THE COST OF POLLUTION 19

ENVIRONMENTAL ECONOMICS

The value of the ecological services of the world's environment is of the same size as the net global product, or 33 trillion dollars yearly, according to a recent research report. (Photo: Lars Rydén.)

"The economic value of the services provided by the world wide ecosystems is worth between $16 trillion and $54 trillion a year - average $33 trillion. Nutrient cycling appeared to be the most valuable eco-service with a value of $17 trillion a year. Marine ecosystems account for about $20.9 or 63% of the $33 trillion average annual value of nature services, and terrestrial ecosystems, such as forests and wetlands, contribute the other 37%."

Reported by a team of researchers from the United States, the Netherlands and Argentina (Nature; May 15, 1997)

In modern society we are used to dealing with money for everything we need, want, or wish. The market economy teaches us that everything can be bought and sold. So what about environment? To take an example from what the forest gives us, it is obvious that such resources as fish, game, berries, and timber have a price. In addition we may ask what the forest is worth when it comes just to enjoying it. This is also possible to estimate in terms of money. The figures for all these resources when added together for a whole country are very large compared to the gross national product.

Pollution and many other kinds of environmental impact destroy part of the natural resources. Pollution thus has a cost. It reduces the output of timber, berries, or fish from the forests, and it may reduce the pleasure of visiting the forest as well.

In principle it is possible to exactly calculate the cost of the impact of pollution, but many difficulties need to be overcome before a final figure can be arrived at. Even if we can estimate the size of the decrease of production during a year it is difficult to specify the amount of damage that was caused by the pollution in a particular year. It is also difficult to specify all impacts of a polluting substance, e.g. on health, destruction of materials, decrease in property value, etc. As mentioned some values can not be measured in economic terms, and monetary equivalents can only be estimated.

It is important for several reasons to know the value of the environment and the cost of pollution. We may compare the cost of abatement, that is treatment, with doing nothing and find out for instance if it is good business to clean air. Governments use estimated costs of pollution in their taxation and environmental policy. Today the cost of pollution and the value of the environment are being introduced in green budgets in several countries in Europe.

It may seem obvious that those who use a service, such as the environment, should pay for it, as is done for all other services in society. However even if there is near consensus on this point, the so-called polluter pays principle, is far from being applied everywhere. The reasons are many but in particular it is difficult to connect a specific loss of environmental value to a specific polluter. More often it is the victim, the one who loses value due to environmental damage, who pays. Still market-based economic policy instruments are introduced in many countries in Europe today to fight pollution. When these function well, pollution is diminished with the largest possible economic efficiency.

It is now clear that environmental concern is becoming a major part in the economy in modern society and amounts to several percent of the BNP. In this chapter the economics of the environment and environmental impacts are discussed, as well as the many economic instruments used to cure poor environmental performance.

Authors of this chapter

Linas Cekanavicius, environmental economics and the value of the environment; Daiva Semeniene, the polluter pays principle and economic policy instruments; Frans Oosterhuis, environmental taxes in the EU; Ekko van Ierland, Greening the tax system in the Netherlands.

The cost of pollution

Environmental and conventional economics

The cost of environmental impact

Who should pay? – The polluter pays principle

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Environmental and Conventional Economics

The roots of environmental economics

Economics begins wherever and whenever people are confronted with scarcity. Scarcity means that needs exceed available resources. In fact, all human activities have an economic aspect since everyone has some unfulfilled dreams and unsatisfied wants for the lack of time, health, money or other resources.

Scarcity forces us to make *choices* among the available alternatives of resource use. Economics is the science that explains *how* the choices are made and recommends how they *should be made* in order to maximise one's welfare.

Environmental economics is concerned about the optimal use of the scarce environmental goods and services. One can distinguish three broad categories of these that could be beneficially used by people:

- natural resources
- recreational goods
- assimilative capacity

Environmental economics is the study of the economic aspects of the interactions between human society and its natural environment. Unlike traditional economics, which is concerned with the interactions of various parts of the economic system, and unlike ecology, which deals with the interaction of living entities within their natural environment, environmental economics investigates the interactions between the two systems – economics and nature. Thus it "tends to be more holistic than economics as traditionally construed – it takes a wider, more all-encompassing view of the workings of an economy" (Pearce & Turner, 1991). However, it is still a branch of economics as it relies on the paradigms of modern economic thought.

Environmental economics is a relatively young branch of science. It crystallised in the 1960s when the environmental problems of modern society, as well as their economic consequences, became vividly apparent. However, roots of environmental economics go as deep in history as to the end of 18th century when the industrial revolution was taking place and the so-called *classical* economic paradigm was born. Classical economics regarded natural resources as the important determinants of economic growth and the limits of economic development. More than 100 years later, at the end of 19th century, a new theory, the *neo-classical* economic paradigm, started to develop in the then seemingly endless economic growth. It was not so much concerned with the level and distant results of growth as with the structure and efficiency of the economic activities.

Figure 19.1. The value of the environment. Each piece of the environment has a value that may be estimated in several ways. The largest sums are ascribed to the value of environment as a sink, for instance when a water course takes care of emitted nitrogen oxides. (Photo: Inga-May Lehman Nådin.)

Externalities

Analysis of market mechanisms brought neo-classical theory to two discoveries of cardinal importance for the development of environmental economics: externalities and market failures.

Alfred Marshall (1842-1924) observed that the results of an activity often do not limit themselves to what is deliberately intended. They are accompanied by external effects or *externalities*, e.g. when the welfare level of other people, who do not take direct part in the activity, is affected. If the external impact causes loss of welfare, then it is called a negative externality, if it gives rise to increased welfare it is a positive externality. An important feature of an externality is that neither corresponding costs nor benefits are borne or received by the

Externalities

When the result of an activity does not limit itself to what is deliberately intended, one says that it is accompanied by external effects or *externalities*. Typical examples of externalities are effects on the welfare level of other people, who do not take direct part in the activity, and effects on the environment. Externalities may be either beneficial, that is positive, or damaging, that is negative. Costs or benefits of externalities are not borne or received by the agent causing it.

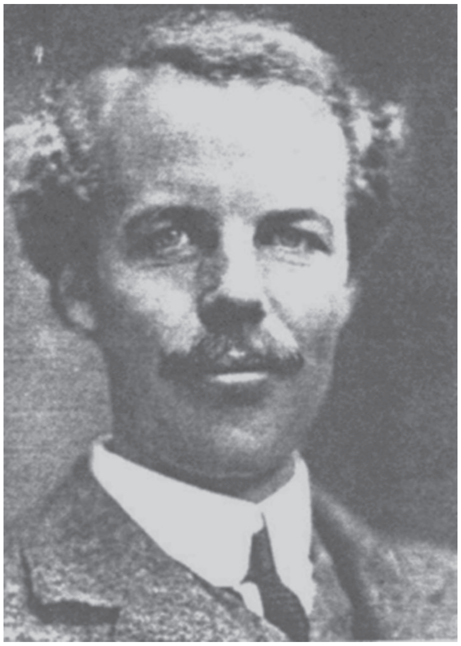

Figure 19.2. Arthur Cecil Pigou (1877-1959). British economist, one of the fathers of neo-classical economic theory and welfare economy. Pigou recognised the failures of the market and searched for ways to make the polluters responsible for negative environmental externalities, that is pay the damage they caused, e.g. by a tax. Such a tax is today referred to as Pigouvian tax, after Pigou.

agent causing the externality. Thus, private costs or benefits of the activity differ from its social costs or benefits. Social costs or benefits refer to all effects of the activity, both the direct ones, appropriated by the involved party, and the externalities, borne by others.

The basic concept of the *market mechanism*, the famed "invisible hand," is based on the notion that each of the economic agents – producers and consumers alike – is pursuing individual self-interest and try to maximise his private surplus of benefits over costs. The very existence of externalities as the difference between private and social effects means that the market forces can induce private decisions which, while being rational from the point of view of individual self-interest, may be inefficient from the point of view of society as a whole.

This impotence of the "invisible hand" is called *market failure*. Arthur C. Pigou (1877-1959), who cited pollution as a classical example of a negative externality, searched for ways "to cure" market failures and proposed that they should be internalised, i.e. making them part of the undertaken economic decisions. Pigou argued that agents should be made responsible for the external costs of their actions via the introduction of an appropriate tax (Pigouvian tax) proportional to the size of externality. He also gave theoretical proof that such tax is, in principle, able to correct market failures.

The economics of the human-environment relationship

The environment is an asset that provides a broad set of useful and, indeed, unique services. These services are produced by nature. Humans do not bear the costs of their production. Some environmental goods, e.g. timber, mushrooms and oil, are traded on the market, but many others are not and, therefore, do not acquire market prices. Does this fact and their "natural" origin mean that their use is without cost and that they cannot, or should not, be priced? Environmental economists say that they should be. The reasons are mainly the following:

- First, the use of an environmental resource provides the possibility to save on man-made capital and labour costs. For instance – all other conditions kept equal – a healthy environment lowers the need for medical care. Indeed, even such controversial use of the environment as a "waste sink" enables us to save, this time on abatement (treatment) costs.
- Secondly, as vast as they might be, environmental resources are available in limited quantities only, either in space or, in case of flows, in time. In other words, environmental resources are scarce and that means that their use is costly: employment of these resources for the satisfaction of one's needs precludes or, at least, limits their use for another.
- Thirdly, many environmental resources used today, i.e. by the present generation, will not be available to use for future generations. This includes non-renewable resources, such as oil, coal, and gas, but also, for instance, a picturesque valley turned into a power station dam. This adds an inter-temporal dimension to environmental resource use.
- Fourthly, "maintenance" of the environmental services, i.e. environmental protection and conservation, is paid for. This is the costs of environmental protection as well as the lost benefits for environmental production or consumption.

Figure 19.3. The commons. The international waters of the world, are clear examples of commons. It is very difficult to develop institutional mechanisms for managing the resources of such commons, which often lead to their overexploitation. (Photo: Lars Rydén.)

Thus, we might conclude that both the use and the conservation or protection of the environment is bound with economic gains and losses. This shows that the utility of environmental goods could be assessed in economic terms. Economic estimation of environmental benefits is required in order to balance them against the costs of their conservation or benefits of their depletion.

If the use of environmental services carries an implicit price, then the following question is a legitimate one: why are we confronted with environmental problems at all? Why does not the celebrated "invisible hand" of the market take care of them in the same way as for other goods and services efficiently regulating their supply and demand?

The reason is that the efficient allocation of resources via market mechanism is possible only when a number of conditions prevail. This includes private property rights assigned to and enforceable for all goods and services, that all goods and services are marketable, and that no externalities exist. A well-defined and enforceable property right to the resource means that all the benefits and costs related to the use of that resource should be carried exclusively by its owner. If so, an owner of a resource is motivated by self-interest to use that resource efficiently. He or she will then maximise the net benefit of resource use, because waste of it would be equivalent to the loss of opportunity to increase the owner's welfare.

Who owns the environment? – the dilemma of common property

It is evident that a discrepancy exists between these requirements and the special character of environmental resources. A set of obstacles prevents market forces from an efficient regulation of use of the environment. There are in particular a lack of well-defined and enforceable property rights for many environmental resources. Resources like clean air, the assimilative capacity of the environment, the beauty of the landscape, wilderness, etc., are not exclusively controlled by a single agent and nobody can be excluded from their use. These are called *common property* or *open access resources*. If the ownership of the resource is either ill-defined or non-existent it is difficult to imagine how a market could exist for that resource. The price of access to it is zero for everyone concerned.

The open, free of charge, access abolishes the incentive to save the resource and, instead, promotes over exploitation. This leads to "*the tragedy of the commons*", a term coined by the ecologist G. Hardin. He published a paper under the same title with historical evidence of the overgrazing and subsequent deterioration of village common land. Access to it was free and unrestricted for all the villagers.

History is full of evidence that common property or open access resources are most likely to be overexploited. Recall, for instance, the case of the American bison that became nearly extinct to the end of 19th century because of the treatment of its herds as a common property. A vivid example in the Baltic Sea region is the Swedish island of Öland that, reportedly, once was covered by trees and bushes. In the 1640s the King granted Öland's inhabitants the rights of free access to the grazing lands and timber resources of part of the island. In the few decades that followed this unfortunate decision, frantic exploitation on a first-come, first-serve basis devastated the island, downgrading its vegetation mostly to moss and shrubs.

Many environmental goods, as well as the environmental impacts of human activity, are not bought or sold on a market at all. These include aesthetic environmental values or the climate, the Earth's atmosphere. Furthermore, costs for pollution are not always enforced. Take an upstream located paper-mill that discharges toxic wastewater into the river, causing a decrease of the fish yields downstream. The market does not regulate the production of the externality by forcing the factory to compensate the losses of fishermen operating downstream. The private costs of paper production does not include the monetary value of the catch lost by fishermen. The production becomes deceptively cheaper, thus leading to a higher, socially and environmentally inefficient, output level (Figure 19.4).

Thus, the "invisible hand" of the market not only fails to stimulate the efficient use of the environmental services. In this case it actually promotes inefficiency in the absence of external incentives.

