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On the General Principles of Environment Protection

A report from the Swedish Environmental Advisory Council

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A report from
the Swedish Environmental Advisory Council
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CONTENTS

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FOREWORD

Albert Einstein once said that we often make the mistake of believing that we can solve our problems using the very measures that caused them.

The transition to a sustainable society will pose tremendous demands in terms of change, re-appraisal and innovation the world over, compelling mankind to find new lifestyles and patterns of development.

The purpose of internationally accepted environmental principles is to make it possible for us to take dangers into account before they materialise. It is therefore essential for us to consider the real implications of these principles, as well as ways in which they can be extended. We hope that this report will contribute to the national and international follow-up of the undertakings made at the United Nations Conference on Environment and Development at Rio de Janeiro in 1992.

Olof Johansson
Minister of the Environment
President of the Environment Advisory Council

INTRODUCTION

Modern environmental protection is founded on a number of important principles. Some of them, such as the principle of sustainable development and the precautionary principle, are comprehensive in nature and can thus be seen as general guidelines for the environmental development of society.

Others — such as the Polluter Pays Principle (PPP) and the Best Available Technology Principle (BAT) — highlight the responsibilities of the polluter. These two principles are nowadays relatively well established in the West and are employed both in national legislation and in international conventions.

The principle of the cyclic society is less well known, however. It may be seen as an aid in gaining an operational interpretation of sustainable development. The concept of critical load is, in turn, an aid in determining the demands which must be made on polluters in order to attain the goal of sustainable development.

The substitution principle is related both to BAT and to the precautionary principle and is based on the idea that unnecessarily hazardous substances or methods should never be used.

When reference is made to such principles, however, the terms are not always interpreted consistently. In several cases, there are no clear and generally accepted definitions. This applies to BAT, for instance, and even more so to sustainable development. In other cases, the original definition may have become out of date; examples can be found of both deliberate and unintentional re-interpretation. PPP, for instance, is nowadays taken to imply that all environmental costs are to be internalised, which is not what the OECD intended when the principle was introduced in 1972.

The following report represents a contribution by members of the Swedish Environmental Advisory Council to the discussion of how these principles should be interpreted and applied in environmental work at both national and international levels. The varying lengths of the chapters reflects the fact that certain of the principles have already been the subject of comprehensive discussion while others are relatively new and little known outside a small circle of specialists.

The principle of the cyclic society and the substitution principle have been coined in Sweden. One of the objectives of this report is to make them more widely known in other countries.

The report opens with a chapter on the principle of sustainable development. This is followed by the principle of the cyclic society and the concept of critical loads. The discussion then continues, by way of the precautionary principle and the substitution principle, to BAT and PPP. The final chapter provides some concluding reflections.

Arne Jernelöv

THE PRINCIPLE OF SUSTAINABLE DEVELOPMENT

A clear lodestar or a diffuse aurora?

The concept of *sustainable development* gained worldwide usage through the Brundtland Report of the World Commission for Environment and Development. The purpose of this report was to answer the question of whether the future lodestar for the UN should be economic development, to provide the poor of the world with a basic material standard, or environmental protection, to guarantee the survival of the human race.

With its implication that two apparently incompatible goals actually can be united, the term rapidly gained political acceptance the world over. Sustainable development was one of the main concepts at the UN Conference on Environment and Development in Rio de Janeiro in June 1992, where Agenda 21 was able to draw up as a programme for how sustainable development could be attained. An "official view" of what the term implies can be found in Principles 3 and 4 of the Rio Declaration, which state:

- The right to development must be fulfilled so as to equitably meet developmental and environmental needs of present and future generations.

- In order to achieve sustainable development, environmental production shall constitute an integral part of the development process and cannot be considered in isolation from it.

In the light of this, one might think that it would be a simple matter to answer the question contained in the heading above. It should also be a simple matter to adapt the Rio decisions to national conditions, for example in a future Environmental Code. Words which approximate to sustainable development are also included in the Maastricht Treaty (Article B of the "Common Provision") and in the amended Article 2 of the Treaty of Rome. However, before the concept can become operational, a couple of fundamental questions must first be discussed. Simply because the words "sustainable" and "development" have been placed alongside one another, it does not automatically mean that the two have become one.

The need for clarification

The term sustainable development has not actually been defined. It is a philosophical principle which has been described only as a development which makes it possible for today's generation of mankind to satisfy its needs without making it more difficult for future generations to satisfy theirs. This is a politically attractive description, but it provides little foundation for decision as to whether one form of technology or economic programme is compatible with the objectives or not.

The vagueness of the term already gave rise to problems at the regional drafting meetings for the Rio conference, although this very vagueness has probably been essential in order to gain broad political acceptance for the term. In Kampala, Uganda, where the African regional meeting was held in 1989, sustainable development was used as a synonymous and replaceable term for sustainable growth by practically all speakers. It is quite natural that the developing countries consider that they have the right to some of the development that has created our economic prosperity. The problem with this interpretation of the term, however, is that in most cases growth is not sustainable. The world's environmental problems are also largely created by the classic growth philosophy of the industrialised nations; were the developing nations to follow the same course, it would lead to global environmental collapse. Like the continued development of the industrialised nations, therefore, the development of the poorer nations

must take on a much more sustainable form than conventional "growth".

What can continue to grow and what cannot?

Obviously, continued growth in physical terms is incompatible with ecological balance and environmental sustainability. A continued increase of anything — population, the use of energy, sugar production or iron ore extraction — will sooner or later lead to collapse when the Earth is no longer able to produce more.

When it comes to composite economic concepts like GDP, however, the question of ongoing growth becomes somewhat more complicated. The production of goods, measured in volumes, can probably continue to rise if it is the "knowledge content" of the goods which grows. The same applies to the production of services. Services which consume natural resources, such as transportation, cannot grow continuously without sooner or later coming into conflict with the tolerance of the ecosystem or the capacity of the Earth to supply such resources. On the other hand, we can take care of one another, sing opera arias or play football to a practically unlimited extent, and get paid for it, without noticeably disrupting the ecological balance. Since GDP and the economy include all these different types of production, ongoing economic growth is conceivable on condition that there is a simultaneous shift in the content of production towards greater knowledge content in the products and a greater proportion of services (which do not consume natural resources). GDP growth on a basis that includes items previously excluded (the work of women in the home, for instance) is also conceivable without coming into conflict with the concept of sustainable development.

Time scales and activities

The philosophical implication of the concept of sustainable development is that it should be possible for a given activity to continue for an unlimited period of time. Naturally, this is not the case with any activity if we consider time scales that encompass the very existence of the solar

system. This perspective is hardly relevant, however, so what sort of time scales should we consider to be unlimited in practical terms?

It is clear that the time scale must be long in relation to a human lifetime. It is also clear that it must be longer than our normal planning perspectives. However, if it is also to be longer than the time scales involved in the development of civilisations and technology in agriculture and mining, we are talking about millennia. If we are also to take biological evolution into account, along with succession in the ecosystem and climatological processes, we are talking about hundreds of millennia. Perhaps a couple of thousand years could serve as an acceptable "unlimitation", particularly in northern regions, where we can expect this to take us up to the next ice age.

Another important issue consists of activities. Do we link the question of sustainability to a geographically defined technology or project? This question can be illustrated with a couple of practical examples:

1. Can traditional clearing and burning, where the farmer cultivates an area for a few years and then moves on, be regarded as sustainable if the farmer's successors return to the site a few centuries later?

2. Can the collection of guano from bird colonies be considered sustainable if the amount of guano at each site only lasts for ten years and takes a thousand years to regenerate, and there are a hundred sites to collect it from?

3. Can the extraction of minerals be considered sustainable if the global reserves would last the lifetime of the solar system, but each deposit only lasts a decade?

If the question of sustainability only concerns individual projects — in the form of a given activity in a given geographical area or a given time scale — none of the above projects can be regarded as sustainable. If sustainable development relates to the technology as such, they could be. From a philosophical point of view, one might say that if the area is small enough and the time scale short enough, then no activity is sustainable.

In principle and in practice, the conclusion is that sustainability must be a question of the technology rather than the project in order to have any real meaning. A development or process that is sustainable in a global context is therefore one that can continue unimpeded for at least a few thousand years. For all the above examples, the practical answer is thus in the affirmative. One must consider the capacity for natural regeneration when determining whether or not a given development is sustainable. One must also ensure that the resources are available. A principle of sustainable development based on an assumption of human life without any utilisation of resources is not viable, nor is it politically accepted.

Sustainable development vis à vis the limits of growth

In the early 1970s, a group of researchers at the Massachusetts Institute of Technology and Boston University (MIT) were commissioned by the Club of Rome to produce a report which was published under the title of *Limits to Growth* — a book which generated a great deal of interest when it appeared.

One could summarise this book by saying that its point of departure was that the Earth can support only a certain population. It then went on to attempt to estimate the actual figure and to establish the main limiting parameters, reaching the conclusion that the population could not sustainably be higher than it already was at the time and that it was the food supply and availability of non-renewable raw materials which were the limiting parameters.

Interest waned rapidly and the report even fell into disrepute when the green revolution produced high-yield varieties of rice and wheat which raised the output per hectare, even in developing countries, to levels previously only dreamed of. (The authors have since published their own review of the book, in which they maintain that their conclusions were still basically correct.)

Now that the concept of sustainable development has become a platform for international agreements in Rio and for the national post-Rio environmental work in a number of countries, including Sweden, there is every reason to try to clarify the difference between the terms "the limits of growth" and "sustainable development". This difference can most simply be expressed by saying that the approach adopted by

the Club of Rome was static while that of the Brundtland Commission is dynamic. What are the implications of this?

Let us take a historical example: how many people could live on bronze-age technology, and for how long? (On the basis of modern know-how and estimates of high-grade surface deposits of copper and tin, we are in a fairly good position to answer this question.) A plausible answer would be: a few million people for a few thousand years. Bronze-age technology was thus not sustainable — but bronze-age development was!

The build-up of material resources, such as manpower and firewood, and the bronze-age development of metallurgical know-how, made the leap into the iron age possible. This gave access to a much broader base of raw materials. This development process can be likened to stepping from one tuft of grass to another in a marsh, having to find a new tuft before the present one starts to sink.

Obviously, there are many other historical examples of cultures that disappeared when the natural resources upon which their technologies were based had been consumed or destroyed. The most well-known ones are those based on irrigation (without drainage), which eventually results in salt being accumulated in the soil so that the production capacity is lost, as in ancient Babylon and Egypt. There was no new tuft of grass in sight or within jumping distance on the time scale, so the cultures wasted away.

There is one important difference between the historical examples and today's situation. Historically, many cultures utilised different resource bases in such a way that, although one culture might consume its resource base and succumb, others could survive. With modern transportation systems and a global market, however, there is no local shortage of copper or butter in any part of the world where people can afford to pay for them. Shortages take on a global relevance and are first felt where the ability to pay is lowest, not where the wastefulness is greatest. Mankind has become a single technological culture. One might say that we are all standing on the same tuft of grass or that the Earth has itself become one.

Where are the limits to growth?

If one attempts to analyse the limiting parameters for mankind's development in a dynamic light, i.e. by trying to take account of technological development, one finds that the limitations do not lie primarily in the availability of non-renewable resources. Far-reaching substitution possibilities exist both for metals and for minerals.

The term "ore" has, moreover, been defined in economic terms. It is a deposit which is economically feasible to extract. On the basis of the distribution of the elements in the Earth's crust, one might formulate the following rule of thumb: if the price of an element doubles, the economically extractable ore increases tenfold.

One possible exception to the conclusion that the availability of elements is not a limiting factor is phosphorus. Phosphorus, in the form of phosphate, is mainly used as a fertiliser and its use is essential to a high long-term biomass yield. There is no possibility of substitution. Plants will not begin using arsenic, whatever the price structures of mankind's economic systems.

The limitations are therefore unlikely to be noticed on the supply side first. Instead, it will be the emissions that first impose the limits. Emissions of carbon dioxide will pose real difficulties long before the availability of fossil fuels does. The accumulation of cadmium in agricultural land will be a problem long before cadmium shortages become acute.

Another difficult limitation is to be found in the biomaterial-freshwater-energy triangle. In simple terms, one might say that if we could solve one of the problems in this complex, we would have the solution to them all. Since, however, they are interdependent, we find ourselves in a Catch 22 situation. One problem cannot be solved unless one of the others has been solved first, which in turn requires that the initial problem is dealt with. If we only had the energy, we could desalinate seawater and transport it to wherever we need it. Then we could grow the biomass and get all the energy we need.

The static approach

The traditional approach of the Club of Rome has not outlived its interest in any way, however. In many contexts, it can be worth

adopting a static point of departure in describing the current situation and problems as they appear in the light of current values, lifestyles and technologies, so that we can see where changes in the parameters have the greatest effect.

The question can thus be formulated as follows: how many people can the Earth support at the average standard of the OECD nations, with the average technology of these nations, before the accumulation of residual products or shortages of biomaterial-freshwater-energy become limiting parameters? Depending on what sort of limits one has in mind, the answer lies somewhere between 400 and 800 million. If the best available technology were to be used, the figure would be much higher, albeit still far below the current world population.

The problem is that more than a billion people are already living at this material standard without using the best available technology in any way, and a further four and a half billion aspire to it. One can therefore observe that, with a static approach, the current development is unsustainable. How about a dynamic approach?

High technology — the problem or the solution?

On the basis of the dynamic approach — i.e. the concept of sustainable development — the most important test of whether or not a technology or activity is sustainable is to be found in flow analysis. If this shows that the activities tend to use more renewable resources than are being generated, or that the concentration of residual products in the biosphere tends to increase, then the activity is not sustainable. The technology must eventually be abandoned, or modified so as to achieve an cycle.

In this context, it is worth drawing attention to the change in the front line of the environmental debate among almost all industrialised nations during the past decade. Ten years ago, the debate focused on whether or not environmental issues were even important. The dividing line was drawn between those who wanted to protect the environment at any price and those who considered protection to be unnecessary and environmentalism to be hysterical. Today, practically everyone realizes that the environment needs protecting and, moreover, that such protection is a matter of long-term economic necessity.

Nowadays, the dividing line is drawn between those who feel that we should protect the environment by refraining from (large-scale) harmful technology and those who want to protect it by developing and refining the technology. The nuclear power debate in Sweden serves to illustrate the issue. Should we close down nuclear power or replace today's nuclear power stations with inherent safety systems? Should we endeavour to make nuclear power renewable and sustainable by extracting the uranium from the sea which is constantly being leached from the land?

Two cycles

Although the term "cycle" is considered unambiguous in everyday usage, it actually involves two types of process which in many practical applications involve different requirements and thus come into conflict with one another.

The natural ecocycles assume that the substances that we use are degradable and can be regenerated in the natural environment. Such substances, however natural they may be in themselves, must also be dispersed so that they do not occur in unnatural amounts or concentrations.

The technical cycles — those which we create with our own technology — assume, on the other hand, that the substances that are to be re-used are persistent and that they occur in large volumes or high concentrations so that the energy required for gathering them is not excessive.

Paper, which is a natural product, can be used to exemplify this problem. Cellulose fibre is degradable, both biologically and chemically. Like the raw material, timber, it can be recirculated in natural cycles. When we want to recycle paper, however, this very degradability becomes a disadvantage. After going through the process a number of times, the cellulose loses the properties which give the paper its basic characteristics. Technical recycling would be easier if cellulose were persistent.

Obviously, it is easier to maintain ecocycles in rural areas. Emptying a latrine in the natural environment would hardly give rise to any environmental problems, but the toilet waste from a big city would constitute a rather unmanageable heap. In our everyday conceptions,

environmentally sound living means living in the countryside in harmony with nature, while urban city-dwelling symbolises environmentally destructive lifestyles and a high level of resource consumption.

Seen in terms of technical development, however, the cities come into a new environmental light. Without reflecting on the matter, the spontaneous reaction might be that the major cities of the world can never be ecologically sustainable. (The majority of the world population is expected to consist of city dwellers soon after the turn of the century.) However, the city makes technical cycles possible and it is quite probable that recycling will reinforce the process of urbanisation. The example of paper recycling may also serve to illustrate this. If paper is recycled as much as the fibre quality allows — perhaps 80 per cent — the source of raw materials for paper mills will primarily coincide with the market, i.e. the urban regions. This is where the new paper mills will be built and where the employment opportunities will be created, which will in turn promote migration to the cities and consequent urban growth.

In a series of novels about Stockholm, Per-Anders Fogelström has made a general observation which may be of major significance in the context of urban and global environmental issues. He has said that in the city, unlike the countryside, more people die than are born. The cities never have a birth surplus — they grow as a result of migration. Could it be that urbanisation is the key to global population stabilisation?

Individual lifestyles

In order to illustrate the difference between classic environmental country life and life in the city, one can perform estimates of the environmental impact of a "typical" country family and a "typical" urban family — and the results leave no room for doubt. The long trips to school and shops and the heating of large, poorly insulated houses overshadow all else by a wide margin and mean that the move from the country to the city reduces a family's environmental impact. City dwelling is, in most cases, more resource-friendly and thus more environmentally sound than living in rural areas.

