protests against plans for dramatically increased phosphorite mining in the 1980s. Phosphorite was extracted by strip mining which ruined vast land areas and polluted groundwater.
- Lithuanian protests against the Ignalina nuclear power station. In September 1988, several thousand people formed a human chain around this power plant as a protest to its operation. In October 1988, some 600,000 people (16% of Lithuania's population!) signed a petition against Ignalina.
- The attempts to improve the air quality situation in the Bulgarian town Ruse. In 1988, the population in Ruse, a city situated on the Danube, began to protest against the chlorine emissions from industries in the Romanian town

Giurgiu on the other side of the river. The issue was picked up by intellectuals in Sofia who subsequently created Ekoglasnost, a nationwide and independent environmental organization, which put the government under considerable pressure. Its activities had the effect of being a catalyst for internal struggles within the communist party, something which contributed to the democratic breakthrough in Bulgaria in November 1989.

- The 1986 nuclear catastrophe in Chernobyl.

The process towards systemic change brought great hopes for improved environmental management in this region. When Western European countries and other OECD countries began to seriously address their environmental problems in the 1970s, these countries were stable and rich market-based democracies. In the 1990s, when the Eastern European countries in transition began to deal with the environmental heritage of socialism, the situation was different and more difficult in the sense that the East European governments had meagre financial resources and they had to contend with unstable political and economic systems.

A NEW STRATEGY FOR MAN AND THE ENVIRONMENT

The challenges

How do we get out of the environmental dilemma? A more comprehensive approach to environmental resource management is needed. Four different transformations required of our societies are:

- *technological transformation*, including de-materialization of materials cycles, de-carbonization of energy flows, substitution of toxic materials, closing material cycles, etc.;
- *institutional transformation*, including internalization of external costs, liability regulation, etc.;
- *spatial transformation*, including spatial efficiency and equity; and
- *structural transformation*, that is, changing consumption and production patterns.

These four transformations alone amount to a very fundamental reformation of industrial civilization. It seems necessary to also add new ethics, a new world view, and changes in lifestyles. It is time to establish a new perspective on how humans handle the environment. The old knowledge of the 20th century is insufficient to describe the totality of the new situation. We need new knowledge to develop coping strategies that can facilitate survival of the societies of the world in a healthy environment and in a sound interaction with natural resources. The resource base is the ecosphere, including all living species and the thin layer of matter that is the surface of the planet.

Let us look at the fundamental conditions for creating a new kind of society, in harmony with its environment.

Ecostrategies

Humans have always faced the challenge of mastering their immediate surroundings for harvest of natural resources, and to find shelter and feed

themselves. They also had to take responsibility for handling wastes in a reasonably sustainable way. They evolved an *ecostrategy* for their own survival. The challenge of the 21st century is to apply that approach to all societies on a global basis, and also to societies that are very different from the early ones.

An ecostrategy has been defined by geographers (Sandell, 1988) as strategies by individuals or groups of individuals for the utilisation of nature. The fundamental classification of strategies distinguishes between *domination* and *adaptation* strategies; the adaptation strategies may be considered as either active or passive.

There are many examples of traditional societies with working ecostrategies, lifestyles which could be prolonged indefinitely without long-term impact on the environment. In the Baltic Sea region, we may point to the Sami population in northern Norway, Sweden, Finland, and Russia, which rely on reindeer herding for their food as well as many other resources. All over the world, traditional societies practice such adaptive strategies.

Industrialised societies have become comprehensive and standardised in many ways, and the strategy behind their function today is clearly that of domination with respect to natural ecosystems. The foremost strategic dilemma today is that large territories and sea beds all over the world must be cared for by a reasonably coherent and organised action. Development of a functioning ecostrategy includes both use of natural resources and waste management.

Limits of technical solutions

There is a several hundred years long history of development and industrialisation in the Baltic Sea region and a very short history of environmental awareness and efforts to address environmental impact (Sörlin, 1997). The first attempts to technically manage the emerging environmental problems in the large systems of modern society may be summarised with the terms *dilution* and *end-of-pipe solutions.* The waste substances, e.g. from a factory, were first discharged in the surrounding air and water. When they became a nuisance for those living close to the factory, they were channelled through higher chimneys and longer pipes, that is they were diluted in the air and far away waters. Later on, outlets were controlled by filtering and cleaning devices exactly at the end-of-pipe. The drainage and sewer systems were equipped with, as time went on, more and more ambitious purification plants. The great problems of landfills were beginning to be observed and provisionally cared for.