The commons

Common property or open access resources, shortly called *commons*, are resources where the ownership is either non-existent or ill-defined. Its price is zero and it is thus a resource without a market. Common resources include clean air, the assimilative capacity of environment, and the beauty of the landscape. The global commons are e.g. Antarctica and the bottoms of the oceans. The commons are in best case managed by an institution representing all users, such as a village council or, in the case of waters, a fishery commission.

Tragedy of the commons

An open access, free of charge, resource is at risk of being overexploited by individual users, since it is in their interest to take as much as possible before others take it. The resource may thereby be destroyed for everyone. This is called *the tragedy of the commons*, a name given by the ecologist G. Hardin.

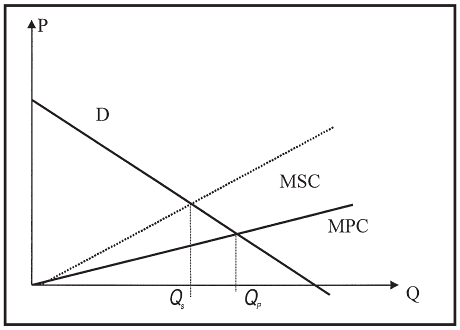

Figure 19.4. Difference between the social and private costs of production. The diagram shows how production (P) is related to cost (Q). The optimal level of production is when the demand (D) curve intersects the marginal cost (MC) curves. The marginal social cost MSC of production is the cost when one more unit is added and all externalities included. The marginal private costs, MPC does not include externalities. The socially optimal level of production is Q_S, and the private optimal level of production Q_P.

Externalities, common property and open access resources belong to the category of distortions that is called *market failures*. The market fails to promote the rational use of environmental resources because it is incomplete. Many environmental goods and services are not traded on the market. Hence, the obvious direction to look for the improvement of the economic mechanism of human-environment interaction is to introduce environmental values in the market agents' motivation. In other words, the implicit economic value of environmental goods and services should be made explicit.

Prices and willingness to pay

It is clear that environmental goods could be assessed in monetary terms, but the question still remains: should they? Some regard it as a wrong, even immoral. Money is perceived as an object of greed and egoism, that leads to so many tragedies in the history of mankind, as an inevitable evil. Its influence should be minimised, not expanded to non-market values.

Methods
Box 19.1

Optimal environmental use

Trade-off between pollution and abatement

Both the use and the conservation of the environment are bound with economic gains and losses. If the environment is used as a natural "waste sink" we save on abatement (waste treatment) costs, such as investment in end-of-pipe technology, while at the same time suffering economic damages because of the resulting lower quality of the environment. Clearly there is a trade-off between the savings on abatement and pollution induced damages. We might ask what level of abatement is economically efficient: How much pollution control should take place in order to maximise the net benefits of the "waste sink" services of environment? Or, equivalently, to minimise the sum of abatement costs and damage costs.

Costs of abatement

Let us assume firstly that the marginal costs of abatement tend to increase with the amount of pollution controlled; and secondly that the marginal damage caused by the unit of pollution increases with the amount emitted. Then, the economic efficiency considerations dictate the following: The increase of abatement efforts should be undertaken up to the point where the marginal increase of emission reduction costs is balanced by the incremental decrease of pollution damages. This is the economically optimal abatement level.

A mathematical treatment

Mathematically this problem of optimal abatement level could be defined as the minimisation of the total pollution costs (TPC). TPC consists of abatement costs (AC) and of pollution induced environmental damage (ED) within the range of different pollution (abatement) alternatives:

$TPC(z) = AC(z) + ED(z)$ where z = pollution level

z_0 = non-dangerous and z_{max}=maximum (uncontrolled) pollution.

The solution to this problem is found at the point where the first-order derivatives of abatement costs and environmental damage – marginal abatement costs (MAC) and marginal environmental damage (MED) – are equal, that is: MAC=MED.

If, for the sake of simplicity, we visualise both these marginal cost curves as linear, the economically optimal pollution level is achieved at their intersection (see the figure) and is denoted by z^*.

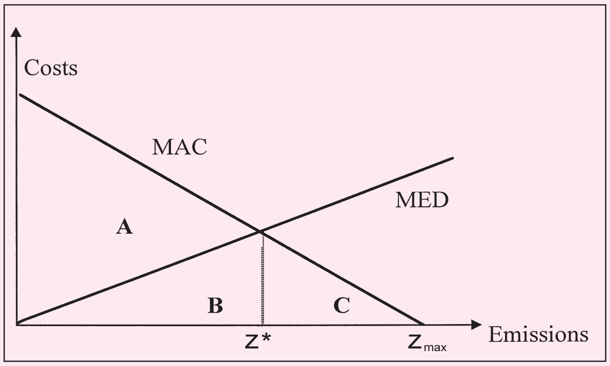

Figure 19.5. Calculating economic optimum of pollution control.

At that point total pollution costs amount to the sum of areas of B (pollution caused economic damage) and C (abatement costs).

Optimal level of abatement (or pollution)

It is easy to see that, if other conditions are kept equal, any deviation from the z^* level of pollution – either to the direction of increase or decrease – causes the increase of total pollution costs. Hence, z^* is the optimal level of pollution. It minimises the total pollution costs or, to put it in a different prospective, maximises net benefits of the assimilative services of environment. Net benefits of pollution in this case are the difference between the amount of unspent abatement costs (area of A+B) and suffered environmental damages (area B), that is the area of the triangle A. It is clear that A is the largest area of net benefit that is possible to obtain.

The notion of economic optimum can be extended to other environmental benefits, i.e. natural resources and recreational services, as well. To judge if our actions bring us closer to the point of the environmental use optimum we need at least an approximate assessment of both environmental control costs and environmental damages (or benefits of environmental improvement).

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The search for alternatives, that could be meaningfully used for both costs and benefits, has led to some interesting ideas, such as "energy values," but all these lack one substantial feature of money: ability to reflect relative human preferences of one good versus the other. Money constitutes "instruments of exchange," which in different forms (coins, notes, cheques, etc.) do not lose value in the exchange process. Money and their tangible counterpart – gold, treasury credits, foreign currency, etc. – are related to the needs of market transactions. All these properties do not exist with the alternatives.

Strictly speaking, *money values, i.e. prices*, do not express real or implicit values of the goods, even if these are traded on a market. Prices are just a measuring rod that are used to indicate the welfare gains and losses connected to these goods. Welfare gains or losses in turn depend on the satisfaction of human wants, expressed as preferences for one type of goods relative to others. The same goods can have different prices in different places and in different periods of time: the welfare gains or losses associated with it are subject to a series of factors – supply, income, fashion, available substitutes, etc.

Market prices are the outward, "on the surface" manifestation of the resource-backed preferences of the people. However, they consist of the preferences of many individuals, and the individual preferences are not always identical. One individual might be ready to pay for the good, if needed, a much higher price than the market price, while another will pay less. What individuals are asked to pay does not necessarily coincide with what they are willing to pay.

Those who would be willing to pay more receive an intangible bonus since they raise their welfare for less money than they were prepared to pay. This bonus is called *consumer surplus*. Hence, the total expenditures on the good can be just an indicator of a lower boundary to the total benefit gained by consumers. The market price is thus not a necessary prerequisite for economic valuations of benefits and losses. What counts is the consumers willingness to pay for the particular change in their welfare or how much they are willing to accept in order to forgo that change. The difference between these two notions helps to distinguish two basic concepts of economic measures: *willingness to pay* (WTP) and *willingness to accept* (WTA). WTP reveals how much an individual is willing to pay to secure the increase of his/her welfare or to prevent its loss. Alternatively, WTA manifests how much an individual is willing to accept in order to compensate the welfare loss or to loose its increase.

The value of the environment – use and non-use values

The environment confers various benefits on its users. Some are the classical *values of natural resources* such as energy, minerals, arable land, timber and other goods for the productive use within the economic system.

However, there are other user benefits of the environment such us fishing, hunting, recreation, wildlife watching, and the like. The use of the assimilative capacity (of pollution) of the environment could be assigned to this group as well. These benefits can be reaped by either the present or future consumers. A distinction should be made between the *use value* and the potential, or *option, value* of the environmental benefits. Retaining an option to the use of a resource in the future takes into account the interests of the future generations. It also allows for the possibility that the growth of knowledge and technological advance might enable us later to derive other benefits from the resource than the ones we are now aware of.

However, we might ascribe even more values to the natural environment. Individuals might derive satisfaction from the pure awareness that some environmental good exists independently of any effect that the use or existence of that good has on him now or will have in the foreseeable future. Even when

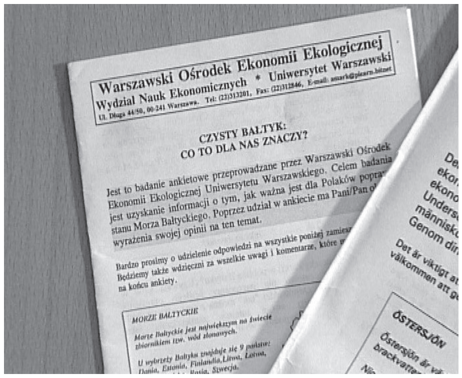

Figure 19.6. A willingness to pay (WTP) study. Questionnaires to study the willingness to pay for cleaning up the Baltic Sea. In the questionnaire a hypothetical Baltic Sea tax was introduced. This proposal of a tax was received well by a majority of the respondents, and the sum that each one was willing to pay was measured The study was performed in Poland, Lithuania and Sweden. The total WTP sum for the whole Baltic Sea drainage basin was calculated by assuming that the response in the other countries would be comparable to one of these three. (Photo: Magnus Efverström.)

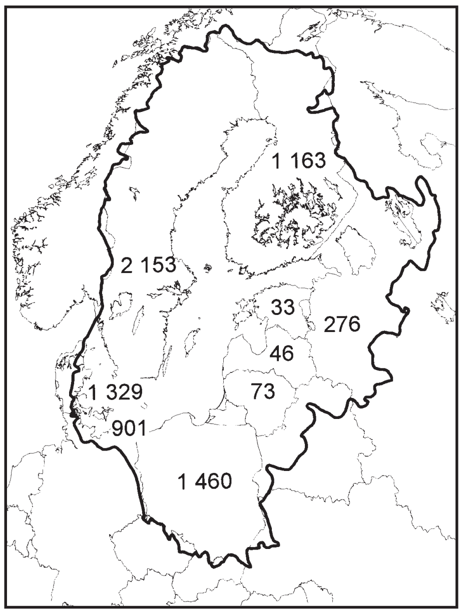

Figure 19.7. Results from the WTP study on cleaning up the Baltic Sea. The willingness-to-pay was measured in Poland, Lithuania and Sweden. The total WTP sum for the whole Baltic Sea drainage basin was calculated by assuming that the response in the other coastal states would be comparable to one of these three. Figures are given in million USD annually. The total sum (7,434 million) is close to the estimated real cost for a clean-up programme. (Source: Żylicz et al 1995.)

Figure 19.8. The value of the environment include benefits, such as enjoying a clean beach, that often are not included in financial reports. Children on Jurmala beach, Latvia. (Photo: Uldis Cekulis.)

no current or future benefit at all is expected it still might be of concern to the individual. For example, many people are happy to know that, say, the population of pandas in China was saved from extinction, or that the population of the Baltic Sea porpoises is being successfully restored, or in general one might be concerned about the preservation of the genetic pool of the Earth. Still another environmental value is ethno-ecological: every culture is influenced and shaped by the natural environment in which it develops. Barren desert might be as dear to the Bedouin's heart as the green meadows and forests are for Nordic people, or the looming mountains for the Caucasian's.

All these "intangible", *non-use values* are jointly referred to as *existence values*. Like use values, existence values are based on human preferences, therefore they are amenable to economic analysis as well.

To sum up, *the total economic value* of the environmental good is the sum of its use and non-use values, that is:

Total environmental value = Productive and consumptive use values
+ Option values + Existence values.

Economic value of the world's environment

A team of 13 researchers coming from the United States, the Netherlands and Argentina sponsored by the National Centre for Ecological Analysis and Synthesis, Santa Barbara, California, reported in *Nature* (May 15, 1997) that an estimated average worth of ecosystem services worldwide is 33 trillion USD per year. The new estimate for the first time attempts to grasp the economic value of the worldwide ecosystem processes that benefit humans, claimed the authors of the report. It says that ecosystems worldwide provide services worth between $16 trillion and $54 trillion a year - average $33 trillion. Nutrient cycling appeared to be the most valuable eco-service with a value of $17 trillion a year. Marine ecosystems account for about $20.9 or 63% of the $33 trillion average annual value of nature services, and terrestrial ecosystems, such as forests and wetlands, contribute the other 37%.

