PUBLIC HEALTH & ENVIRONMENT

Crosscutting Planning, Design & Production

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INDEVELOPMENT

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1 INTRODUCTION

Development planners and engineers are more and more given the responsibility to respond to concerns from the society with regard to public health and environment. Nowadays a common situation in high-income countries, but due to international and domestic pressure an emerging situation in low and middle-income countries.

Many projects funded by bilateral and multilateral donors require environment impact assessments. The planners and engineers involved in these projects however are not necessarily equipped to carry out and understand these assessments. Various donor organisations have developed manuals, which give step-by-step guidance in preparing environmental impact assessments. This does not mean that the outcomes of these steps are understood. Both economists and engineers love to apply equations to obtain hard and unambiguous results. However with reference to our environment and the public health, hard results are deceptive. Correct interpretation requires sufficient background in developing environmental and public health related standards and regulations and a sound understanding of decision-making techniques like environmental economics.

This document does not replace these manuals, but intends to provide this background information to scholars and practitioners of the various engineering and planning disciplines. Civil engineers will find this document in particular useful, because of its examples from this industry.

2 THE CONCERNS

If only a few people live along the river, their bathing in the river will not jeopardise the use of the river as a source for drinking water. But the river looses this function when a road construction emits its waste into the river. When many people live along the river, the river water can only be used for one purpose, either drinking water, bathing or as a waste belt.

Natural resources

We harvest a portion of the flora and fauna available in the nature, we use water and wind, we cultivate land, and we extract oil, gas and other minerals. In a nutshell we need the nature as a resource for production and consumption but we also need it to emit our waste.

Both activities may change the characteristics of the nature, resulting in adverse effects on our public health, the various production functions of the environment and may have negative impact on ecosystems themselves.

Public health

Public Health is concerned with threats to the overall health of the population of a community. It generally concentrates on surveillance and control of infectious diseases and promotion of healthy behaviours.

In many ways, Public Health is largely a modern concept, although it has roots in antiquity. In order for public health policies and programs to develop, it was necessary for governments to gain some understanding of the causes of disease. Early on, it was recognized that polluted water and lack of proper waste disposal were implicated in spreading vector-borne diseases. By Roman times, it was well-understood that proper diversion of human waste was a necessary tenet of public health in urban areas.[1]

Production functions

The nature is one big resource for our production and consumption patterns. This resource is the production function of the nature. Actually the environment has a number of production functions. It provides land, it provide energy, water, and raw materials; it also provides space to dump our waste.

Eco-values

Thus human behaviour affects the flora and fauna in particular areas. Besides the values as a resource for production and consumption, nature has a value to and by itself. When a certain species of animal becomes distinct in a certain area, this is not only sad but will have serious consequences for the population of other animals. These nature-related values are the so-called eco-values.

Environmental User Space

The nature is able to absorb the consequences of human behaviour to some extend. For example, limited harvesting of flora and fauna may not affect the composition of the nature given the fact that

[1] http://en.wikipedia.org/wiki/Public_health

under these circumstances the flora and fauna will regenerate itself. However when the harvest exceeds the bearing capacity, it will affect the regeneration capacity and population size. As a result certain species may become distinct. Similarly nature has the capacity to transform waste in useful materials, which it uses in its regeneration processes. Think of the production of compost that is used to feed the soil and plants. However when the composition and amount of waste exceeds the capacity of the nature to transform, the waste accumulates and changes the nature into a waste belt. Depending on the half times of the waste components, eco-values and natural production values may be lost for extreme long times.

In other words, many natural resources are relative scarce when their use is limited but when their use is beyond a certain capacity they transform from relative scarce resources into absolute scarce resources. The capacity of the nature is referred to as Environmental User Space and maximum tolerated bearing capacity is referred to as Limited Environmental User Space.

Limited Environmental User Space

Although this concept is relatively easy to understand, it is not that easy to apply. It is difficult to determine when a society exceeds the Limited Environmental User Space, as most environmental effects are latent by nature. Often the effects of our activities are only visible, decennia after its initialisation. We do not always understand the causal relationship between changes in nature and human behaviour. In particular because the observed changes in nature often have multiple causes. Furthermore we also have been able to expand the Limited Environmental User Space by improving the efficiency of extraction technology, transport technology and technology to recycle and transform waste in useful materials.

The boundaries of the Limited Environmental User Space also depend on the norms and values in society. We may find it acceptable when a river is polluted when that river does not serve any human beings, but we may consider it unacceptable if the river is used as a source of drinking water.

Maslov

The norms and values with regard to environmental protection develop over time as result of gradual improving of (lower hierarchy) need satisfaction. The theory of Maslov indicates that before an actor will address higher needs like esteem, self-actualisation and environment, the more fundamental needs like basic needs, safety and security have to be sufficiently satisfied. The current high-income countries were hardly concerned with the environment, when their populations were dominantly poor and they had yet to develop their industries. Nowadays the high-income countries have the most progressive environment protection acts and intervention plans.

It also relates to beliefs in society about the opportunities to expand the Limited Environmental User Space through technological innovations. Optimists think that future generations will find new sources of energy, raw materials and places to store waste. For example we have been able to develop renewable sources of energy

and developed techniques to recycle and reuse waste.
Others are more pessimistic about options to substitute inputs in our production processes.

2.1 EXAMPLES

What are these concens? How do they look like? What are their causes? And wat are the limitations of the environment? This paragraph gives some background information about common environmental problems like waste disposal, extraction of raw materials and emissions.

Waste

All consumption and production processes result in waste. Waste that we may choose the recycle or emit in the enviornment.
There are two types of wastes:

- Waste containing elements that already exist in nature
- Waste containing elements that are not natural

The nature is able to degrade natural existing waste elements. For example, bacteria can clean up the organic waste in waste water and change them into minerals. However if the amount of organic waste exceeds the transformation capacity of the bacteria, the waste starts to accumulate and deteriorate the ecological capacities in nature. Therefore excess organic waste should not be dumped uncontrolled in the environent. By the way, pure organic waste can be an excellent raw material for the production of compost and fertiliser.

Xenobiotic compounds

Waste compounds of materials that do not originate from nature, are thus man-made and degrade only very slowly. Therefore these so-called xenobiotic compounds should not be dumped uncontrolled in nature and preferably be recycled.

Recycling

Recycling is the activity that regenerates the waste into a product or a raw material. For example, empty beer bottles can be cleaned and refilled or its glass can be melted and used as raw materials for new glass products.

Ideally the waste is regenerated to a level that it can be used for the same product or as a raw material to produce the same product. Often this is not possible. Their hundreds of qualities of paper. Recycling of paper almost always results in degradation of the paper value. Recycling of plastics and other synthetics is still extremely difficult, due to the many different kinds and mixes of plastics and additives. As a result fully regeneration of plastics is only possible, when the product is reused. When plastic waste is melted, it can only used for inferior plastic products, like beer crates.

An important consideration for factories to accept waste as raw materials is its composition. Contaminated waste is difficult and expensive to clean. Or the waste composition is not selective enough, which means that the company has to sort the waste. Therefore many factories are hesitant to accept waste generated

from solid waste. To avoid contamination and unnecessary handling at the factory, the various waste components should be separated at the source and later sorted by experienced waste contractors.

Deposit money

Many people need incentives to reduce their waste production, or sort waste at the source. They are simply not concerned with the environment. Most people are concerned about the financial consequences and see waste as items with no or negative values. Something to get rid off. However deposit money changes the perception of waste from an item with no or a negative value to a useless item with a certain financial value.

Planners should be careful not to give the wrong incentives. Projects in the Netherlands to charge for waste collection per volume or weight has resulted in illegal dumping.

Extraction of raw materials

Other typical environmental degradation is caused by extraction of raw materials. Nature is able to regenerate some of these raw materials, but needs time to do so and therefore the regeneration capacity is limited. We also consume so-called exhaustible resources. The environment is unable to regenerate these materials. Once used they are depleted for always.

Absolute versus relative scarce

Depletable resources are absolute scarce. Provided that the limited environmental user space is not overstretched, the environment will regenerate the renewable resources. Nonetheless the resources can be used to meet different needs. As there is seldom an absolute surplus of these renewable resources, choices about their allocation have to be made. Therefore the renewable resources are considered to be relatively scarce.

Energy Sources

Energy is traditionally produced by burning exhaustible resources like gas, crude oil and coals. The production of energy from these sources also results in emissions that have negative effects on the environment. The table below present the emission values in grams per production 1 GJ of lower heating value.

Fuel	CO_2	CO	CH_4	NO_x	SO_2
Gas	56100	15	1	65	0
Fuel Oil	78100	15	3	165	600
Coal	94200	80	2	580	1500

Source: OECD 1991

Renewable energy

There are various sources of renewable energy:

- Wind Energy
- Solar energy
- Biogas
- Hydroelectric power
- Geothermal energy

Burning of timber may be considered a renewable source of energy on condition that plants and trees are replanted. In that way this source of energy is considered CO_2 neutral. The burning process

emits 96,400 gram of CO_2 per production on one GJ (lower heating value), but the plants earlier absorbed the emitted CO_2. Still the production of energy from this source also produces 1715 gram CO per GJ.

Nuclear energy is also a renewable energy source, but its production is considered dangerous and results in nuclear waste. For these reasons most environmentalists reject nuclear energy.