In other words, it is travel and heating that are the areas of our western lifestyle where our individual choices have the greatest impact

on the environment. For "normal" lifestyles, these are followed by hot water consumption (bath, shower and laundry), the amount of meat in the diet, and clothes.

Social organisation and behaviour

The environmental problems of the cities are largely related to traffic: the transportation of people and goods. Countless analyses and studies have endeavoured to find solutions in terms of traffic planning and vehicle technology, or have considered the possibilities of economic instruments — subsidies and charges — in order to make public transport more attractive than private motoring. Many measures have been tested and others are pending. As so often, the state is attempting to offset the consequences of the right hand's actions with those of the left. A large proportion of journeys by private motorists in Stockholm take place in leased cars. Since taxation of this perquisite is independent of the distance driven, journeys are free once the motorist has his or her car. The only reason to use public transport would be if it were to be faster. Since traffic planning measures are aimed at improving the traffic flow, however, this is unlikely to be the case. One might be able to reduce car traffic by changing the leasing system, however.

The above should not be interpreted as implying that measures which target traffic planning and vehicle technology have been of no significance when it comes to reducing the environmental impact of transport. Less lead in petrol, catalytic emission control, more energy-efficient engines and traffic systems around the city centres and smoother traffic flows have all meant a lot. The city air has also improved. Measures, whether planned or implemented, cost money, however. A lot of money. The lack of funds that can be earmarked for environmental purposes often appears to be the real obstacle to environmentally sound action in this field. However, it is easy to identify measures that the economists would applaud and which would also mean that the impact of traffic on the city environment could be drastically reduced. If, for instance, we were to switch from working eight hours a day for five days a week and instead worked in shifts of thirteen hours per day, three days a week, journeys to and from work would be reduced by 40 per cent at the same time as the utilisation of premises and machinery

would be almost doubled. Both the environment and the economy would benefit — as, perhaps, would family life.

Apart from illustrating that there are other interests incompatible with the environment than purely economic ones, this example can serve to demonstrate the environmental potential of social organisation and behavioural changes.

Questions raised by sustainable development

The above discussion illustrates a couple of points which are central to the choice and interpretation of the guiding principles for the sustainable development that must be mankind's objective.

First: sustainable development has not been clarified in such a way as to make it practical as a political instrument. In our view, the principle must be applied to technologies rather than individual projects in order to be applicable, and the overall scope of an activity is a crucial factor. The time horizon according to which the sustainability of an activity is judged must be set at a few thousand years, at least. Further clarification is required, however, particularly when it comes to international acceptance of the above or of similar analyses of the concepts involved.

Secondly: the resource base, the technologies and the population represent the traditional main components of development and sustainability. Other overlooked components that probably offer considerable potential include social organisation, systems of values and behaviour. This means that effective control systems will incorporate ethics, morals and economic policies. How should such control systems be designed and who is to introduce them?

Thirdly: the ecocycle principle, which is a central concept — even a criteria — of sustainable development, consists in its practical application of two separate components, involving quite different prerequisites. The ecocycle society is dual in nature — one natural component where degradability and dilution represent a benefit and one technical component which requires persistence and concentration. These two may require different social organisations, control systems and technologies. How are they to be designed and made to work in harmony with one another?

Björn Wallgren

THE PRINCIPLES OF THE ECOCYCLE SOCIETY

Introduction

The purpose of this chapter is to discuss and define the *ecocycle society*, i.e. a society in which the flows of various material *within* society have been reduced and closed to such an extent that the flows *from* society to the environment do not exceed the limits of sustainability. Two different types of closed flows of materials will be discussed: natural "ecocycles" (sometimes referred to as biogeochemical cycles) and "technocycles" — the cycles created by man within society.

Natural flows of materials are largely closed, but the scales may differ considerably in terms of time and space alike. Many materials may participate both in local cycles of short duration (which are never completely closed, however) and in very long-term global cycles, as in the case of carbon and the nutrients phosphorus and potassium. Nitrogen is involved both in the rapid local cycles and in a relatively fast global cycle. The same applies to water. Metals are also involved in cycles, albeit on a geological time scale.

Technocycles are, however, still largely a vision — the flows of materials in society today are in no way closed. On the contrary, we extract various materials from nature, we use them for a while and then consign them to waste sites. The materials can then be dispersed in the environment from these sites. In many cases, they spread to the environment even while they are being used, but more on this below. Certain of the materials flows in society are partially closed, at least, either for economic or for environmental reasons. Metal is recovered from scrap, for example, paper is recycled and packaging is reused.

The main thesis of this chapter is that we should limit our extraction of various materials from nature — whether renewable or non-renew-

able — and that reuse and recycling are two ways of achieving this goal. First, I should like to take up the issue of why the extraction of materials should be limited.

Why should we limit the extraction of materials?

There are three important reasons for limiting the extraction of materials from nature, as well as two subsidiary reasons. These are discussed below. First, however, I should like to comment on the use of the word "limit" rather than "reduce".

It would be incorrect to draw the general assumption that the current extraction of all materials for all purposes should be reduced. On the contrary, it is quite probable that we should increase our extraction of certain materials, particularly biofuels and other renewable materials, in order to promote reductions of more problematic ones. There is, of course, a limit to how much it is advisable, or feasible, to extract a given material, and this also applies to the less problematic ones. This is why I have chosen to use the word "limit" rather than "reduce".

Let us examine the reasons for limiting the extraction of various materials. Such reasons may vary in importance for different materials, and several of them may be valid for one and the same material. The three main ones are:

- Extraction and processing of the material may generate hazardous emissions and/or consumption of scarce resources. This applies to iron, aluminium and paper, for example.

- The material may be environmentally hazardous in itself. Matter is indestructible. Every kilogram of a material which mankind has brought into the technosphere will leave it again sooner or later, either directly into the biosphere or to a landfill. The very use of the material means that it spreads to the environment, either immediately or eventually. Zinc, for example, reaches the environment from galvanised iron and steel constructions; copper from copper roofing; nickel and chrome from stainless steel, and so on.

- The material may be a scarce resource. Here, we have to distinguish between two types of scarcity. For renewable materials it is the extractable amount per time unit that is limited. A field, for example, can only produce a certain amount of wheat per year. The availability of freshwater in a given area is limited by the catchment. For non-renewable materials it is the total available amount that imposes the limit. There is, for example, only a finite amount of exploitable phosphorus in the world (see below).

The following table shows the most important reasons for reducing the extraction of different materials. It is naturally highly simplified — there may well be other reasons. The important point is that *it is usually the environmental reasons, not the risk of scarcity, that should impose the limits for our extraction of non-renewable materials*. There is one important exception, however: phosphorus. Phosphorus is mainly used as a fertiliser and cannot be substituted by any other substance.

There are two further, albeit less important, reasons for limiting the extraction of materials:

- The material may involve problems in waste disposal in terms of sheer volumes. Large amounts of construction and demolition waste, excavated earth and rocks and other environmentally harmless materials are currently deposited at sites that are mainly intended for household waste and other more problematic forms of waste. Space for waste disposal is in short supply, both in purely physical terms and because people are unwilling to accept waste disposal sites in the vicinity of their homes. If these volumes were to be put to good use instead, the volume problem would be reduced.

- The material may litter the environment. Aluminium cans are an excellent example — many of them will end up in the natural environment, however much is done to collect them. They represent a highly unwelcome form of litter, particularly considering the fact that they are so prominent and will remain intact for centuries.

How can extraction be limited?

The prime goal is to limit the extraction of materials from nature so that the five problem areas listed above can be either solved or reduced to acceptable levels. Acceptable levels are discussed below.

One of the methods of limiting extraction of a given material would, of course, be to refrain from using the material in question for certain or perhaps even all purposes. In many cases, this may prove to be the simplest method. Since a technocycle can never be completely closed, particularly hazardous substances should be completely phased out. Sweden has therefore decided to phase out the use of cadmium, mercury and lead in the long term, for instance.

There are many materials and uses which we would like to be able to continue with, but without allowing any of the above-mentioned environmental problems to take on unacceptable proportions, even in the long term. If this is to be done, efforts must be made to handle these materials in closed cycles within the technosphere so that they do not flow directly from the technosphere out into the environment or from the technosphere to the landfills. Or, more correctly, since we will never be able to eliminate all such undesirable flows of materials, we must try to handle the materials in such a way that the outflow from the technosphere never exceeds acceptable levels.

The extraction of a given material may therefore be limited in two fundamentally different ways: by *reducing the flow* of the material within the technosphere or by *closing the flow* within the technosphere. These measures represent means to the end, not the end in itself.

In order to limit the extraction of a given material X, the following should be done:

- In goods containing X, in which X can be substituted by a less problematic material, X should be substituted by this material. This is the substitution principle as laid down in Swedish legislation concerning chemical products. Substitution in the broader meaning of the word may mean that the substance X can be replaced by a measure which has the same effect. One such example is when timber constructions are designed so that chemical wood preservation agents are rendered unnecessary.

- Reduce the use of goods containing X if X is spread to the environment by virtue of such use and if X is not even theoretically recyclable, e.g. lead in petrol and shot, zinc in galvanised metal roofs, tin in boat paints, etc.

- Reduce the use of such goods in cases where X reaches the disposal stage — which makes recycling theoretically possible — but where X is so mixed with other materials that it becomes impracticable to recover it for recycling. Examples include copper-chrome-arsenic in pressure-impregnated timber, metal compounds in paints, metals and plastics in composite materials and a number of metal components in buildings.

- Develop systems which mean that other goods containing X really are collected to an extent and in a condition that makes recycling possible. If the flows of X in the technosphere are few in number and concentrated, it will be generally simpler and less resource-intensive to collect the material than if there are a large number of diluted flows. This means that the range of goods containing X should be limited and that it will be easier to collect them in urban than in rural areas.

- Develop, if necessary, techniques for recycling X.

- Recycle X from the collected goods.

Which rates of extraction of different materials are compatible with sustainability?

So far, I have tried to show why the extraction of different materials from nature may need to be limited and the principles by which this can be done. The next question is how far one should go with such restrictions. Is it possible to state a maximum figure for extraction of X which is compatible with sustainable development? In other words, what is the maximum extraction of X that nature and human life can withstand in the long run? This is a difficult question, and is discussed in more detail in the chapter on sustainability. Here, I shall content myself by saying that a minimum condition for sustainability must be

that no environmental impact occurs which is irreversible and which becomes more severe as time goes on. Activities which have such impact are by definition non-sustainable, since the effects would sooner or later reach unacceptable levels, regardless of how such levels are defined, and since such impact would persist for ever. This condition applies in cases — most cases, in fact — where it is environmental concern that should set the limits for the extraction of materials from nature.

When it comes to phosphorus and other non-renewable materials where it is the danger of shortages which impose the limits, the question is harder if not impossible to answer. Phosphorus in fertilisers can never be substituted by anything else. Every time phosphate is removed from the phosphate deposits of the world, the amount of phosphate available to future generations is reduced, regardless of the fact that new recovery techniques will probably make it economically feasible to use phosphate minerals which cannot be used today. In the future it may be feasible to extract phosphorus from seawater, which will mean that phosphorus will have become a practically inexhaustible resource. It will then become one of the substances for which it is the environmental effects which set the limits for how much we can use. The only thing that can be said for the moment is that extraction of phosphate should be limited "as much as possible" and that all use of phosphorus should be phased out in applications, such as detergents, where it can be substituted by other materials.

The question of management of other non-renewable materials still remains, however. This, and other, issues were dealt with by a Swedish parliamentary committee, the Commission on Natural Resources and the Environment, which was appointed in 1979. In 1983 this Commission submitted its report *Use and husbanding of natural resources* (SOU1983:56, in Swedish) in which it proposed five ethical norms for the management of natural resources in Sweden. The fourth of these norms stated that non-renewable natural resources should be used in such a way as to make them last. This was, however, so vague that it provided little guidance. The Commission commented:

> "When issuing guidelines for the management of non-renewable resources, it is not possible to stipulate the condition that the rate of consumption should be adapted to the needs of future

> generations. A condition of this sort would be impossible to fulfil. However low the rate of extraction of each individual non-renewable resource may be, shortages will sooner or later arise which will give rise to difficulties, unless mankind is able to reduce dependence on the resource in question before that time (by modifying requirements and/or substitution). An ethical norm for the extraction of non-renewable resources will therefore be inherently inexact and open to a range of interpretations."

The Swedish Government and the Riksdag have since spoken in favour of sustainable management of non-renewable natural resources in different contexts — without stating, naturally enough, how far they consider that the resources should last. The Government Bill *A living environment* (prop. 1990/91:90) stated that "The objective of environmental policy is to ... manage natural resources to ensure long-term use". The *Ecocycle Bill* (prop. 1992/93:180) said "The achievement of total balance is a Utopian idea, but we can do much to streamline and reduce our use of resources so that the collective natural assets of the world will last longer".

Eternal sustainability is impossible, in principle. This is still the goal towards which we should strive, however. It would therefore be very valuable if we could reach some sort of agreement on what is meant by statements to the effect that non-renewable natural resources should be used in such a way as to make them last, so that they can be "utilised in the long term" or "last longer". How much longer? A hundred years? A thousand years? Ten thousand years? A question of this sort is impossible to answer, of course. It is impossible to apportion a given non-renewable resource to the people of the world in such a way that it will suffice for a predetermined period of time. In any circumstances, however, one must bear a time scale of at least a thousand years in mind when contributing to the depletion of a non-renewable resource. Pending evidence to the contrary, the present generation must assume that the resource in question will be required for a long time to come.

Finally, when it comes to biomass, it is a simple matter in principle to state limits for sustainable extraction. In the long term, we cannot extract more than the yield. This applies to vegetable and animal products alike.

The same applies to freshwater. It is the amount that flows in that determines the amount we can take out.

The ecocycle society

A society which applies principles of cyclic materials management can be described as follows:

The material flows in the ecocycle society will have been reduced and closed to such a degree that:

— *flows from society into nature can be added to the natural cycles without causing unacceptable environmental impact, even in a very long-term perspective,*

— *extraction of non-renewable materials is sharply limited in order to preserve resources for coming generations,*

— *supplies of biomass and water satisfy the needs of mankind without extraction exceeding growth or inflow.*

The origin of the ecocycle principle

The fact that the use of different materials may lead to environmental problems or scarcity of resources is a logical consequence of two fundamental laws of nature that have been known for several hundred years: *material is indestructible*, and *everything spreads*. In recent years, these insights have been incorporated in words like "ecocycle", "re-use", "re-cycling", "minimum-resource technology", "management of natural resources" and "environmentally sound products". It has been said that recycling is a pre-condition of sustainability in society.

The problems surrounding management or mismanagement of natural resources have long been the subject of international environmental debate. A full list of all the Swedish and international documents which have taken up these issues would be long, so I will content myself with mentioning a few reports that have been particularly

important in the development of Swedish policies on the environment and natural resources during the past twenty years.

One early example which attracted a great deal of attention in its day was the report *Limits to Growth*, commissioned by the Club of Rome in the early 1970s. The main findings of this report were that humanity was in danger of exhausting the world's non-renewable resources and that the use of materials was in itself generating environmental problems. The report posed the question as follows:

> What happens to the metals and fuels extracted from the earth after they have been used and discarded? In one sense they are never lost. Their constituent atoms are rearranged and eventually dispersed in a diluted and unusable form into the air, the soil and the waters of our planet... It is little wonder, then, that another exponentially increasing quantity in the world system is pollution.

The above-mentioned Parliamentary Commission proposed, among other things, that the use of heavy metals and other rare elements should be mapped out, in general but comprehensive terms, since their use *per se* results in the substances being dispersed in the environment sooner or later. In its report, the Commission stated that measures should be proposed as considered justified in order to counteract the accumulation of unacceptable quantities or concentrations of such substances in (areas of) the country. This proposal did not, however, result in any immediate action on the part of the Government or the authorities.

The report *Our Common Future*, published by the World Commission on Environment and Development in 1987 (known as the Brundtland Report) introduced the concept of sustainable development. In the context of non-renewable natural resources, the Commission wrote:

> With minerals and fossil fuels, the rate of depletion and the emphasis on recycling and economy of use should be calibrated to ensure that the resource does not run out before acceptable substitutes are available. Sustainable development requires that the rate of depletion of non-renewable resources should foreclose as few future options as possible.

Here, the world *recycling* appears. As in the report from the Club of Rome, however, the emphasis is on the risk of finite resources becoming scarce, not on the dangers to the environment which may arise from their use, although in the context of fossil fuels the Brundtland Report did highlight both scarcity and the environmental impact of use.

The United Nations Conference on Environment and Development in Rio in 1992 adopted a programme of action for the coming century, *Agenda 21*. Issues taken up in this programme include the current unsustainable patterns of production and consumption, particularly among the industrialised nations. Chapter 4 states that "Reducing the amount of energy and materials used per unit in the production of goods and services can contribute ... to the alleviation of environmental stress". According to Agenda 21, governments should therefore co-operate with industry and the general public to promote sound use of renewable natural resources, re-use in industry and management and introduction of more environmentally sound products. Waste issues are dealt with in Chapters 20-22, where recycling plays a prominent role.