This estimation is regarded as a conservative one that probably represents the lower estimate of what nature is worth, said the researchers, because they did not assign money values to some ecosystems - those in urban areas, tundra, and deserts. Nevertheless, the obtained estimate is impressive, especially if compared to the global gross national product that is about 18 trillion USD. (Source: Bureau of National Affairs, Inc., 1997)

Linas Cekanavicius

The cost of environmental impact

Environmental accounts and net national income

The value of the environment in some countries is starting to make its presence felt in national accounts, so-called *green budgets*, which contain *environmental accounts*. The United Nations has developed a System of Environmental and Economic Accounts, SEEA, to make national accounts from member nations comparable. The environmental accounts are said to be satellite accounts to the national accounts: they add information without distorting the established structure. They are intended to give a platform for conducting an economic policy of the country that takes environmental effects into consideration.

The environmental accounts contain the estimated costs of the environmental impact on the economic activities in the country, and the consequential changes in the value of natural resources. For example, in the Swedish environmental accounts, damage from sulphur and nitrogen emissions are given (see Box 19.3). In addition the accounts contain the "trade balance" of emissions. It is noted that about 70% of the sulphur deposition in Sweden is due to imported emissions, while some of the Swedish emissions are exported. Similarly, the eutrophication of Swedish waters is partly from foreign sources, and for the Baltic Sea foreign sources account for about 90%. The Swedish trade balance when it comes to these emissions is thus negative.

The environmental accounts may be allocated to various economic activities, i.e. different industrial branches, or private consumption and public consumption. In this way they can be included in the normal economic accounts of a country, the national accounts, and be useful in developing national economic and environmental policy. The environmental profiles of six branches of Swedish industry are shown in Figure 19.9. They contain data for production, conversion, export, employment, use of energy and emissions of CO_2, SO_X and NO_X. It is clear that, for example, pulp and paper industry is a large user of energy both in relation to other branches and in relation to export and added value. Iron, steel and metal works have large emissions per value, while the manufacturing industry has small emissions of acidifying gases as compared to its total value.

Indirect estimation of environmental values

There are two general approaches to the economic appraisal of environmental values: direct and indirect valuation. *Direct valuation* methods depend on attempts to attribute the money value directly to the environmental quality gains or losses. *Indirect valuation* methods consist of two stages. In the first stage the physical, biological, medical or other effects of environmental quality change, e.g. "dose-response" relationship between pollution and recipient, are identified and quantified. In the second stage these effects are converted into money value, applying either their known market prices or direct economic valuation techniques.

Productivity change approach (PCA) is based on the assumption that environmental changes affect the output or costs of production and thus the supply and/or price of the product. For example, acid rain might cause the decline of soil fertility and a decrease in harvests; polluted water bodies will yield lower fish catches, and so on. There is a main difficulty with the first step of PCA, the determination of the physical effects of environmental change. Usually methods are used such as field research, comparative laboratory experiments and statistical regression techniques, which single out the influence of the relevant factor on the productivity change. An effort is usually made to compare the situation with and without the environmental impact, in order to define the changes it caused.

Conversion of physical impacts to money values is a relatively simple one, employing actual market prices for either output or production costs.

Total environmental value

include the following:

- *values of natural resources, e.g. timber*
- *use values, e.g.* recreation
- *use values, e.g.* assimilative capacities for pollution
- option values (for future use)
- non-use or existence values, e.g. knowing about biodiversity

Case
Box 19.2

Counting the cost of pollution in Sweden

National accounts for pollution and waste

Several countries have since the early 1990s developed environmental accounts to report costs of pollution. The accounts include air pollution, effluents to water, and solid waste. Sweden, Germany, and the Netherlands have a large activity in this area. Both the European Union and the United Nations have developed norms for how to carry out the national environmental accounts.

The Swedish Environmental Economic Accounts is available in several versions, showing preventive costs, costs allocated to the different sectors of the economy, and the decrease in natural and man-made capital. The environmental protection costs for emissions of sulphur and nitrogen are given in Table 19.1.

Different kinds of costs

Preventive expenditures include: 1) costs for reducing emissions of nitrogen oxides from cars through introduction of catalytic converters, and 2) investments in wastewater treatment to reduce eutrophication due to nitrogen effluents to water. The costs in Swedish industry for preventive measures are large but not included, since it was too difficult to estimate.

Replacement costs include: 1) cost for restoration of damages caused by acid rain by adding chalk to lakes, forests and agricultural land; 2) the costs for repair and replacements of corroded equipment; and 3) costs in the health sector.

The total costs for preventive and replacement activities according to these studies were 2.5 billion SEK (250,000 Euro) or 0.2% of the GNP. The study might be the first estimates of costs related to specific emissions.

An effort was made to estimate the reduction of natural capital caused by emissions of sulphur and nitrogen. The values of decreased production of timber was estimated as 320 million SEK. Nitrate in wells was estimated to reduce natural capital by 110 million SEK, which is the cost of preventive action if made. The decreased value of real estate property prices close to water was estimated to be 160 million SEK. The total reduction of natural capital is thus 0.59 billion SEK. This figure is thus an estimation.

The costs for reducing air pollution

The costs for reducing emissions of sulphur and nitrogen in Sweden up to the politically agreed targets were calculated as 6.7 billion SEK. This should be compared with the result of a WTP, willingness to pay, study of environmental protection. The figure was much larger than those above, about 20 billion SEK. However, here many more variables are included, not the least recreation and other immaterial values.

Table 19.1. Cost for emission of sulphur oxides in Sweden during 1991. Values are estimated by cost of protective measures. In million Swedish crowns, MSEK. (Source: the Swedish Institute for Economic Research, 1996.)

Protective Measure	Costs (MSEK/yr)
Chalking (lakes, soil, forest)	135
Converters in cars	225
Costs in health system	450
Corrosion	968
Waste water treatment plants	730
Total	**2.508**

The application of PCA requires extensive quantities of data and substantial statistical technique skills. It is difficult to distinguish and attribute a specific man-induced change in the environment to its impacts on the receptor. The determination and quantification of the physical links between them usually relies upon numerous assumptions. Examples are the Swedish evaluation of the costs for SO_X and NO_X emissions (see Box 19.3).

Preventive expenditure (PE) and *replacement cost* (RC) approaches deduct what people are ready to spend to prevent the decrease (PE) of an environmental service or to restore an environmental service to the pre-damaged state (RC). Estimations could be obtained by use of different techniques:

- assessment of the required costs for remediation of the environmental damage,
- estimation of the total value of the precautionary measures (protection, prevention, aversive behaviour, relocation, substitutes of natural goods), and
- calculation of the costs of “shadow” projects, designed to compensate the expected loss of an environmental service.

Information for these assessments could be obtained either by the direct observation of the actual behaviour of the economic agents on the market of

Case
Box 19.3

Green budgets – environmental and economic profiles

The green budget, or environmental accounts, of a country includes data on environment together with the traditional data. In a report from the Swedish Institute for Economic Research, the traditional statistics (1-3) are given together with data on energy (4-6) and emissions (7-9) for 12 sectors in the economy.

The data reported are the following:

- *Traditional statistics* (production value, processing value and employment)
- *Energy* (all fuel to be incinerated (i.e. not uranium), biomass and electricity and district heating)
- *Emissions* (carbon dioxide, CO_2, sulphur oxides, SO_x and nitrogen oxides, NO_x)

The sectors are very different in terms of economic value per environmental impact. Manufacturing, such as pulp and paper, and the transport sector, is quite polluting while the service sectors are low in this respect.

Figure 19.9. Environmental and economic profiles for 12 industrial sectors in Sweden, share of total in 1998. Figures are given in percent of total for Sweden. Since not all sectors are included the sum of the reported values are less than 100%. (Source: the Swedish Institute for Economic Research, Statistics Sweden, 2001 SCB, MI 53 SM 0101.)
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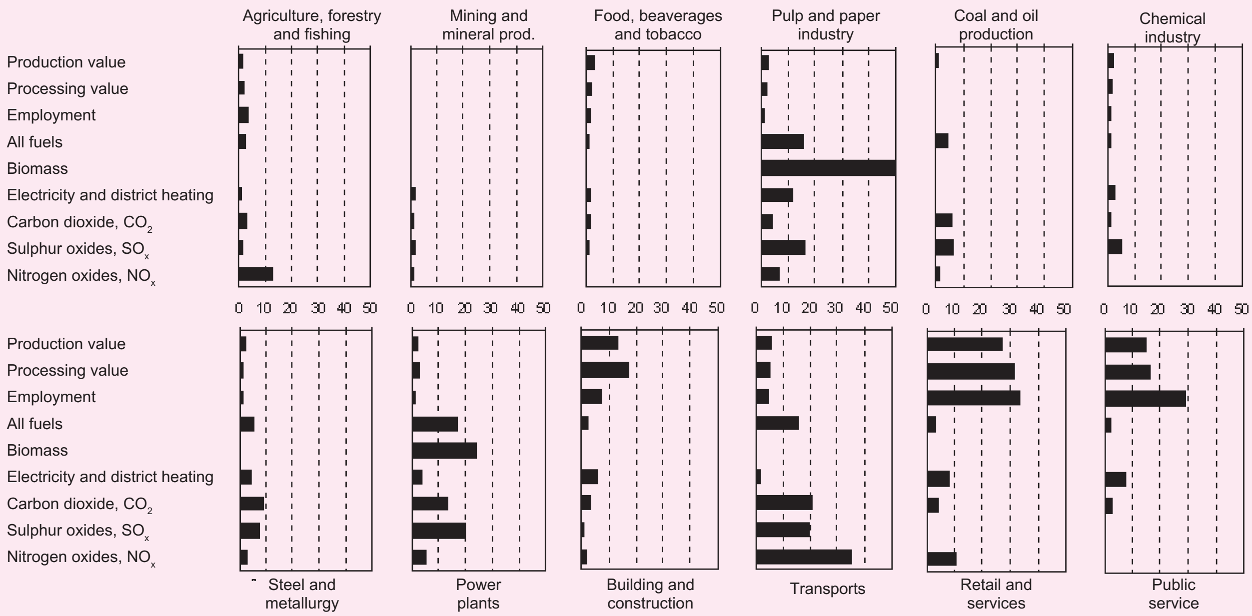


relevant preventive or replacement goods, or by questioning people what measures they would undertake to defend themselves against the adverse impacts of environmental deterioration.

There are two possible distortions in the estimations. First, *under-estimations* are caused by too strong assumptions that the environmental damages can be fully remediated (i.e. that there will not be any unreplaceable losses) or prevented. Therefore the costs of remediation or prevention fully reflect the price of environmental services. Second, *over-estimations* are caused by ignoring the possible multi-benefit schemes of either preventive or remediation measures. For instance, installation of a triple glass window might serve the goal of increasing heat insulating properties as well as the prevention of noise nuisance.

Because of these limitations PE and RC methods are usually used as proxies (approximations) in the absence of data or resources necessary to carry out more precise valuations of environmental quality changes.

The human capital approach

The *Human capital approach* (HCA), as the name indicates, treats people as productive factors of the economy. The economic value of environmental changes is inferred from the assessment of the environmental impact on human health and of the corresponding loss of the human capital, i.e. productive potential (work time). Lost earnings, preventive expenditures and costs of medical treatment and/or premature death are usually taken into account in HCA. The HCA technique basically consists of the following steps: a) determination of the "dose-response" relationship between the environmental pollution level and the incidence of illness, b) estimation of the number of individuals threatened by the pollution, c) calculation of the corresponding expected impact of pollution on the human capital, and d) placement of the monetary values on the health and productivity losses.

Like the PCA approach also the HCA technique heavily relies on luck in obtaining non-controversial and interpretable data and a sufficiently large amount of data necessary to properly quantify the cause-effect relationship. Additional shortcomings of the HC approach are: 1) *under-estimations* caused by ignorance of psychological costs of illness or premature death: discomfort, suffering, loss of close relatives, etc. (these might have been assessed in terms of willingness to pay to avoid them); 2) *over-estimations* when health impacts to "non-productive" humans, e.g. retired or disable persons, are considered (the calculations may even result in a negative value); and 3) *time lag*, when there is a long time-lag between the causative influence and the resulting disease (e.g. cancer, which is a major effect of the Chernobyl disaster, may take some 20 years after the accident to appear). It is quite problematic to use the method.

The indirect valuation methods are quite useful and often employed in various project analyses. They are often criticised, however, for the failure to estimate consumer surplus, connected with the environment-caused gains or losses, let alone to grasp the existence value of the environment. At the best they estimate what people *do pay* or lose because of environmental changes, not what they *are willing to pay* in order to avoid the environmental deterioration. Therefore, in most cases indirect methods could be trusted to provide only lower-bound estimates of the economic value of environmental changes.

Direct methods for assessing environmental values

The indirect valuation methods relies in principle on prices on existing markets and people's willingness to pay money, time, etc., to obtain an increase of environmental quality. The direct methods are in contrast used in the absence of a market for environmental quality. The economic value of an environmental quality is instead deduced either from the observed behaviour of people on a market of related goods, or from their declared behaviour on a hypothetical market.

Estimating the cost of environmental impact

Indirect valuation methods

***1. Productivity change approach* (PCA).** The relationship between pollution and productivity of the recipient, e.g. the amount of timber in a forest is estimated, then these effects are converted into money using known market prices.

