7 Environment

7.1 Definition

7.1.1 Environment

We define environment as *'the set of conditions for living'* (Hendriks 1993). In this definition, both 'conditions' and 'living' can be more closely specified. By means of substitution, more precise concepts of the environment arise, such as 'the set of physical conditions required for plant life' or 'the set of managerial conditions required for animal life'.

conditions	**life**
managerial	human
cultural	
economic	animal
technical	
ecological	plant
mass/time/spatial	

Fig. 763 *Substitution possibilities in defining environment*

One can presume a sequence of conditionality in both columns (one cannot imagine management without a culture to carry it; one cannot imagine animal life without plant life, etc.). That becomes an issue as soon as one attempts to weigh the importance of different environments against each other. However, also *without* the above presumption, these substitution possibilities allow 18 more precise environmental definitions to be made. We can summarise managerial, cultural and economic conditions as 'societal conditions' and the remaining ones as 'physical conditions'. In this way, the number of environmental definitions is reduced to 6. Plant and animal life-forms can be summarised as 'non-human life-forms' (12 environmental definitions), but they can also be more precisely distinguished in the five 'kingdoms'[a] currently recognised in biology, with *homo sapiens* as the sixth category, bringing the number of environmental definitions up to 42. This figure increases further, if we define a species-specific environment for every species.

The current environmental definition of 'physical conditions for human life' (more or less according to Udo de Haes in Boersema, Peereboom et al. (1991))) is just one of the environmental definitions identified above. Udo de Haes' formulation[8635] can be expressed as a technical definition, by reducing it to 'the collection of physical conditions for societal life'. However, by doing this, the physical surroundings become less optional than those postulated as a *condition* for societal life.
In other words, an asymmetry is assumed in the 'relations' between society and the physical environment.

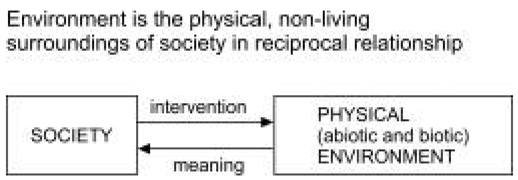

Fig. 764 *Environment according to Udo de Haes*

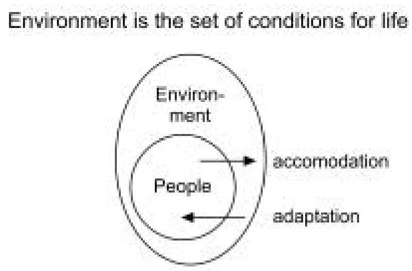

Fig. 765 *Environment in technical sense*

After all, one cannot imagine people, let alone a society, without physical surroundings, but one can imagine physical surroundings without people. A physical environment is thus a technical *condition* for human and societal life.[36] Because of this, a specific physical environment is not the cause of one or other *form* of human life[87], such as physical determinism at the end of the last century would have led

[aa] Vroeger werd alleen planten- en dierenrijk onderscheiden. Tegenwoordig worden naast deze rijken monera (bacterieën zonder celkern), protocristen (eencelligen met celkern) en fungi (schimmels) onderscheiden, see Margulis, L., K. Schwartz, et al. (1994) The illustrated Five Kingdoms; A guide to the diversity of life on earth (New York) Harper Collins College Publishers ISBN 0-06-500843-X..

one to believe[a]. After all, human beings are able to create new physical conditions for themselves (accommodation) and are thereby the cause of their own conditions. However, they are also able to adapt themselves to existing conditions (adaptation), and only in that case do they partly allow the causality of their lives to be determined by the physical environment[88]..[37]

7.1.2 Conditions

Technical conditions are related to what is possible, while causal relations have a bearing on what is probable within that possibility. After all, what is probable is, by definition, also possible, but not everything that is possible is also probable.There are, therefore, improbable possibilities. One cannot predict these, so one has to design them.[8938]

The analogue of this is that every cause is a condition for something happening, but not every condition is also a cause. The foundations of a house can be a condition for building that house, but, that does not mean that they are a reason why that house was built. A house can be a condition for a household; it can create the possibilities for a certain kind of household, but, nevertheless, it is still not the cause of that household.