Traffic

In many countries the traffic is the largest producer of NO_x. Furthermore it emits CO_2, SO_3, H^+ and VOS. It produces odour and noise, and waste like tyres and wreckages, indirectly polluting the air, water and soil. It heats up our environment and reduces space for our children to play. Traffic consumes energy, and space for physical infrastructure. Many roads are barriers to the animal population, affecting their breeding and mating patterns growth, possibly resulting in inbreeding.

The tables below present the energy consumption and emission patterns of the various transport options in the Netherlands.

Transportation	Energy consumption (10^6 J/km)	CO_2 (gr/km)	NO_x (gr/km)
Car	1.80	127	1.3
Train	0.88	64	0.2
Tram/Metro/Trolley bus	1.28	92	0.22
Bus, public transport	1.30	99	1.4
Bus, private	0.32	24	0.4
Plane	1.8	150	0.4

Transportation	CO_2 (gr/ton.km)	NO_x gr/ton.km)
Road	150	2.90
Rail	41	0.22
Water	41	0.43

Agriculture

High concentrations of fertilizer, pesticides, and insecticides in our soil affect the quality of our drinking water. These elements are easily transported through the groundwater and end up in the surface water, where it causes harmful effects to water organism, insects, birds and other animals.

In addition, the extraction of groundwater and surface water for irrigation and other commercial purposes affects the availability of water for the production of safe drinking water.

Increasing space requirements

Ecological systems require sufficient space to survive. If the space is too small, the ecological system will deteriorate. A typical example is the species at the top of the food chain that become distinct. Due to population growth, but also due or increasing demands, human beings have been cultivating more and more land that once was part

of the nature. The slash and burn cultivation in many low and middle-income countries not only had negative impacts on the eco-values, but also caused erosion and in the end crop failures.

Nature

Nature means that the environment in an area is not influenced by human behaviour.

Spatial levels

It is important to understand that the various consumption and production activities affect the environment differently. For example emissions in the air are likely to be transported over large distances and thus are able to affect large areas. On the other and they become more easily diluted. Emissions in the soil are relatively immobile in comparison to emission in the air. But even in the soil the contamination may be spread due to groundwater movements. Emissions in surface water are less mobile than emissions in the air, but more mobile than emissions in the soil. Emissions in the soil and water follow the direction of the water flow. The compounds may also react with other compounds in the environment, affecting its toxicity and ability to transport.

Most other activities have dominantly local effects. Although it should kept in mind that the local areas can be larger than the exact location of the activity, e.g. the negative consequences of accidents in factories often influences surrounding neighbourhoods and villages.

3 GOVERNMENT INTERFERENCE

Many inhabitants of low and middle-income countries live in rural areas and depend on subsistence farming for their livelihoods. They produce their consumption products in collaboration with their extended families. Only surpluses are traded at local markets. A small group of inhabitants still live of gathering and hunting and depend on existence of nature.
A growing group live in urban areas and depend heavily on trade and production of goods and services for their livelihoods. For the actual consumption of food, the population in urban areas rely on the created surpluses in the rural areas, among others through intensive agricultural.

Economic subjects aim at maximising their satisfaction while allocating their resources. They exchange their resources to meet their own needs or demands. A typical example of a resource is income. The economic subject is clearly the owner of that resource. But who is the owner of the nature, from which we take raw materials or where we emit our waste? As nobody owns the environment, many feel they can exploit the natural resources, without paying. To save nature for future generations, governments have to operate as custodians and take care of the nature or charge fees to finance its regeneration and compensate the losers.

Besides operating as custodians, governments may be interested to influence the allocation of natural resources for production purposes. It could question whether scarce resources should be used for the production of certain goods and if it is necessary to control the production volume. Pro-poor orientated governments will favour the allocation of natural resources for goods and services that are in demand by low-income segments of the population or which require labour-intensive technologies.

Governments are also concerned about the production processes, as these determine the efficiency of waste production and consumption of other natural resources. Advanced governments require their producers to recycle their waste or have process requirements prior emission.

Governments certainly should have requirements with regard to the location of production facilities. As accidents at production facilities can have serious negative impacts on neighbourhoods. Kindly note that roads are also seen production facilities, as traffic contributes heavily in air and noise pollution. Roads provide access and if not properly sited may provide access to locations that benefit of isolation like primary forests.

3.1 SUSTAINABLE DEVELOPMENT

Extreme liberal orientated economists argue that government interference is not required because they expect that prices for natural resources will increase when they become scarcer. The higher prices will encourage producers to invest in substitution of the natural resources. This argument may be considered valid for natural resources that are used as raw materials, when you are of opinion that nature may be fully exploited and therefore in the end completely destroyed. These optimists also think that future generations will find new sources of energy, raw materials and places to store waste.

Most others are more pessimistic about options to substitute inputs in our production processes and subscribe to government interference to ensure that the nature maintains it functions for future generations. The term Sustainable Development is widely used in this context.

Sustainable Development

The World Commission on Environment and Development, the so-called Brundtland Commission formulated the following definition of sustainability:

"Development is sustainable when it meets the needs of the present without compromising the ability of future generations to meet their own needs."

Many who have to work with this definition will find it rather vague and open to different interpretations. Unfortunately for them it is not possible to give a blue print of Sustainable Development.

There are various alternative definitions, giving meaning to the word development. Sustainable could relate to:

- Financial situation
- Economy of country or region
- Social situation
- Prosperity
- Ecological values.

Respectively resulting in terms like sustainable growth, sustainable economy, sustainable prosperity, and sustainable environment. Although they do have different meanings the definitions are often mixed up, resulting in misunderstandings.

3.2 STEADY-STATE ECONOMY

Sustainable development has a long-term perspective. Shifting the focus from survival of this generation to survival of the species. This means that in our choices, we implicitly have to take in consideration the choices of future generations. However we do not know the demands and priorities of future generations. So we assume they are the same as ours.

In this theory, the current generation will ensure with its consumption of the environment that future generations' prosperity levels are:

- Growing, improving, stable but not decreasing
- Above a certain minimum level (survival related)

Spaceship Economy

Boulding argues that "*without unlimited reservoirs of anything, either for extraction of for pollution, and in which, therefore, man find his place in a cyclical ecological sytem which is capable of continuous reproduction of material form event though it cannot escape having inputs of energy*"[2]

Boulding is concerned with the fact that it is close to impossible to recycle energy.
Boulding's economic order starts with te argument that the nature is entitled to set limitations to our need satisfaction. If we exceed these limitations, ecological values will deteriorate and in the end the whole economic system collapses.
Unlike other micro-economists, who judge success on basis of profit and economic growth, Boulding judges success on basis of ecological consumption efficiency, while maintaining prosperity levels.

Conspicuous Consumption

Our consumption patterns have the tendency to grow, irrespective of real need for products and services. When a certain need is fulfilled, we all try to consume another.

Steady-state economy

Boulding and in particular Daly want to escape this notoruous growth behaviour and argue in favour of a steady-state economy.

"*A stead-state economy is defined by constant stocks of physical wealth (artifacts) and a constant population, each maintained at some chosen desirable level by a low rate of throughput-i.e., by low birth-rates equal to physical depreciation rates, so that longevity of people and durability of physical stocks are high. The throughput flow, viewed as the cost of maintaining the stocks, begins with the extraction (depletion) of low entropy resources at the input end, and terminates with an equal quantity of high entropy waste (pollution) at the output end. The throughput is the inevitable cost of maintaining the stocks of people and artifacts and should be minimisd subject to maintenance of the level of stocks.*"[3]

The ideology of the steady-state economy may be appealing to a part of the population in rich countries. In general the theory find support among those who have met the highest of their needs, like esteem. For the poor in low and middle-income countries a steady-state economy is simply not acceptable. They still live below the minimum survival levels. They need economic growth, despite the negative ecological consequences.The governments of these countries are challenged to find an answer on the question if they should use their resources to reduce poverty of the current

[2] Boulding, K.E. (1966); The Economics of the coming Spaceship Earth*" In K. Jarret: Environmental Quality in a Growing Economiy. John Hopkins Press Baltimore*
[3] Daly, H.E. (1974); The economics of the Steady State, American Economic Review

generation or allocate natural resources to reduce poverty of future generations. This question is in particular challenging, as it is likely that the size of future generations exceed the current one. The environment may be able to regenerate a part of the resources, but there are also various resources that will be completely depleted once consumed, the so-called exhaustible resources. It is also questionable if the economic growth generated with the consumption of these resources can be sustained and used as an investment for self-reliance.

4 GOVERNMENT POLICIES

The arguments in favour for government interventions to protect the public health and the environment are self evident and described in the previous chapter. This chapter gives a brief introduction of the policies of governments to provide that protection.
There are basically two types of environmental policies:

1. Policies affecting activities of human beings
2. Policies to prevent hazardous effects for human beings, ecosystems and their production functions.

The basis of policies affecting activities of human beings is that all effects on the environment are harmful. These policies aim at preventing and reducing environmental harmful activities of target groups. Typical target groups are the various industries, consumers and the government itself.

The starting point of the policies preventing hazardous effects for human beings, ecosystems and the environmental production functions is that the environment should always maintain a certain minimum quality. Thus in other words not all negative effects for the environment are considered harmful. In addition to interventions aiming at preventing and reducing environmental harmful activities, these policies may also result in interventions to improve the quality of the environment, at locations where it has deteriorated.