***2. Preventive expenditure* (PE) *approach*.** The money people are ready to spend to prevent the decrease of an environmental service.

***3. Replacement cost* (RC) *approach*.** The cost to restore an environmental service to the pre-damaged state.

***4. Human capital approach* (HCA).** The number of individuals hit by pollution is counted, the impact on human health is estimated, e.g. sickdays, and finally the monetary values on the health and productivity losses.

Direct valuation methods

***1. The Hedonic pricing method* (HPM)** is based on the isolation of the influence of environmental variables, such as noise and air pollution, on the property value, from others like value of the building itself by means of multiple regression analysis. The established "price-pollution" function tells how much consumers have to pay for an increase of environmental quality.

***2. The travel cost method* (TCM)** is used to evaluate the value people place on a recreation site from the observed costs, the time used and money paid to travel to the site. A "recreational demand curve", which relates visitation rates to the site to the estimated costs, makes it possible to measure how much people would be willing to pay for the opportunity to use recreational benefits of the area.

3. The *contingent valuation method* (CVM) finds how people would value certain environmental improvements by simply asking them about it. The techniques used vary from the simple questionnaire to procedures such as bidding games, and "real market" stipulations.

Case
Box 19.4

Economic valuation of environmental damage inflicted by the Soviet/Russian military in Lithuania

The detailed assessment of the environmental damages and their monetary valuation was carried out by the Baltic Consulting Group (Lithuanian-Danish-Swedish joint-venture), together with Krüger Consult (Denmark). Areas of the land, forests, and lakes, occupied by the Soviet military bases were carefully measured, the quality of environmental resources was assessed and the physical environmental damages were calibrated at each of 275 identified former Soviet/Russian military sites in Lithuania.

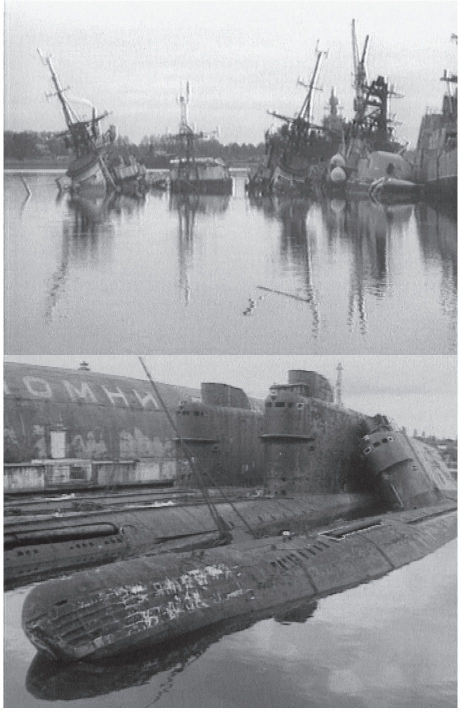
Economic losses were conceived to include: 1) Lost environmental benefits due to restricted access to natural resources (i.e. land, forest, and water bodies) during the period of occupation (1945-1993), and the period of rehabilitation of damaged territories (since 1993); and 2) Costs of remediation of damaged territories.

The monetary valuation of the lost benefits was based on the unpaid rent on the arable land and on the lost (non-exploited) yield of fisheries, timber and non-timber production of forests. In order to take the time-factor into account, benefit losses in the past were calculated with compounding interest (an interest rate of 3%, the official rate on state bonds, was used) and the estimated remediation period losses were discounted to their net present value in 1995. A sensitivity analysis was carried out in order to determine reaction of the obtained evaluations to the incremental changes in the magnitude of the parameters used (prices, interest rates, etc.).

The figure obtained for the lost environmental benefits was about 650 million USD, whereas the value of the total economic loss amounted to 1,700 million USD. Since the magnitudes for most of the parameters used for the calculations were selected to represent the "lowest possible ones," these figures could be regarded as an indication of the low end of the sums required to compensate environmental damage inflicted by the Soviet military.

(Source: Baltic Consulting Group and Kruger Consult,1995.)

Figure 19.10. Soviet military base in disuse. This base in Liepaja in Latvia, 1993, is polluted by abandoned ships leaking e.g. heavy metals from batteries. (Photo from video: Uldis Cekulis.)



The *hedonic pricing method* (HPM) is based on the assumption that real estate property prices, as well as wage differentials, depend on the differences of environmental quality. The essence of the property value approach is to isolate the influence of the environmental variables (noise, air pollution) on the property value, from others like value of the building itself, the neighbourhood (local facilities, absence of crime, etc.) and accessibility (distance to work, etc.). It is done by means of multiple regression analysis. When the "price-pollution" function is identified it gives how much consumers *have to pay* for an incremental increase of ambient environmental quality. The next, more complicated step is to obtain an estimate how much consumers *would be willing to pay* for environmental improvements of the property premises.

Similarly, the underlying assumption of the wage differentials approach is that wage differences could be attributed, beside such variables as education, skills, age, industry sector, etc., to the environmental risk such as an unhealthy or dangerous working environment. Again, statistical regression techniques are used to single out the effect of environmental risk magnitude on wage levels.

The main limitation of HP methods is that they require a large amount of data on many variables some of which are difficult to quantify, e.g. prestige of neighbourhood or occupation. They also depend on the questionable assumption that the interviewed persons are well-informed, especially about the environmental aspect of their choice; they ignore the possibility of averting behaviour, and the fact that both labour and property markets deviate from a perfect competition model. Like in all studies involving techniques of statistical analysis, the results of HPM application are highly sensitive to the skills of the researcher.

The *travel cost method* (TCM) is mainly used for the evaluation of the recreational services. The value that people place on a recreation site is derived from the observed costs, the time they sacrifice and money they pay to travel to the site. The technique enables construction of a "recreational demand curve", that relates visitation rates to the site to the costs of travel to it (time costs are converted to money as well). Once obtained, the demand curve makes it possible to measure how much people would be willing to pay for the opportunity to use recreational benefits of the area.

In general, the procedure of TCM follows these steps: the surrounding area of the recreation site is divided into concentric circular zones; visitors to the site are sampled to determine which zone they came from; visitation rates (visitor days per capita) are calculated for each zone; regression analysis is carried out in order to relate visitation rates to travel costs and other socio-economic variables, such as average income, education, etc.; a recreational demand curve is traced out on the basis of an obtained "visitation rates-travel costs" relationship.

The limitations of the TCM are mostly caused by the underlying assumptions, e.g. that the recreational benefits of the site is the *sole* purpose of travel to it. Thus, both the social amenities of the site and the possible pleasure of a trip itself is ignored.

The *contingent valuation method* (CVM) rests on the hypothetical market behaviour of people. On one hand, it makes the CVM potentially applicable to virtually all situations when observed data are unavailable, plus that CVM is accepted to be the only way to obtain estimations of existence and option values. On the other hand, evidence suggests that the CVM is rather vulnerable to the various biases on the part of respondents to the hypothetical questions.

The idea of a CVM study is to find out how people would value certain environmental changes by simply asking them about it. Both the changes and the answers about the willingness to pay for them are hypothetical – hence the name of the method. The techniques used to elicit people's money-backed preferences for environmental values vary: from the simple questionnaire surveys to various iterative procedures (e.g. bidding games and the Delphi method), and a "real market" stimulation. The closer the hypothetical situation is to a real market, the more reliable are the data on people's willingness-to-pay for the environmental improvements.

The most often cited respondent biases that may distort the estimates obtained by the CVM technique are: a) a strategic bias – when answers of a respondent are deliberately shaped in order to influence the outcome of a CVM study; b) design bias – when respondents answers may depend on the way the questions are formulated; c) an operational bias – when what the respondent claims to be ready to pay differs substantially from what would be paid in a real situation; d) an information bias – when respondents may be forced to attribute money values to what they have little or no understanding about; and e) a starting-point bias – when in the bidding games the initial bid may inadvertently suggest to the respondent the range of "acceptable" answers.

Use of contingent valuation for water quality improvements in Latvia

The CVM study was carried out in Sigulda, Latvia, a medium sized town (ca.12,000 inhabitants) located 50 km northeast of Riga. The sewage and treatment collection system in Sigulda is considered inadequate to cope with current waste-water loads, resulting in occasional discharges of untreated sewage into the Gauja River. Drinking water quality was also found to be unsatisfactory.

The survey was two-sectioned: one section discussed drinking water quality, and the second sewage treatment and the Gauja River's water quality. In the drinking water section, survey respondents were presented with three different filter schemes, each improving water quality to a different degree at a different cost. For the Gauja River the programme consisted of the modernisation of sewage facilities in Sigulda. The payment vehicle for both programmes was an increase in monthly fees for water and sewage service.

The survey was administered both by in-person interviews and through mailed questionnaires. The final result was 200 complete in-person interviews and 173 answers by mail.

The estimated median WTP for a drinking water improvement programme was 0.42 Lats/month (in addition to the presently paid 1.80 Ls/month). For the Gauja River, the median WTP was found to be 0.13 Ls/month. To investigate factors influencing the support for both water quality improvement programmes, regressions were estimated including a number of demographic and attitude characteristics.

(Source: Ready, R.C. et al., 1998.)

Usefulness of economic appraisal of environmental values

Generally speaking, the accuracy of economic valuations of environmental changes needs to be improved. In some cases the range of errors of the obtained estimates were 60% or more. Still, economic valuations of environmental changes are useful for the three following reasons.

- Firstly, even an approximate assessment of the magnitude of economic impacts might indicate the importance of environmental policy benefits.
- Secondly, the use of the valuation techniques enables us to ascribe monetary figures on at least some environmental costs and benefits, thus making possible a comparative analysis.
- Thirdly, the problems of reliability of the obtained data can be partly alleviated by sensitivity analysis. The fluctuations of the assessments is then tested against the variations of the parameters used.

Most importantly even an incomplete and imperfect evaluation of the economic consequences of environmental impacts might be sufficient. If the low-end estimate of costs dramatically exceeds the expected project benefits, it is clear that it is good economics not to accept such impacts and avoid such environmentally detrimental projects.

Figure 19.11. The value of improved water quality. Investing in improved water management was one of the first priorities after the systems changes. (Photo: André Maslennikov.)

PPP

The *Polluter Pays Principle*, PPP, says that the one using the environment should pay. The implementation of the PPP leads to many difficulties, such as to measure how much a polluter needs to pay to achieve a reasonable application of the principle

Who should pay?
The Polluter Pays Principle

Who pays for pollution?

Who should pay for the costs of environmental pollution or the cost for using natural resources? One might think it is selfevident that the person or entity that is "using" the environment, either as a sink (pollution) or as a source (natural resource use), should pay for it. However, this is not so often the case. A big part of environmental degradation is not paid for at all. One might say that the victim is left to pay.

More recently, however, the principle of letting the one using the environment pay has received much recognition and is also formulated into a principle: the *Polluter Pays Principle*, or PPP. The implementation of PPP is not straightforward. Many difficulties have to be dealt with, not least a way to measure how much a polluter needs to pay to achieve a reasonable application of the principle.

Even if the PPP today is becoming the main and most important principle there are also many others. When it is difficult to apply strict financial responsibility of one single polluter, one might argue that the group of polluters is committed to bear costs in order to maintain an acceptable level of environmental quality. This is the *Polluters* (note the plural form) *Pay Principle*. In this case all polluters are charged environmental protection costs, according to the proportional impact (damage) that they cause to the environment.

One more extension of the PPP is the "*Polluter and User Pays Principle*". The price of extraction of natural resources often does not reflect the full costs. Deterioration and diminishing of natural resources is often disregarded. Services connected with the natural resources supply are also not always covered by charges paid by customers (for example, water users often do not pay the full price because water companies are subsidised from other sources). The polluter and user pays principle should help to internalise costs disregarded by the user (i.e. be included in the price of natural resources).

The main environmental principles extensively used in environmental protection policy are shown in Table 19.2. The principles are all interrelated. The Table gives a short definition of principles which most often are the basis for environmental policies throughout the world.

The Polluter Pays Principle (PPP)

The British economist Pigou may be called the "father" of the PPP. In 1920, he expressed welfare economic ideas that prices of goods and services should reflect

Table 19.2. Principles for deciding who should pay for environmental impact.

Principle	Short description
Polluter Pays Principle	Polluter should bear the costs of preventing the harm to the environment
Polluters Pay Principle	Several polluters are charged in proportion to the environmental damage each one causes.
User Pays Principle	Users of natural resources should pay the full price for natural resources and their supply.
Victim Pays Principle	For some reasons the polluter cannot be expected to pay for the damage and the victim subsidises the polluter.
Prevention or Precautionary Principle	One seeks to avoid irreversible damages to the environment with the help of imposing safety requirements.
Economic Efficiency/Cost Effectiveness Principle	A principle used to select the proper environmental policy instruments. It says that reflection of full environmental costs in prices diminishes the necessity to intervene in order to achieve environmental goals.
Subsidiarity (Decentralisation) Principle	This principle seeks to assign environmental decision making to the lowest possible level of a government.

full social costs, that is, not only the costs related to the direct production of goods, but also costs which reflect the damage done by pollution and natural resource extraction. The negligence of this would lead to over-exploitation of natural resources and pollution, which the environment cannot absorb. When a polluter pays for this, it internalises these environmental externalities. However, one cannot forget that a company which is a polluter in this case is just the first accountable actor and it has the right to pass these environmental costs on to the consumers. Nevertheless, market forces, i.e. competition, would always stimulate producers to minimise their costs and, hence, minimise the pollution they cause.