The above argumentation gives an exact indication of what the responsibility of the designer is, in contrast to that of the researcher. If (s)he designs a home, (s)he must not do it in a way that presumes its occupancy by a specific type of household - that would be an encroachment on the freedom of choice of the future occupants - his design must keep possibilities open for its occupancy by different sorts of households.

The same sort of dilemma exists in ecology. It is not always possible to forecast where a certain ecosystem will come into existence, but we can create the conditions under which certain ecosystems can exist, but others can not.[9039]

7.1.3 References to Definition

Boersema, C. Peereboom, et al. (1991) Basisboek Milieukunde HOOFDSTUK 01 (Meppel) Boom ISBN 90-6009-977-x.

Claval (1976) De geschiedenis van de aardrijkskunde (Utrecht) Het Spectrum.

Hendriks, L. W. J. L. (1993) Begrippen rond bouwen en milieu (Rotterdam) SBR Stichting Bouwresearch.

Margulis, L., K. Schwartz, et al. (1994) The illustrated Five Kingdoms; A guide to the diversity of life on earth (New York) Harper Collins College Publishers ISBN 0-06-500843-X.

[a] De op- en neergang van het determinisme in de ruimtelijke wetenschappen omstreeks de eeuwwisseling is onder meer duidelijk beschreven in Claval (1976) De geschiedenis van de aardrijkskunde (Utrecht) Het Spectrum.

7.2 Environmental problems

7.2.1 Lacking conditions

With this environmental definition, *environmental problems* are simply '*missing conditions for life'*, that have to be specified further, by substituting for 'conditions' (physical, social) and 'life' (human or other). For the other forms of life, human beings have, by now, become a plague, and, in this sense, are the cause of environmental problems. Physical conditions are becoming increasingly unavailable to non-human life forms.

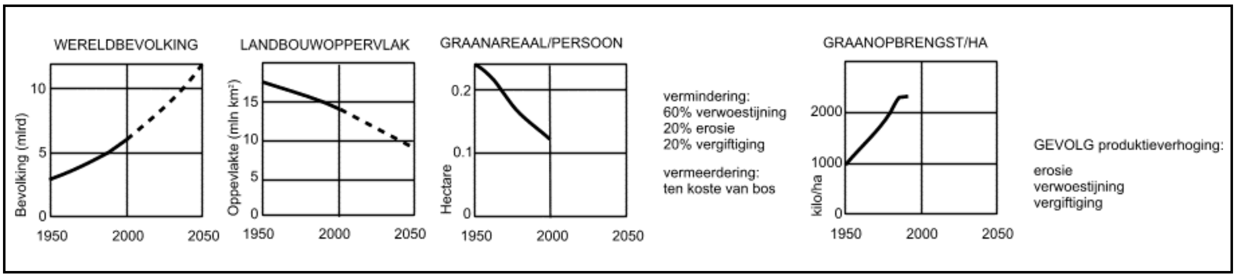

Fig. 766 *Doom scenario*

Using the technical definition chosen here, environmental problems are easily definable as life-sustaining conditions that are missing, and environmental regulations as actions designed to provide for them. For a technical definition, therefore, environmental regulations do not need to be directed only on restoring an earlier situation (that is often an illusion), they can also create new life-sustaining conditions. This perception of the environment distinguishes designers from researchers. The relations between organisms and their surroundings (including that of the human society and its physical environment) can, for the time being, still be only very partially understood. However, they do not need to be completely understood to restore lost life-sustaining conditions, or to create new ones. In addition, many environmental problems cannot be solved any more by removing the cause[91].
We cannot return any more to the situation of 10,000 years ago. At that time, there were an estimated 3 million people on earth and at least 50,000 species more than there are now.
And, because we cannot go back, we have to do more than just maintain the old environmental conditions; we have to create new ones.