Government Instruments

Governments have various instruments, which it can use to pursue policies.

- It can issue laws to forbid or prescribe certain behaviour
- It can issue incentives to discourage or encourage certain behaviour
- It can use information campaigns to influence behaviour
- It can invest in physical infrastructure and land development
- It can develop environmental planning town and country

Forbidding or prescribing certain behaviour

Government interventions that forbid or issue directions to follow certain procedures need supplementing policies to track down and penalise dissidents. This type of interventions is usually used to force a change in behaviour. However it should be noted that many of these interventions are only partly successful. When acceptation of the policy is low, it is likely that the target group will disobey the directions. In those cases the law will only become effective when the police are able to track down improper behaviour and find sufficient evidence to get the dissidents penalised. The penalties should be high enough to discourage the target group of disobeying.

Incentives

Most common used incentives are taxes, penalties, fees and subsidies. A challenging task is determining the correct height of these taxes, penalties, fees and subsidies. Taxes, penalties and fees are used to discourage behaviour but they are also used to compensate “others” for their losses or to regenerate the natural

resources. In a way they are used to correct the, from a public point of view, “too low” private production costs. For example a road-widening project that needs to cut trees should in this view pay a fee to the environmental department, allowing it replant the trees and purchase the land required.
For its own projects, the government may decide not to collect this fee but just use it while screening and ranking projects. The adjusted costs are used as a shadow costs. However to effectively influence the behaviour of private enterprises and consumers the government has to collect the fees, penalties or taxes.

With the fees, and taxes the government trades environmental and livelihood rights against rights to emit.

Information campaigns

Our surroundings influence our behaviour. Most of us follow the common accepted norms and values in society, certainly when our behaviour is visible. Governments can use information campaigns to influence norms and values in the society. It also uses information campaigns to strengthen other interventions, e.g. by providing information about penalties for various environmental offences. Chapter 3 of “Basics in Planning” discusses this subject in more detail.

Physical infrastructure

Infrastructure development projects can influence behaviour. For example, governments can close road links during the night that cross sensitive ecosystems or close them for trucks and busses. On the other hand, so-called wild viaducts and tunnels allow animal populations to cross roads without hinder. Bicycle lanes can stimulate the use of bicycles in urban areas. And central waste deposit boxes could stimulate separate solid waste collection, which is necessary for high-quality recycling.

Land development

In some rich countries, governments have been active to rejuvenate land that was polluted by human activities. For example houses were built on top of the closed waste belts or its top soil land was cultivated. As the waste in the waste belt was still in the chemical transformation process, these waste belts emit hazardous compounds to the plants, groundwater and air, resulting in harmful effects for the public health.

Governments also have been involved in land relocation projects to regroups scraps of nature to create one natural area that provides habitat to more different species.

Environmental planning town and country

With aid of the environmental planning town and country the government is able to control human behaviour on specific parcels. Its focus is on the technical, legal, and organizational aspects of land registration and the interrelations between land parcels and their use, and the effects thereof on the functioning of (eco) systems on these parcels.
It can for example indicate where the potential hazardous industries should be sited in relation to other areas. After all, the last thing a local government want to happen, is a firework factory to explode in

a neighbourhood.

4.1 STANDARDS & REGULATIONS

Standards

Governments need to identify if there is a need for their interventions. They want to know if there is a problem. Problems are current or expected future situations that deviate from the ideal situation. The government formulates the ideal situation with regard to the environmental quality, harvesting of natural resources or emissions in standards. . A typical example of a standard is the drinking water standards, as formulated by the WHO. Standards like those for drinking water are very precise, but there are also more vague standards, e.g. reintroduction of the tiger in game reserves in parts of India.

3 purposes of standards

The standards have three functional purposes:

1. Identify problems
2. Regulate behaviour of economic subjects
3. Evaluate the effectiveness and efficiency of government interventions

Bench-mark

The standard allows everybody to judge if his/her plans are in line with the government's ideas about the ideal situation. They are useful when bench-marking performance.

Regulations

Often regulations are attached to the standards, prescribing the actions to be taken when the standard is not met. Environmental impact assessments are used to determine if the standards are met and when not, it has to provide directions about actions to be taken. The standards can result in regulations that prohibit or prescribe certain behaviours. Other regulations affect the behaviour of the government itself.

Regulations may specify that the subjects have to meet certain performance requirements. In other words the economic subjects are bound to result commitments. Other regulations only commit the economic subjects to carry out certain tasks, to carry out certain efforts, regardless the achievements.

Environmental problem tree

Environmental degradation may cause problems with regard to public health, the economic production functions of the environment and degradation of the eco-vales. The environmental degradation, itself is caused by emissions of waste and harvesting of natural resources. The production and consumption to satisfy our human needs requires this harvesting of natural resources and emitting of waste. This relationship is called the "environmental problem tree".

Because of the relationships between all these elements, it is in theory possible to translate the standards related to public health, the economic production functions of the environment and the eco-values themselves into standards for each of the other elements in the environmental problem tree.

Thus the government can develop standards with regard to:

- Human behaviour
- Products
- Production processes
- Emissions
- Zone (distance between source and receiver of environmental hazard)
- Environment quality
- Exposure to risk, hazard

4.2 DEVELOPING STANDARDS

This paragraph discusses how standards with regard to public health, the economic production functions of the environment and the eco-values are developed. As described earlier, the standards describe the ideal situation. This means that they relate to norms and values of the government.

Although the ideology of steady-state economy may be solely appealing to high-income countries, governments of less fortunate countries can use this theory to develop their standards. It gives guidance through questions like:

- How much of the environmental user space can be consumed within a given area without jeapordizing ecological processes?
- How much of the environmental user space can be harvested without affecting future generations?

Dose-effect relationships

In other words governments and their economic subjects have to rationalise their choices with regard to allocation of natural resources. Unfortunately at present there is unsufficient insight about the relationship between human activities and ecological degradation and the subsequent consequences on human beings, ecosystems and the economic production functions of the environment, the so-called dose-effect relationships.

A precise description of the relationship is almost impossible and certainly extremely expensive.

Synergy effects

First of all, the combined effect of different sources of pollution is seldom the sum of the effects of the individual sources of pollution. Sometimes the combined effects strengthen each other to make their impact worse. In other situations the combined effect is actually less, than the sum of the effects of the individual sources of pollution.

Buffer capacity

Our environment has a buffer and is able to absorb to some extend pollution or renew natural resources. However when the pollution or harvesting exceeds this buffer capacity, the buffer collapses and as a result the absorption capacity and regeneration capacity of the environment. Many effects are latent, but when finally visible they increasingly progress.

Nonetheless the establishment of dose-effect relationships is the most common approach to develop standards. The question remains should the standards relate to the public health, the economic production function or the eco-values? Or should it relate to two or all three issues?

Integrated environmental standards

The integrated environmental standards are the combined standards with regard to protection of human beings, ecosystems and the economic production functions of the environment.

Public-health standards

To set the standards related to public health, it is necessary to know the relationships between the quality of the environment and its effect on human beings. The risks for human beings are usually described with indicators as:

- Death
- Disability
- Illnesses
- Disturbances

The dose-effect relationships are developed with aid of toxicity and epidemic studies. Toxicology is the science that studies the relationships between intakes of toxic elements and their effects on the health of human beings.

Epidemic studies

Epidemiology is the study of the demographics of disease processes, including the study of epidemics and other diseases that are common enough to allow statistical tools to be applied. So, besides contagious diseases, it also focuses on diabetes, coronary heart disease, high blood pressure and the like.
Epidemiology is an important auxiliary branch of medicine, helping to find the causes of diseases and ways of prevention (as in the case of AIDS). It can, using statistical methods such as large-scale population studies, support or refute treatment hypotheses. Another major use of epidemiology is to identify risk factors for diseases. Modern medicine, especially evidence based medicine, relies upon sound epidemiological methods.

Dr. John Snow is famous for the suppression of an 1854 outbreak of cholera in London's Soho district. He identified the cause of the outbreak as a public water pump in Broad Street, and had the handle removed, thus ending the outbreak.
This was a major event in the history of public health, and can be regarded as the founding event of the science of epidemiology. Another breakthrough was the 1956 publication of results of the British doctors study, which lent statistical support to the suspicion that tobacco smoking was linked to lung cancer.[4]

Acceptable daily intake

With these studies, like animal testing, scientists have been able to formulate so-called acceptable daily intakes (ADI). It is found that ADI depends on three factors:

1. Exposure to toxic elements
2. Intake, transport, transformation and excreting
3. Illness, Death

Exposure

There are various ways of exposure:

- Oral (eating and drinking)
- Inhalation
- Dermatological.

Different forms of exposure may lead to different illnesses.

[4] http://en.wikipedia.org/wiki/Epidemiology

Depending on the materials, and exposure the elements may accumulate at specific locations or be distributed equally over the body.

Transformation processes in the body may reduce or increase the toxicity of the materials.
The effects may be reversible (irritated throat due to smoke) or irreversible (cancer). The illnesses may be immediate or be delayed. All these elements are important while formulating the ADI for a toxic element.