A market approach to environmental policy is increasingly used in many countries of the world. Rather than forcing polluters to comply with a specific rule unconditionally, it encourages the creation of flexible strategies for environmental protection or reduction of pollution.

Different policy instruments (economic instruments are described below) can help to apply market approaches. Using these instruments the state interferes in the natural forces of the market and forces polluting entities to behave in a special way. This means that polluters, optimising their decisions in order to get the biggest profit, benefit the environment as well. For example, one of the economic instruments used by a government for environmental purposes could be a pollution charge, that is, a charge put on every unit of a polluting substance discharged by any company to the environment. Paying money for pollution means an additional financial burden for the company, and because of this the company will take special measures to avoid payment of charges and hence to avoid pollution. Of course, efforts to avoid pollution would depend on the level of the pollution charge. This means that this instrument balances pollution and pollution abatement. Environmental taxes and charges are a way of implementing the PPP by including environmental costs in the price of goods or services.

A favourable outcome of this situation is that society enjoys the benefits of a cleaner environment, and the social costs to achieve this gain are minimised, as a company will always do that in an optimal way.

The idea of the PPP is that people should pay more for things that are bad from the environmental point of view and pay less for those products which are less harmful to the environment. Industry could also benefit from this method of pricing goods. For example, introduction of taxes on water resources could possibly have three separate outcomes or a combination of them: some water users will make investments in greater water usage efficiency, others will respond in a reduction of water consumption, and others may still decide to continue to use water as before and pay an extra tax. In all these different cases polluters pay for the harm to the environment, as environmental costs are included in the price of products.

Thus, like in many other theoretical economic spheres, environmental protection policy is based on a defined principle. The Polluter Pays Principle is the basic economic principle for environmental policy. The first (narrower) version of the PPP dates back to OECD recommendations of 1972 and 1974. It says that the *polluter* should bear the costs for complying with environmental requirements decided for that polluter by a relevant environmental authority. It shows also one necessary condition of the applicability of the PPP: the latter could be applied only when environmental quality targets are defined, that is, only when specific requirements (standards) are set for polluters by environmental authorities.

The extended PPP's interpretation broadens the meaning of the PPP. It states that polluters could be required to pay for all harm their activities cause to the environment. Even though the OECD has encouraged this broader principle during the last decade, most countries try to use the narrower version of the PPP in practice because of the weaknesses in applying the principle in practice, as we will discuss below.

Figure 19.12. Applying PPP. The polluter pays principle is easy to apply when the impact is local and well defined. Most often this is not the case, as when large forest areas are damaged by air pollution from far away. A tax on emitted SO_x is one way to apply the principle, but it does not necessarily help the land owner. Here a forest in the Sudety Mountains 1996, then in a terrible state, but today slowly regaining its former condition. (Photo: Pawel Migula.)

The weakness in applying PPP

In spite of the fact that the environmental legislation of many countries includes the PPP as the basic principle, the interpretation and especially the practical application of the principle still have many ambiguities. One of the main reasons for this is that the real world is complex and the relationship between emissions to the environment and environmental damage, and hence costs for the control of this damage, is not uniform across time and space, nor is it fully understood.

In addition, discussions are continuing on some of the aspects related to the PPP. First of all, there is no explicit definition of a polluter. Each country can interpret the concept of polluter as it wants. Secondly, it is not clear how much a polluter should pay, that is, how to evaluate damage to the environment. Thirdly, among other things subsidies in the environmental protection field are still in use in order to give polluters some time to adjust to pollution level requirements set by relevant authorities. For example, if some industries suffer severe difficulties and for some reasons governments want to sustain them, financial support will be provided in spite of the pollution they may cause.

So even if the Polluter Pays Principle says that polluters are responsible for any harm caused to the environment, they are sometimes still subsidised. There is no agreement yet on whether subsidies are, or are not, consistent with the PPP. Therefore, in practice important exceptions from the PPP are acknowledged and tolerated in many countries.

Implementing PPP in the Baltic Sea region

All Baltic countries have the Polluter Pays Principle as an integral part of their environmental legislation. In most countries of the region the PPP is implemented through a system of taxes or charges, which apply to natural resources used and/or most substances released into the environment. Also other economic instruments could be used for the implementation of the PPP.

However, countries around the Baltic Sea, as many other European countries, are not very strict in the interpretation and implementation of this principle. As mentioned, although the PPP is a non-subsidising principle, subsidies are often used to encourage producers to reduce their environmental pressure or to reduce compliance.

In some countries the PPP is being violated for equity reasons. It happens especially if the polluter is a municipal body. Quite often polluters are financially supported through funds collected from pollution charges. In Poland, for instance, the funds originating from pollution charges account for almost 50% of the overall environmental investment expenditure. Environmental charges are also viewed as an integral part of Poland's commitment to the PPP. In Germany subsidies are considered compatible with the PPP if they assist in achieving the implementation of the PPP or enable stricter environmental controls. In Lithuania so far state subsidies have been used for environmental protection projects, mainly in the water sector, though the PPP principle is implemented by including it in the main national environmental legislation.

The Water Fund in Denmark is one out of four subsidy schemes used there for water and the aquatic environment. The Fund is targeted at water utilities that supply drinking water and face costs related to the increased Danish groundwater contamination by pesticides and nitrates.

The practice of pollution control in many countries so far has shown that the main goals of different economic instruments used in the environmental sector are related to the achievement of environmental objectives and fund-raising. Therefore, as environmental economists state, the PPP so far has played largely a moral role enabling governments to require the introduction and use of some economic instruments but keeping their incentive function at a level acceptable to the entire society. The PPP so far has not been the crucial factor in decision making on pollution control instruments.

Internationalising the PPP

A very important aspect related to the PPP is its relationship with international environmental policy. Uneven environmental regulations, that is, an uneven level of subsidising of environmental activities in each country and different level of environmental economic instruments may become a source of trade distortion, as prices of goods can be very different in such a case. For instance, if two chemical plants with the same technologies producing the same goods in different countries pay very different charges for the same pollution, their goods will be priced differently and hence trade distortion and capital flights could be the result. Thus, there is a need to co-ordinate the implementation of the PPP among different countries. This is quite an appropriate task for the near future, as the PPP is set as the main environmental principle in most of the world.

The PPP is also seen as a principle that could be applied to some global pollution issues. For instance, it is expected that regulation of global climate change will be based on the PPP.

Economic policy instruments I

Taxes and charges

Curing the market through policy instruments

The main task of environmental management is to achieve specified environmental goals. Governments may seek to improve the quality of surface water, reduce contamination of soil, and cease pollution by solid waste, etc. These goals could be achieved through a very wide spectrum of methods, so-called *policy instruments*. Potential and actual, i.e. in use, environmental policy instruments range from a complete prohibition of polluting activities to milder forms of voluntary agreements. There are three main kinds of policy instruments:

- administrative (direct controls), i.e. legal regulation,
- voluntary agreements and information strategies, and
- price incentives or market-based instruments.

The entire problem of environmental policy implementation is surrounded by the constantly changing natural and economic worlds. If a particular set of actions is effective under one set of conditions, these actions may fail to have acceptable results under a different set of conditions. Governments should be aware of this and seek to introduce an instrument or instruments, that succeed in achieving environmental goals by way of minimising social costs.

Traditionally, environmental protection in most countries, including the Baltic Sea countries, was managed with the help of administrative instruments, that is, so-called *command and control* (CAC) measures or direct controls. The CAC approach means the enforcement of laws and regulations which prescribe certain objectives, standards and technologies for a polluter, e.g. in cases of discharging wastewater into a river, emitting pollutants into the air or disposing of waste. A polluter must comply with these requirements. In order to be effective, the CAC system must be followed by monitoring and control systems, that is, much resources

Policy instruments

- Administrative, regulations etc
- Economic, taxes etc
- Voluntary, information etc

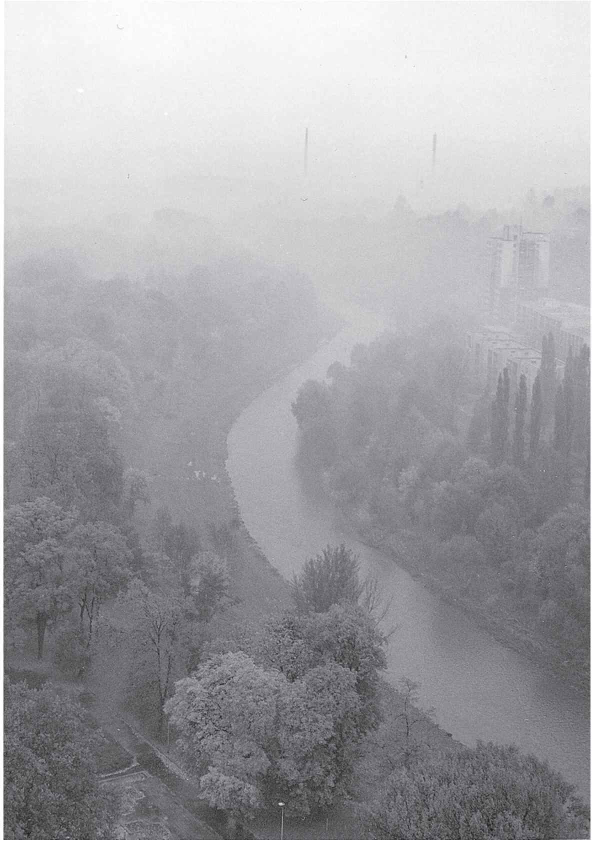


Figure 19.13. Cost of natural resources. During communist times no charges were used for water in the households. A result was overconsumption and inefficiencies, for examples leaking faucets. Cost for water has remedied this considerably and water consumption has decreased up to threefold in the former socialist countries. A charge on water may be considered a tax since it is not always directly related to the cost. Here Ostrava river in the Czech Republic. (Photo: Lars Rydén.)

need to be spent on tracking pollution activities, controlling them and using human and money resources to force economic agents to meet the set requirements. Also the effectiveness of the regulatory system depends on the carefulness of a responsible controlling agency. This direct regulation is still a quite commonly used instrument in many countries around the world, even though an economic approach, i.e. use of market-based instruments, is becoming more and more important.

There are cases when, for political reasons, a government is not inclined to implement certain environmental policy goals using usual legal or economic instruments. Practice shows that in such cases only actions which are *voluntary* on the polluter's part, can be used to achieve such goals. An example of this could be a request to people to voluntarily return used mercury or nickel-cadmium batteries to special places. Moreover, sometimes companies make voluntary agreements themselves in order to avoid more stringent government measures. Usually a voluntary agreement is achieved through a process whereby an industry sector or a group of individual companies agree with a government to reach certain environmental objectives within a defined time frame.

In some cases *the public sector itself* takes responsibility for "curing" the environment. For example, it may happen that natural disasters worsen environmental quality, that is, no company or person is responsible for the harm to the environment and hence environmental quality cannot be corrected by the usual ways. In these cases the public sector should be directly responsible not only for the provision of certain environmental infrastructure, but also for its overall planning and management.

Recently environmental economists started to emphasise the importance of *information strategies* as a prerequisite for efficient environmental policy. The main reasons are that the systems of direct regulation and market-based instruments are related, in most cases, to a very big number of polluting substances to be controlled, and that countries very often lack sufficient controlling infrastructures. However, with technological progress the collection, aggregation and dissemination of information are becoming less and less expensive. Thus, the importance of information strategies as a potentially new regulatory tool is growing.

The main disadvantage of administrative environmental control systems is that polluters are not given an incentive to go further and reduce pollution more than is required by the environmental authorities. In addition, as mentioned, this system is not efficient, because the enforcement and control needed is very resource and time consuming.

This is why *economic instruments*, in other words, market instruments, are being used more and more in many countries. It is reported that more than 200 different economic instruments are used in OECD countries. The main categories of the environmental economic instruments are:

- pollution charges,
- product charges,
- deposit-refund systems,
- tradable permits.
- damage compensation, and
- subsidies.

Each of these are described and discussed below.

Pollution charges or taxes

A free market allows balancing supply and demand of different goods in the optimum way. In the case of the environment, however, as discussed above, this mechanism does not work, because environmental components have a value, but do not have a price. Therefore, the intervention of forces, which are outside the market, is necessary in most cases. Governments may do this by introducing a pollution charge, which means payment for each unit of pollutant discharged into the environment.

Polluters react to a charge on their emissions or discharges by reducing them to a level where the unit rate of the charge and the marginal pollution abatement cost, that is, the cost of removing one additional unit of pollutant, are equal. In other words, if for a company it is cheaper to pay charges rather than install cleaning equipment, it will do that. If a company needs to pay more for pollution charges than for pollution abatement, the incentive for the company to install pollution abatement equipment is very strong.