In the beginning of 1993, the Swedish Government presented the Ecocycle Bill mentioned above. This Bill stated that more efficient resource management would be essential if sustainable development is to be achieved, including a transition to cyclic management of materials. It also stated that the ecocycle society would be more economical with resources, reduce its impact on the environment and preserve biological diversity. The Bill was adopted by the Riksdag without amendment. The Government has appointed a special delegation, the Ecocycle Commission, whose directives include drawing up proposals concerning a strategy for work on the application of ecocycle principles in the goods sector.

This Bill contained both general guidelines and concrete legislative proposals in a number of areas (see below), including waste. In other countries, such as Germany and the Netherlands, similar measures have been taken in the field of packaging, for instance. Sweden has, however, adopted a cyclic approach to society at large and has stated a clear goal: the ecocycle society. The Ecocycle Bill represents the start of a new phase in environmental conservation and the management of natural resources in Sweden.

Where do we start?

The thought processes which are to result in a long-term and well-considered strategy to limit the extraction of materials from nature should begin as far upstream as possible, starting with the raw materials. These are few in number and therefore easier to overview. The non-renewable materials consist of *metals*, of which there are no more than ten or so that are used to any great extent (apart from the "new" metals used in areas such as electronics, solar energy collectors and superconductors, etc.); *oil, gas* and *coal*; *phosphorus*, a unique resource; and certain minerals and bulk materials such as *gravel, stone* and *limestone*, etc. The renewable materials consist of various types of *biomass*. *Water*, i.e. clean freshwater in the right place, is also a renewable material.

If, for instance, the net input of a given metal to society is to be reduced, the patterns of use of that particular metal must be identified. How is use divided between different areas of application? Which uses mean that the metal is difficult or impossible to recover? Which applications would be cheapest, per kg metal, to cut down on or even refrain from completely? When an analysis of this sort has been completed in fairly general terms, it should be possible to see how one could achieve a certain desirable reduction of the total consumption of the metal.

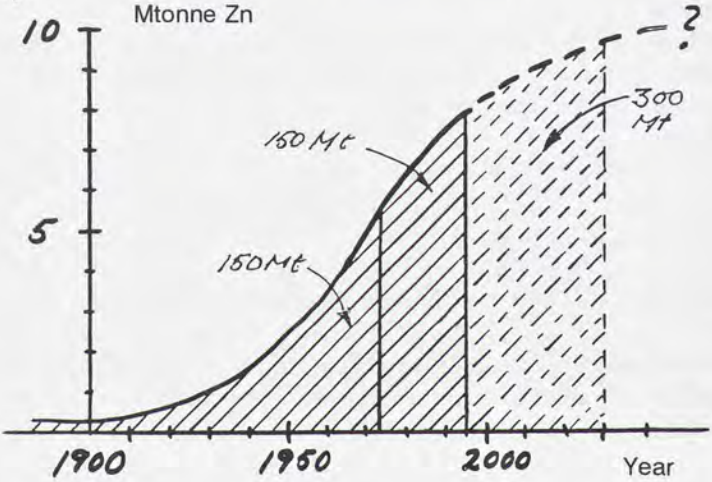
If, however, one were to start by searching among the thousands of different goods we use, there would be a great likelihood of incorrect decisions. Where would one start, among all the goods in a single department store?

Even without a comprehensive analysis, one can still identify individual goods for which there is no doubt that net consumption should be reduced, either via recycling or other measures. Measures of this sort have been taken in Sweden for batteries, solvents, a number of goods containing cadmium, mercury thermometers, etc. Further measures were announced in the Ecocycle Bill, including action against chlorine and chlorinated compounds, cleaning agents, certain types of packaging, paper, nickel-cadmium batteries, certain types of plastic, and scrap cars and tyres.

Final comments

Naturally, it will be no easy matter to develop an ecocycle society. All consumers, from trade and industry to public bodies and private individuals, will have to refrain from many of the goods that are now commonplace. They will have to become accustomed to new goods, and use them in new ways. Many conventional manufacturing processes will have to be replaced by new ones. A lot of new technology will have to be developed. The industries which extract raw materials will decline — once materials really are led into closed cycles in the technosphere, the need for virgin materials will diminish. The countries that are at the forefront of this development will meet with protests from those that lag behind, since their manufacturing and raw materials industries will face difficulties.

Ecocycle adaptation is essential, however, if we are to achieve sustainable development. In no way does this imply a return to a more primi- tive lifestyle. On the contrary, a sustainable society will be a high-tech society in the best meaning of the word — a society in which far more renewable raw materials and renewable energy sources are used than is the case today and which applies intelligent technology to reduce the consumption of finite resources to a fraction of what it is today.



World Zink Extraction

The above diagram shows the rate at which the world has been extracting zinc, from the bronze age to the present day. The shaded area beneath the curve shows the total amount of zinc which has been extracted to date. About 150 million tonnes were extracted between the bronze age and the mid-1970s. During the following twenty-five years we extracted the same amount again. Even if we were to freeze the extraction of zinc at today's level, we will have extracted as much zinc within the next generation as we have done up to the present day.

One common, and quite reasonable, assumption is that Sweden accounts for 1 per cent of the world market. The total zinc input to the Swedish technosphere can thus be estimated at 3 million tonnes. An unknown proportion of this zinc has already found its way into the Swedish environment, as it all will sooner or later, apart from the little which we succeed in isolating in landfills — where it will remain for all eternity. The amount of zinc involved here is many times greater than the total of all point emissions of zinc to date.

Zinc is only one example. The situation is similar for other non-renewable resources. The use of different materials will, in the long run, lead to the spread of harmful substances in our environment in quantities that are orders of magnitude greater than inputs from industrial emissions and other point sources, unless we can learn to handle such materials better than we have been doing to date.

The most important reasons for reducing the extraction of different materials

	Extraction harms the environment	*The material harms the environment*	*The material is in short supply*
Non-renewable			
Iron	X	—	—
Aluminium	X	—	—
Heavy metals and other scarce elements	—	X	—
Oil, coal and gas	—	X	—
Phosphorus	—	—	X
Renewable			
Biomass	—	—	X
Water	—	—	X

Henning Rodhe

THE CONCEPT OF CRITICAL LOADS

Background

The term critical load first appeared when acidification of soil and surface waters in Europe became an issue and discussion focused on the extent to which sulphur and nitrogen oxide emissions would have to be reduced (Nilsson, 1986; Nilsson and Grennfelt, 1988). Previously, the objectives had been expressed in general terms ("acid deposition is far too high, so emissions must be reduced") or in the form of targets (e.g. the 30 per cent target for reductions in sulphur dioxide emissions) without any clear link with the actual damage. During recent years, a lot of work has been devoted to specifying critical loads for acidifying substances on the basis of more scientific criteria (Kämäri et al., 1992; Sverdrup et al., 1992; Henriksen et al., 1992), as well as to mapping out the relevant loads in geographical terms, with due regard to the sensitivity of soils and surface waters (Hettelingh et al., 1991; Kuylenstierna and Chadwick, 1989). A historical overview has been provided by Brodin and Kuylenstierna (1992). Today, the critical load concept plays an important role in EC negotiations aimed at reducing acid deposition in Europe.

The term critical load has also been applied to toxic metal deposition (Tyler et al., 1988). A corresponding term, critical level, has come into use in the context of damage caused by high concentrations of toxic gases, particularly ground-level ozone (ECE 1988; Grennfelt, 1993). Similar concepts have also been suggested in conjunction with climate change (Rijsberman and Swart, 1990).

Definitions

To aid discussion, I shall begin by providing some brief definitions of critical load and certain related terms.

Critical load is the highest load at which no harm is caused to the environment, even after long-term exposure. When it comes to acidification, the limits are generally expressed in terms of deposition of sulphur, nitrogen or hydrogen ions per surface unit and time unit. The corresponding definition applies for heavy metals. For ozone damage, the limits (critical levels) are expressed as the sum of the hourly ozone concentration values during a vegetation period (expressed as ppb hours). In the context of climate, an appropriate measure might consist of a critical rate of change in the mean global temperature expressed in degrees Celsius per decade.

Target load is the load which is set up as the goal at any given time on the basis of political and administrative criteria. The term *target level* is defined correspondingly. From the ecological point of view, this limit should be either the same, or lower, than the critical load (level) for the most susceptible ecosystems or for human life. In reality, it is often higher for "practical" reasons (technological and economic feasibility), which means that a certain amount of environmental impact is accepted, at least on a temporary basis.

Related terms that are applied in various areas include:

Pollution space; which refers to the amount of a pollutant which may be released in a particular reservoir before harmful effects begin to appear. *Assimilative capacity* is a similar term which has mainly been used in the context of marine recipients.

Target values for air quality in urban areas. These target values indicate the levels of air pollutants — CO, NO_2, SO_2, for instance — which should not be exceeded. They are mainly based on estimates of health risks. Similar target values also exist for other types of air and water pollution.

Dose threshold for deterministic effects of ionising radiation on human tissue is defined as the dose level below which the function of the tissue would not be impaired by the killing of cells (ICRP, 1991). Radiological

criteria are also being developed for ecosystems, on the basis of *dose rate limit*. This limit is defined as the level below which observable changes in species and ecosystems are unlikely to occur.

It is interesting to note that for stochastic effects, where irradiated cells are modified but not killed, no threshold is believed to exist. In this case, the probability of cancer is non-zero even at very low doses, and increases with increment of dose.

Tolerable daily intake indicates the amount which can be taken per person and day without any unacceptable health effects. This term is used by WHO, for instance, in conjunction with intake of metals.

Applications

A. The impact of acidification

In the context of acidification, there can be little doubt that critical loads have played an important role in the discussions of recent years on reducing sulphur and nitrogen emissions in Europe, and have helped to provide a fair idea of the reductions required in order to avoid further harm. By mapping out the geographical distribution of critical loads (on the basis of the local geologies and ecosystems), moreover, it has been possible to compile data as a platform to enable serious discussion of how the reductions should be distributed in regional terms and thus maximise the benefits of a given economic measure. Table 1 shows the latest estimates of critical loads for sulphur and nitrogen deposition in various parts of Sweden.

Discussion of critical loads has also prompted researchers to look into the long-term resistance of soils and watercourses and their ability to recover from acidification if deposition were to decline.

The USA views critical loads with greater reservation, since there is greater disagreement among researchers as to the definition of the term and it is not compatible with the present formulation of the Clean Air Act. There is also greater reluctance among politicians to implement emission reductions.

There are also certain inherent difficulties in the term which may limit its usefulness. One objection is that once emissions have been brought down to the presumed critical load, there is nothing to encourage further reductions. When the real load is lower than the

critical load, or about the same, the term becomes dangerously similar to pollution space or assimilative capacity, concepts which have in several cases proven to be not only unworkable but even hazardous. The reason for this is that it is very difficult to prove that a critical load really is safe and that a lower load would not be better. In several cases, it has been shown that diffuse, widespread impact has occurred despite the fact that emissions have been kept within what was regarded as the pollution space. This approach is reminiscent of the factory chimney philosophy of the 1950s and 1960s, which meant that local target values for sulphur dioxide could be met while regional acidification problems were exacerbated.

In the light of the above, one might claim that the term "critical load" is most applicable in situations where the real load is well in excess of the critical figure. This assumes, of course, that scientific data is available to allow the critical load to be determined and that it is possible to provide an adequate estimate of the relationship between the load and the emissions that cause it.

Another problem is associated with the way in which one views the most susceptible areas of ecosystems. These are often already "sacrificed" when determining critical loads, on the pretext that the figure would otherwise be impracticably low.

B. Heavy metals

When it comes to heavy metals, environmental goals have been discussed both for forested land and for agricultural land. With what is known today, however, it is only possible to make very general statements such as "efforts should be made to ensure that the long-term balance in terms of metals in the soil ecosystem is kept at a level such as to eliminate the risk of undesirable impact by a wide safety margin", and "in the short-term, the large-scale accumulation of metals in the humus layer of the soil should be as small as possible" (Swedish Environmental Protection Agency, 1993).

C. Ground-level ozone

When it comes to the impact of high levels of ground-level ozone, the term critical level has played a less prominent role to date. This is to some extent attributable to the fact that ozone is formed as a result of complicated — and as yet not fully explained — processes involving a number of precursors: nitrogen oxides, carbon monoxide and hydrocar-

bons. A further complication is that the ozone levels which damage crops and other vegetation do not exceed the natural levels by a factor of more than about two. This means that in order to judge the anthropogenic contribution of the observed ozone levels, a very high background level must be taken into account. The inherent difficulties of the critical load concept mentioned under section A above also apply in this case.

D. Persistent toxic compounds

For certain types of toxic substances, including persistent organic compounds, the term critical limit is somewhat problematic since all loads can be expected to result in damage sooner or later. The critical limit should be zero.

E. Climate change

In the context of the climate, one could hardly claim that critical loads (or corresponding concepts) have played any significant role to date. Rijsberman and Swart (1990) have suggested that a temperature rise of 0.1 degrees per decade could be a reasonable maximum global rate of change which would allow the ecosystem to adjust. This is based on the fact that the natural temperature variations during the past centuries would seem to have remained within this limit and that these variations therefore define the maximum level for natural climatic stress for the Earth's ecosystem. There is, however, little agreement among ecologists and climate researchers that this is the best figure to use, or even if it is the right type of critical limit to specify. One obvious problem is that a global temperature change says little about changes in specific regions. An anthropogenic climate change of the same global mean value as earlier natural changes would not necessarily result in the same regional patterns of change.

Above and beyond the limit for the rate of temperature change, total global limits of between 1 degree (low-risk limit) and 2 degrees (high-risk limit) above the pre-industrial level have also been suggested (Rijsberman and Swart, 1990). These limits are based on estimated temperature fluctuations over the past millennium. They are of particular relevance when it comes to the long-term impact of rising sea level, for instance.

Safety margins

There is justification for including safety margins when determining the various limit values defined above. WHO, for instance, has raised this point in the context of urban air quality, stating safety factors of 2-5 for substances with relatively insignificant and short-lived effects, or up to 5 000 for substances which may have a serious impact and to which many people are exposed for long periods of time.

The critical loads for sulphur and nitrogen deposition, like the critical levels for ozone, include no safety factor. Nor, evidently, do the above limit values for temperature change. If the precautionary principle is applied to the critical loads, it would probably be necessary to reduce them to a level considerably below the estimated figures (see Tables 1 and 2). The corresponding argument also applies to limits for global temperature change.

It is open to discussion whether the safety margins should be included in the critical limits purely as a matter of principle or whether they should be included in the targets themselves. In the former case it would be primarily up to the researchers to judge the uncertainty in the scientific data; in the latter it would be for the politicians to make the final assessment of which risks are acceptable.

Conclusions

The term critical load is useful and valuable for general assessments of the need for reductions in acidifying substances in strongly polluted regions. Further work is required, however, in order to gain a better idea of loads which would be risk-free in the long term and which would include reasonable safety margins. More must be done, moreover, to estimate critical loads for other, less acidified areas of the world (cf. Kuylenstierna et al., 1992).

When it comes to the damage caused by ground-level ozone, much better scientific data are required before the concept can be used to develop effect-oriented control strategies. The problem consists partly of the difficulty of relating ozone levels to emissions of precursors and partly of the relatively high natural ozone levels.

When it comes to the climate, it can hardly be claimed that any viable method of defining critical limits has been put forward to date,

even less that it has been possible to quantify such limits. Continued discussion of these issues, among researchers and decision-makers alike, is a matter of the utmost importance.

REFERENCES

Brodin Y.-W. and Kuylenstierna, J.C. I. 1992. Acidification and critical loads in Nordic countries: A background. Ambio 21, 332-338.

ECE, 1988. Report from ECE Critical levels workshop held in Bad Harzburg, F.R.G., March 14-18 1988. Umweltbundesamt, Berlin.

Grennfelt, P. 1993. The critical levels for ozone and the necessary reduction of the emissions of ozone precursors. The Swedish NGO Secretariat on Acid Rain.

Henriksen, A., Kämäri, J., Posch, M. and Wilander, A. 1992. Critical loads for surface waters in the Nordic countries. Ambio 21, 356-363.

Hettelingh, J-P., Downing, R.J. and de Smet, P.A.M. (eds.) Mapping critical loads for Europe. CCE Technical Report No. 1, National Institute of Public Health and Environmental Protection, Bilthoven, The Netherlands.

ICRP 1991. 1990 Recommendations of the International Commission on Radiological Protection, ICRP Publication 60. Annals of the ICRP 21 (1-3). Pergamon Press, Oxford.

Kämäri, J., Amann, M., Brodin, Y-W., Chadwick, M.J., Henriksen, A., Hettelingh, J.-P., Kuylenstierna, J., Posch, M. and Sverdrup, H. 1992. The use of critical loads for the assessment of future alternatives to acidification. Ambio 21, 377-386.

Kuylenstierna, J.C.I. and Chadwick, M.J. 1989. The relative sensitivity of ecosystems in Europe to the indirect effects of acidic deposition. In Kämäri et al. (eds.) Regional Acidification Models. Springer Verlag, Heidelberg, 3-21.