No-effect level

An important characteristic is that most harmful effects only appear if the dose is higher than a certain level. This limit is called No-effect level, which means that any dose below this level has no effects on human beings. Note that some materials have no-effect levels with the value "0". This means that these materials are always harmful to the health. In those situations it is common to measure and describe the lifetime risk on adverse effects.

Dose-effect and dose-response relationship

It is also important to note the difference between Dose-Effect Relationships and Dose-Response Relationships. The first is an indicator for the gradual effects and in theory could be measured at one response unit. Dose-response relationships measure and describe the incidence of the number of people affected by the exposure. Thus the Dose-Effect Relationship describes the harmful effects for the average person in relationship with different doses. The Dose-Response Relationship describes the chance that effects take place in response to different doses.

It is relatively easy to determine the dose level when 50% of the population respond by dying.

Median Lethal Concentration LC_{50} and Median Effect Concentration EC_{50} express the dose value as a percentage of the medium (air, water) in which it is diluted. LC_{50} refers to lethal effects while EC_{50} refers to special defined effects.

Besides the dose or concentration, the responses or effects also depend on the exposure duration. Therefore it is necessary to specify the duration, i.e.:
$LD_{50}{}^{48\ hours}$

Laboratory animal

The toxicity study should also include bearing, breast feeding, young and old laboratory animals to cover the risks for similar human beings. Often studies operate with inbred populations to ensure that the animals are genetic uniform.

The ADI is the result of the extrapolation of the test results of the animals to human beings. The extrapolation is a two-step process. The first step is a correction for body size. The second step is applying a risk factor.

Risk factor

The risk factor allows us to deal with variance in inspection results. The variance could be caused because the animals are tested in laboratories and the human beings are exposed under changing

environmental conditions. Furthermore variance could be caused due to variance of the characteristics of the test animals and human beings. Another cause of variance is related that the species of the test animals may be more or less sensitive for the materials than expected on basis of other relationships.
However it is difficult to determine the value of the risk factor. In reality scientists use the value 100 when the body size is corrected with aid of body weight and the value 30 when the body size is corrected on basis of body surface or demand for calories.

In theory the Acceptable Daily Intake values have to be translated in environmental standards for food, drinking water and other products. Depending on the exposure method, these products standards are again translated in standards for water, soil and air that are used as inputs to produce these products.
It is not necessary to translate the Acceptable Daily Intake for inhalation to acceptable concentrations in the air, as they are the same.

Oral

The oral intake levels relate to the consumption of food and drinking water. To establish the acceptable concentration in the different items, we need information about consumption patterns and concentrations of pollutants in these consumption items.
Eating and living habits can vary considerably. It is therefore not acceptable to limit the study to consumption pattern of the average person or to copy these from other parts of the world.
The translation of the standards for the different food items to standards for the soil, water and air is very complex, certainly in comparison to setting standards for drinking water. They are based on models like “Human Exposure to Soil Pollutants-model”. However there is a lively discussion about the validity and plausibility of these models. And therefore often this translation step does not take place.

Standards for economic production values and eco-values

Eco-toxicological tests and studies are used to record the quality impacts of polluting materials on different compartments of ecosystems and their ability to regenerate. Often it goes beyond describing effects on flora and fauna and also describes the effects on the relations between different species and between species and the components soil, water and air.

The tests are very similar to regular toxicological tests to establish the ADI for human beings. However there are also differences. Regular toxicological tests use animals, which have similarities to human beings. The eco-toxicological tests select their test animals on basis of their relationship with the compartment (soil, water, air) for which it intends to set standards. Usually it is necessary to work with several species. Some researchers argue to use the most vulnerable species within the ecosystem. When these species are safe, it is assumed that the whole ecosystem is protected. However it is not recommended to use protected and endangered species. Often we do not know which species are most vulnerable to certain pollutants. Other researchers prefer to use the same test species.

They argue that this way it is easier to make comparisons.
Often the species are selected on basis of the function with the food chain or the specific economic production function like cows for their milk and meat products.
Acute exposure seldom happens in the nature. It is therefore preferable to work on basis of chronological exposure. However these studies are far more expensive and time consuming than studies focusing on acute exposure. Cost and duration can be saved by using extrapolation models and to focus on the most sensitive live situations like embryo-larval-stages. However we do not know enough about validity of the extrapolation models.

Toxicity indicator

There is a lively discussion about the choice of the toxicity indicator. A number of methods use the no-observed-effect level (NOEL) or concentration (NOEC). Unlike the LC_{50} and LD_{50} indicators these tests often miss out on certain effects.
The results of these tests give an impression about the sensitivity of certain species. However the sensitivity does not necessarily correlate with the adverse effects for the ecosystem. Furthermore the toxicological tests do not take into account the reproduction capacity of the species or their competitive position. Extrapolation of the toxicological tests on species, therefore, does not take into account these relationships either. Alternative research is required to describe the effects of toxic elements on ecosystems.

It is possible to use models in laboratories that simulate ecosystems. These laboratory models are expensive and difficult to apply in large and diverse ecosystems. Field research is another alternative. However it is difficult to establish causal relationships with field research and therefore this type of research is not very helpful in formulating standards. Field research requires extensive information about the history of the ecosystem and its exposure. It can however provide information about the sensitivity of elements with regard to certain pollutants.
The adverse affects of environmental harmful elements do not only depend on toxicity but also on the chance to be exposed. After emission, the elements may be transported and distributed and even change their composition and characteristics. Whether or not these processes take place, depend on the characteristics of the emission itself and the characteristics of the environmental compartments. The quality standards for the environments should be based on these distribution and transformation patterns.

Transportation

The transportation can be caused by air and (ground) water movements. Furthermore there are biological movers like migration of birds. Transport usually dilutes the concentration but nonetheless may carry unacceptable doses to other ecosystems.

It is even possible that elements move from compartment to compartment. For example the development of gasses in the old waste belts. The emissions may also accumulate at certain places and as a result reach dangerous concentrations.

Transformation

Transformation is a chemical reaction that results in a change of

characteristics of the element. It may become more or less toxic. Sometimes it may result in complete new elements.

As a result of these studies, materials may be blacklisted, are only be available on prescription or can only be used under specified circumstances. But because a lot is still unknown or uncertain, producers may have to obtain all kinds of information and make these available to specific departments. This information may relate to inspection and maintenance activities, but also include reports about accidents and evaluations of emissions and purification activities.

Air Quality Standards

Particles in the air are very mobile and can be transported over very long distances and cross borders before entering the water or soil. The most important function of the air is the provision of oxygen and the protection against ultraviolet radiation. These functions are everywhere the same. It is therefore not necessary to define specific air quality standards for certain locations. As air pollution may cross borders, it is recommendable to develop international treaties with neighbouring states. Air pollution is difficult and expensive to clean. Therefore governments concentrate on prevention.
Concentration levels vary and often depend on the weather conditions. Till now all air quality standards are only developed to protect the public health. Air quality standards for ecosystems are yet to be developed.

Water quality standards

Particles are less mobile in water, but not as static as in soil. Civil engineers involved in their assessments about transportation of groundwater and surface water. Unlike the air, polluted water can be cleaned and we differentiate standards in relation to its function; drinking water, irrigation water, swimming, fishing, hydropower production, navigation, fish and shellfish and clam production and aquatic ecosystem values. The last function not only implies the variety of the different fish populations but also those species that live of the fish population and other species in the water. Various countries and organisations, e.g. WHO, have developed such standards. Note that due to the exchange processes the top layer of the soil of the surface water has the same composition as the surface water. Except for the standards for metals because these elements bind themselves with clay and are less mobile. As groundwater and surface water are in contact with each other. They have the same standards.

Soil standards

Standards for the soil depend among others on the soil conditions:

- Percentage clay
- Acid level (pH)
- Humus level

These soil conditions affect the processes like accumulation, transformation, absorption, and leaching. Therefore the standards are presented in formulas, which take into account the concentrations clay and humus in the soil. In particular for metals and arsine.
Like the standards for water, the standards for the soil depend on its

function. As most locations have several functions, the soil standards are usually related to the most dominant one. Examples of these functions are:

- Living
- Extraction of groundwater for drinking water
- Agriculture
- Extraction of raw materials
- Nature and landscaping

Agriculture

For example agricultural products should meet product standards, in particular so when the products are traded. The standards are developed in order to avoid product loss due to toxic particles in the soil or groundwater and to prevent diseases among animals due to toxic pollutants. In most cases the standards are developed for the most sensitive product and the most sensitive animals.

Location specific

It is impossible to prepare one set of integrated standards for all the different functions of the soil, surface and groundwater. First of all there are conflicting environmental functions and secondly the environmental characteristics vary from location to location. It is therefore necessary to translate the generic functional standards into location specific standards.

Water management plans

A typical conflict is the use of groundwater for both irrigation and drinking water in arid zones. Too large consumption, dehydrates the soil and jeopardises both production functions.
Furthermore emissions from waste and application of pesticides and insecticides pollute the quality of the groundwater, degrading its drinking water qualities. Too avoid such conflicts governments prepare so-called water management plans that regulate the functions of water at certain locations.