This mechanism enables the reduction of overall emissions at the lowest total cost. This is a very important advantage of pollution charges compared to direct regulation. Faced with a choice between abatement or paying a charge, those companies which are best suited to reduce pollution cost effectively, that is, those with the lowest marginal abatement costs, will reduce their emissions. Those who cannot abate emissions cheaply will pay the charge.

It is however, difficult to know which charges to use. Firstly, the cost of pollution is mostly not at all known. Secondly, it is not known at which charge rate the polluters will collectively meet the environmental goals. In practice so-called mixed systems are mostly used. Charges are combined with emission standards and polluters need to pay charges as well as meet the set standards. For example, very often pollution charges are introduced in conjunction with a permit system: an environmental authority sets the limit for some pollutant, which could be emitted (discharged) by a company to the air or water. A base charge rate is applied to all pollution within the permitted level and a penalty rate is added for pollution above that level (the so-called non-compliance fee).

However, while most environmental authorities, especially in the eastern part of the Baltic Sea region, think that their pollution charge systems increase incentives for investment in pollution control, little evidence exists that charge systems actually do provide such incentives. In most cases charge rates are too low. On the other hand, Poland's and Lithuania's experience suggests that charge

Examples of economic policy instruments

Pollution charges

- Tax e.g. on emitted SOx
- Non-compliance fees (when exceeding permitted emissions)

Product taxes

- taxes on fertilizers
- taxes on fuel such as petrol

Deposit refund systems

- deposit on bottles for beverages
- deposit for other packages

Case

Box 19.5

Tax on commercial fertiliser in Sweden

Environmental charge on commercial fertiliser

Leaching of nitrogen and phosphorus causes eutrophication of inland and surface waters. Over the last 20 years levels of nitrogen and phosphorus, both nutrients, in the Baltic Sea have doubled. The Baltic Sea suffers from eutrophication. The correlation between the use of fertilisers and excessive nutrient levels is not direct. Nevertheless, control of the input of nutrients in agriculture is one of the main factors of reducing the risk of excessive nutrient leakage to waters.

The purpose of the environmental charge on commercial fertiliser, which was introduced in 1984, was to reduce demand of such a fertiliser and to fund an action programme to reduce the adverse impact of agriculture on the environment. The rate and the content of this charge had been changed many times since then and now a tax on nitrogen in commercial fertiliser is in effect. This tax constitutes approximately 20% of the price of fertiliser. It is levied on commercial fertiliser manufactured in Sweden or imported. Producers and importers are under a duty to register, submit returns and pay taxes on quantities delivered each month.

Data shows that nitrogen consumption was at its lowest in 1991/1992 when charges were at a maximum, 2.35 SEK per kg. When the total charge burden lowered sharply to 0.60 SEK per kg at the end of 1992, the total consumption of fertiliser increased by 16%.

The price elasticity

Therefore, special calculations were made to analyse how nitrogen consumption depends on the price of fertiliser. The *price elasticity* (how much consumption changes with price) of nitrogen was estimated to be between 0.12 and 0.51 depending on the catchment area, that is, the use decreases by 0.12 - 0.5% when the price rises by 1%. These results indicate that short-term demand for nitrogen in fertiliser does not vary much with changes in its price, but in the long run the response may be expected to be greater, since other factors such as new technology may reduce the need for nitrogen in the form of commercial fertiliser.

Generally, it was concluded that such a tax can be used as an instrument to reduce fertiliser use, although it must be quite high in order to have an impact.

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revenue collection rates decline with the increase of charge rates. Therefore, monitoring and enforcement play a very important role and the effectiveness of the pollution charge system depends greatly on them. Usually monitoring and metering costs are relatively high, which is a barrier to effectiveness.

Nevertheless, most economists believe that pollution charges are the most efficient economic environmental instrument. It has a further advantage in that it raises revenue for a government, which gets financial resources for environmental protection.

Product charges or taxes

When sources of environmental pollution are numerous and hence it is quite difficult to control them, the use of pollution charges or tradable permits (the latter described below) is not effective. A better instrument in such a case could be a product charge.

A product charge is an upward adjustment to the price of a product, if its manufacturing, distribution, use or disposal may cause environmental damage. Product charges are imposed on specific products. This may be finished products, intermediate products, or raw materials.

Product charges are very close to both pollution charges and deposit-refund systems (discussed below). On one hand, they are charges for potential damage that can be caused by scrap products, so they are characterised as pollution charges. On the other hand, deposit-refund systems can be defined as a refundable product charge. Therefore, product charges are classified differently in different literature.

A product charge has a direct impact on producers and indirect impact on consumers. The main purpose of product charges is to give incentives to reuse, recycle, recover or safely dispose of harmful products. The most widespread products subject to the product charge are raw materials and intermediate inputs such as fertilisers, pesticides and chemicals, natural gravel, and final consumer products such as different packaging, batteries, car tires, and automobiles. For

Case
Box 19.6

The Lithuanian system of pollution charges

Maximum allowable pollution

The abatement policy used in Lithuania is a mixture of economic incentives and command-and-control (CAC) standards. For every pollutant discharged by a company the "maximum allowable pollution" (MAP) standard is established, which is the maximum amount that can be discharged into the environment during a given time period. If for technical and financial reasons a company is unable to reach MAP, authorities may establish a "temporarily allowable pollution" (TAP) limit for that company.

Pollution charge rates

The law on pollution charges (last updated 1999) sets two types of pollution charge rates: base and penalty rates. Companies, which emit below the standard set for them, pay the base rate. For companies, which are above their standards, a penalty rate applies. The penalty rate is the basic rate multiplied by a penalty coefficient. Polluters having TAP permits will not be allowed to use base rate from the year 2004 and will need to pay 20% higher charges in comparison to those having MAP permits.

Charge allowances are provided for in the Lithuanian law on pollution charges. Those polluters who operate under the MAP system and implement pollution abatement measures, which reduce pollution by 25%, could be relieved from the payment of charges for three years. In practice, this waiver has been an ineffective instrument so far, because charge payments are very low due to low charge rates.

Improvements in the pollution charge system

Since pollution charges are the main economic instrument in Lithuania, it is very important to design it in the best possible way. Taking into account some experience and mistakes made, policy makers proposed some improvements in the pollution charge system in 1999, eight years after the pollution charge system was established in Lithuania. These improvements covered firstly a more precise definition of the environmental goals Lithuania is supposed to achieve. Aggregate emission reduction targets were defined which the system had to reach. Secondly, a simplification of the structure of the charge system was made reducing the number of charge rates from the earlier more than 200 different rates for different pollutants. Thirdly, the charge rates were increased.

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example, most countries have introduced an annual vehicle tax based on engine size and/or age of the car.

In addition, taxes on energy products (e.g. fuel) is a widespread form of product charge. It is estimated that in OECD countries taxes on motor fuel constitute more than 75% of all environmental tax revenues.

Countries around the Baltic Sea either have quite good traditions in the application of different types of product charges (the Scandinavian countries), or are starting to introduce them (Poland and all the Baltic countries). In Estonia, a product charge was introduced in 1997 on bottles to reinforce a sagging deposit refund system. This tax, which allows for an exemption when manufacturers have verified a specified recovery rate (40% in 1998 and 60% in 1999), was linked to a specific policy target of 60% recovery of packaging waste by June 2001.

Figure 19.14. Deposit-refund system. The deposit-refund system is well established in Sweden. The larger PET bottles are refunded with SEK 4 (almost 0.5 Euro) while bottles and aluminium cans at present are paid less. All larger shops have machines which receive empty bottles and cans. (Photo: Lars Rydén.)

Deposit-refund systems

A deposit-refund system is a refundable product charge: an up-front charge, a deposit, is paid for potential environmental damage when buying a certain product and later returned as a refund if the product is given back to an appropriate dealer. There are three types of the deposit-refund system:

- producer initiated or market deposit-refund systems,
- government initiated systems, and
- so-called performance bonds.

A deposit refund directly influences consumers. Very often producers, which in their manufacturing processes use refillable packaging, introduce deposit refund systems. This is caused by their interest in the less expensive used packaging and also by environmental concerns. For example, beer producers in many countries pay a refund for the used glass beer bottles and the collection costs to the companies that pay the refund to the consumers and collect these bottles.

Sometimes governments may have reasons to introduce deposit-refund systems or intervene in those already initiated by producers in order to promote the reuse and recycling of products.

Performance bonds are usually used to control other kinds of pollution. For instance, restoration of some sites after a certain kind of activity is closed may require avoidance of unwarranted permanent risks. In such cases the producer could be required to pay a deposit, which reflects likely maximum restoration costs or maximum damages, before the restoration and it would be refunded if certain restoration conditions were met. Moreover, if banks or insurance companies trust the producer, they may take over the liability at a price. In such a case, the deposit-refund system is transformed into a performance bond.

Deposit-refund systems are widely used in the field of packaging management. Packaging represents approximately one-third of the total waste stream produced in the European Union countries and therefore causes one of the biggest environmental problems nowadays. High deposit rates assure big return rates. Practice shows that where deposit-refund systems with high rates exist return rates come up to 95%.

As an illustration let us look at the system in Denmark. The purpose of the system is to maximise the reuse of beverage containers and so diminish the amount of waste. The system has been in effect since 1981. It implies that a deposit is paid upon purchase of beer, carbonated soft drinks and other beverages in refillable containers. The deposit is repaid upon return of the container. The size of the deposit is set in an agreement between the breweries and the retailers. The deposit level reflects a balance between the need to ensure a sufficient economic incentive to return the container, and the need to ensure that producers of drinks have an incentive to reuse returned bottles, rather than new ones.

The Danish system is considered to be very successful, as the return rate is 90-99% depending on the type of containers. The reuse of containers leads to lower production of new containers, and a reduction in the use of energy and raw materials. Life cycle assessments indicate that refillable containers have a smaller environmental impact than one-time containers.

Environmental taxes and charges in the European Union

In 1997, environmental taxes accounted for 6.7% of total tax revenues in the 15 countries of the EU (Eurostat, 2000). This share ranged from 5.3% in Austria and Germany to 9.7% in – perhaps surprisingly – Portugal. Taken as a percentage of GDP, it ranged from 2.1% in Spain to 4.9% in Denmark.

Energy is the main tax base from which environmental tax revenues are drawn: it accounts for more than 75% of these revenues in the EU-15. Taxes on motor fuels constitute the largest part. Transport, mainly taxes on motor vehicles, accounts for almost 20% and taxes on pollution and resources other than energy for less than 5%. However, one should note that for several EU countries a number of important environmental charges, such as those on waste and wastewater, are not included in the statistics on environmental tax revenues, due to lack of data. Moreover, a high amount of revenues is not necessarily a good indicator for the importance of an environmental tax. If its main function is to discourage the emission of the taxed pollutant or the use of the taxed product, the so-called "incentive function", a low amount of revenues might in fact be a sign of success.

Examples of such success stories, i.e., where the incentive effect has shown to be quite strong, include the following (cf. EEA, 2000):

- differentiation in the excise tax rate on fuels, e.g. lower rates for unleaded petrol and low-sulphur heating oil, applied in many European countries;
- energy and CO_2 taxes, providing incentives to reduce energy consumption and CO_2 emissions, especially in Denmark, where the tax rates are quite high;
- the Swedish NO_x charge, one of the very few examples of a "pure" incentive charge: the revenues are returned to the charge payers in proportion to their net energy production;
- the water pollution charge in the Netherlands, a revenue raising charge with a strong incentive effect;
- taxes on the landfilling of waste, applied, among others, in Denmark and the UK, where they have led to less waste, and to a shift from landfilling to incineration, reuse and recycling.

Figure 19.15. Energy taxes is by far the prevailing environmental tax in Europe. Petrol (gasoline) is taxed by about 200 % and the price for the consumer per litre is about 1 Euro or more in most of Europe. To reduce car-driving significantly the price should more than double. (Photo: Lars Rydén.)

In recent years, the number of countries applying some kind of energy/CO_2 tax scheme has grown. Among them are now also some large EU Member States: Italy and Germany introduced such taxes in 1999 and France and the UK intended to do so in 2001. Furthermore, the range of tax bases for environmental taxes is expanding. For example, several EU Member States now have taxes in place on raw materials (sand, gravel, groundwater, etc.), disposable articles, certain chemicals (such as chlorinated solvents and pesticides), batteries, and packaging.

At the level of the European Union, however, attempts at introducing common, harmonised environmental taxes have thus far not been very successful. Only for mineral oils minimum excise tax rates exist since 1993. In 1992, the European Commission had also presented a proposal for an EU-wide energy/CO_2 tax. However, this failed to get unanimous support from the Member States, even after amendments were made. A new, more modest draft Directive was issued in 1997. This proposal extends the existing system of minimum excise taxes on oil products to other energy products, coal, natural gas and electricity. However, in May 1999, Spain blocked a decision in the Council of Ministers on this proposal by its veto (fiscal measures at the EU level have to be agreed upon unanimously). For the time being, the role of the EU in the area of environmental taxation seems to remain confined to issuing guidelines for the application of environmental taxes and charges by its Member States (cf. European Commission, 1997).