7.2.2 Diversity of conditions

What is meant by 'conditions' and 'life', can turn out to be different when put into practice. One can define abiotic, biotic, technical, economic, cultural and managerial conditions for different forms of plant, animal and human life. General technical environmental definitions of these different substitutions form just as many environmental concepts, in which apparently conflicting opinions about environmental problems and regulations are brought to the fore.[9241]

For example, the abiotic conditions for plant life are contained in an environmental concept that is different from those for animal life. In particular, the construction of ecological linkages creates new abiotic conditions for certain forms of animal life. Viewed from their predominantly botanical understanding of the environment, the authoritative plant ecologists, Westhoff and Van Leeuwen see, and rightly so, more value in isolation, than in the construction of linked 'ecological infrastructure'.

7.2.3 Conditional conflicts

It is thus impossible to talk about 'the environment' in general, and to put a general stamp of 'environmentally friendly' on one or other regulation. Every interference with the surface of the earth increases the possibilities of the one species, to the detriment of other ones.

In agriculture, for instance, we create optimal conditions over enormous areas of land (by fertilisation, hydraulics, etc) for a few plant species, with the result that, with such strong competition, every other species is eliminated. In urban architecture, we optimalise in favour of the human species and, within that, for each location, according to certain societal categories.

Thus, for each intervention, we must specify which environment we are talking about.[93]

7.2.4 Urban design providing human conditions

In that perspective, we can now define (urban)architecture as supplying, research- and design-based conditions for *human* life by constructing buildings and organising space (whether or not on a larger scale than that of a single building). *(urban) architectural problems* consist of the (future) absence of those conditions. The aim of *(urban)architectural research* is to draw attention to, anticipate or formulate in a programme these (missing) conditions. Therefore, it includes not only anticipatory, explanatory and problem-indicative research, but also design research and effect analysis *beforehand* and evaluating research *after* completing the construction. The aim of *(urban)architectural design* is to present these conditions in a realisable spatial relationship.[94]

7.2.5 Probable, possible and desirable conditions

Environment is the collection of conditions for life in general. *Ecology* is the research into the *probability* of these conditions, and *technical ecology* is the (design)research into their *possibility*. *Environmental planning* is the provision of conditions for life in general by means of research, design and policy (of course, as far as these can be appreciated by human beings), viewed from the higher scale levels to the lower ones (*an inward-directed approach*). In a similar way, *environmental technical design* is viewed from the lower scale levels to the higher ones (*an outward-directed approach*)[95]

7.2.6 Anthropocentric and ecocentric conditions

With respect to the environment, two standpoints, one of them *anthropocentric* and the other *ecocentric*, can be discerned. The first standpoint should view every aspect from the point of view of human beings, and the second one, from the point of view of 'nature'. As 'nature' is a human concept, the debate between anthropocentrists and ecocentrists, that flares up once in ten years or so, invariably veers in favour of the anthropocentrists. Thus, an '*ecocentric standpoint*' includes only that part of the anthropocentric standpoint that attempts to distance itself from human biases (*?p???*, epochè) in depicting and organising the environment (the conditions for life). Due to this, the concept 'anthropocentric' has, in fact, become useless, because as long as animals and plants are unable to speak an understandable and convincing language, every standpoint is, by definition, anthropocentric.[96]

7.2.7 Operational and conditional action

There are *direct* requirements for human life which, if missing, cause loss of comfort or even the death of people, and *indirect* requirements (such as the existence of plants and animals) that, should they be missing, would adversely affect these direct requirements. The existence of direct requirements for life is thus linked to indirect requirements and, in turn, these are linked to requirements that lie even further away (*conditional links*).[a] For example, for many organisms, the necessary existence of oxygen in the air is, itself, indirectly dependent on the existence of photosythesis by plants. It is these indirect requirements that are often either easier to influence by *conditional* design or (if they have been irretrievably lost) by providing a new form, than to 'tackle' the missing direct requirement *operationally* as being the 'cause' of the problem.