Standards for ecosystems

The protection of the economic production functions of the environment, like food production, drinking water production, recreation, production of renewable production materials, experience values requires protection of the structure and functioning of the ecosystems (the physical environment) itself and are therefore often similar to the standards for the eco-values.
Ecological standards relate to one characteristic of an ecosystem. Its purpose is to protect the ecosystem and to create a natural equilibrium within it.
An ecosystem contains organisms and abiotic components. These biotic and abiotic components have characteristics and because they interact, the ecosystem itself has a set of dynamic characteristics like:

- Composition of species
- Diversity of species
- Food chain

When the characteristics of organisms and/or abiotic components vary, they may influence other organisms or components through the food chain or change the competitive relationships between them. A well-functioning eco-system is able to control some kind of

equilibrium between the organisms and abiotic components. However we seldom understand these control functions.

Identification of Ecosystems

Ecological standards are usually related to a specific ecosystem. We therefore need to be able to establish the boundaries of the ecosystem. The boundaries are often set on basis of the functions for a specific parcel of land. We often use abiotic components to set boundaries for ecosystems and set tem where landscape changes from

- Water to land
- Deep to shallow water
- Sea to fresh water
- High to low land

Modern techniques relate boundaries to living and breeding area of populations and aim for closed food chains. This way the ecosystem is assumed to be in a natural equilibrium. Not an easy task, as ecosystems interact with each other. Groundwater flows from one ecosystem into another, species crosses these artificial boundaries, etc.

Eco-district

With the aid of spatial plans, the government can assign land parcels to certain functions and even describe the standards of the specific ecosystems. As the different ecosystems interact with each other, the spatial plan can describe the interactions through the use of overlays. This ways it is possible to describe the land parcels in terms like:

- Eco-regions
- Eco- districts
- Eco-sub-districts
- Eco-sections

Where eco-regions overlap one or more eco-districts; an eco-district overlaps one or more eco-subdistricts and each subdistrict covers one or more eco-sections that represent an ecosystem.

Standard classification

Every ecosystem is unique, but it is impossible or extremely expensive to formulate standards for each individual ecosystem. The common approach is to develop standards for common found ecosystems.

Ecological standards should include the following elements:

1. Description of natural situation of ecosystem's (a)biotic characteristics
2. Description of natural situation of ecosystem's animal populations
3. Criteria crucial for maintenance of the animal population, reference to (a)biotic components, e.g. hydrology
4. Values of (a)biotic components optimum for ecosystem: physical, chemical, hydrological and morphological characteristics (optimum relate to function of ecosystem)
5. Description of the consequences on activities of humans (producers, consumers and government), water management, waste disposal, ecosystem management, harvesting of materials in ecosystem

The development of ecological standards requires information that describes the sensitivity of ecosystems on various environmental exposures. In reality we use the sensitivity of selected species as an indicator for the sensitivity of the whole ecosystem.

To allow easy data collection, it should be easy to monitor the population of these species. Many scientists have selected species that are appealing to the public and politicians in order to create awareness. Other considerations to select the species are:

- Availability of quantitative information about the species
- Population control possible
- The species should be an indication for behaviour of ecosystem

The standard should describe which human activities affect these representative species directly or indirectly through changes in other parameters, like the water quality. It is necessary to identify the ideal and just acceptable values for these parameters. These values are important for planning activities. The current values are monitored and compared with the ideal and just acceptable values. The ideal values are used as the development goal, while situations that are worse than the just acceptable value require immediate action.

Current values

While monitoring the values of the various parameters it should be kept in mind that they may fluctuate over the years or seasons. It is therefore best to work with ranges rather than exact figures and to specify the periods in the year when measurements should take place.

Standards for build-up areas

The technique of zoning is not only used for natural habitats (ecosystems) but is also common in the cultivated and build-up areas.

External safety

Dangerous substances and preparations at industries may cause adverse impacts on local residents and neighbouring ecosystems through accidents and emissions. Local governments who are keen to avoid the consequences of accidents apply to zoning techniques to protect local residents and their environment. In order to do so, they need information from the industries about their activities, their application of the dangerous substances and preparations and mitigating activities to avoid external risks. Ideally industries have to seek permits from the local governments, concerning location and production activities and the local governments have the right to issue instructions to mitigate adverse risks.

Risk contours

The adverse effects of an accident reduce with increasing distance to the epicentre of the accident. Spatial planners use so-called contour lines to determine where industries and living areas should be located. The risk contour lines not only depend on the distance but also on the substances that are likely to be emitted during an accident, the media in which they are emitted (air, water), prevailing wind directions and water flow directions and barriers for the

substance to dilute and to be transported away (hills and valleys). The risk contour lines depend also on the expected harmful effects on human beings and sometimes the ecosystems. The estimates of the harmful effects are based on toxicological and epidemiological models.

Similar techniques are used to deal with issues like noise & odour pollution.

Noise pollution

Exposure to loud noise can cause permanent hearing damage. Damages can involve loss of hearing ability and people may also suffer a permanent sensation of noises or ringing in the ears, known as 'tinnituses.

Sound

The loudness of sound depends on its pitch and volume. The pitch again depends on the frequency (hertz or octave). Volume (L) is expressed in decibel (dB).
Factors that contribute to hearing damage are:

- noise levels [given in decibel units dB(A)]
- how long people are exposed to the noise, daily and over a number of years

Other damages can be classified as disturbances and they often relate to the source and period of exposure. For example loud music from the neighbours is considered as a disturbance. Noise during the night is considered a nuisance, because we want to sleep, while the same noise during the day would not be noticed.

Equal Loudness contours

Planners work with equal loudness contour lines, which are graphical representations for ratings of the loudness of a sound. Often it is necessary to work with two types of loudness contour lines to accommodate the different effects of a constant monotone sound and occasional loudness. These ratings are compared with the standards to identify problem areas. Note that sound standards are purpose specific.

Odour

Odour is usually the result of a composition of various elements. Adverse effects of odour are classified as nuisance. More specifically odour may cause headache, nausea and breathlessness. The odour volume, frequency and exposure duration all influences the perception if odour is nuisance or not. It is difficult to work with models to identify problem areas with odour. In most cases local governments wait for complaints to identify problem areas. And use interview techniques to quantify the problem. A typical indicator for the quantification is the number of households exposed to bad odour. A household is assumed to be exposed to bad odour when at least half the population experiences it.

Due to variations in emission volumes and climate changes, it is necessary to specify the duration of the exposure. Temporary odour disturbances are considered acceptable. The temporary exposure can described as a percentage of the time it is experienced like 5, 2, 1, and 0.5% of the time. These percentages depend on the source of the odour and function of an area. There are different standards for living areas, recreation areas, work areas, agriculture areas, and industrial areas and for natural areas.

4.3 EXANTE EVALUATION TECHNIQUES, THE USE OF ECONOMICS

In the previous chapter, I discussed the need for government interference to control and stimulate the behaviour of its subjects. The previous paragraphs of this chapter described the fundamentals of environmental policies, typical government interventions and techniques for developing standards. This paragraph concentrates on techniques that are used to prioritise between functions of parcels.

Collective prosperity

Planners and engineers a like, are faced with the challenge to balance the interests from the environment with other development goals like social and economic development. This challenge is immediately evident while assigning functions to land parcels or when the function of land parcels have to change in order to pursue economic or social development. Perhaps the politicians of the smaller towns and districts have the time to take decisions about each parcel, but in larger jurisdictions the civil servants are expected to form their own judgement. The main judgement criterion is usually "collective prosperity". Collective prosperity means that all interests and concerns are taken into account and are balanced.

Perhaps governments can answer the question if the road-opening project for economic development would result in collective prosperity. Most governments judge each individual project separately on basis of varying and different criteria. As a result government's behaviour could be very inconsistent and their interventions lack coordination. Modern governments therefore tend to develop social welfare functions (Multi-Criteria Analysis) that encourage appraising projects on basis of a consistent set of criteria.[5]

However if governments want to survive they need information about the demand and costs of collective goods like roads, primary forests, etc. And perhaps more important they need information about priorities within the society. What is more important to the subjects, the economic potential of logging or the loss of primary forest and loss of livelihood of forest dwellers?

Micro-economics

The science of micro-economics provided us with techniques to prioritise. This science deals with the allocation of scarce resources to maximise satisfaction of human needs. In standard micro-economic theories, the environment is considered a resource for our production and consumption. More recent developments in this discipline have tried to include the concerns to preserve the environment for future generations and to appreciate eco-values.