In the long run it was discovered, however, that these provisions, although in many respects successful, were insufficient. There are very basic reasons why these approaches fail. The two fundamental laws of thermodynamics state, in popular terms, that *nothing is destroyed*, a statement that applies formally to all atomic matter and to energy, and that *everything is dispersed*. Thus, the pollutants do not disappear through the high chimneys. They were only dispersed more evenly in the environment and over larger regions, in the end to the whole globe. Environmental problems have the ability to spread and to convert the originally local problems to regional, national, and global challenges.

Sustainable development and human ecology

A strategy that allows for both long-term use of natural resources and a non-destructive management of waste on all levels is called *sustainable*, meaning that it may go on forever. A development that leads to a sustainable society is called *sustainable development*. Today the people of all societies of the world face the new task of promoting sustainable development.

Sustainable development is a comprehensive concept and has many dimensions: ecological, economic, social, cultural, etc. Preserving a sound and healthy

Basic concepts

Ecostrategy
Strategies by individuals or groups of individuals for the utilisation of nature. The fundamental classification of strategies distinguishes between domination and adaptation strategies; the adaptation strategies may be considered as either active or passive.

Human ecology
The fundamental idea in human ecology is to elucidate the ecostrategies of humans according to the same principles as the strategies of other species, now including the economic activities in the society. The general science of ecology applies to human species as well as to all other species. Humans are an integral part of the biosphere, today with an unparalleled impact on it.

Environmental science
Environmental science includes the inter-disciplinary studies of the impact of human activities on nature, the biosphere, as well as various measures to avoid or minimise these impacts through technical, political and other means. Environmental science is not a single academic discipline, but rather a collection of results from several disciplines including engineering, natural sciences, economic and social sciences, as well as history and other humanities.

Sustainable development
In the 1987 Brundtland report, *Our Common Future,* sustainable development was defined as the development "that meets the needs of the present without compromising the ability of future generations to meet their own needs." Sustainable development focuses on good management and use of (renewable) resources, reduction of environmental impact to sustainable levels, and good economic and social development.

Figure 1.12. Ecostrategies. Classically, reindeer herding was the eco-strategy of the Sami population in the Arctic area. Reindeer provided the hunters/herders with food (from their meat), shelter (from their skins), and for transportation as the animals were used for pulling sleds. The reindeers got all they needed in the wilderness in the mountains. At present reindeer herding is more industrial, and is no longer a sustainable strategy. (Photo: Johan Gunséus, courtesy of STF.)

environment, from the local to the global level, is one part of it. From an ecological point of view, the comprehensive concept of *human ecology* is of interest.

The fundamental idea in human ecology is to elucidate the ecostrategy of humans according to the same principles as the strategies of other species. The general science of ecology applies as well to the human species as to all other species. Humans are an integral part of the global ecosystem, today with an unparalleled impact on the biosphere. Humans supply themselves with food, water and materials from the surroundings according to the same basic principles as all living species do. In modern society, humans have also become accustomed to a large number of services that require access to natural resources of several different kinds, most easily summarised as matter and energy. The intellectual, emotional, cultural, and organisational abilities of humans must be considered as important background factors for human ecostrategies.

Living on the surface of our Earth

The new visions may imply that humans will rediscover the importance of the surface area of the Earth. It is only a small fraction of the land masses of the Earth that are entirely barren. As well, the significance of the waters of the world, covering 70% of the surface area, can hardly be overestimated. The blue planet, planet Earth, could even be called the water planet. Water is one of the indispensable substances to every living cell in the ecosphere, and especially the oceans must be monitored and cared for in the future. Clean air is likewise a necessary part of the environment that life depends on.

The surface we utilise has been called our *ecological footprint*. The footprint corresponds to the land area needed for all the ecological services we enjoy: food, space, fibres such as paper and wood, and the area needed to absorb all the waste. The footprint is thus several types of areas put together: fields, forests, wetlands, etc. It is possible to calculate how much area is available for each person on Earth. This is about 2.2 ha or six soccer fields. In the Baltic Sea region we use much more than our share, more than 4 ha. The severity of the situation is emphasized by the fact that today there is a global overshoot, due to burning of fossil fuels, deforestation, etc., and that the total area available is decreasing.