Kuylenstierna J.C.I., Cinderby, S. and Chadwick, M.J. 1992. A preliminary mapping of relative sensitivity of terrestrial ecosystems to acidic deposition in Asia. In Foell, W.K. and Green, C.W. (eds.) Proceedings of Third Annual Conference on Acid Rain and Emissions in Asia. Asian Institute of Technology, Bangkok.

Nilsson, J. (ed.) 1986. Critical loads for nitrogen and sulphur. Nordic Council of Ministers, Environmental report 1986:11. Copenhagen, Denmark.

Nilsson, J. and Grennfelt, P. (eds.) 1988. Critical loads for sulphur and nitrogen. Nordic Council of Ministers, Environmental report 1988:15. Copenhagen, Denmark.

Rijsberman, F. R. and Swart, R. J. (Eds.) 1990. Targets and indicators of climatic change. Report from the Stockholm Environment Institute.

SNV 1993. Ett miljöanpassat samhälle. Aktionsprogram Miljö 93. Statens naturvårdsverk, Stockholm.

Sverdrup, H., Warfvinge, P., Frogner, T., Hääya, A.O., Johansson, M. and Andersen, M. 1992. Critical loads for forest soils in the Nordic countries. Ambio 21, 348-355.

Table 1.a) Typical critical loads for sulphur in forested land and surface waters; current deposition and necessary reductions in different parts of Sweden.

	Critical load kg S/km²/year	**Current deposition kg S/km²/year**	**Necessary reduction %**
Götaland	300	700-1800	60-80
Svealand	250	500-900	50-70
Norrland	250	300-600	15-60

NB: Typical critical loads and deposition refer only to anthropogenic sulphur deposition. Non-acidifying sulphur deposition from sea salts is not included. Current deposition consists of mean values for squares of 50 x 50 km.

Table 1.b) Typical critical loads for nitrogen deposition on soil, current deposition and necessary reductions.

	Critical load kg[1] N/km²/year	**Current deposition kg[2] N/km²/year**	**Necessary reduction %**
Götaland	500	600-1800	approx. 60
Svealand	400	500-900	approx. 40
Norrland	300	200-600	approx. 20

1) Determined according to the risk of nitrogen leaching or changes in vegetation in forested land and mires.

2) Mean deposition for 50 x 50 km squares, 1989-1992.

Arne Jernelöv

THE PRECAUTIONARY PRINCIPLE

Caution in environmental contexts

The precautionary principle can be said to be a philosophical expression of the self-preservation instinct that we all tend to apply in all our actions. The principle has been referred to increasingly often in the argumentation of the environmental movement in recent years, particularly since a preparatory UNCED meeting in Bergen in 1990 gave it international acceptance. Such references often take the form of very general statements such as "it is wise to be cautious" or "one should not take action without being able to predict the consequences". In southern Europe, references often include formulations related to a central concept of Roman justice — the good family father.

It was in Germany that the precautionary principle first appeared in environmental legislation, albeit with the implicit qualification that economic considerations should be taken into account. This has been discussed by Konrad von Moltke in the IEEP Report *The Vorsorgeprinzip in West German Environmental Policy (1987)*.

Lengthy negotiations were held prior to UNCED and the Rio Declaration, and the precautionary principle was one of the subjects covered. Legal experts discussed choices of words and punctuation and negotiators scrutinised the formulations in the light of desirable and undesirable consequences at international level. The result was Principle 15 of the Rio Declaration, which was worded as follows:

> In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for post-

poning cost-effective measures to prevent environmental degradation.

Since the Rio Declaration has been signed by a very large number of countries, including Sweden, this can be regarded as the official formulation. Reference to any other formulation of the precautionary principle in international environmental contexts would only lead to confusion. Even so, one can observe that the precautionary principle as framed in the Rio Declaration is considerably circumscribed by virtue of reservations and references to the capabilities of states and to cost-effective measures, thus reducing its importance as a lodestar for environmental protection. Nor is there any clarification of when a threat is to be considered imminent and how scientific certainty is to be interpreted. On the other hand, this vagueness represented the price of broad international acceptance, which is a prerequisite if the principle is to be of any significance at all.

When interpreting the precautionary principle, the fact that it deals with (environmental) decisions involving (scientific) uncertainty is of paramount importance. In this respect, it is clearly related to the principle of "reverse burden of proof", which states that it is not guilt but innocence that is to be proven. However, the precautionary principle circumvents the theoretical pitfall that non-existence can never be proven.

Outside the environmental field, parallels with the precautionary principle can be found in national regulations in pharmaceuticals and health protection.

Environmental experience

It is worth calling to mind the environmental experiences upon which the precautionary principle was based when it was put forward in Bergen:

Many classic environmental problems — acidification in Scandinavia, methyl mercury poisoning in Minamata and the effects of DDT and its metabolites on bird reproduction, for instance — persisted long after the problems had been discovered and the causes identified, since the polluters claimed that the exact quantitative causal relationships had not been established and that it was therefore impossible to judge the

action required at their facilities in order to adequately limit the problem. The precautionary principle gained international acceptance as a means of avoiding this sort of time delay in the future and preventing the effects from being exacerbated pending the findings of research into the mechanisms and links between doses and effects.

Application: General issues

It is quite clear that many of the environmental issues and problems that call for solutions will differ from those which provided the basis for the formulation of the precautionary principle. At the same time, it is quite clear that the purpose of formulating principles for environmental protection is to avoid similar, albeit not identical, problems to those which have been experienced in the past. What "similar" can, and should, be interpreted to mean is clearly a matter of opinion. Among other things, the application of the precautionary principle requires answers to the following general questions:

- *Is the precautionary principle applicable to something which does not yet exist or only to the effects of current activities?*

Although the formulation of the Rio Declaration does not actually say so, the work on the drafts and negotiation documents shows that the principle was intended to cover future events. This becomes particularly clear in the context of cost-effective solutions, which may involve more stringent requirements for newly-built facilities than for existing ones. The precautionary principle is applicable to things that do not exist at the present time.

- *Can the precautionary principle be applied to a structure, such as a factory building or road, when it is not the structure itself but the activities conducted there which are expected to give rise to the main environmental impact?*

In this case, there is little guidance to be found among the drafts and negotiations prior to the Rio Declaration. Parallels will have to be sought in other areas, such as laws and regulations concerning weapons and medical equipment. Here, the point of departure would appear to

be that if anything, such as a gun or a syringe, is designed for a specific purpose then it can be assumed that it is to be used for that purpose. Manufacture, sale and possession are regulated thereafter. It is not considered advisable simply to issue regulations for use. Analogously, the precautionary principle should be applicable to structures which are designed for a specific purpose, for example a motorway or a bridge, while the question of a factory building depends on how purpose-specific the construction is. Consideration of this issue should not cover just the structure itself, but also the consequences of planned use.

When it comes to quantitative aspects, the point of departure should be that the full capacity of the facility will be utilised unless strict rules on the degree of utilisation and/or emissions can be linked with the licence to put the facility into operation.

○ *Is the precautionary principle applicable only to a single object, or does it cover the entire chain of possible consequences?*

All human activity has an impact on the environment. The scope of such environmental impact depends on the scope of the activities. If one were to apply a form of Kant's categorical imperative to the environmental field and say that "The only actions which are permissible are those which every person can do to the same extent where he or she lives without the environment ever being harmed", then very few things would be permissible. Jones would be unable to build a 100m² greenhouse if the condition was that the environment should be able to support 5 billion identical greenhouses. Nobody would be permitted to drive a car or light a wood fire.

The logical consequence of this is that the environmental impact and permissibility of an activity must be limited to the foreseeable consequences of the decision in question. The precautionary principle must also be circumscribed by the proviso that it can only be applied to individual links and not to the entire chain in all its unknown length. In practical and administrative terms, this must be solved by new independent tests where the point of departure is not that the earlier decision is prejudicial ("If Jones could build a greenhouse, so can I") but that the question of whether the benefit of one further link in the chain under consideration will outweigh the environmental impact.

At the time each decision is reached, the precautionary principle is applicable only to the individual object and its direct consequences.

Another aspect on the application of the precautionary principle becomes apparent if one considers emissions from a specific group of substances — greenhouse gases, for instance.

As we have observed above, the precautionary principle arose in the light of experience of the difficulty of quickly solving environmental problems that had in many cases been caused by long-range pollution. The precautionary principle is thus applicable to greenhouse gases. In this case, the problem is identified in the light of the entire chain, whose individual links consist of the activities that give rise to the emissions. Since the entire chain is the sum total of its links, the precautionary principle must be extended down the chain and applied to the activities from which the problem originates.

The above argument thus leads to the conclusion that the precautionary principle is limited only to the direct future consequences when it is applied to an activity, but that it must also cover all the underlying causes when applied to a problem.

It should be stressed that the object of the precautionary principle, like that of other environmental principles, can scarcely be that it should be used to select and eliminate known dangers in favour of unknown ones. This problem is discussed further in the chapter on the substitution principle.

The precautionary principle in Sweden

One could say that one of the cornerstones in Swedish environmental legislation is that it is up to any person wishing to conduct an activity that can be expected to have an impact on the environment to prove that this is not the case (or that the impact is outweighed by the benefit). If the activity is found to be acceptable from the environmental point of view, a licence can be granted, otherwise not. The drafts of the Environment Protection Act also state that the general public should not be the ones to suffer from any uncertainty surrounding the danger of a given substance.

Together with other expressions of the precautionary principle in Swedish law, these two instances are, however, symptomatic of a somewhat archaic national approach. The awareness that environmental problems are often international, if not global, is more in evidence in the proposals of the Commission of Inquiry on Environment Protection

concerning a new Environmental Code (SOU 1993:27). This contains both the precautionary principle and the underlying principles as expressed in the text of the law itself. Even without pre-empting the legislation, the impression is that the precautionary principle enjoys a strong position in Swedish environmental legislation.

A comparison between the precautionary principle as expressed in the Rio Declaration and in current Swedish law shows that the older Swedish law focuses on the environmental impact of the individual object, while both the Rio Declaration and the proposals of the Commission of Inquiry on Environment Protection concerning a new Environmental Code also take other broader issues, such as climatic impact, into account. The proposals in the Environmental Code show more clearly than the Rio Declaration the preventive nature of the precautionary principle and do not involve the same clear limitation with respect to cost-effectiveness.

Cost-Effectiveness

Cost effectiveness is not expressly a principle for environmental work, but clear references to cost-effective solutions are often made in environmental contexts such as Principle 15 of the Rio Declaration — the precautionary principle — and in both current and proposed substitution regulations.

When one studies references to cost-effectiveness among various environmental players, it becomes clear that there are two different views of what the term actually means. One interpretation is that measures are cost-effective when the cost of the damage that arises if the measure is not taken is greater than the cost of the measure itself. The other interpretation is that a cost-effective measure is the cheapest way to attain a given environmental goal (e.g. an emission restriction) regardless of whether it has been possible to estimate the economic scope of the damage, or of the results of such an estimate. In this second interpretation, the cost of a possible measure is compared with the cost of alternative measures.

The strictest and most austere interpretation is naturally that both criteria must be met if a measure is to be termed cost-effective. The cost of the measure in question should be lower than both the cost of the damage in the absence of measures and of the cost of alternative

measures. If, however, one examines the contexts in which references are made to cost-effectiveness — such as the above-mentioned Principle 15 of the Rio Declaration — this strict interpretation would not seem to be the most plausible one. Principle 15 of the Rio Declaration says that "lack of scientific certainty shall not be used as a reason for postponing cost-effective measures". Scientific certainty in the form of quantified causes and effects should in most cases be an essential prerequisite for the calculation of the marginal cost of damage and for comparing this cost with the marginal cost of measures.

If, in order to determine whether a cost-effective measure is available, one were to require the very scientific certainty that the polluter pays principle states is not to be required, the legal experts and diplomats behind the Rio Declaration will have created a Catch 22. This can hardly have been their intention, which suggests that a measure is cost-effective by definition if it is the most inexpensive alternative. This means that the definition of cost-effectiveness in terms of environmental economy will differ from the accepted economic one. This fact may cause some confusion, but it is essential to recognise it if the environmental principles from Rio are to be anything other than a play for the political gallery.

In purely practical terms, there is good reason in this context to highlight the fact that our resources are limited. It is often said that every 50 per cent cut in emissions of a substance costs an equal amount. The first 50 per cent of purification thus costs roughly as much as the following 25 per cent or the following 12.5 per cent. This means that, in terms of total purification, the effect per unit of money will be greater — both globally and regionally — if one concentrates resources on the areas where the problems are greatest. A given sum of money at the current time will often do more good in eastern Europe, where environmental work has been extremely neglected until recently, than in Sweden, where we already have a relatively effective overall environmental effort. This also applies in a local Swedish perspective.

Arne Jernelöv

THE SUBSTITUTION PRINCIPLE

The idea behind the substitution principle is that substances and products which represent a danger to health and the environment are to be substituted by less dangerous ones. The wording of the principles determines whether the technical and economic circumstances will be attributed greater or lesser importance.

Unlike most other environmental protection principles, the substitution principle is not really covered by the Rio Declaration or other international agreements.

Current and proposed legislation

In current Swedish law, the substitution principle is to be found in § 5 of the Act (1985:426) on Chemical Products, which says that:

> Anyone handling or importing a chemical product shall take such steps and otherwise observe such precautions as are necessary to prevent or minimise harm to human beings or to the environment. This includes avoiding chemical products for which less hazardous substitutes are available.

In Chapter 3 § 5 of the proposed Environmental Code, the substitution is more specific, stating that:

> Each and every person who causes or intends to cause environmental impact shall avoid chemicals or biotechnical products or goods which can, with significant benefit to the health, environment or long-term good management of environmental

> resources, be substituted by chemical or biotechnical products or goods which are less hazardous or which involve reduced use of natural resources.

The draft of § 6, however, stresses the importance of the technical and economic conditions:

> If it is clear that a certain measure of precaution required pursuant to §§3-5 is excessively expensive in relation to the benefit it involves for the environment, a less expensive measure of precaution may be chosen.

The proposals of the Swedish Commission of Inquiry on Environment Protection require that the benefits of substitution in terms of human health and the environment are considerable, and that the cost is not. The Commission maintains that the change involves overall codification of generally accepted practice, but with certain changes. According to the new proposal, both biotechnical products and other goods with negative environmental impact will be subject to the regulation, not just chemical products as in the prevailing wording. The substitutions required by the law are also to be significant; very minor improvements are not to be taken into account. It is also made clearer than before that the substitution principle applies to everyone, not just enterprises that are subject to regulation, but also private individuals who choose petrol for their cars or weed-killers for their gardens.

If these changes in the wording of the law take effect, certain questions surrounding the application of the substitution principle will be answered. Certain other important questions will remain, however. In practical terms, the general problem of weighing different effects against one another will still arise. How many severe allergies or how many square meters of dead Baltic seabed offset one case of cancer? It is clear that there are no "true" answers, but that administrative practices must be drawn up on the basis of current values in society.

In practice, it is often not a matter of comparing one actual effect with another, but the probability of one effect with the probability of another. The probability of a negative effect is, by definition, a risk. This risk naturally depends not only on the properties of a substance, but also on the exposure. The risk can thus be reduced by substituting

a hazardous substance by a less hazardous one and/or by preventing the substance from coming into contact with the objects which it affects.

In Agenda 21, Chapter 19, which deals with toxic chemicals, the goal stated in item 19.48 is worded as follows:

> The objective of the programme area is to eliminate unacceptable or unreasonable risks and, to the extent economically feasible, to reduce risks posed by toxic chemicals, by employing a broad-based approach involving a wide range of risk reduction options and by taking precautionary measures derived from a broad-based life-cycle analysis.

A methodological issue of principle and strategic importance is that of whether the environmental danger of the substance or product in use is to be assessed, or whether the "cradle to grave" approach is to be adopted. A closely related question is that of whether it is just the substance or product or the entire technical system in which it is used that is to be assessed. A hypothetical detergent may serve as an example. The detergent contains phosphates which may become a limited resource and which cause eutrophication if they reach watercourses. On the other hand, they allow washing at low temperatures, with the result that energy conversion involves less environmental impact.

Should one take the raw material in the detergent and the manufacturing process into account? Should one take the energy savings when it is used into account? Should one consider that more than 90 per cent of use is expected to occur in places where chemical precipitation removes almost all the phosphates from the sewage?

It would be unreasonable to intentionally exclude available information or adopt a narrower approach than is necessary. One should endeavour to adopt a holistic view almost as a matter of course, particularly at a time when life-cycle analyses in other related contexts represent an important environmental principle and method in themselves. This approach permeates the proposals of the Commission of Inquiry on Environment Protection for the new Environmental Code.

Another important point which is given clearer attention in the proposed Environmental Code is the necessity of not allowing the search for a perfect, fully comprehensive basis for decision to result in

an inability to take action. This can be avoided by applying the polluter pays principle in this context too.

One further factor to take into account is the amount of available knowledge. Perhaps the best strategy is to "rather bear those ills we have than fly to others that we know not of". The substitution principle should, in any case, not be applied in such a way that new substances are always classed as less dangerous because we know less of their risks than of the older substances. This does not imply that the polluter pays principle should be set aside.