Problems with quantifying environmental concerns

It is close to impossible to quantify all environmental concerns and is certainly very difficult to give them a price tag, based on econometric models. We are still unable to describe and predict the

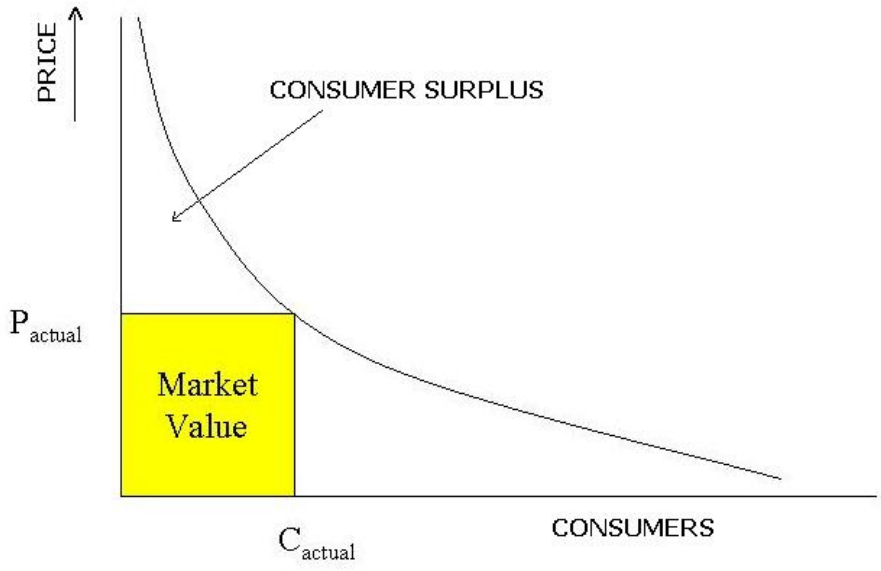
[5] For more information about development of multi-criteria analysis consult "Basics in Planning", which is available on www.indevelopment.nl

consequences of human activities like production and consumption on the environment. Most effects have various human causes and their impacts may be changed due to environmental processes like transportation and transformation.
Equally we do not fully understand the economic relationship of the environment on the economy. The availability of raw materials is only one of the many stimuli for economic growth. The various economic models disagree with each other about the exact contribution of raw materials and other stimuli. It is widely recognised that the reliability of these models are low and they do not take into account the social preferences of the current and future generations. But still the science of micro-economics does provide us with techniques to prioritise between goals of different nature.

Use Values

To determine the monetary importance of collective goods, like the environment, economists distinguish actual use values and non-use values of using/having an environmental resource like species, rainforest, etc. Most environmental assets are non-tradable and therefore have no real use values. Due to our short-term behaviour, we, human beings, tend to exploit these free assets for our own benefit.

The actual use value is the existing market value plus the consumer surplus[6] of the asset. The existing market value depends on the number of clients that consume the environmental asset against the retail price. The market value can be calculated by multiplying the number consumers with the retail prices. In addition a part of these consumers are willing to pay more to consume the asset. This additional part is called the consumer surplus. In the figure below, the consumer surplus is the area size above the market value.



Bequest Value

The bequest value is the amount of money an economic subject is

[6] http://www.digitaleconomist.com/cs_4010.html for explanation of the consumer surplus

willing to pay to preserve an environmental asset for future generations.

Philanthropic value

The Philanthropic value is the amount of money an economic subject is willing to pay to preserve an environmental asset for the current generation, with the option to use it later.

Existence value

The existence value is the amount of money an economic subject is willing to pay for an environmental asset without the intention of ever using it.

Appreciation

The technique of "appreciation" enables us to quantify the price tags of environmental benefits and costs. Appreciation answers questions like:

- How much are economic subjects willing to pay to improve the environment?
- How much are economic subjects willing to pay for destroying the environment?
- How much are economic subjects willing to accept as compensation for environmental losses caused by others?

However answering these questions is not as simple as it seems. It is difficult to appreciate collective goods like the environment. Unlike private goods, multiple consumers can consume collective goods at the same time, and producers cannot exclude individuals from consumption. It is impossible to exclude people from inhaling cleaner air. If contributions for cleaner air or a cleaner environment in general, are voluntary, many people will not contribute.
They will take a free ride, benefiting of the contributions from others.

Social dilemma

We speak of a social dilemma when personal interests and collective interests are not correlating or are even conflicting. In this case the personal interest relates to the financial contribution and the collective interest to a cleaner environment.

Research techniques

Researchers have used both direct and indirect assessment techniques to determine the willingness to pay and willingness to accept.

Direct assessments

Typical direct assessments make use of interviews, where consumers bid for exact described environmental improvements (willingness to pay) or deteriorations (willingness to accept). It is important to distinguish between the willingness to pay and willingness to accept. The willingness to pay criterion is used if respondents want to purchase, preserve or create something. The willingness to accept relates to compensation practices for losses. In both cases an auction method is used. For the willingness to pay criterion, the price to pay moves upwards. The respondents are first asked if they are willing to pay the lowest sum. If the answer is yes the respondents is asked the next lowest sum. The process is repeated till the respondent is no longer willing to pay for the purchase, create or right to preserve.

The auction procedure for willingness to accept is reverse; the prices

are moving downwards.

Alternatively respondents may be asked to indicate their price on a chart.

Starting point bias

It should be noted that the range of options limits the respondent's freedom to select its price. Often it is necessary to give respondents the option of an open answer when they feel that the starting price is too high or too low.

Information bias

It is important to describe the environmental improvement or deteriorations in every detail and very exact prior asking the bid. Maps, pictures and other visual information may help to convene information. When the information is incorrect, the bid is unlikely to correlate with the real preference of the respondent.
In real life scenarios, consumers will take enough time to study the risks involved in their bidding practice, while purchasing or selling expensive items like land and houses. During interviews the respondents do not have this time.

Vehicle bias

The conditions of the contribution should be clear to the respondent. Is the contribution made only once, on a yearly or monthly basis or basis of consumption?

Instrument bias

Furthermore it is important to indicate to whom the contribution is paid. In some countries, mismanagement within governments has resulted in distrust among its subjects.

While investigating the willingness to pay to preserve a certain nature reserve, the respondents have to be informed about the existence of other reserves and concrete plans to eliminate them or to construct new reserves.

Willingness to pay versus willingness to accept

It should be noted that the willingness to accept and pay will differ and often depend on the relative financial consequences for the respondent. A subsistence farmer will have difficulties to understand the real consequences when loosing land to road opening or road widening projects. Many subsistence farmers do not know the value of their land and are unable to price their productivities. They will encounter difficulties to purchase land, at similar conditions within travel distance of their residences. The financial contributions offered is often attractive to these farmers as they pay for immediate needs, but on the long term many of these farmers loose food production capacity. Increased land values may be attractive to farmers with sufficient land, but when the plot size is too small for survival production, its value is seldom enough to buy productive land elsewhere.

Indirect assessments

The most common indirect assessment technique is the Hedonic Pricing Method. This method compares the values of two identical commodities or activities but in different environmental circumstances. For example, the prices of two identical houses and gardens that are sold in different municipalities give an indication of the attractiveness of the municipalities. Or alternatively, assessment may focus on the price change of a commodity due to sudden

change in the environment, i.e. dropping retail prices as a result of the construction of a highway in the direct surroundings of the neighbourhood.

However it may be difficult to find two identical commodities or activities and it is seldom easy to describe the exact composition of the environment.

Travel-cost method

Another indirect appreciation method was developed to estimate the actual use value of relaxation areas like game reserves. Visitors not only pay entrance fees but also spend on transport and invest their time to travel to these areas. This technique requires that time is converted into money, a technique that is never easy, but very cumbersome in countries with extreme differences in income and where large part of the population depend on subsistence farming. Furthermore it should be kept in mind that travels to recreation areas are often considered to be part of the recreation itself and are often combined with other travel purposes. More importantly this method cannot be used to estimate the other economic values of recreation areas.

There is often a huge difference between the results of the direct and indirect assessments, sometimes up to 50% or 60%.

It is also likely that respondents will value benefits and costs differently. For example a road-opening project through a primary forest is very attractive to logging companies, as it provides them with cheap access to a new source of raw materials. However forest dwellers and environmentalists are very concerned with these types of projects. Most economists choose to optimise the collective prosperity of the society with aid of the so-called Pareto criterion.

However the problem arises when the owners of the logging companies are rich and when the forest dwellers are subsistence farmers with no cash-income. It is expected that the logging company is willing to compensate the forest dwellers for their loss of livelihood. However the neo-Pareto theory requires that the forest dwellers are asked to compensate the logging firms when the road project is cancelled. As forest dwellers do not have any income, this situation is unlikely and on basis of the Pareto criterion the project is granted, provided that the forest dwellers are compensated.

A pro-poor and pro-environment perspective would not require the poor or the environment to compensate producers for their loss of consumption potential. Thus the ex-ante evaluation of the project excludes the scenario that forest dwellers compensate the logging firm for loss of access to raw materials. In a way the environment owns itself and the government act like its custodian.

5 SOME SELECTED STRATEGIES

It is recognised that the earlier chapters are often rather abstract and many seek practical guidelines in dealing with the environment. It should be clear from the previous chapters that it is necessary to understand the starting point of the guidelines.

World Conservation Strategy:

For example the guidelines of the World Conservation Strategy concentrate on the eco-values. It intends to preserve species. Its strategy concentrate on three main points:

- Avoid that species become distinct
- Protection of unique and representative ecosystems
- Sustaining of the maximum number of species, both in captivity and natural habitat (diversity)

In contrast an eco-centric philosophy does not prioritise between species or eco-systems, as they are perceived equally important.

Natural resource Management

The ideas of the steady-state economy have resulted in a pseudo science of natural resource management. Its aim is to sustain the use of natural resources.
Extraction, harvesting (output) of renewable resources should not exceed its regeneration. Extraction of non-renewable resource should be minimised, through more efficient technologies, less spillage and waste and more recycling.