Figure 1.13. All energy on Earth comes from the Sun. The sun provides us with a total of some 200,000 terawatts. It warms the atmosphere, lightens the planet, and moves material around to produce the weather. About 40 terawatts are used for photosynthesis. Man uses about 12 terawatts (1990 estimation), or about 30% of the total amount used for photosynthesis. A sustainable energy regime will have to rely on solar energy either indirectly through wind, water, and waves or directly through heating, solar electricity, and fuel such as biomass. (Photo: Inga-May Lehman Nådin.)

Using the sun

As the use of fossil fuels is phased out, much more attention will be focused on use of renewable energy resources. These are all based on the rich and absolutely essential solar radiation in which the earth is immersed. The streams of solar energy are converted to subfluxes of exergy carrying structures in winds, ocean streams, waves, temperature differences and flowing water in rivers and brooks. Even the global surrounding gives an ecological meaning to the whole of the Earth in that solar energy can penetrate the atmosphere and the residual heat radiation – the outlet – can leave the system. All of it constitutes an exquisite systems solution for an ecosystem. A future sustainable society will be a solar society.

The future

It is in this context that the vision of sustainability has been created. But visions do not carry very far without pragmatism and conscious individuals taking steps to change things. Even a long journey starts with a first step. Now humans can no longer, as in early societies, rely on their senses only to stipulate in private terms what sustainability is in practice. New knowledge has to be produced in fields that many people are today barely prepared for. The limited carrying capacity of the resource base must first be understood and then generally recognised among people, and among many different cultures and societies of the world.

This knowledge must involve many sciences. The material world has to be understood in large-scale and small-scale perspectives. It will also deal with the processes through which knowledge is disseminated to affect public opinion. What are the fundamental relationships between the individual and the collective in large societies – how is an opinion formed and how is it changed? There are many challenging aspects to the study of sustainability, that includes the fields of education, democracy, and politics.

The environmental situation in our societies and how these may be changed into sustainable societies, will be discussed in the following pages of this book. We will focus on environmental protection and environmental management in the context of sustainable society, with all its complexity of economic, social, cultural, and other issues. Managing, protecting, and restoring the environment is an integrated and essential part of this picture.

Review questions

1. Give four important dates in the history of the human environment.
2. List four scientists that were important to research and publicity about environmental impacts in the 1960s.
3. Summarise six important global environmental problems.
4. Summarise two important regional environmental problems.
5. Explain why environmental problems have become more complicated during the last generation.
6. Describe the basis of environmental politics.
7. Describe how concern for the environment had a role in the political transformation of Central and Eastern Europe.
8. Summarise the most important ways to deal with environmental impacts.
9. Define the key concepts of human ecology, ecostrategy, and sustainable development.
10. Describe the role of the sun in an environmentally friendly society.

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INTERNET RESOURCES

BOING - Baltic On-line Interactive Environmental Information Service
http://jolly.fimr.fi/index.html

Climate Network Europe
http://www.climate.org

CO2 Science Magazine
http://www.co2science.org/

Easter Island Home Page
http://www.netaxs.com/~trance/rapanui.html

Environmental sites on the internet
http://www.lib.kth.se/~lg/envsite.htm

The Helsinki Commission (HELCOM)
http://www.helcom.fi/

Historical Estimates of World Population
http://www.census.gov/ipc/www/worldhis.html

Human Population through History
http://www.igc.apc.org/desip/populationmaps.html

Intergovernmental Panel on Climate Change (IPCC)
http://www.ipcc.ch/

International Institute for Sustainable Development
http://www.iisd.ca

International Solar Energy Society (ISES)
http://www.ises.org/

International Union for the Conservation of Nature (IUCN)
http://www.iucn.org

Organisation for Economic Co-operation and Development (OECD)
http://www.oecd.org

The Regional Environmental Center for Central and E. Europe (REC)
http://www.rec.org