Peer reviews

One central issue in the combination of the substitution principle and polluter pays principle is the question of when does a threat exist, or when is a suspicion scientifically founded? Unlike cultural activities or sports which are judged by points, there are no external judges in science. Scientific quality is assessed only by scientists and researchers themselves. The prevailing system of peer reviews is subject to a great deal of discussion and criticism, but all attempts to find an alternative have so far foundered.

The question of what constitutes a scientifically founded suspicion in the same way as scientific quality, through peer review. In practice, the simplest thing would be to say that a suspicion that is published in a scientific journal after customary peer review is scientifically founded. The natural and principally important attendant question is: how long does scientifically founded suspicion last? What is required in order to dispel it? The above answer naturally provides the answer to these questions too. A study of such quality that it is accepted for publication in a scientific journal, which examines the entire suspicion and gives a clear answer, should be both an essential and adequate method of dispelling the suspicion. Should anyone be dissatisfied with the answer, the procedure should be repeated, with peer reviews to inspect scientific quality at all steps.

Substitution by other measures

One further question worth taking up is how the substitution principle is to be applied in cases where the alternative to an environmentally hazardous substance consists of another type of measure with the same effect. The example of manual clearance of undergrowth as an alternative to phenoxy acids comes to mind. In cases like this, it is not the substance itself that is substituted, but its effect. The wording of both the current and the proposed Acts does nothing to suggest that the legislators have considered this possibility for substitution. The necessity of a holistic view of the environment was discussed above, and this is also one of the recurring themes of the report of the Commission of Inquiry on Environment Protection. The conclusion was that it is not just the substance or the product, but the entire technical system, that is to be taken into consideration when the substitution principle is applied. Seen in this light, it would seem reasonable to regard the use of other means to achieve the desired effect as substitution. Naturally, the technical and economic considerations remain unchanged in this type of substitution. The proposed formulation of Chapter 3, § 5 of the proposed Environmental Code should, for the sake of clarity, be supplemented with "methods", to the effect that *each and every person who causes or intends to cause environmental impact shall avoid chemicals or biotechnical products or goods which can, with significant benefit to health, environment or long-term good management of environmental resources, be substituted by chemical or biotechnical products or goods or methods which are less hazardous or which involve reduced use of natural resources.*

Sven-Olov Ericson

THE BEST AVAILABLE TECHNOLOGY PRINCIPLE

Like the Polluter Pays Principle and the Precautionary Principle, the Best Available Technology Principle (BAT) represents a formalisation of common sense. The uniting feature of all these principles is that anyone who causes pollution or puts the environment at risk is under obligation to take action and foot the bill and remedy any harm done by existing operations. Insofar as possible, the best available technology is to be used in limiting emissions and reducing the risk of accidents, and precautionary measures must be taken even in cases where the consequences and risks are not fully known.

The principle is a common component of national legislation, conventions and policy declarations in a number of areas associated with emissions, pollution, risks or forms of other environmental impact. Some examples are given in Annexes 1 and 2 to this chapter.

BAT is defined somewhat differently by different international organisations. In September 1993, the European Commission proposed a new Directive on Integrated Pollution Prevention and Control, (IPC) — COM(93)423 — (OJ C311, 17.11.93). This directive will eventually replace present directives relating to discharges to water and air and defines "best available techniques" as follows:

> The term "Best Available Techniques" signifies the latest stage of development (state of the art) of activities, processes and their methods of operation which indicate the practical suitability of a particular technique for preventing, or where that is not practicable, minimising emissions to the environment as a whole.

For practical reasons, therefore, the terms "technology" or "techniques", "available" and "best" need to be defined.

Techniques

In the draft EU directive on integrated pollution prevention and control, techniques are defined as follows:

> "Techniques" include both the technology used and the way in which the installation is designed, built, maintained and operated and decommissioned. The techniques must be industrially feasible, in the relevant industrial sector, from a technical and economic point of view.

Available

The meaning of "available" in BAT must always be defined in order to be of any practical use in a specific area. In most cases, it is taken to mean existing technologies or procedures that can be applied at a reasonable cost.

The draft EU directive states that the term "available" refers to techniques which have been developed on a scale that permits implementation in relevant industrial contexts under economically viable conditions, whether or not such techniques are used or produced inside the Member State in question, as long as they are reasonably accessible to the operator.

In the application of §5 of the Environment Protection Act, a technology or procedure is considered to be available if it is being applied on a commercial scale elsewhere in the world. This could lead to a Catch 22 situation in which nobody needs to use a good technology until it is in commercial operation somewhere else. This is not the case in practice, since new technology is often applied in some special situation where it can be used inexpensively, by the supplier offering favourable terms or by an organisation giving priority to a certain environmental problem.

In Germany, the principle has been applied somewhat differently: the requirement is not necessarily that the technology is available on a *commercial* scale — it merely needs to have been successfully demonstrated.

In the USA, available technology in the conversion and review of existing facilities is assessed according to NSPS — New Source Performance Standards — which, in certain situations, require emission standards corresponding to those that are applicable to corresponding newly-built facilities. This is done in order to avoid new projects being disguised as conversion projects in order to evade environmental requirements, which is at least a theoretical possibility.

In the radiation protection field, the principle has been expressed in terms of all radiation doses being minimised insofar as is feasible. This is contained in the second principle (ALARA — As Low As Reasonably Achievable) of the International Commission on Radiological Protection (ICRP). In this context, less importance is attributed to the possibility of achieving a given emission level or dose using technology that is already in commercial use. Instead, the assumption is that action must always be taken to further reduce radiation doses, but that the limit is imposed by expense and by other inherent problems.

In the USA, the EPA has introduced the concept of MACT — Maximum Achievable Control Technology. According to the EPA, MACT corresponds to the 10 per cent of comparable facilities which have achieved the lowest emission levels; by definition, it is assumed that all comparable facilities can achieve this level.

Best

When controlling emissions to the surrounding environment, the word "best" has often been considered to refer to the technology which has the greatest purification effect or the lowest emissions and which is in commercial application somewhere in the world. In the context of licence reviews pursuant to the Swedish Environment Protection Act, however, a more subtle interpretation has been used. In order for a technology to be prescribed, moreover, the costs must not exceed those which can be borne by a similar company in Sweden. In addition to this, there must be environmental justification for reducing emissions to this level. The burden of proof regarding environmental justification rests on the applicant, however, and unless the applicant can prove anything to the contrary, the measure is considered to be environmentally justified.

The draft EU directive states that "best" means most effective in achieving a high level of protection for the environment as a whole, taking into account the potential benefits and costs which may result from action or lack of action. It does not imply, however, that there is only one set of techniques which may be used by the operator. The best available techniques give special consideration to:

— the use of low-waste technology;
— comparable processes, facilities or methods of operation which have recently been successfully tried out;
— technological advances and changes in scientific knowledge and understanding;
— the nature and volume of the emissions concerned;
— the consumption of raw materials (including water) and energy used in the process and their nature; and
— the furthering of recycling of substances used within the process, where appropriate.

In radiation protection, it has long been considered self-evident that the "best technology" is that which reduces radiation doses to the lowest level without incurring unreasonable marginal costs per avoided radiation dose. During the 1970s, a cost in the region of SEK100,000 per man-Sievert was regarded as a good illustration of where the boundary lay between reasonable and unreasonable costs. Today, this would correspond to about SEK10 million per theoretical fatality caused by radiation, on the basis of the link between radiation dose and health hazard which was assumed at that time.

This sum has never been a clear limit, however. In intention and practice alike, it indicates a broad interval representing the transition from justified to unjustified costs. The implication is that, when it comes to calculating the harm done among large groups of people where each individual is exposed to an insignificant increase in risk, we should always be prepared to invest SEK100,000 to avoid the loss of one year of human life, but rarely more than SEK1 million (IVA 287, page 47).

The development of the principle

Normally, BAT refers to technology that minimises emissions from a given activity via chimneys and drains. The possibility of reducing the total emissions and other environmental impact through the choice of site and by developing co-operation between different parties so that surplus heat or by-products can be used is not encompassed by the traditional interpretation of BAT. Nor does the principle cover the positive effects of environmental impact and resource management which follow from the use of renewable energy instead of fossil fuels or recycled material instead of new material from a mine, for instance. In several industrialised countries, emissions from point sources have been reduced very successfully, while environmental load from the use of products and diffuse spread of hazardous substances from society at large has remained at a level which is unsustainable in the long term. Development towards sustainable systems is largely characterised by the utilisation of such possibilities insofar as is possible. The BAT principle may therefore prove to be of greatest practical importance in the development and application of analogous principles for the optimum siting of facilities. Such principles would be applicable to resource management, best utilisation of by-products, co-ordination at system level so that different activities can work together in the best possible manner in terms of materials and energy flows, energy conversion and maximum efficiency in energy utilisation. The forestry, farming and fisheries sector should combine rational production with nature conservation, recreation and cultural conservation in the best possible manner.

The application of BAT according to this broader interpretation has already commenced. One important example is to be found in the draft EU Directive on integrated pollution prevention and control. A similar broad interpretation of the principle was introduced in 1990 in the UK under the Environmental Protection Act, which extended the principle from only reducing emissions to the water and air to "minimising effects on the environment as a whole".

Similarly, the Swedish Environment Protection Act stipulates that sites should be selected in the light of what is best in environmental terms, as long as unreasonable costs are not involved.

This broader definition is also expressed in BEP — Best Environmental Practices. Since 1992, this has been contained in the Convention

on the Protection of the Marine Environment of the Baltic Sea Area, which specifies the action that should be take to prevent pollution.

Assessment of applicability

The principle of compulsory application of BAT offers several advantages. In many cases, little is known about the full effects of emissions, so BAT becomes a practical means of applying the precautionary principle and thus of minimising emissions and risks at the same time.

In the past, the application of the BAT principle has been a rational and successful method of tackling problems associated with emissions from existing operations and point sources, particularly in cases of severe impact where it is clear that such impact would have been unacceptable even if BAT had been applied. The principle has been relatively well-accepted in a number of countries and has thus created a market for new and better techniques. This means that the practical application of the principle has also precipitated the development of the technology. Businesses have been able to justify major investments in the development of environmental technology on the basis of the application of the principle, providing their product with a market as long as it is competitive. Examples of this are to be found in the development of technology for limiting sulphur and nitrogen oxides from combustion plants and for minimising emissions of metals to the air and the water.

There are also many examples of departures from the principle which have impeded new and better technology, such as the delay in introducing catalytic emission control and unleaded petrol for cars.

One disadvantage of the principle is that it encourages companies that generate emissions to claim that the technology is not available for a given reduction, which means that they do not need to invest in the necessary equipment. Users only have the incentive to participate in the development of new technology if it will give them comparable performance at a lower cost. BAT generates no incentive for the polluter to participate in the development of techniques or routines for better purification and lower emissions. When sulphur and nitrogen purification was introduced for flue gases in Sweden, certain industries claimed initially that there was no such technology in commercial

operation. This delayed the introduction of purification equipment, which would not have been the case if today's environmental charges had already been introduced to complement the BAT principle during the course of licence reviews.

The principle that technology is only considered available if it exists in the form of commercial application elsewhere is mainly relevant in the context of operations where there are a large number of similar facilities with comparable technical possibilities and marginal costs. This is rarely the case. As a rule, industrial facilities and energy production facilities are unique. Their design is unique. It is therefore only possible to translate between the two in extremely approximate terms. When it comes to determining whether a certain purification measure or reduction in emissions can be achieved at a given cost, the criteria is not whether the technology is in operation, but rather whether the fundamental understanding of the process, suitable materials and control technology is available. This is what determines whether a given environmental goal can be achieved. In general, the owner of the facilities is the only one who possesses adequate knowledge, so it is usually more effective to provide the incentive to improve environmental performance than to transfer technology that is already in commercial operation at another site.

At the same time as BAT has been applied with considerable success to point sources and clearly identifiable pollution problems, it is less applicable to either today's or tomorrow's most prominent environmental issues in the context of sustainable development and resource management. In the industrialised countries, the remaining environmental problems are increasingly becoming a matter of diffuse and delayed emissions arising from the use of products and deposition of residual products, consumption of resources and the impact of forestry, farming and fishing on natural and cultural environments.

One may expect environmental ambitions in the industrialised countries to concentrate on these issues to an even greater extent, in which case each activity will have to be analysed in terms of impact at system level. The environmental impact of a dwelling heated by electricity is not the same as the pollution which can be avoided if an oil heater is replaced by an electric one. It is the overall environmental impact of power production which then becomes relevant, together with the management of waste from the power station and, in certain cases, extraction of fuel.

Some examples

Principles analogous to BAT could be worth applying constructively in certain cases in order to create the right conditions on the market for technology with better performance than is available today.

In normal combustion, for instance, some of the thermal value of the fuel is lost via the flue gases, about 10 per cent in larger facilities and considerably more in household boilers. Energy is lost both in the form of heat in the flue gases and in condensing the moisture in the fuel and the water formed in the combustion process from the hydrogen in the fuel. By cooling the flue gases to a temperature below the dewpoint and utilising the heat obtained by condensing the water vapour they contain, efficiency can be increased from about 80-90 per cent to 105 per cent (calculated according to the effective thermal value of the fuel). Commercial techniques are available for this type of improvement. If new facilities had to be built with the highest possible level of efficiency, a market would be created for new technical solutions. It would not take long before these appeared in the form of new boilers with integrated absorption heat pumps which would be driven by low-pressure steam, for instance, and take up heat from a nearby watercourse. This would mean that a facility could emit heat corresponding to up to 125 per cent of the lower thermal value of the fuel.

In Sweden, there have been rapid developments in the field of small-scale heating with firewood over the past ten years. Despite this, new installations often use older technology. Modern boilers are also often installed in such a way that their potential for good combustion cannot be achieved in practice. The application of BAT would mean that all new installations would use the best available equipment and that it would be installed using the best control technology and would be adapted to each individual house in the best possible way. Within a few years, it would be possible to reduce emissions of unburned volatile hydrocarbons (VOC) sharply.

Should BAT be applied without exception?

From the point of view of total efficiency, perhaps the most urgent area for the application of a principle analogous to BAT is in the construction or conversion of energy production facilities. The purpose of a

principle of this sort would be to require the greatest possible efficiency both in the facilities themselves and in a wider context, taking into account every possibility of energy cascading. Control and environmental reviews should focus less on emissions from the facility itself and more on its efficiency, its position in the system and the secondary effects in terms of overall resource management. Least Cost Planning and Demand Side Management may be suitable methods of optimising energy supply systems in this way.

If the principle is strictly applied, it is in many cases possible to limit emissions more and more at an ever increasing cost. It is not the technology that sets the limits, but the costs, which eventually become unjustifiable in relation to the marginal benefit. A point is reached where further investments may well reduce emissions even more, but where the improvements in themselves become a waste of resources rather than good conservation. Overall resources are limited and must be sensibly distributed between different requirements. Ultimately, the operation of emission control in the form of energy use, chemicals, etc., results in environmental impact which offsets the benefit of further emission control. The application of BAT in situations where EU environmental quality standards, critical load or WHO guidelines are being met is currently under discussion both in the OECD and the EU. The draft EU Directive on integrated pollution prevention and control includes a proposal in Article 9 that less stringent standards than BAT may be allowed under certain conditions.

It was this insight which led to the formulation of the BATNEC principle (Best Available Technology Not Entailing Excessive Cost) in the EU Framework Directive 84/360 (OJ L 188 16.7.84), in which Article 4 states that authorisation may only be issued when all appropriate preventive measures have been taken, including the "application of best available technology, provided that the application of such measures does not entail excessive costs". In the field of radiation protection this is expressed in the ALARA principle (As Low As Reasonably Achievable).

When technology is available that allows emissions to be limited more than is justified in the light of the marginal environmental benefit or reduced risk, the question arises of how far one should be prepared to go. The application of the principle becomes a question of incentive for the development of new technology for good or better environmental performance at a lower cost.

In the converse situation, in which not even the best available technology will achieve an acceptable environmental benefit, the outcome depends on whether it is existing or new activities that are under consideration. If a new activity is being considered, the logical consequence is for it to be rejected. If the activity comes under radiation protection legislation, it falls under the first principle, which states that an activity is only permissible if its benefit exceeds the damage it causes. When this is the case, the BAT principle offers an incentive to develop better technology since it would mean that the activities under consideration will be accepted.

When it comes to an existing activity whose impact is still unacceptable even with the application of BAT, better technology must be developed. This is provided for in the 1992 Convention on the Protection of the Marine Environment in the Baltic Sea Area, which stipulates that further action must be taken if reductions in emissions through the use of best environmental practice and best available technology do not lead to environmentally acceptable results.

Annex 1

Some examples of BAT in the EU

In the EU, discharges from industrial plants to water are regulated by Directive 76/464 (OJ L 129, 18.5.76), which states that the Council may lay down limit values for certain substances, taking into account the best technical means available. In a Council minute, this was clarified by saying that the "best technical means available" must take the economic availability of such means into account. Emissions to the air from industrial plants are regulated by Framework Directive 84/360 (OJ L 188 176.7.84).