Greening the tax system – the green tax shift

A so-called green tax shift refers to increasing environmental taxation at the same time as income tax is decreased. This tax policy is pursued in e.g. Germany, Sweden, Denmark, and the Netherlands.

In the Netherlands in the revision of the tax system, which came into effect on January 2001, the top marginal rates for income tax have been reduced from about 60% to about 50%. At the same time the value added tax, which is basically paid when consumption takes place, is increased from 17.5 to 19 per cent. Ecotaxes are charged on use of water, energy, natural resources – like sand and other building materials – and on emissions of various pollutants and waste produced. An extraction fee is paid for each cubic meter of groundwater extraction. The tax on petrol is relatively high and amounts to about 2/3 of the price that is paid per litre. In the tax system the Polluter Pays Principle is applied as much as possible.

The additional revenues from ecotaxes are used to reduce other tax revenues like income and profit tax. This strengthens the competitive position of the Netherlands, and compensates for the inflationary pressure of the ecotaxes and the increased values added tax. In some cases the revenues are dedicated to specific purposes, for example subsidies for reducing energy consumption.

The macroeconomic effects of the tax revision have been studied in detail in the context of the "double dividend" discussion, which focused on the question whether ecotaxes could at the same time improve the environment by taxing pollution and reduce unemployment by lowering the real wage costs. In general the debate remains open, because very specific assumptions on the functioning of the labour market are crucial for answering the question whether the "double dividend" occurs or not.

ECONOMIC POLICY INSTRUMENTS II

TRADE, PERMITS, AND SUBSIDIES

Tradable or transferable permits

A pollution permit, which sets requirements either for technologies or for the level of discharges, is a necessary element of policy in almost all countries. The previous sections discussed pollution and product charges, which could be called administratively set prices on discharges. There is another possibility to set this price, and the market could be used for this purpose: permits could be tradable among interested parties. The easiest way to do this is to allow sources of pollution, which reduce pollution more than required, to sell it to those, who cannot cope with the environmental obligations. In other words, it implies the *establishment of a trading system of the "rights to pollute".*

For example, the total permitted level of discharges of particular substances for a particular stretch of water could be divided among relevant polluters. Some polluters may be able to reduce their discharges below permit levels at low cost. If they do so, they may then sell their rights to discharge to others – polluters for whom reduction is more expensive and who therefore wish to buy permits.

Environmental regulation and economic welfare

The impacts of environmental regulations on economic welfare are complex. There are two opposite views on the relationship between environmental regulations and economic welfare. The first (e.g. Porter, 1995 and Dohlman, 1997) emphasizes the positive effects of environmental regulations, indicating that environmental policies may promote technological progress and stimulate new products and markets. A first mover might gain advantages in international trade according to the Porter hypothesis. Properly crafted environmental standards can trigger innovation offsets, allowing companies to improve their resource productivity. Environmental regulation is helpful to improve economic welfare by creating new opportunities of trade and stimulating innovation.

Another view (Oates, Palmer, and Portney, 1993) note possible negative effects of environmental regulations. The realization of environmental welfare through environmental regulation or policy is in this view likely to entail economic costs, and therefore reduce economic welfare. The following issues are essential:

(1) Investments in more pollution control may crowd out other investment.
(2) More stringent abatement requirements for new plant may prolong the life of older and less productive plant.
(3) Pollution control equipment requires labour to operate and maintain with no contribution to saleable output.
(4) Compliance with environmental regulations absorbs managerial and administrative resources with no contribution to saleable output.
(5) Uncertainty about present and possible future regulations may inhibit investment.

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Figure 19.16. Chimneys in South Poland. (Photo from video: Urzula Dembinska.)

The first economist who proposed such markets of pollution permits, in 1968, was the Canadian economist Dales.

In such a system, contrary to a pollution charges system, quantities of possible pollution instead of charge rates are set administratively and prices for pollution reduction are determined by the free choice of those who participate in the tradable permit system.

Instead of setting emission standards, governments distribute or sell "pollution permits" according to the total amount of tolerable or allowable pollution in a certain region. These permits can be sold and purchased on the market. As long as trading partners benefit from these transactions, the market will function and the cost of pollution abatement will be minimised, like in the case of pollution charges.

It means that the desired ambient quality of the environment is achieved at the least social cost. There are some additional advantages of trading permits in comparison with pollution charges. First of all, the total quantity of pollution is known in advance, so the uncertainty regarding achievement of ambient quality in this case does not exist. Secondly, tradable permits adjust to inflation automatically. There is no need for a government to index, like in the case of pollution charges.

Though in principal tradable permits could be used to solve both global (e.g., reduction of CO_2 emissions) and local pollution problems, one condition needs to be emphasised: the tradable permits system could work successfully only when the location of a discharge is not so important. If a company, who buys more rights to pollute, emits pollutants into a densely populated area and thus worsens social conditions and causes a potential harm to health, a market of permits would need to be controlled with some additional measures.

One more very important consideration is related to initial allocation of permits. There are two possible ways of allocation, either by selling them, or by so-called "grand-fathering," i.e. distribution according to the actual pollution of recent years of a certain company. Mostly the second way is used. This does not always give the optimum allocation of the rights to pollute. Moreover, in order to observe what is going on in the permit market quite a complicated bureaucratic infrastructure is needed.

Case
Box 19.7

The Chorzów project – a case of trading pollution permits

A tradable permit market was established in the city of Chorzów, which used to be one of the most contaminated cities in Poland. Chorzów is a large city in the heart of the Upper Silesian Industrialized Area. Two plants, which were the biggest air polluters, participated in the project. One, a steel mill, was the major polluter of carbon monoxide and hydrocarbons and had quite good technological possibilities to reduce pollution. The other, a power plant, was very old and expected to be shut down in the nearest future. The former was low-cost with respect to pollution reduction, but in a bad financial situation. The other was a high-cost one and in a relatively good financial state. Therefore, the power plant participated in the steel mill's air pollution reduction.

Quite a considerable decrease in pollution from the steel mill was achieved by this project already in two years, which is demonstrated in the chart below. Emissions from the power plant grew somewhat, but the total effect was undoubtedly positive. Economists studying the project state that it accelerated the restructuring process of the steel mill by 2.5 years. Also they stress that a considerable reduction of pollution was achieved mainly by transferring permits between just two plants. Thus, one of the main conclusions from this permit market is that tradable permit markets are viable in economies in transition.

(Source: Żylicz, 1994.)

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Table 19.3. Emissions from the steel mill in Chorzow. (Source: Żylicz, 1994.)

Pollutants	Before the project	After the project
Particles	4200	400
CO	17000	0
SO_2	3100	900
NO_2	1800	800
VOC	700	0

Economists recognise tradable permits together with pollution charges as the best environmental economic instrument. Yet, mostly because of the latter problem, tradable permits are not yet used widely in Europe. This is contrary to the USA, which are well known for the development and implementation of systems of tradable permits, especially for air pollution control. Nevertheless, some countries in the Baltic Sea region already tried (Poland) tradable permits systems. One of the most cited experiments is related to the permit market in the region of Chorzów in Poland (see Box 19.7).

Damage compensation

The instruments discussed above are related to more or less continuous point or non-point source pollution, which at some level is allowed by environmental authorities. However, history may give many examples of environmental accidents, Seveso, Amoco Cadiz, Valdez, Bhopal and others, that led to expensive clean up operations to restore the damaged environment. Therefore, many countries have established civil liability as a means for allocating a responsibility for the costs of environmental restoration. Damage compensation is then not always accepted as a valid environmental economic instrument. This is mostly because of the large difficulties to assess the damage in monetary terms and to identify polluters and victims in some cases.

Civil liability is a legal and financial tool used to make those who are responsible for causing damage to pay for the remediation of it. Indirectly it forces companies to meet standards and avoid activities, which may cause the same damage in the future. Therefore, a damage compensation instrument is strongly related to two main principles of environmental policy: the Prevention Principle and the Polluter Pays Principle.

Damage compensation, as, described above, is closely related to legal aspects. Civil liability arises under private law, distinguishing it from obligations arising under public law, and criminal and administrative responsibility. Many countries have introduced two types of civil liability for environmental damage: 1) *liability with fault* and 2) *strict liability*.

Fault liability, requires proof that the liable person committed a wrong act. The victim may have difficulties in proving the other party's guilt and thus this does not provide a means to recover environment restoration costs where fault cannot be shown.

Strict liability, or liability without fault, does not require that the fault is established. It is enough to prove that the damage was caused by a given polluter in order to make him/her liable for paying the compensation. Therefore, it provides an incentive to possible polluters to take measures to prevent environmental damage.

Sometimes environmental damage may occur because of aggregate effect of actions of many polluters, though each single action does not by itself exceed allowable levels of emissions. In such cases it is very difficult to attribute the damage to separate plants, therefore, joint mechanisms of compensation are established.

Usually joint damage compensation mechanisms requires financial structures based on contributions from economic entities. They are similar to insurance systems. Potential polluters are required to contribute to a special compensation fund to cover, when it is needed, costs of cleaning up or restoring the environment. The advantages of such a system are that, first of all, in contrast to civil liability which needs quite a long legal process, joint schemes allow to collect funds in advance and finance restoration works immediately. Moreover, if a polluter is not able financially to cover all needed costs, joint compensation schemes can then help to provide additional resources.

Such systems are already established by a number of countries. For example, industries with particular large risk of causing environmental damage, especially oil industry, have established funds, which can be used to provide additional money

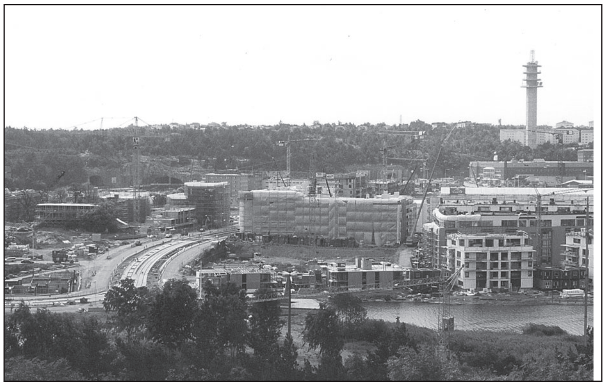

Figure 19.20. Subsidies for remediation of polluted soil in so-called brown fields. Cleaning up old industrial sites for building new areas constitute one of the largest environmental costs. It is often made possible through a system of subsidies, since it is difficult to find and charge the polluter, often one or two generations old, and it is too expensive for the builder. The new residential area Hammarby Sjöstad by the waterfront in central Stockholm is built on a former industrial area that was very polluted. Some 200 million SEK of private and public funds have been invested in soil remediation and several new methods have been applied. (Photo: Lars Rydén.)

for the compensation, paid by the polluters or their insurers. One of best known is the International Fund for Compensation for Oil Pollution Damage, which was established already in 1971.

Subsidies

A subsidy is a form of financial incentive for companies in order to help them comply with the set environmental requirements. In other words, *it is a payment or a tax concession that provides financial assistance either to pollution reduction or plans to mitigate pollution in the future*. This instrument is frequently used in many countries.

There are two kinds of subsidies: direct and indirect. Direct subsidies usually come from the state budget and are earmarked for environmental purposes. Indirect subsidies are related to either tax allowances or preferential state credit rates for environmental projects.

The use of subsidies is an obvious alternative to pollution charges. The latter penalize polluting activities, while subsidies give an incentive to increase abatement activity. The latter approach is called the "carrot" approach and is opposite to the former "stick" approach.

Outlook
Box 19.8

Global trade, economic development, and environmental regulations

Trade and the environment

For a long time, international trade has been recognised as the engine of economic growth of nations. But as national health, safety, and environmental regulations grow in importance, different national regulatory priorities may create serious friction for trade and development strategies. Some regulatory differences exist among regions at the same stage of development, but in the world as a whole environmental and health regulations show a gap between North and South.

How can international trade be promoted and at the same time improve the quality of the environment? Policy coherence and compatibility between trade and the environment was the principal objective agreed upon at the United Nation Conference on Environment and Development. The conclusions were laid down in the Rio Declaration and Agenda 21 (Dohlman, 1997).

What is the effect of international trade and environmental policy on welfare and environmental quality? On the one hand, international trade improves environmental quality by promoting more efficient use of natural resources, and reducing wasteful patterns of production and consumption. On the other hand, it also may result in environmental damages. First, international trade enhances global output and consumption. With increased output, waste management problems will also be increased. Second, some trading regions specialise in the production of environment-intensive goods such as tropical timber. This damages not only the environment of these regions, but also that of other regions in the case of transboundary environmental impacts, for example climate change. Third, trade needs transport, transport needs energy, and energy use damages the environment. Finally, international trade in hazardous waste may damages the environment of the regions that import the waste.