General recommendations

Other guidelines include issues like:

- Sustainable use of renewable natural resources
- Substitution of non-renewable natural resources through renewable natural resources
- Recycling of non-renewable natural resources
- Minimizing waste emissions into natural environments, controlled dumping
- Minimising slicing ecosystems in pieces
- Minimising disturbances in ecosystems
- Maintaining a large diversity of species within ecosystems
- Technology efficiency related to material and energy consumption and waste contribution
- Minimizing space allocation for physical infrastructure, industrial and living purposes
- Decreasing population

5.1 APPLICATION IN THE CONSTRUCTION INDUSTRY

It becomes clear from these guidelines that in particular engineers need to have thoroug understanding of the production processes and possible reuse of waste products of the products they intend to use in their designs and other activities. This paragraph translated the generic guidelines in concrete advises for civil engineers and contain product information that may be helpful to civil engineers.

Some of the recommedations are already provided in the above generic guidelines, like

- Minimizing waste emissions in the natural environment is an important criteria for who have to design waste belts
- Minimizing space allocation for physical infrastructure, industrial and living purposes is important to those who are involved in spatial planning; e.g. to discourage traffic movements, roads should not be widened unless it is really satured.
- Minimising slicing ecosystems in pieces and minimising disturbances in ecosystems are both important criteria for those who have to prepare alignments of new roads

Other recommendations relate to the designs of civil engineers. Many civil engineers are involved in the designs of buildings, not only to do the structural analysis, but also to provide the water and sanitation facilities and support the heating and ventilation systems.

Saving water

In many parts of the world excess water consumption is a problem. The problem is self-evident in arid climates, but even in countries with an absolute water surplus, clean water may become scarce, or groundwater levels may drop at specific locations.

These problems are caused by various of reasons like extraction, but also due to our sewer systems. The paper already highlighted the water conflicts in arid zones, where irrigation is jeapordising the production of drinking water. On the other hand build-up areas and their sewer systems prevent that rain water can infiltrate in the soil and run off, through a system of roads and sewer pipes straight into the surface water. As a result the surface water may become polluted but more importantly the groundwater levels in certain areas drops, which may affect the flora and fauna compesition in certain ecosystems. Factories also cause environmental problems, by emitting polluted process water. Note that the temperature of the water can also cause severe environmental damages. Many machines are cooled with water, when this heated water is dumped straight into the surface water, it will change its ecosystem.

Civil engineers are often involved in the preparation of water management plans. They should be familiar with techniques that safe, purify and recycle water. Simple tricks are; to reuse dirty water from showers as a source for flush toilets and catch water from the roof for irrigation of gardens.

Saving energy

Both in cold and hot climates most of the energy in buildings is consumed for the creation of a more pleasant interior climate. Because of the temperature difference between the inside and outside of the building, the heat is transported outside and inside the building in respectively the cold and hot climates. The faster the heat transfer takes place the more energy is needed to keep the interior at pleasant temperature levels. Isolation of the roof, floor and walls and double-glazing can reduce the velocity of the heat transfer considerably. Furthermore designers should consider the

energy efficiency of the heating and cooling equipment. Not all isolation materials are environmental friendly. Materials from natural sources like glass wool and mineral wool are the best solution. Expanded polystyrene is still acceptable as they do not contain CFCs (chlorofluorocarbons). CFCs have serious advers effects on the ozone layer. Expanded polyurethane on the other hand do contain CFCs and are therefore not acceptable.

In subtropical and tropical climates, it is also possible and common to create pleasant interior climates through air movement. Ventilators consume far less energy than air-conditioners. The design of the building can accommodate natural ventilation through correctly positioning of the doors and windows. Ideally every wall contains openings and the openings are located in opposite walls. If there is a dominant wind directions the openings in the wall facing the wind should be smaller than the other openings. As hot air moves upwards, openings at high locations also stimulate air movement. Because most people want to keep mosquitoes and other insects outside the house, the openings require mosquito fencing.

Another option of saving energy is the use of solar panels or windmills to generate energy. There are also solar panels that are used to heat up water.

The production of building materials requires also energy. The production of walls of adobe or compressed earth blocks requires far less energy than for example the production of a wall of burned bricks. If properly protected against wind and rain through a coating, walls of adobe and compressed earth blocks last as long as walls of burned bricks. Adobe and earth blocks can almost completely be recycled. It is possible to produce new adobe and earth blocks from old adobe and earth blocks. The main challenge is to separate the cladding/coating. Recycling of burned bricks is very difficult and often results in debris that only can be used as an aggregate. The production of burned bricks transforms clay permanently.

Most recommendations in this industry relate to product information. Which products are produced from renewable sources and which products require “dirty” production processes or result in hazardous waste.

Renewable source

Timber is a typical renewable source on condition that the trees are replanted. Nonetheless hard wood from tropical rain forests should be avoided.

Recycling

Certain products can be reused while others can be recycled. For example, the rubbish of demolished buildings can be used as aggregates. About 35% of old asphalt can be included in the production of new asphalt with standard equipment. Special equipment makes 100% recycling possible. Fly-ash, produced from waste, is often used as an aggregate for concrete and road pavement foundations.

Chemical substances

Pesticides, insecticides, most cleaning products, paints, white spirit and heavy metals like lead, copper, sink, mercury and cadmium contain chemicals that are very dangerous to the environment and public health. Residues of these products needs special attention and are ideally burned under controlled circumstances under extreme heat. In reality, in most countries the residues of these substances are directly disposed in the soil, water or sewer systems.

Paints

Paint coatings on basis of water binders, linseed, safflower, poppy seed and walnut are better for our environment than paints with solvents of white spirit or carbon tetrachloride. The latter paints can cause headaches and concentration disorders. Spraying of paint is not recommendable as the sprayers often contain CFCs. This way of painting is very inefficient with regard to paint consumption and thus is expensive. Colouring agents can contain harmful substances like metals. The mat red, brown and brown-yellow paints often contain harmless colouring agents. Hard and dark colours contain very toxic substances and possibly carcinogens.

Stain prevents the development of fungus. They therefore contain various toxic substances, i.e. pentachlorophenol. A material very toxic to the painter that slowly is transported outside the timber element. It is not necessary to use stain for all timber elements. Only certain timber elements that are exposed to water and wind may develop fungus, or develop decays. Alternatively to applying stain, the manager can apply a maintenance control system based on annual inspections. If fungus or decay is found, the defect is usually still small and can easily be reduced by applying normal paint. For more serious problems, it is recommended to use boric. Some woodwork requires protection against woodworm. The best method is to preserve the timber with zinc Naphthenate that is applied under vacuum pressure.

Plastics

Plastics are produced of mineral oil. A non-renewable source. There are various types of plastics. Most products are produced of a combination of plastics, filler materials and stabilisers. It is therefore difficult to recycle plastics through a process of heating and recasting. The result is an inferior plastic that can only be used for certain purposes. All plastics have very long half-times. The production and combustion of some plastics, like PVC and polyurethane have severe side-effects on the environment because of its emissions. The production and combustion of other plastics like polyethylene and polypro peen emit mainly harmless substances.

Insecticides and pesticides

Rural engineers are often involved in providing advice concerning agricultural production including selection of insecticides and pesticides. Excessive use of the insecticides and pesticides are very bad for the public health, as it usually accumulates in the groundwater, the source for drinking water for most people.
The production of insecticides and pesticides also result in all kinds of chemical waste products.

The best alternative for insecticides and pesticides is organic

agriculture. Through mixing of products on a particular parcel, the parcel becomes less attractive to insects and it is more difficult for pests to spread itself. Herbs have proven to be very effective to scare away insects. Snails hate thyme. Ants stay clear of garlic and flees evade camomile, coriander, lavender and eucalyptus. Aphids avoid the smell of tomatoes and stinging nettles. The plants could be sprayed with a nettle-soap mixture, or extracts of earlier mentioned products. In addition, most insects have natural enemies. With the use of biological insecticides, farmers are able to control pests and plagues. Organic agriculture is more labour-intensive and therefore more expensive. Its products may therefore not appeal to the masses in low and middle-income countries.

Certain insecticides are more harmful to the environment than others. Some are more selective and only have negative effects on certain plagues and pest, while others may affect a large part of the food chain. The detriment of the substance depends on its format (powder, gas or liquid), concentration and characteristics of the toxic elements in the substance.

Organophosphates

Organophosphates kill insects through inhalation. Although it degrades fast, it is not recommended to use this very toxic substance. It is not very selective as it also kills also other animals (fish, small mammals and birds). Adverse effects for human beings vary from disorder of the nervous systems to paralysis.

Carbamate

Carbamates are in general not toxic for mammals, but in general are not selective and therefore also not recommended.

Chlorinated hydrocarbons

Also known as organochlorines, these synthetic organic compounds contain chlorine. They tend to be persistent in the environment and to biomagnifies in the food chain. This means that an animal or plant that absorbed the substance will carry it for the rest of its live and therefore cannot be used for human consumption.
Chlorinated hydrocarbons are the worst possible form of pesticides for public health and the environment. This group include DDT, aldrin, dieldrin, heptachlor, chlordane, lindane, endrin, mirex, hexachloride, and toxaphene. Unlike carbamates and organophosphates, this substance degrades slowly.

Pyrethrin

We recommend the use of pesticides and insecticides that are based on pyrethrin. There are two types of pyrethrin:

- Natural
- Synthetic

Natural pyrethrin is very toxic for all insects but far less harmful for other animals. Furthermore it degrades fast.

The synthetic variety degrades a little less well, but is also toxic for fish.

Asbestos

The application and demolishing of asbestos cement can cause cancer. It should therefore not be used. Where it already exists, an

analysis should indicate if the material is eroding, i.e. due to movements. If the material is eroding it should be removed under controlled circumstances.