EU directives stipulate that every country which conducts certain types of activity must use the best available technology. For combustion plants, moreover, specifications must be updated on a regular basis and each individual major power station must be subject to review every five or ten years with regard to environmental conditions in the light of the best available technology at any given time.

REFERENCE

1988 Council Directive of 24 November 1988 on the Limitation of emissions of certain pollutants into the air from large combustion plants, 1988/609/EEC.

Annex 2

BAT in conventions for the protection of the marine environment

The Convention on the Protection of the Marine Environment in the North-East Atlantic stipulates that work must be based on the precautionary principle and the principle that the polluter pays, and that these principles must be met through the application of BAT and BEP.

On the basis of the 1992 Convention on the Protection of the Marine Environment in the Baltic Sea Area, the BAT principle has been extended to cover best environmental practice (BEP) for all sources and best available technology for point sources, together with the requirement that emissions to water and air must be minimised or eliminated from all sources through emission limitation strategies. The Convention also stipulates that if best environmental practice and BAT fail to produce acceptable results, further action must be taken.

Best environmental practice is defined in the Convention as follows:

> The term "Best Environmental Practice" is taken to mean the application of the most appropriate combination of measures. In selecting for individual cases, at least the following graduated range of measures should be considered:
>
> - provision of information and education to the public and to users about the environmental consequences of choosing particular activities and products, their use and final disposal;
> - the development and application of Codes of Good Environmental Practice covering all aspects of activity in the product's life;
> - mandatory labels informing the public and users of environmental risks related to a product, its use and final disposal;
> - availability of collection and disposal systems;
> - saving of resources, including energy;
> - recycling, recovery and re-use;
> - avoiding the use of hazardous substances and products and the generation of hazardous waste;

- application of economic instruments to activities, products or groups of products and emissions;
- a system of licensing involving a range of restrictions or a ban.

According to the Convention, particular consideration should be given to the following when determining which combination of measures constitutes Best Environmental Practice in individual cases:

- the precautionary principle;
- the ecological risk associated with the product, its production, use and final disposal;
- avoidance or substitution by less polluting activities or substances;
- scale of use;
- potential environmental benefit or penalty of substitute materials or activities;
- advances and changes in scientific knowledge and understanding;
- time limits for implementation;
- social and economic implications.

The main environmental issues in the future will relate to sustainable development. A broad definition of the BAT principle, as in BEP, could be applied to good advantage in this context, with the emphasis on long-term effects in terms of the depletion of natural resources and accumulation of waste materials.

Per Kågeson

THE POLLUTER PAYS PRINCIPLE

The principle that the polluter should pay the price of environmental damage is one of the cornerstones of modern environmental policy, despite the fact that many exceptions can still be found. The principle was first put forward in an international context in 1972, when the OECD formulated the Polluter Pays Principle (PPP) as one of the Guiding Principles Concerning the International Economic Aspects of Environmental Policies. It has since been incorporated in Article 130r of the Treaty of Rome and in Principle 16 of the Rio Declaration.

The OECD Declaration

The intention behind the OECD's guiding principles was to prevent national governments from subsidising the environmental costs incurred by their own industries, since subsidies of this sort could constitute a form of trade barrier. The OECD thus based its principles more on trade and economic efficiency considerations than on any desire to improve environmental protection. However, the principles do recognise the justifiability of member states taking far-reaching action to protect their environments.

The most important item in the document (§ 2a) reads as follows:

> The principle to be used for allocating costs of pollution prevention and control measures to encourage rational use of scarce environmental resources and to avoid distortions in international trade and investment is the so-called "Polluter Pays Principle". The principle means that the polluter should bear the expenses of carrying out the above measures decided by public authorities

> to ensure that the environment is in an acceptable state. In other words, the cost of these measures should be reflected in the cost of goods and services which cause pollution in production and/or consumption. Such measures should not be accompanied by subsidies that would create significant distortions in international trade and investment.

As is clear from the text quoted above, the OECD had two reasons for formulating PPP. The first was "to encourage rational use of scarce environmental resources", and the second was "to avoid distortions in international trade and investment". The ensuing text shows, however, that the emphasis is on the second of these two objectives. Attention should also be drawn to the fact that the aim is to avoid "international" distortions. The ambitions stated in the document are limited to the costs that arise as a result of decisions by authorities concerning protection of the external environment.

According to the OECD principles, the polluter must pay all the costs arising as a result of endeavours by the authorities to ensure that the state of the environment is acceptable. No attempt is made to define an acceptable state, however. On the contrary, this is said to be something that the authorities in each individual country must stipulate.

Four principles

One very important — and often overlooked — point is that the OECD document also contains three other principles that relate to the organisation's definition of PPP. This is rarely mentioned when PPP is referred to in various contexts.

The first of these principles states that product-related environmental requirements should, insofar as is possible, be the subject of international harmonisation. The OECD makes it clear, however, that there are several points in favour of national regulations in different countries. One stated reason is that the capacity of the natural environment to withstand pollution varies from one country to another. Another is that countries may have different objectives and priorities, as well as different degrees of industrialisation and population density.

The second principle states, with reference to GATT, that national environmental policies must take the principles of national treatment and non-discrimination into account.

Finally, the OECD declares that differences in environmental legislation should not cause countries with more stringent requirements to protect their own industries through import levies or export rebates. The document claims that effective implementation of the OECD principles will make it unnecessary to adopt compensatory measures of this sort.

What does PPP cover?

Despite the fact that more than twenty years have elapsed since the OECD put forward PPP, the concept has not been the subject of any real development. The EC has adopted the OECD interpretation almost *in extenso*. One might therefore assume that reference to PPP in other international contexts also coincides with the OECD interpretation, which means that there is every reason to discuss the real implications of the OECD definition in greater detail. The following headings are of particular interest in this respect:

1. Spatial definition
2. Sectoral scope
3. Compensation to victims
4. Choice of controls
5. Internalisation of external costs.

Spatial definition

The OECD recommendation clearly states that the purpose of PPP is to avoid "significant distortions in *international* trade and investment". This means that, in the OECD's view, PPP is meant to cover the environmental protection costs which may have a bearing on the competitive relationships between enterprises in different countries. In practice, however, most enterprises and operations are subject to competition to a greater or lesser extent. This applies particularly to smaller nations with economies that are highly integrated in interna-

tional terms. The establishment of the single EC market, the North American Free Trade Agreement (NAFTA) and GATT's Uruguay Round will mean that almost all national markets will be subject to competition to a greater or lesser extent. When governments refer to PPP in their national decisions, therefore, it is unlikely that they draw any distinction between national and international distortions.

Sectoral scope

It is clear from the OECD definition of PPP that the concept does not just cover pollution, but also "control measures to encourage rational use of scarce environmental resources". Agriculture and forestry involve extensive environmental impact, and the principle that the polluter pays must also apply to these sectors. The OECD principles are rooted in a desire to prevent governments from subsidising the cost of environmental measures, which means that there is no reason to exempt any particular branch of trade and industry.

It should almost be a matter of course today that the primary sectors are covered by PPP when it comes to their impact on the air, water and land belonging to others. The EC Commission has stated (1988), for instance, that PPP "must of course apply to agricultural activity as it does elsewhere". This approach has implications in terms of the spread of pesticides and leaching of nutrients. One difficulty in this context, however, is that agriculture is highly subsidised in most industrialised nations, so it would seem somewhat unreasonable to interpret support to more environmentally sound production methods or to upgrading manure storage facilities as a breach of PPP. The European Union has exempted such forms of support from PPP by virtue of Council Regulation No. 2078/92 of 30 June 1992.

As long as such forms of support do not involve a significantly higher degree of subsidy than is involved in conventional farming, one can hardly interpret them as a departure from PPP. One point of departure might be that support for more environmentally sound forms of cultivation should not be permitted to exceed the support to conventional cultivation by more than what is motivated by the socio-economic benefit of reduced environmental impact. High levels of agricultural assistance, however, can be considered as working at cross

purposes to PPP. Both environmental and non-environmental agricultural subsidies should thus be eliminated in the long term.

A more complicated issue is that of how one should view impact that forestry and agricultural enterprises have on their own land and the flora and fauna which exist there. Semantically, this can hardly be referred to as an external effect. The landowner owns everything that grows on his land. However, it is worth noting that the Swedish Environment Protection Act contains provision for adverse effects which may involve pollution of soil or water on all land, including the land upon which the enterprise operates. This is presumably a common feature of legislation in other countries as well.

There is also much to suggest that the landowner does not have unlimited rights. It would be quite reasonable to regard the importance of soil and water to the survival of other biotopes and species as a matter of public interest. This means that, although the landowner may have the right of disposition as regards the land in question, he must also accept that it has other inherent values in addition to being a productive resource. Aesthetically, the idea that someone might own a wild species (or what might be some of the last individuals) is scarcely attractive. The long-accepted practice of protecting endangered species also represents a generally-accepted restriction on the right of disposition.

It can be observed that forestry, fishing and certain areas of agriculture have long been subject to restrictions motivated by the need to protect species and, to some extent, biotopes. A code of practice concerning how much the landowner must be prepared to accept has gradually emerged. The fact that the regulations vary between different sectors and countries reflects the different positions of strength of various parties and is based in differences in attitude to the issues. It can thus be claimed that PPP is already being put into practice to some extent.

On the whole, this means that both agriculture and forestry must accept regulations which limit the possibility of hunting, clear-felling, land drainage and the removal of barriers to cultivation without any (extra) compensation. However, the fact that certain biotopes contain items of particular natural value, such as populations of endangered species, does constitute a problem. In the USA, it is possible to impose far-reaching restrictions on the landowner in such cases. In the northwestern USA, for instance, clear-felling has been prohibited on land

where the last individuals of the spotted owl live, despite the fact that the survival difficulties this species is facing have largely been caused by other landowners. Allocation of responsibility in this way may result in the landowner who has waited longest to exploit land and water being the one to face the most stringent restrictions.

A more reasonable interpretation of PPP in the primary sector would be to regard all landowners as being collectively responsible for the protection of biodiversity. Jernelöv and Kågeson (1992) have shown how this responsibility could be defined for forestry in Sweden in purely practical terms. They propose that all landowners should pay an annual fee to a forest conservation fund. Money from the fund would finance compensation or land purchases in cases where the natural values are so great that it would not be enough for the landowner to follow the basic rules of consideration.

In certain cases, a species or a biotope may be endangered by transboundary pollution or climate change rather than by the landowner's cultivation methods. In such cases, it would be reasonable for the state to take responsibility for the necessary measures (e.g. liming or the establishment of migration corridors).

Compensation to victims

Certain observers believe that PPP includes responsibility for enterprises to compensate the victims of emissions or other environmental impact. The World Bank's World Development Report (1992) stated that one problem inherent in PPP is that is "can be interpreted in two different ways: as requiring polluters to pay only the costs of pollution control and cleanup (standard PPP) or, in addition, to compensate citizens for the damage they suffer from pollution (extended PPP)". Without analysing the text in any greater detail, Sandbu (1993) takes it for granted that the principle as formulated by the OECD is intended to ensure that the victims are compensated.

There is, however, nothing in the OECD document to support an interpretation of this sort. On the contrary, the OECD expressly states that the principle refers to the costs which arise as a result of the demands of national authorities in the context of pollution prevention and control measures. Moreover, the OECD states that the principle is not intended to cover the costs of transboundary pollution, which

should be seen as a sign that PPP was not intended to include responsibility for compensating victims, since they may be both inside and outside the country where the company operates. The foreword to a book on PPP which the OECD published in 1975 stated that PPP is "not a principle of compensation for damage caused by pollution", but also states that measures of this sort would not be contrary to PPP.

The OECD Council has since adopted a "Recommendation on the Application of the Polluter Pays Principle to Accidental Pollution" (OECD 1989). This states that "the operator of a hazardous installation should bear the cost of reasonable measures to prevent and control accidental pollution", "which are introduced by public authorities in Member countries in conformity with domestic law prior to the occurrence of an accident". It is also stated that PPP also implies that "the cost of reasonable measures to control accidental pollution after an accident should be collected as expeditiously as possible from the legal or natural person who is at the origin of the accident". Exceptions are made in both these respects "if the accidental pollution is caused solely by an event for which the operator clearly cannot be considered liable under national law, such as a serious natural disaster that the operator cannot reasonably have foreseen". Article 8 of the Recommendation states that "measures to prevent and control accidental pollution are those taken to prevent accidents in specific installations and to limit their consequences for human health and the environment". The Article expressly states that such measures do not include "measures to compensate victims for the economic consequences of an accident". This shows that the OECD is adhering to the principle that PPP does not require compensation for the victim.

Choice of controls

In a separate note to the principles, the OECD states that PPP is to be applied regardless of the controls chosen in environmental policies (OECD 1975). This note highlights the fact that PPP applies in contexts where economic instruments are used. This also applies in cases where two or more instruments are used in parallel. The note also emphasises that PPP is nothing other than a principle to ensure effective distribution of the responsibility for costs and that it neither imposes

demands on nor excludes the possibility of reducing pollution to an optimum level.

Internalisation of external costs

As discussed below, the UN draws a direct link in the Rio Declaration between PPP, the internalisation of environmental costs and the use of economic instruments.

In the 1975 note on the implementation of PPP (OECD 1975), however, it is said that PPP "is no more than an efficiency principle for allocating costs and does not involve bringing pollution down to an optimum level of any type, although it does not exclude the possibility of doing so".

It is quite clear, however, that as far back as 1975 many perceived PPP to be a demand for internalisation of environmental damage. A book published by the OECD (1975) maintains that PPP meets the demands both of effectiveness and of fairness. By effectiveness, the authors mean that the cost of external effects is covered by the price of different goods and services (internalisation). It is clear from the foreword, however, that these texts are not to be regarded as an authorised OECD interpretation of PPP.

Omissions

The note described above also takes up the question of possible exceptions to PPP and says that under certain circumstances there may be justification for such exceptions — when rapid and comprehensive tightening-up of political environmental measures is required, for instance. Subsidies could be accepted in such cases on condition that they are part of a transitional arrangement, the duration of which is determined in advance. Another prerequisite is that it does not lead to any significant disruption in international trade. Exceptions from PPP may therefore be accepted if there is a risk that the environmental requirements threaten important social or political objectives in a region or a country. Examples of this sort could include regional political problems or unemployment. Such exceptions should, however, be limited in time and scope to what is necessary to achieve the specific

goal. Support to research and development does not conflict with PPP, according to the document.

In 1974, the omission regulations were included in a special recommendation issued by the OECD council as to how PPP is to be implemented by the member nations. The recommendation also includes the requirement that countries are to notify other OECD members if they wish to make any exceptions to PPP. Finally, the declaration states that each member nation has the right to call for consultation if they have any objection to any exceptions to PPP in another country. This possibility has never been made use of, however.

The Victim Pays Principle

Certain economic experts believe that it makes no difference whether it is the polluter or the victim that pays. According to Coase's theorem, the question of who should pay should be settled by negotiation. Skogh (in Bergman, 1989) states, in line with Coase, that the Victim Pays Principle, VPP, could be just as cost-effective as PPP. This may be correct in individual cases, but if different countries apply different principles, a situation of unfair competition will arise. Skogh also ignores the fact that VPP means that the price of polluting products is not affected by the costs and damage which arise, which in turn means that the demand for environmentally disruptive processes and products will exceed the optimum in socio-economic terms. PPP is therefore preferable if one wants to achieve equality, fair competition and cost-effectiveness. This does not, however, prevent departures from the principle from being necessary at times in order to protect the environment. Grants from western Europe for environmental investments in eastern Europe provide one example of this.

PPP in the EC

In 1975, the EC Council of Ministers adopted a recommendation concerning PPP (EC 1975). The emphasis in this document is also on avoiding unfair competition and trade. In other respects, the recommendations follow the OECD guidelines. In conjunction with the Single European Act, the EC confirmed, in Article 130r of the Treaty of

Rome, that PPP was to apply throughout the Community. The exceptions which are permitted are fully in line with the OECD recommendations. The Commission's proposal concerning the setting up of an environmental fund, LIFE, states that it might be reasonable to make exceptions from PPP in the following areas:

— protection of biotopes
— cleaning up of land where it is no longer possible to determine who is responsible for the damage
— expenses that can be seen as a complement to PPP, such as subsidies for the development of public transport
— initiatives at international level in conjunction with the financing of subsidies that may be motivated by common interests, cost-effectiveness and solidarity.

A community code for government aid

In late 1993, the European Commission (1994) approved a proposal concerning new guidelines for state aid for environmental protection. Aid may be authorised in cases where an investment will help to improve the environment, but only for the extra costs which are necessary in order to meet the environmental objectives, and subject to the following ceilings:

— 15 per cent gross of investments carried out in order to comply with new mandatory standards;

— 30 per cent for investments which represent an improvement upon mandatory standards, or where no standards exist; the level of aid actually guaranteed must be in proportion to the degree to which standards are exceeded.

The Commission notes that aid for environmental protection has been stable at between 1 and 2 per cent of all government aid to industry. One conclusion to be drawn from this should be that subsidies in general represent a far greater problem from the point of view of competition than subsidies to environmental investments.