Rocky Mountain Institute
http://www.rmi.org

Swedish EPA
http://www.environ.se

The Swedish NGO Secretariat on Acid Rain
http://www.acidrain.org/

The United Nations Environment Programme (UNEP)
http://www.unep.org/

US EPA - Ozone Depletion
http://www.epa.gov/docs/ozone/

Women in History: Rachel Carson
http://www.lkwdpl.org/wihohio/cars-rac.htm

The World Conservation Union
http://www.iucn.org/

World Wildlife Fund (WWF)
http://www.wwf.org

Yahoo: Environment and Nature
http://dir.yahoo.com/Society_and_Culture/Environment_and_Nature/

Glossary

acidification
reduction of pH levels caused by acid rain. Acidic residues, especially from burning of fossil fuels, containing sulphuric acid but also nitric acids, precipitates as acid rain, and can turn lakes into life-less "wet deserts"

affluent society
a society where consumer goods are available in large amounts

biocides
chemicals that are used to kill, more or less specifically, plants, such as weeds, and animals such as parasites, etc. Biocides may have indiscriminate effects on bird fauna and on many other levels in ecosystems

deforestation
cutting all trees in a forest so that it is converted into open land. When tropical rain forests are deforested, only a thin layer of soil remains that is easily eroded

desertification
the turning of land areas into lifeless deserts by depletion of soil through erosion caused, e.g. by overgrazing

development
traditionally, development refers to economic progress caused by, e.g. improved trade and industrial development

ecological footprint
the surface we use, the footprint, corresponding to all the ecological services we enjoy: food, space, fibres such as paper and wood, and the area needed to absorb all the waste

ecosphere
the whole of the thin layer of matter that makes up the surface area of the planet together with all biological species living on it

ecostrategy
strategies by individuals or groups of individuals for the utilisation of nature. The fundamental classification of strategies distinguishes between domination and adaptation strategies; the adaptation strategies may be considered as either active or passive

enhanced greenhouse effect
the increased global average temperature caused by certain gases, added to the Earth's atmosphere, such as carbon dioxide, and CFCs, which absorbs heat (infrared) radiation from the surface of the planet

environmental policy
the response of societies to environmental problems, consisting of political decisions on environmental protection, through legal and economic means and other policy measures, such as education, and on all levels - local, national, international as well as global

environmental protection
all actions that reduce the impact of human activities on nature, the biosphere, as well as various measures to avoid or minimise these impacts through technical, political and other means

environmental science
includes the interdisciplinary studies of the impact of human activities on nature, the biosphere, as well as various measures to avoid or minimise these impacts through technical, political, and other means. Environmental science is not a single academic discipline, but rather a collection of results from several disciplines including engineering, natural sciences, economic and social sciences, as well as history and other humanities

environmentalism
activities in the non-official sector (e.g. by NGOs, or non-governmental organisations) to protest against or lobby against environmental destruction. The environmental movement includes scientists, and activists from a wide range of backgrounds

erosion
the loss of soil from a land area. Erosion is caused when barren soil is washed away by rain or blown away by wind

eutrophication
large increases of concentrated nutrients, mainly nitrogen and phosphorus, to water. Eutrophication causes increased algae growth, oxygen depletion, and large changes to ecosystems

flue gases
the polluted air from combustion that leaves chimneys in a power plant, a factory, or furnaces to heat homes

human ecology
the elucidation of ecostrategies for humans according to the same principles as the strategies of other species, including economic activities. The general science of ecology applies to human species as well as to all other species. Humans are an integral part of the biosphere, today with an unparalleled impact on it

over-fishing
fishing to the extent that a fish population collapses, and can not be further fished

recycling of waste
the reuse of waste, e.g. use of paper for new paper products or sludge for fertilizer in agriculture, which avoids waste management problems such as growing land fills

salination
increasing the salt content of a land area, e.g. after long-term irrigation. Salination impairs growth and can turn an area into desert

sewage
the polluted water from toilets in a city or a factory

spatial intrusion
removal of natural ecosystems and habitats, e.g. building of cities and roads due to economic development

sustainable development
the 1987 Brundtland report *Our Common Future* defined sustainable development as development "that meets the needs of the present without compromising the ability of future generations to meet their own needs." Sustainable development focuses on good management and use of (renewable) resources, reduction of environmental impact to sustainable levels, and good economic and social development

tragedy of the commons
destruction of a common resource when many actors harvest it without co-ordination, leading to the destruction of the resource. Restraints by a single actor are not sufficient to save the common resource