A quiet study room can be a requirement for studying. Noise from neighbours leads to the problem that this direct requirement for studying is destroyed. Indirect conditions that can restore this direct requirement can, in this case, be: adopting a complementary living rhythm (so that the noise occurs at times when no one is studying), thick walls or quiet neighbours. Noise from neighbours can thus be solved in more ways than just by 'removing the cause'.

7.2.8 Interference of conditions

By (taking measures) providing missing direct requirements (to solve environmental problems) one can, in addition, adversely affect other (mostly indirect) requirements. In building a house, one provides, in a direct way, requirements (an 'environment') for human life, but, by so doing, one adversely affects the environment for other life forms and thereby perhaps the indirect requirements for human life. Thus, not only living requirements, but also environmental measures (the provision of certain conditions), are conditionally linked with each other.

For example, to save energy, there is no sense in letting sun enter the house if that house does not stand in the sun, but, in reverse, there is. If the last-mentioned requirement is not met, then it would be

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[a] De theorie van de voorwaardelijkheid is uitgewerkt in Jong, T. M. d. (1992) Kleine methodologie voor ontwerpend onderzoek (Meppel) Boom.

senseless to provide the first-mentioned requirement. Environmental measures can become each others' requirements or restrictions, without, however, also being each others' direct cause.

7.2.9 Conditional sequence

Environmental problems (missing requirements)[97] have a conditional link with each other in this way. After all, one environmental problem can facilitate another one, without directly causing it. Eliminating the direct causes (operationally) without analysing the requirements, followed by creating (conditionally) all related requirements for success has often be shown to be ecologically counterproductive.[98]

For example, one cannot bring a manure-polluted drainage ditch back to its original state by stopping the manure pollution as Nienhuis (1993) and Hekstra, Strien et al. (1993) show. In the short term, manure pollution is irreversible. The same sort of problem occurs in medical science: a complaint appears to have a direct cause, but the true cause may lie in shortages elsewhere in the body, so that, unexpectedly, one of the requirements of the body that would otherwise ensure that this sort of complaint does not manifest itself, is not met.

Environmental strategies are combinations of environmental regulations, such that they enable and even strengthen each other, both in the time taken and in the sequence of requirements, without creating new problems. *Environmental tactics* is one of the locally or temporarily (politically, culturally, economically, technically) adapted effects of the strategy to the various situations.[99]

7.2.10 References to Environmental problems

Hekstra, Strien, et al. (1993) Uitdagingen in de oecologie. Theorie en toepassing (Den Haag) Nederlandse Ecologen Vereniging (NEV) ISBN 90 71040 06 2.
Jong, T. M. d. (1992) Kleine methodologie voor ontwerpend onderzoek (Meppel) Boom.
Nienhuis, P. H. (1993) Voedingsstoffen in het water: van teveel naar minder. Hoe reageren de levensgemeenschappen? in: G. Hekstra, W. v. Strien and J. Wevering Uitdagingen in de ecologie: theorie en toepassing (Den Haag) Ned. ecologen vereniging
Westhoff, V., P. A. Bakker, et al. (1970) Wilde planten, flora en vegetatie in onze natuurgebieden , deel 1, 2, en 3 Vereniging tot behoud van natuurmonumenten.

7.3 Environmental hygiene

In this section, a number of technical aspects of environmental hygiene are brought to the fore that are important for making short reports on environmental effects and environmental policy plans. There is much literature about this subject primarily summarised in Boersema, Copius Peereboom et al. (1991) to be completed with recent figures from RIVM (2001).

Environmental hygiene, spatial planning and nature conservancy are policy sectors concerned with the unwanted side-effects of human activities. In spatial planning and nature conservancy, in the first place, this has to do with the mechanical effects such as management, disruption, and small and large interventions in nature and space. Environmental hygiene is mainly concerned with material and energetic effects, among others, on materials, people, other organisms, systems and entire geographical areas, including nature reserves.