The Rio Declaration

The Rio Declaration, which was adopted at the United Nations Conference on Environment and Development, also lends its support to PPP. Principle 16 is worded as follows:

> National authorities should endeavour to promote the internalisation of environmental costs and the use of economic instruments, taking into account the approach that the polluter should, in principle, bear the cost of pollution, with due regard to the public interest and without distorting international trade and investment.

PPP in international conventions

Only a few international conventions contain any explicit rule that the polluter should pay. In all cases, such conventions are either of relatively recent date or have been subjected to far-reaching revision. In no case is the concept subject to interpretation, nor is there any reference to the OECD principles. The conventions which cite PPP are:

- The Convention on the Protection of the Marine Environment of the Baltic Sea Area, 1992 (replaces the 1975 Convention).
- The Convention for the Protection of the Marine Environment of the North-East Atlantic (replaces the earlier Oslo and Paris Conventions).
- The Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Economic Commission for Europe).

The same conventions include detailed interpretation of the concepts of best available technology and best available environmental practice, as well as a fairly clear description of the precautionary principle. The fact that PPP has not been subjected to the same in-depth treatment may either be interpreted as implying that the question of who is ultimately to pay in such contexts is considered to be of lesser impor-

tance, or as a sign that PPP is considered to be a well-known concept (despite the real problems of interpretation that exist).

It is worth noting that neither the Geneva Convention on Long-Range Transboundary Air Pollution nor the United Nations Framework Convention on Climate Change contain any reference to PPP. Such references are thus only to be found in a few of the regional conventions.

The UN Convention on Biological Diversity contains no regulations concerning PPP either, but the following proposal was still to be found in the second revised draft which was presented to the fourth session of the Intergovernmental Negotiating Committee: "Those responsible for activities which threaten or could (damage) (cause significant loss of) biological diversity are responsible for the costs of avoiding that threat or damage and for remedial action directly or through financing where damage occurs."

Is there any need to develop and clarify PPP?

The intention of the OECD as expressed in PPP is primarily to avoid distortion of trade and investment. There is therefore little point in discussing PPP without also discussing the three other principles in the OECD recommendation, i.e. the need for harmonised regulations concerning goods, the principle of national treatment and non-discrimination and the prohibition of import levies and export rebates. Since the two latter represent the cornerstones of the General Agreement on Tariffs and Trade, it will also be necessary to touch upon the GATT regulations.

However, it is also worth looking into the other motive behind the OECD's Polluter Pays Principle, i.e. "To encourage rational use of scarce environmental resources". Here, the emphasis is on the necessity of managing and conserving natural resources, and global attitudes have had time to develop considerably in this respect since 1972. There is thus good reason to analyse the extent to which recognition of the precautionary principle and sustainable development among the international community should be allowed to influence the interpretation of PPP in the future.

Opinions will always diverge as to where the limits of the polluter's responsibility should be drawn, and this ultimately depends on the

extent of the requirements imposed by the authorities. Despite this limitation, it would be useful if any revision of the OECD principles were able to express the idea that damage to the environment should be internalised in such a way as to achieve *sustainable development*. In this context, the precautionary principle should also be taken into account. This would mean that PPP would not just make it clear who is to pay, but also the approximate extent of the polluter's responsibility.

Different types of subsidy

Clarification of the scope of the polluter's responsibility highlights the problem of countries which subsidise their own industries by setting environmental protection requirements unreasonably low. It is time to admit that such indirect subsidies may also involve distortion of competition. If certain countries refuse even to meet the most elementary environmental protection requirements in terms of global and regional threats, it will become necessary to allow sanctions and/or border tax adjustments in order to prevent free riders. We will return to this issue shortly.

First, however, we will examine the fact that PPP may be indirectly eroded by other types of subsidy. Many countries provide far-reaching subsidies for agriculture and transportation, for instance. Certain countries also subsidise coal-mining and nuclear power. Industries which require large amounts of electricity, such as aluminium smelting, enjoy unjustifiably low electricity charges in certain countries. The OECD does not seem to have considered the fact that these direct subsidies represent an indirect subsidy to the company's environmental protection costs and thus undermine PPP. A general subsidy makes it easier for a company to cover its costs, including the costs which may arise as a result of environmental regulations.

GATT currently permits countries to subsidise their producers, although they are not allowed to facilitate exports with the help of targeted subsidies. From the environmental point of view, it would be reasonable for GATT to develop regulations which prohibit general subsidising of environmentally hazardous processes or products. This would mean that the parties must, within a specified period of time, phase out state subsidies for coal mining and nuclear power, for

example. It might also be reasonable to demand that certain minimum requirements should be imposed on environmental protection for nations to be members of GATT at all. Demands of this sort must be formulated to take into account the level of development of the individual country, however (per capita income).

Subsidies for environmentally sound *production and products* should not be permitted above and beyond research and development, since they go against the principle that the polluter should pay and could constitute export rebates. Subsidies for *consumption of environmentally sound products among households and the public sector* and investments in infrastructure could be permitted, however, without conflicting with the trade regulations. One pre-requisite of this, however, is that foreign products and suppliers are not subject to discrimination.

National sovereignty vis à vis environmental protection

It is not easy to decide where the dividing line between national sovereignty and international environmental requirements should be drawn. The principles of the Rio Declaration attribute great importance to the sovereign right of states to exploit their own resources on condition that they "do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction" (Principle 2). The Declaration also states that "standards applied by some countries may be inappropriate and of unwarranted economic and social cost to other countries, in particular developing countries" (Principle 11). The Rio Declaration also states that "Unilateral actions to deal with environmental challenges outside the jurisdiction of the importing country should be avoided. Environmental measures addressing transboundary or global environmental problems should, as far as possible, be based on an international consensus" (Principle 12).

In these contexts there may be good reason to distinguish between failure to protect the environment when the consequences affect only the environment and health of a nation's own citizens, and problems that have an impact on the environment and people in other countries. The first example is comparable with shortcomings in occupational protection and social rights, while the second has an impact both on competition between companies in different countries and on the environment in the surrounding world. It is quite clear that sanctions

or other measures are more justified in the latter case than in the former.

Different reasons for restrictions

As a basis for discussion of how trade issues and environmental issues should be weighed against one another, it would be useful to distinguish between different motives for trade restrictions:

1. Protection of a country's own population and environment against the effects of products.

2. Protection of a country's own population and environment against the effects of both domestic and transboundary pollution.

3. Protection of the atmosphere.

4. Protection of the global commons, e.g. the open sea.

5. Protection of population and environment in the exporting countries.

Protection against products

Measures aimed at protecting a country's own population and environment against the effects of products should, if they are well-founded and tailored to their objectives, not conflict with the current GATT regulations. If one were to wish for any amendments or supplements to the agreement, they would primarily consist of clear formulations which would make it easier to interpret Article *XX* concerning general exceptions (including protection of species and natural resources). The preamble to the agreement should also make it clear that the precautionary principle and PPP must apply in all these contexts. In addition, regulations will be required to the effect that GATT panels which deal with measures based on Article *XX* should possess expertise not only in international trade law but also in environmental protection.

Protection against transboundary pollution

Protection of a nation's own population and environment against the effects of pollution arriving from outside should, in principle, not be dealt with any differently from the import of environmentally hazardous products. One difficulty in this context, however, is that it is often very difficult to link transboundary pollution with any individual product that may occur in trade. Acidifying substances such as sulphur dioxide and nitrogen oxide primarily originate from residential heating, power production and transport. Import of electricity from countries with inferior flue-gas purification could, however, be subject to measures on the condition that such electricity could be distinguished from the total production of a given power company. It might also be possible to introduce measures aimed at products which require a large amount of such energy for their manufacture. On the whole, however, one must observe that it is difficult to take action against countries with poor environmental legislation on the basis of trade-related measures.

Protection of the atmosphere

The protection of the atmosphere has already led to two international environmental conventions: The Vienna Convention, which includes the Montreal Protocol, and the UN Climate Convention. On the basis of the Montreal Protocol, it is relatively easy to determine which products from non-signatory countries have been manufactured with the help of CFCs. Measures aimed at net emissions of carbon dioxide represent a far more complicated issue. Fossil fuels are used in many different contexts and it is probably only for the most energy-intensive production processes that trade restrictions could be considered at all. Possibly the most appropriate measure would be for countries which have imposed charges on carbon dioxide themselves to decide to impose import levies on products manufactured with the help of such processes. Such products might include aluminium, commercial fertilisers (nitrogen), steel, paper and pulp, cement and certain base chemicals (such as chlorine). In such cases, the importer would have to pay a fee corresponding to the domestic carbon dioxide tax multiplied by a standard rate of energy use. If the importer is able to prove that the

actual energy use in manufacture is less, the charge should naturally be adjusted to correspond to the actual consumption.

Unless the GATT and OECD regulations are changed so that import levies of this sort are possible, it will be very difficult to persuade the more environmentally ambitious nations to introduce domestic charges on energy-intensive activities. This will also make it more difficult to limit emissions of carbon dioxide, unless the environmentally ambitious nations are willing to introduce very high and not particularly cost-effective charges on emissions from activities which are not subject to competition. The possibility of introducing import restrictions or levies may, moreover, prove to be the only way of counteracting environmental dumping and of tackling free riders. One might possibly also give the environmentally ambitious nations the right to permit deductions for their own industries for that part of production which is exported to countries which have not imposed a corresponding carbon dioxide tax. Without this possibility, industry in the environmentally ambitious nations will face difficulties in competing with companies in countries with lower requirements or no requirements at all.

Protection of the global commons

The question of how we should handle products which have an impact on our common seas is also a difficult one. If protection is targeted directly at migrating species, it would seem reasonable to allow sanctions against exports from countries whose products threaten the survival of such species. Things become considerably more complicated, however, if the threat consists of effluent to the sea and if such effluent originates from a number of different sources. Once again, it might be practicable to introduce import restrictions against products manufactured at facilities which generate such large amounts of effluent to the open sea that they have a significant impact on its production capability and ability to support certain species. Introducing restrictions against non-related goods simply because another country fails to meet reasonable standards of emission purification (including diffuse sources) would, however, appear to be a difficult and dangerous course of action.

Protection of the environment in the exporting country

The use of trade restrictions in order to protect environmental assets in the exporting country is much harder to justify. One may, of course, claim that the flora and fauna of the exporting country represent a part of our common global cultural heritage, but this is countered by national sovereignty as expressed in the principles of the Rio Declaration. One must also take into account that the richest industrialised nations did much to harm "their" share of the global environmental heritage during early phases of their development without the rest of the world being able to protest. It is also quite clear that the will to pay for protection of people and the natural environment is closely linked with the ability to pay. One should therefore not be surprised that environmental protection and occupational protection enjoy a lower priority among developing and recently industrialised nations.

At the same time, it can be observed that the CITES Convention was drawn up in order to protect certain endangered species from extinction. This is an international convention which authorises prospective importer countries to take action against the import of endangered species. If the same species are threatened by deforestation, however, the countries which import the forest products cannot take action. There is thus a clear conflict not just between CITES and GATT, but also between the Rio Declaration and CITES.

Revision of the OECD guidelines

Finally, we will discuss the concrete changes which may be required in three of the four principles in the OECD guidelines. As far as the principle on national treatment and non-discrimination is concerned, there is no reason to call for any change from the environmental point of view. This principle is therefore not discussed here.

The Polluter Pays Principle

The principle that the polluter bears the responsibility for the cost is an important one, both when it comes to avoiding distortions in trade and

investments and to making optimal use of the aggregate resources of society. These two motives should, in future, be attributed the same importance. If PPP were to be formulated in this way, it would be quite natural to let it cover both the costs which arise as a result of direct demands for measures to protect the environment and the expenses which arise as a result of the authorities using taxes and charges to force enterprises and consumers to take indirect responsibility for the environmental impact of their operations. There is general political agreement among the EU and EFTA nations that the externalities should be internalised. According to the OECD, PPP should be regarded as applying to both administrative and economic instruments in its present form.

PPP does have some bearing on the question of compensation to victims. Enterprises should naturally bear the cost of the insurance policies required if they are to be able to compensate victims in conjunction with accidents of various kinds. There are still differences between OECD countries in this respect, in terms of third-party liability in conjunction with accidents at nuclear power stations, for instance. These differences are so great that they can affect the competitive climate for power stations in different countries. One example of this is that a power company in Germany is required, if necessary, to use its entire assets to compensate a third party. In Sweden, however, the power companies are only required to compensate victims up to the limits of their liability insurance, which involves a ceiling of SEK1,200 million.

When it comes to internalising the external effects of normal activities, however, it cannot be taken for granted that PPP should involve any requirement that individual victims should receive compensation. In most individual cases, the causal relationships are not sufficiently clear to provide a basis for direct compensation. The important point about internalisation is not that those who suffer should be compensated. The intention is rather to create fair conditions for competition between different players and activities and to provide all manufacturers and consumers with clear signals regarding the costs involved. The question of compensation to private individuals is of secondary importance in this context.

One natural consequence of attributing environmental protection the same importance as the principle of free and equal competition is that the environmental policy of all OECD countries should meet certain

minimum requirements in order for PPP to be regarded as having been met. If any country fails to meet the requirements, the question arises of whether the other countries are entitled to take action.

The need for harmonised regulations

Both justifications for PPP suggest that one should strive for a certain amount of harmonisation of environmental regulations in different countries. The OECD guidelines provide a good description of the benefits and disadvantages of harmonised international standards. The advantages include the fact that common regulations help to create equal conditions for manufacturers in different countries. Standardisation facilitates trade and promotes compatibility between different technical systems.

The OECD guidelines state, however, that "differing national environmental policies, for example with regard to the tolerable amount of pollution and to quality and emission standards, are justified by a variety of factors including, among other things, different pollution assimilative capacities of the environment in its present state, different social objectives and priorities attached to environmental protection and different degrees of industrialisation and population density".

The conclusion is that "governments should seek common standards for polluting products", when these are traded internationally and where there could be significant obstacles to trade". The OECD also says that "measures taken to protect the environment should be framed, as far as possible, in such a manner as to avoid the creation of non-tariff barriers to trade".

There is hardly any cause to raise objections against the OECD's description of the issue, but there is good reason to clarify it in three respects. First, it should be quite clear that the common minimum regulations upon which implementation of PPP is intended to be based should be so stringent as to ensure that people and the environment are not normally harmed. This means that harmonisation can be clearly linked with the precautionary principle and the principle of sustainable development.

Secondly, it should be made quite clear that the principle does not only refer to polluting products but also to polluting processes. This is particularly important in cases where the processes cause damage to

other countries or to global commons such as the high seas or the atmosphere.

Thirdly, one should stress the rights of individual nations to take more far-reaching measures in the light of the susceptibility of their own ecosystems and local pollution levels, on condition that the regulations are non-discriminatory. It is particularly important not to prevent nations from using "soft methods" such as environmental labelling, economic instruments, criteria for public procurement and advice and instructions based on the substitution principle. This right should also be safeguarded within the framework of GATT regulations. The soft instruments have the advantage over hard that they do not involve any absolute prohibition of certain products. The only thing in favour of international harmonisation of economic instruments is the risk of different national systems leading to double taxation on imported products. It ought to be possible to eliminate this problem by basing charges on sales rather than on imports. As far as charges on raw materials and/or process emissions are concerned, several methods are available to nations in order to prevent their own export industries from finding themselves at a disadvantage in comparison with a situation where environmental requirements are completely drawn up within the framework of administrative regulations.

Prohibition of export rebates and import levies

If individual countries continue to dump their prices by not imposing adequate environmental demands on their own industries, it must be possible in the future for countries which themselves apply PPP to take action. Action of this sort might include imposing some sort of border adjustment tax. As has already been said, the OECD guidelines prohibit the use of such compensation import levies. Now, however, discussion is under way regarding the possibility of relaxing this prohibition in conjunction with a revision of the principles.

The clearest example consists of the need of action against nations which refuse to take their share of the responsibility for reducing the anthropogenic emissions of greenhouse gases. Countries with stringent environmental requirements should be permitted to impose a charge on imports of energy-intensive materials corresponding to the difference between their own energy/carbon dioxide charges and any charge which

is payable in the exporting country. In order to prevent this right from being used for protectionist purposes, it should be restricted to raw materials and semi-manufactured goods which require a large amount of energy for their manufacture. For industries with a low proportion of energy costs, competing free riders do not constitute a problem.

International transportation

Finally, it is worth drawing attention to the fact that the lack of environmental requirements regarding international shipping and aviation means that world trade is growing faster than the optimum rate in socio-economic terms. The OECD and GATT should endeavour to come to terms with this by developing common forms for international taxation of aviation and bunker fuels which will involve internalisation of environmental costs. Minimum requirements must also be introduced concerning the sulphur content of bunker fuels and nitrogen oxide emissions from aircraft and marine engines. These minimum requirements may be adjusted to some extent to agree with the recipient conditions in different regions. The imposition of such requirements on international transportation would be a logical extension of PPP.

REFERENCES

Baldock, D./Bennett, G. (1991), Agriculture and the Polluter Pays Principle. Institute for European Environmental Policy, London.