Chipboard

Chipboard, triplex and multiplex can contain formaldehyde, which can cause headaches, irritation of eyes and fatigue. Due to high temperatures and high humidity, it is likely that it is emitted from the board into our environment. We absorb it through inhalation. It is best to avoid materials with high formaldehyde contents (>10 mg/100 gram board) and to isolate the air in the boards from our interior climate with a lacquer, foil or alkyd resin.

Gypsum

Gypsum may have natural or synthetic origins. Synthetic gypsum is produced from waste of the artificial fertilizer industry and coal used in the electricity industry. Gypsum products may give ionising radiation. Natural gypsum and gypsum from the coal using electricity industry are less radio-active than gypsum produced from waste of the artificial fertilizer industry. The main disadvantage of the use of natural gypsum (lime and gravel) is the damages to the landscape.

Adhesives

All adhesives in the construction industry have negative environmental effects. Adhesive with organic solvents, higher risks for painters. Epoxy adhesives are very harmful to the environment Preferably use adhesive on basis of water binders. Adhesives in powder form that have to be mixed with water are certainly water binder based.

The construction activities themselves also require energy, equipment and tools. Although it not really considered an environmental issue, it is a proper public health conduct to ensure that workers use protective clothes.

Illumination

In many countries construction activities take place 24 hours a day. In most cases the site is illuminated with fluorescent lamps. It should be noted that the tubes contain various heavy metals.

Batteries

All types of batteries contain heavy metals. Batteries are expensive and therefore it is better to use tools that can be connected to the electricity grid. The site lay-out should take into consideration the need for electricity during construction.

Alkaline batteries are popular because of their long duration, but they also contain a lot of mercury and are therefore quite hazardous. Nowadays a good alternative are the rechargeable batteries, they are also the cheapest option.

Cleaning products

An important maintenance activity for tools is to clean them at the end of a working day. The finishing touch of a construction project is to clean the created building or asset. Producers of cleaning products have been very successful in convincing consumers to use special products to clean toilets, floors and windowpanes. At the same time it produces and sell all-purpose cleanser. These all-

purpose cleansers contain harmful substances like preservatives and thinners. The special products are even more harmful. Toilet cleansers contain acids. Some acids are aggressive like phosphor acid and hydrochloric acid. Others are less aggressive like acetic acid and citric acid. The truth is that most tools and building elements can be cleaned with liquid soap, a cheap and environmental solution. Panes can be cleaned with water and salt.

5.2 ENVIRONMENT REGULATION & ECONOMIC POLICY

The radical pro-environment development path

Assume that a nation would like to pursue a truly environmental friendly development path. Such a nation would be concerned about the production within its borders that result in unnecessary waste; emits its waste in the air, water or soil; use exhaustible natural resources affecting the regeneration capacity and many other issues. As a result the nation may issue regulations with regard to production within its territory. The domestic industries, including the foreign direct investors have to produce environmental friendlier and their products should not include hazardous components for the environment. Where environmental damage is permitted, the polluter has to pay for the damage. In the short run the cost for production and consumption rises and as result the nation's cost competitiveness in certain industries will reduce. In the long run many domestic industries will create capacities in environmental production. The latter depends largely if the industries will be able to generate sufficient economics of scale to maximize production potential. Long term projections show that many more advanced economies will follow this development path. Early innovators are likely to have a competitive advantage with this regard.

Concerns from Industries

The concerns from the domestic industries relates to their higher relative prices and their difficulties to compete on the export markets and increased competitiveness of the imports.

The environmental friendly development path requires governments also to ban imports of products that harm the environment within their territories. It may therefore ban products with harmful components. Likewise it may set requirements to production processes that result in pollution of the air or the international waters, depletes natural resources, destroys natural habitats, reduces population of endangered species etc. However such trade barriers may have adverse impacts on domestic industries that use these products as inputs in their production process.

Differences between nations

The environmental protection offered by the different nations varies considerably. In general there is a positive correlation between the income per capita and the offered protection level. Countries with higher income levels tend to develop a culture which gives more emphasis on protection of the natural environment.
As described before the regeneration and absorption capacity of the natural environment differs considerably over the world.
Furthermore countries have different population levels and industry intensities. It is therefore justified that countries apply different emission and harvesting norms.

WTO

Countries who are member of the WTO may wish to explore the options under Article XX(a), which permits an exception to the trade rules for various reasons, including the environmental protection. However the Appellate Body (AB) of the WTO also ruled that "it is not acceptable in international trade relations for one WTO member to use an economic embargo to require other WTO members to adopt essentially the same comprehensive regulatory program, to achieve a certain policy goal, as that within that member's territory, without taking into consideration different conditions which may occur in the territories of those members". However it is allowed for countries to protect their environment with measures like trade barriers. In other words they can ban products or issue environmental tariffs on products that have negative effects on their environment and conserve exhaustible natural resources outside their territory, i.e. emissions in the air or international waters. However nations should first engage themselves in bilateral negotiations prior applying such measures.

It goes without saying that members of the WTO can only impose tariff barriers to protect the environment when they apply the same regulatory measure to its own industry and industries in countries with similar conditions. Another difficulty is that the regulation should be based on scientific evidence. The SPS agreement, allows the WTO to remove restrictions that do not meet these criteria. Countries may in particular have difficulties to provide the scientific evidence to support its embargos and environment related tariffs.

Countries that are not member of the WTO have of course more options to pursue their own trade policies.

A compromis

Most governments will be careful to follow a radical pro-environment path. They are concerned about the adverse economic effects for their producers and consumers. There are some measures that governments can apply without adverse effects.

- Target industries operating in nontradables
- Target products and production processes that can be replaced with domestic products/services
- Target consumer products for which alternatives with acceptable prices are available
- Target imports that do not serve as inputs for domestic production
- Concentrate on products and production processes for which scientific evidence concerning their adverse effects are available or relatively cheap to obtain.

APPENDIX 1: FURTHER READING

Epidemiology

- Epidemiology (*http://www.ncbi.nlm.nih.gov/books/bv.fcgi?rid=mmed.chapter.631*). Chapter 9 from Medical Microbiology 4th ed textbook at US National Center for Biotechnology Information. Plain format at University of Texas Medical Branch at Galveston (*http://gsbs.utmb.edu/microbook/*)
- Epimonitor (*http://www.epimonitor.net/index.htm*) has a comprehensive list of links to associations, agencies, bulletins, etc.
- Epidemiology for the Uninitiated (*http://bmj.bmjjournals.com/epidem/epid.html*) On line text, with easy explanations.
- North Carolina Center for Public Health Preparedness Training (*http://www.sph.unc.edu/nccphp/training/*) On line training classes for epidemiology and related topics.

Public health

- Control of Communicable Diseases Manual edited by James B. Chin, APHA, 2000
- Encyclopedia of public health edited by Lester Breslow, Macmillan Reference 2002
- Antony van Leeuwenhoek (1632-1723) (*http://www.ucmp.berkeley.edu/history/leeuwenhoek.html*)
- Introduction to Virology (*http://www-micro.msb.le.ac.uk/109/introduction.html*)
- John Snow (*http://www.ph.ucla.edu/epi/snow.html*): Mode of Communication of Cholera (*http://www.ph.ucla.edu/epi/snow/snowbook.html*)
- U Leicester Online Tutorials (*http://www-micro.msb.le.ac.uk/Tutorials/Tutorials.html*)
- Centers for Disease Control (*http://www.cdc.gov*): Public Health Information Network (*http://www.cdc.gov/phin/*)

Organic Agriculture

- http://www.biologischelandbouw.net/indexUK.html

APPENDIX 2: THERMODYNAMICS

Conservation of energy (the first law of thermodynamics) is one of several conservation laws. It states that the total inflow of energy into a system must equal the total outflow of energy from the system, plus the change in the energy contained within the system. In other words, energy can be converted from one form to another, but it cannot be created or destroyed.[7]

In physics, the second law of thermodynamics, in its many forms, is a statement about the quality and direction of energy flow, and it is closely related to the concept of entropy. The second law states that thermal energy, or heat, is special among the types of energies: all the forms of energy can be converted into heat, but in a way that is not reversible; it is not possible to convert the heat back fully in its original form. In other words, heat is a form of energy of lower quality.

What makes heat so special? According to the kinetic theory, heat is due to the random movement of atoms and molecules, so it looks much like kinetic energy. The difference is that those movements cannot be observed or predicted, while all the other forms of energy are the result of some orderly movement of particles. The second law says that the amount of random movement, i.e. the entropy, can only increase in a closed system, i.e. that we cannot put this randomness in order without some external influence. (Some systems, for example living cells, spontaneously become structured when they receive energy from the outside - see dissipative structures).

Yet, there is one thing predictable about heat: it flows from hot to cold bodies. This can be used to convert some heat into mechanical energy, using a Carnot heat engine. The cycle stops when both bodies reach the same temperature: it can be shown that the amount of random movements has not decreased in the process. The second law of thermodynamics is important to engineers because it provides a way to determine the quality, as well as the amount of degradation of energy during a process. [8]

[7] http://en.wikipedia.org/wiki/Conservation_of_energy
[8] http://en.wikipedia.org/wiki/Second_law_of_thermodynamics