7.3.1 A chain of impacts

In order to be able to estimate the unwanted side-effects of all sorts of activities in a given location, beforehand, it is best to divide these activities into living, traffic, nature and agriculture, businesses and incidental activities. These categories can be subdivided into a multiplicity of activities for which, for each activity, emission factors are known. By multiplying these factors by the number of inhabitants, jobs, or km^2 , one can gain an impression of the emissions. This emission is dispersed by air, water, the ground or other dispersion agents, and eventually has a negative effect on materials, people or other organisms.
These can be summarised in the following diagram:[10049]

economic activity---->	direct effect of emission ---->	indirect effect of transmission ---->	end-effect of emission and exposure
SOURCES (7.3.2) 1. Homes 2. Traffic 3. Agriculture 4. Businesses 5. Incidents	EMISSION (7.3.3) 1. Inorganic 2. Energetic 3. Mechanical 4. Information 5. Potential emissions	DISPERSED BY (4) 1. Air 2. Water 3. The ground 4. Food chains 5. Transport	OBJECTS (5) 1. Materials 2. People 3. Other organisms 4. Systems 5. Locations

Fig. 767 *The chain of effects*

In this table, no account is taken of unwanted socio-economic side-effects,. All that is given is a checklist to assess the environmental effects. The nature of sources, emissions, dispersing agents and objects is dealt with in more detail, respectively, in Sections 7.3.2 t/m **7.4** inclusive.
By estimating the expected emission, transmission, immission and exposure, one can make a report of the environmental effect for an activity or for an entire area,. However, in such a report, no policy will have been formulated to restrict these effects.

A policy of that kind must weigh-up the unwanted side-effects against the useful effect of the intended activity, or of the situation that has come into being, which can then be expressed in an environmental policy plan. A similar consideration occurs due to standardisation. Standards to reduce the damage that many objects suffer due to different human activities, originate in these objects. Initially, it can be established where the limits of damaging influences need to be set, in order to prevent that particular object from suffering an adverse effect. This can lead to quality standards being set for the ground, water and air, that, in turn, lead to the setting of limits for emissions from a wide range of activities. Finally, one can bring about changes in the harmful activities themselves by linking the processing, the product, or the particular establishment as a whole, to standards and regulations.
These are summarised in the following diagram:[10150]

STANDARDS, applied to: the source	the emission <----	the dispersing agent <----	the object <----
product standards processing standards regulations	emission standards - emission ceilings	quality standards	exposure and immission standards
EXAMPLES OF NON-NUMERICAL STANDARDS (‘Policy starting-points’)			
‘Avoiding at the source’ (of the emission)	‘Combating at the source’ (of the emission) ‘Best technical means’ ‘Most practical means’	‘standstill’ principle	‘no effect’ ‘no adverse effect’
EXAMPLES OF NUMERICAL STANDARDS			
Lead content petrol	max. of 500 mln sulphur dioxide per year in the Netherlands	average % of oxygen in the water	EPEL value

Fig. 768 *Standardising to reduce adverse effects*

All standards contain a policy-based consideration of the useful effect of various activities compared with their unwanted side-effects. This is an economic consideration, which is examined further in Section 1.3.7.**Fout! Verwijzingsbron niet gevonden.**.

This standardisation, intended as a feed-back system on human activities in order to prevent negative side-effects, must, of course, be achieved by sanction possibilities.
The Environmental Management Law offers the integral legal framework to accommodate these standards. The international, national, provincial and municipal environmental policy plan can play an important role in this. Whether the standards in the environmental policy plan must be adapted beforehand (by a licencing system), or afterwards (by environmental accountancy) is not yet of importance for the technical aspects of environmental hygiene. In both cases, these remain the same.