Commission of the European Communities (1988), Environment and Agriculture, COM(88)338 final.

Commission of the European Communities (1991), Proposal for a Council Regulation Establishing a Financial Instrument for the Environment (LIFE).

Commission of the European Union (1994), Community Guidelines on State Aid for Environmental Protection, Official Journal C72, 10 March.

Convention for the Protection of the Marine Environment of the North-East Atlantic.

Convention on Biological Diversity, done at Rio de Janeiro on 5 June 1992.

Convention on the protection and use of transboundary watercourses and international lakes.

Convention on the Protection of the Marine Environment of the Baltic Sea Area, 1992.

EC (1975), Council recommendation regarding cost allocation and action by public authorities on environmental matters (75/436 EEC).

European Parliament (1993), Report on Environment and Trade, europe environment document, February 16.

Jernelöv, A./Kågeson, P. (1992), Biologisk mångfald i Sverige, Hur klarar vi uppdraget? Miljövårdsberedningen, Miljö- och naturresursdepartementet.

Kågeson, P. (1993), Miljö och ekonomi i samspel, Naturskyddsföreningens Förlag, Stockholm.

OECD (1972), Recommendation of the Council on Guiding Principles Concerning the International Economic Aspects of Environmental Policies (C(72)128).

OECD (1974), Recommendation of the Council on the Implementation of the Polluter-Pays Principle.

OECD (1975), The Polluter Pays Principle, Definition, Analysis, Implementation, Paris.

OECD (1989), Council Recommendation on the Application of the Polluter-Pays Principle to Accidental Pollution (C(89)88 (Final).

OECD (1992), The Polluter-Pays Principle: OECD Analysis and Recommendations, OECD Environment Directorate, Monograph, Paris.

Pearce, D.W. (1992), Should The GATT Be Reformed For Environmental Reasons?, CTERGE Working Paper GEC 92-06, London.

Repetto, R. (1993), Trade and Environment Policies: Achieving Complementarities and Avoiding Conflicts, WRI Issues and Ideas, World Resources Institute, Washington D.C.

Sandbu, M. D. (1993), Internationellt ansvar vid transnationella miljöskador. Staternas ansvarighet, Juridiska Institutionen, Lunds Universitet.

Stevens, C. (1993), The OECD Guiding Principles Revisited, Environmental Law, Vol. 23:607, Northwestern School of Law of Lewis and Clark College.

Stevens, C. (1994), Interpreting the Polluter Pays Principle in the Trade and Environment Context, Cornell International Law Journal (forthcoming 1994).

Skogh, G. (1989), i Bergman, L., Värdera Miljön, SNS Förlag.

The World Bank (1992), The World Development Report 1992, Washington DC.

United Nations Environment Programme (1991), Second Revised Draft Convention on Biological Diversity, Nairobi, 23 July.

United Nations Framework Convention on Climate Change, done at Rio de Janeiro in June 1992.

CLOSING COMMENTS

In the preceding chapters, we have discussed some of the main principles of environmental protection, the most comprehensive of all being the principle of sustainable development. If this principle is to be applicable, however, it must be interpreted in operational terms.

The crucial question is what we should demand of a policy that is aimed at achieving sustainable development. In this context, the following requirements should be met (Kågeson, 1994):

1. First, we need to define what we mean by sustainable development.

2. For each of the items in our definition, we need a long-term objective which guarantees that the ecosystems of the Earth will maintain their normal qualities for a very long period of time, and that the state of the atmosphere does not deviate from pre-industrial conditions to such an extent that we risk facing a radical change of climate. In cases where it is difficult, in scientific terms, to define a long-term target, it would be better to adopt a provisional target than to wait for a more definitive understanding of the subject in question.

3. In cases where it is quite clear that a sustainable objective cannot be achieved in the foreseeable future (the next 10-15 years), we need to adopt intermediate targets and a clear medium and long-term timetable.

4. The purpose of each such intermediate target should be to bring us considerably closer to our final objective.

5. In order to make our short-term commitments trustworthy, we must reach decisions on the measures and policy levers that will help us to fulfil our objectives.

The concepts of critical loads and critical levels should be used in contexts where we need to establish an absolute upper limit for what different ecosystems and the atmosphere can tolerate in the long term. These concepts should not be taken to imply a *carte blanche* to increase pollution from lower levels up to the limit. On the contrary, in the light of the precautionary principle, there is every reason to stay well below levels at which the load may exceed the tolerance limit of sensitive ecosystems. It is particularly important to take the precautionary principle into account in situations where there is a high degree of uncertainty and where extra care can be taken at a low, or at least reasonable, cost.

Finally, if we navigate with the principles as beacons, it is worth asking ourselves which types of environmental problem we can steer clear of and where the hidden reefs may lie. As has been demonstrated in the previous chapters, past experience and the desire to avoid repeating former mistakes have played a large part in the formulation of the principles. If these principles are followed, therefore, it should be possible to avoid or eliminate environmental problems of the sort we are already familiar with.

Are the principles adequate when it comes to alerting us to other problems? If, for instance, the widespread use of female hormones in oral contraceptives were to be suspected to affecting non-target organisms and individuals, would the principles make us pay attention and would they be of any help in our search for a solution?

Interpreted as they are at present, the principles would be of little guidance. Admittedly, the precautionary principle and the substitution principle might be applied to a group of substances which are neither toxic, persistent nor unnatural in themselves, but this would make the net so fine-meshed that far too much else would get caught up in it. The concept of critical loads might be extended to cover human hormones, but the same problem would arise. If the net were to be too fine-meshed it would be in danger of becoming unwieldy and counter-productive.

There are other environmental problems which have hitherto played a less prominent role in public debate in the industrialised countries

and have therefore influenced the formulation of the principles to a lesser extent. Such issues include the physical destruction of coastal zones such as mangrove swamps, seaweed beds and coral reefs in tropical and sub-tropical areas. Recreational areas such as golf courses and marinas provide another example. Individually, their impact is insignificant; together they may occupy the majority of susceptible biotopes in a given area. Here, too, the principles provide inadequate protection in their present form.

Finally, however, it may be said that the principles are mainly circumscribed by the manner in which they are formulated, not by mistakes in their application. Their formulation is the result of negotiations between environmental representatives and opposing interests. They are not absolute. There is still considerable scope for improvement, in formulation and implementation alike.

Statens offentliga utredningar 1994

Kronologisk förteckning

1. Ändrad ansvarsfördelning för den statliga statistiken. Fi.
2. Kommunerna, Landstingen och Europa + Bilagedel. C.
3. Mäns föreställningar om kvinnor och chefskap. S.
4. Vapenlagen och EG. Ju.
5. Kriminalvård och psykiatri. Ju.
6. Sverige och Europa. En samhällsekonomisk konsekvensanalys. Fi.
7. EU, EES och miljön. M.
8. Historiskt vägval – Följderna för Sverige i utrikes- och säkerhetspolitiskt hänseende av att bli, respektive inte bli medlem i Europeiska unionen. UD.
9. Förnyelse och kontinuitet – om konst och kultur i framtiden. Ku.
10. Anslutning till EU – Förslag till övergripande lagstiftning. UD.
11. Om kriget kommit... Förberedelser för mottagande av militärt bistånd 1949-1969 + Bilagedel. SB.
12. Suveränitet och demokrati + bilagedel med expertuppsatser. UD.
13. JIK-metoden, m.m. Fi.
14. Konsumentpolitik i en ny tid. C.
15. På väg. K.
16. Skoterkörning på jordbruks- och skogsmark. Kartläggning och åtgärdsförslag. M.
17. Års- och koncernredovisning enligt EG-direktiv. Del I och II. Ju.
18. Kvalitet i kommunal verksamhet – nationell uppföljning och utvärdering. C.
19. Rena roller i biståndet – styrning och arbetsfördelning i en effektiv biståndsförvaltning. UD.
20. Reformerat pensionssystem. S.
21. Reformerat pensionssystem. Bilaga A. Kostnader och individeffekter. S.
22. Reformerat pensionssystem. Bilaga B. Kvinnors ATP och avtalspensioner. S.
23. Förvalta bostäder. Ju.
24. Svensk alkoholpolitik – en strategi för framtiden. S.
25. Svensk alkoholpolitik – bakgrund och nuläge. S.
26. Att förebygga alkoholproblem. S.
27. Vård av alkoholmissbrukare. S.
28. Kvinnor och alkohol. S.
29. Barn – Föräldrar – Alkohol. S.
30. Vallagen. Ju.
31. Vissa mervärdeskattefrågor III – Kultur m.m. Fi.
32. Mycket Under Samma Tak. C.
33. Vandelns betydelse i medborgarskapsärenden, m.m. Ku.
34. Tekniskt utrymme för ytterligare TV-sändningar. Ku.
35. Vår andes stämma – och andras. Kulturpolitik och internationalisering. Ku.
36. Miljö och fysisk planering. M.
37. Sexualupplysning och reproduktiv hälsa under 1900-talet i Sverige. UD.
38. Kvinnor, barn och arbete i Sverige 1850-1993. UD.
39. Gamla är unga som blivit äldre. Om solidaritet mellan generationerna. Europeiska äldreåret 1993. S.
40. Långsiktig strålskyddsforskning. M.
41. Ledighetslagstiftningen – en översyn. A.
42. Staten och trossamfunden. C.
43. Uppskattad sysselsättning – om skatternas betydelse för den privata tjänstesektorn. Fi.
44. Folkbokföringsuppgifterna i samhället. Fi.
45. Grunden för livslångt lärande. U.
46. Sambandet mellan samhällsekonomi, transfereringar och socialbidrag. S.
47. Avveckling av den obligatoriska anslutningen till studentkårer och nationer. U.
48. Kunskap för utveckling + bilagedel. A.
49. Utrikessekretessen. Ju.
50. Allemanssparandet – en översyn. Fi.
51. Minne och bildning. Museernas uppdrag och organisation + bilagedel. Ku.
52. Teaterns roller. Ku.
53. Mästarbrev för hantverkare. Ku.
54. Utvärdering av praxis i asylärenden. Ku.
55. Rätten till ratten – reformerat bilstöd. S.
56. Ett centrum för kvinnor som våldtagits och misshandlats. S.
57. Beskattning av fastigheter, del II – Principiella utgångspunkter för beskattning av fastigheter m.m. Fi.
58. 6 Juni Nationaldagen. Ju.
59. Vilka vattendrag skall skyddas? Principer och förslag. M.
59. Vilka vattendrag skall skyddas? Beskrivningar av vattenområden. M.
60. Särskilda skäl – utformning och tillämpning av 2 kap. 5 § och andra bestämmelser i utlänningslagen. Ku.
61. Pantbankernas kreditgivning. N.
62. Rationaliserad fastighetstaxering, del I. Fi.
63. Personnummer – integritet och effektivitet. Ju.
64. Med raps i tankarna? M.
65. Statistik och integritet, del 2 – Lag om personregister för officiell statistik m.m. Fi.
66. Finasiella tjänster i förändring. Fi.
67. Räddningstjänst i samverkan och på entreprenad. Fö.
68. Otillbörlig kurspåverkan och vissa insiderfrågor. Fi.

Statens offentliga utredningar 1994

Kronologisk förteckning

69. On the General Principles of Environment Protection. M.

Statens offentliga utredningar 1994

Systematisk förteckning

Statsrådsberedningen

Om kriget kommit... Förberedelser för mottagande av militärt bistånd 1949-1969 + Bilagedel. [11]

Justitiedepartementet

Vapenlagen och EG [4]
Kriminalvård och psykiatri. [5]
Års- och koncernredovisning enligt EG-direktiv. Del I och II. Ju. [17]
Förvalta bostäder. [23]
Vallagen. [30]
Utrikessekretessen. [49]
6 Juni Nationaldagen. [58]
Personnummer – integritet och effektivitet. [63]

Utrikesdepartementet

Historiskt vägval – Följderna för Sverige i utrikes- och säkerhetspolitiskt hänseende av att bli, respektive inte bli medlem i Europeiska unionen. [8]
Anslutning till EU – Förslag till övergripande lagstiftning. [10]
Suveränitet och demokrati
+ bilagedel med expertuppsatser. [12]
Rena roller i biståndet – styrning och arbetsfördelning i en effektiv biståndsförvaltning. [19]
Sexualupplysning och reproduktiv hälsa under 1900-talet i Sverige. [37]
Kvinnor, barn och arbete i Sverige 1850-1993. [38]

Försvarsdepartementet

Räddningstjänst i samverkan och på entreprenad. [67]

Socialdepartementet

Mäns föreställningar om kvinnor och chefskap. [3]
Reformerat pensionssystem. [20]
Reformerat pensionssystem. Bilaga A.
Kostnader och individeffekter. [21]
Reformerat pensionssystem. Bilaga B.
Kvinnors ATP och avtalspensioner. [22]
Svensk alkoholpolitik – en strategi för framtiden. [24]
Svensk alkoholpolitik – bakgrund och nuläge. [25]
Att förebygga alkoholproblem. [26]
Vård av alkoholmissbrukare. [27]
Kvinnor och alkohol. [28]
Barn – Föräldrar – Alkohol. [29]
Gamla är unga som blivit äldre. Om solidaritet mellan generationerna. Europeiska äldreåret 1993. [39]
Sambandet mellan samhällsekonomi, transfereringar och socialbidrag. [46]
Rätten till ratten – reformerat bilstöd. [55]
Ett centrum för kvinnor som våldtagits och misshandlats. [556]

Kommunikationsdepartementet

På väg. [15]

Finansdepartementet

Ändrad ansvarsfördelning för den statliga statistiken. [1]
Sverige och Europa. En samhällsekonomisk konsekvensanalys. [6]
JIK-metoden, m.m. [13]
Vissa mervärdeskattefrågor III – Kultur m.m. [31]
Uppskattad sysselsättning – om skatternas betydelse för den privata tjänstesektorn. [43]
Folkbokföringsuppgifterna i samhället. [44]
Allemanssparandet – en översyn. [50]
Beskattning av fastigheter, del II – Principiella utgångspunkter för beskattning av fastigheter m.m. [57]
Rationaliserad fastighetstaxering, del I. Fi. [62]
Statistik och integritet, del 2
– Lag om personregister för officiell statistik m.m. [65]
Finasiella tjänster i förändring. [66]
Otillbörlig kurspåverkan och vissa insiderfrågor. [68]

Utbildningsdepartementet

Grunden för livslångt lärande. [45]
Avveckling av den obligatoriska anslutningen till studentkårer och nationer. [47]

Kulturdepartementet

Förnyelse och kontinuitet – om konst och kultur i framtiden. [9]
Vandelns betydelse i medborgarskapsärenden, m.m. [33]
Tekniskt utrymme för ytterligare TV-sändningar. [34]
Vår andes stämma – och andras.
Kulturpolitik och internationalisering. [35]
Minne och bildning. Museernas uppdrag och organisation + bilagedel. [51]
Teaterns roller. [52]
Mästarbrev för hantverkare. [53]
Utvärdering av praxis i asylärenden. [54]
Särskilda skäl – utformning och tillämpning av 2 kap. 5 § och andra bestämmelser i utlänningslagen. [60]

Näringsdepartementet

Pantbankernas kreditgivning. [61]

Statens offentliga utredningar 1994

Systematisk förteckning

Arbetsmarknadsdepartementet

Ledighetslagstiftningen – en översyn [41]
Kunskap för utveckling + bilagedel. [48]

Civildepartementet

Kommunerna, Landstingen och Europa. + Bilagedel. [2]
Konsumentpolitik i en ny tid. [14]
Kvalitet i kommunal verksamhet – nationell uppföljning och utvärdering. [18]
Mycket Under Samma Tak. [32]
Staten och trossamfunden. [42]

Miljö- och naturresursdepartementet

EU, EES och miljön. [7]
Skoterkörning på jordbruks- och skogsmark. Kartläggning och åtgärdsförslag. [16]
Miljö och fysisk planering. [36]
Långsiktig strålskyddsforskning. [40]
Vilka vattendrag skall skyddas? Principer och förslag. [59]
Vilka vattendrag skall skyddas? Beskrivningar av vattenområden. [59]
Med raps i tankarna? [64]
On the General Principles of Environment Protection. [69]

ENVIRONMENTAL
ADVISORY COUNCIL

The Environmental Advisory Council advices the Government on environmental issues.

The Council's task is to look at new environmental issues and to propose new working methods. The Council is also to contribute to facilitate the linking of research, ideas and political decisions. The Council's work shall be outwardedly oriented and contribute to stimulating environmental discussion.

The Advisory Council's current task is to develop the environmental efforts within strategic areas such as the economy and trade, transport, education and research. International environmental endeavours are a central feature of the Council's work, for example the follow-up of the United Nations Conference on Environment and Development. The Environmental Advisory Council's special project on Ecocycles aims at developing societal solutions especially within the urban, transport and product areas.

The Environmental Advisory Council arranges seminars and conferences, publishes reports in the governmental series Statens Offentliga Utredningar (SOU) and in the Environmental Advisory Council's own report series. The Environmental Advisory Council is a committee within the Ministry of the Environment and Natural Resources and was set up in 1968.

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