International competition and regulation

Environmental regulation may lower the level of international trade if environmental policies in different regions impose different costs on competing firms. In order to strengthen the economic competitiveness of nations, stringent domestic environmental regulations for imported products may be used as trade barriers against the other nations. Moreover, international trade may face adjustment costs as a result of environmental policy. This will also lower the level of international trade and therefore reduce economic welfare.

Unilateral environmental policy, for instance only implemented in the North, may lead to "pollution leakage," increasing total global emissions, instead of reducing them. This is a "pervert" effect of environmental policy, which may typically occur in the case of global warming policies, if policies are only implemented in the North. It is interesting to note that this phenomenon may occur, even if the factors of production are assumed to be immobile between the regions. Just the substitution between the production of goods within each region can increase total global emissions. Again, this result depends on the specific environmental characteristics: the reduction of emissions in the North is not necessarily always offset by a larger increase of emissions in the South. If production technologies in the South would be sufficiently clean given the standard technology, overall emission reduction might occur at the global level.

A solution – globally tradable emissions permits?

Imposing exactly the same absolute emission level to both regions can be very restrictive for international trade and inefficient. It may result in lower utility levels in both countries. A globally co-ordinated policy, on the other hand, where the distribution of emission reduction over the regions is left to market forces under a system of tradable emissions permits, results in an efficient allocation of resources. Both regions can gain from this type of international co-ordination.

For uniformly mixing pollutants, like greenhouse gases, well co-ordinated international policies would be more efficient. Various schemes for co-operation and compensation can be implemented, e.g. the clean development mechanism or joint implementation. For non-uniformly mixing pollutants like acidifying compounds, such as sulphur dioxide (SO_2), nitrogen oxides (NO_x) and ammonia (NH_3), region specific emission ceilings are required, depending on the local carrying capacity of the environment.

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Subsidies are regarded as inefficient instruments in the long run. One of the main arguments is that they are incompatible with the Polluter Pays Principle, which actually is an anti-subsidy principle. In practice, as shown above, exceptions to this principle are many, especially in transition economies.

Economists also showed that in the long run subsidies relative to charges will result in an increasing number of companies, a larger output for the industry, and a lower price for commodities whose production generates pollution. This in the end would increase the total industry production and hence emissions. That would be avoided in the absence of any form of subsidy.

Nevertheless, there are many instances where environmental subsidies are used in practice. Some countries use direct subsidies for industries that are changing manufacturing technologies to reduce waste disposal. Many governments use subsidies in the form of tax incentives to encourage recycling activities. The Baltic countries mostly use subsidies to provide state financial assistance to public environmental projects such as publicly owned wastewater treatment plants. In Denmark, by late 1998, there were a total of 36 environmental subsidy schemes in effect. The majority of these schemes have been directed at the energy sector and towards cleaner technology objectives. This reflects the fact that for many years, Denmark has given a high priority to the need to reduce the environmental pressure from the energy sector.

Choice of policy instruments

All economic instruments attempt to use the natural incentives of a market to work toward a solution, which is the best for all society. Of course, instruments differ in their effectiveness for the management of different environmental problems. Some mistakes are, most probably, unavoidable. It is difficult to understand highly complex environmental problems and complicated economic markets, and even more difficult to find a link between both of them. This is usually the case with regulations aimed at correcting market failures.

There are many criteria used for the selection of environmental policy instruments. Some instruments are better for some specific environmental problems. The criteria, which theoretically most often are used by governments for the selection of the instrument, are as follows:

- *Effectiveness*, which reflects environmental aspects of an application of an instrument, that is, if an environmental problem is solved.
- *Efficiency*, or cost-effectiveness, which reflects economic aspects of an application of an instrument, that is, if costs for the solution of a problem are justified by the results achieved.
- *Equitability*, which reflects distributional aspects of an application of an instrument, that is, if appropriate distribution of environmental benefits or costs is achieved.

	Pollution charges	Product charges	Tradable permits	Damage compensation	Subsidies
Denmark		+			+
Germany	+	+			+
Poland	+	+	+		+
Russia	+			+	+
Lithuania	+	+		+	+
Latvia	+	+		+	+
Estonia	+	+		+	+
Finland		+		+	+
Sweden	+	+	+		+

Table 19.4. Environmental economic instruments in countries in the Baltic region.

As mentioned, many other criteria, in addition to those listed, could be used: flexibility, conformity with international agreements, cost of implementation, political acceptability, simple mode of operation, ease of monitoring and enforcement, etc.

The above criteria, however, are not used in practice so often, because some of them cannot be assessed and some are difficult to apply. Moreover, often conflicting goals are set at different policy levels, so the danger of a mismatch of instruments may arise.

Most policy makers, as it was already mentioned, prefer mixed systems. Thus command and control instruments, most often permits for discharges or emissions, are used together with economic instruments, mostly, pollution or product charges. The latter are then used to encourage polluters to perform better than the set standards and to do that in an efficient way.

Therefore, a comprehensive and effective environmental policy in most countries involves a mixture of policy tools.Table 19.4 summarises the economic instruments used in countries in the Baltic Sea region. Instruments for environmental policy can take an enormous variety of forms, and also vary with time and place, they are applied at different product life cycle stages and so forth. Policy makers must seek to find particular combinations of policy instruments that could help to achieve environmental objectives at the lowest possible social cost.

Review questions

1. Define or describe the classical economic paradigm, the neo-classic economic paradigm and environmental economics.
2. Explain the notion of externalities and how they are central in environmental economics.
3. Explain what is the value of the environment in terms of use values and non-use values. Give examples from use of natural resources in your country.
4. Describe the steps to estimate the cost of pollution using the methods of Productivity Change Approach (PCA), Replacement Cost (RC) and Human Capital Approach (HCA). Illustrate by costs for air pollution in a city by SO_x.
5. Explain the difference between the Polluters Pay Principle and the Polluter Pays Principle and the difference between the narrow version and the extended version of the Polluter Pays Principle.
6. Make a list of six important economic instruments and give examples of pollution charges or taxes from your country.
7. There are three types of the deposit-refund system. Describe each of them.
8. What have been the main arguments for European countries not to rely on emissions trading (tradable permits)?

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INTERNET RESOURCES

Chapters of introductory course on Environment and Natural Resource Economics:
http://ase.tufts.edu/gdae/publications/CourseMat.htm

Database on environmental taxes in the European Union Member States, plus Norway and Switzerland
http://europa.eu.int/comm/environment/enveco/env_database/database.htm

EEA - Environmental Taxes - Implementation and Environmental Effectiveness
http://reports.eea.eu.int/92-9167-000-6

Green Tax Shift
http://www.progress.org/banneker/shift.html

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

Links on Environmental and Natural Resource Accounting
http://infofarm.affrc.go.jp/~furu/

The OECD Environment Directorate
http://www.oecd.org/EN/home/0,,EN-home-8-nodirectorate-no-no--8,00.html

The OECD database on policy instruments in OECD countries:
http://www.oecd.org/env/policies/taxes/ or www.oecd.org/env/policies/taxes/index.htm

Regional Environmental Center database on economic instruments in CEE countries:
http://www.rec.org/REC/Programs/SofiaInitiatives/EcoInstruments/Database/SIEI_database.html
http://www.rec.org/REC/Programs/SofiaInitiatives/EcoInstruments/EI.shtml

Statistics Sweden
http://www.scb.se/eng/index.asp

UNSD - The United Nations Statistics Division
http://www.un.org/Depts/unsd/

UNEP Environment and Economics Unit (EEU), Publications Database
http://www.unep.org/unep/products/eeu/ecoserie/

US Environmental Protection Agency's Guidelines for Preparing Economic Analysis:
http://yosemite1.epa.gov/ee/epa/eed.nsf/pages/guidelines

US EPA - Environmental Accounting Project
http://www.epa.gov/opptintr/acctg/

World Bank
http://www.worldbank.org

World Resources Institute
http://www.wri.org

GLOSSARY

abatement
reducing emission through waste treatment, such as end-of-pipe technology

civil liability
a legal and financial tool used to make those who are responsible for causing damage to pay for the remediation of it, forcing companies to meet standards and avoid activities, which may cause damage in the future

classical economics
the economic paradigm, from the end of 18th century and the industrial revolution, that regarded natural resources as the important determinants of economic growth and the limits of economic development

command and control (CAC)
direct controls, an administrative instruments using laws and regulations which prescribe certain objectives, standards and technologies for a polluter

contingent valuation method (CVM)
a method to estimate the cost of a environmental service by simply asking about it; the method thus rests on the hypothetical market behaviour of the people

damage compensation
a means for allocating a responsibility for the costs of environmental restoration

deposit-refund systems
a refundable product charge, a deposit, paid for potential environmental damage when buying a certain product and later returned as a refund if the product is given back to an appropriate dealer

effectiveness
reflects environmental aspects of an application of an instrument, that is, if an environmental problem is solved

efficiency
cost-effectiveness, which reflects economic aspects of an application of an instrument, that is, if costs for the solution of a problem are justified by the results achieved

environmental economics
the study of the economic aspects of the interactions between the human society and its natural environment

environmental accounts, green budgets
satellite accounts to the national accounts, which add environmental information, to allow an economic policy that takes environmental effects into account

equitability
reflects distributional aspects of an application of an instrument, that is, if appropriate distribution of environmental benefits or costs is achieved

existence values
intangible, or non-use environmental values, based on human preferences

Glossary

extended Polluter Pays Principle
the principle that the polluter should pay for measures designed not only to achieve the acceptable state of the environment, but also to reduce pollution below the acceptable state

externality
consequences of an economic activity influencing the welfare of people where neither costs nor benefits are borne or received by the agent causing it; Externalities may be either beneficial, positive or damaging, negative

fault liability
liability, e.g. for environmental damage, that requires proof that the liable person committed a illegal act

greening tax system, the green tax shift
refers to increasing environmental taxation at the same time as income tax is decreased

human capital approach
a method to estimate the cost of a environmental damage from assessment of the environmental impact on human health and of the corresponding loss of the human capital, i.e. productive potential (work time)

invisible hand
another name for market mechanism, assuming that each producer and consumer alike pursue individual self-interest and try to maximise his private surplus of benefits over costs

market failure
factors affecting an economic activity, but which are not part of the undertaken economic decisions, such as extrenalitites

maximum allowable pollution (MAP)
the maximum amount that may legally be discharged into the environment during a given time period

narrow Polluter Pays Principle
the principle that the polluter should bear the cost of pollution reduction measures for achieving an acceptable state of the environment

neo-classical economic
the economic paradigm, from the end of 19th century and the then seemingly endless economic growth, that concerned mostly with the structure and efficiency of the economic activities

optional or non-use value
environmental benefits, such as beauty of nature, biodiversity, that are not used

pollution charge or tax
payment for each unit of pollutant discharged into the environment

Polluter Pays Principle (PPP)
the principle of letting the one using the environment pay for its damage

Polluters Pay Principle
the principle that the several polluters are charged in proportion to the environmental damage each one cause

preventive expenditure (PE)
method to estimate cost of pollution based on what people are ready to spend to prevent the damage of the environment

price elasticity
how the use of a product is changing with its price; e.g. if gasoline is used as much as now regardless of increasing taxation it has a high price elasticity

product charges or taxes
an upward adjustment to the price of a finished products, intermediate products, or raw materials, if its manufacturing, distribution, use or disposal may cause environmental damage

productivity change approach (PCA)
method to estimate cost of pollution based on the assumption that environmental changes affect the production and thus the supply and/or price of the product, as when acid rain cause the decline of soil fertility and a decreased harvest

property value approach
a method to estimate the cost of a environmental damage based on the assumption that the real estate property prices, as well as wage differentials, depend on the differences of environmental quality

replacement cost (RC)
method to estimate cost of pollution based on what people are ready to spend to restore the environment to the pre-damaged state

strict liability
liability, e.g. for environmental damage, that does not require that the fault is established; it is enough to prove that the damage was caused by a given polluter in order to make him liable for paying the compensation

subsidy
a payment or a tax concession that provides financial assistance either to pollution reduction or plans to mitigate pollution in the future

tradable or transferable permits
pollution permits which are tradable among interested parties, to allow those, who cannot cope with the environmental obligations, to buy permits, i.e. a trading system of the “rights to pollute”

tragedy of the commons
the deterioration of a common resource which use is unregulated, and thus open to all for no costs, a so-called common property or open access resources

travel cost method (TCM)
a method to estimate the cost, mainly used for recreational services of environment, derived from the observed time people sacrifice and money they pay to travel to the site

use values
environmental benefits, such as the classical values of natural resources, e.g. energy, minerals, arable land, and timber for the use within the economic system

User Pays Principle
the principle that the users of natural resources should pay the full price for natural resources and their supply

waste sink
part of the environment with the capacity to absorb pollution

Victim Pays Principle
the principle that the for some reasons the polluter cannot be expected to pay for the damage and the victim subsidises the polluter

willingness to accept (WTA)
how much an individual is willing to pay to compensate a welfare loss or forgo its increase

willingness to pay (WTP)
how much an individual is willing to pay to secure an increase in his/her welfare or to prevent its loss