7.3.2 Sources of environmental stress

For the registration of emissions in an area, more facts about the sources are necessary.They can be gained according to the following diagram (a further elaboration of Fig. 767)

Sources	Subdivision
1. housing, temporary-stay recreation	1.1 households 1.2 encroachment onto public space 1.3 public green areas
2. traffic, infrastructure	2.1 cars and other petrol-powered vehicals 2.2 routes used for transporting dangerous substances 2.3 railways and other electrically powered routes 2.4 shipping 2.5 airways 2.6 cables and pipelines 2.7 beam transmissions (e.g. for radio and tv)
3. nature agriculture, forestry, nature recreation	3.1 natural areas 3.2 forestry 3.3 arable farming 3.4 glasshouse cultivation (incl. mushrooms) 3.5 open-air horticulture and fruit growing 3.6 animal husbandry, fisheries
4. business, day recreation	4.1 mineral exploitation 4.2 historical manual skills 4.3 industry 4.4 public utility companies 4.5 building industry 4.6 services
5. incidental activities	

Fig. 769 *Overview of the sources*

In1977, the total emissions for all provinces in the Netherlands were estimated by means of collective registration, supplemented by individual registration. For example, for Gelderland, the emission registration for the four most important emissions gave the following picture:[102 51]

gram per day	Carbon monoxide CO	Sulphur dioxide SO_2	Nitrogen oxides NO_x	Hydrocarbons C_xH_y	per:
Housing	12	4	6	13	inhabitant
Traffic	200	8	54	48	inhabitant
Nature		869	32	690	km2
Glastuinbouw	362	1346	317	43	job
Glasshouse cultivation	107	5	5	35	other agrarian job
Firms	180	588	266	393	job

calculated from the Emission Registration for Gelderland (1997) and LEI statistics (1977)

Fig. 770 *Four important emissions per source category (Gelderland 1977)*

For the benefit of an initial global reference, for emission factors for a particular area, one should be able to use a more recent version of such figures (http://arch.rivm.nl/environmentaldata/).The figures given above are clearly out-of-date, but are useful, as such, because they provide interesting comparative material for assessing policy directed towards emission sources.
Emissions occur due to the processing of fuels or raw materials. This causes combustion emissions and process emissions, respectively. Energy saving could lead to a significant reduction in combustion emissions. The following table gives some insight into the relation between both types of emission during the 1970s.

		Combustion emissions	Process emissions	total
1Tg = 1000 000 000 kg = 1 mln ton		g/inhabitant/day	g/inhabitant/day	Tg/year*
Carbon dioxide	CO_2	8920	90	46.04
Carbon monoxide	CO	286	49	1.71
Nitrogen oxide	NO_x	108	6	0.58
Sulphur dioxide	SO_2	70	8	0.40
Hydrocarbons	C_xH_y	33	25	0.30
Aerosols, dust, soot		20	0.13	
Hydrated calcium sulphate (gypsum)	$CaSO_4$		427	
Salt	NaCL		67	0.34
Sulphuric acid	H_2SO_4		22	0.11

(CBS statistics 1978; Emission registration 1974/1981; Hermans and Hoff 1982)

Fig. 771 *Relation between combustion emissions and other types of emission*

7.3.3 Types of emission and environmental stress

To estimate the nature of the end effect and the manner of dispersal, the emissions need to be distinguished from each other, either by source or by groups of source, as follows:
(an elaboration of Fig. 767)

Types of emission	**Subdivision**	**Examples**
1. inorganic emissions	1.1 metallic 1.2 other inorganic	copper, lead, mercury CO, SO_2, NO_x
2. organic emissions	2.1 pure 2.2 halogenic 2.3 oxygenic 2.4 nitrogenic 2.5 sulphuric 2.6 metallic 2.7 other inorganic	methane, toluene, benzene vinyl chloride alcohols, esters amino acids thiols organic mercury organic phosphorus
3. mixtures	3.1 complex mixtures 3.2 aerosols 3.3 solid waste 3.4 microbic	BZV (biological oxygen consumption), CZV (chemical oxygen consumption), kjeldahl (method for measuring nitrogen) fly ash, industrial waste tetanus, botulism
4. energetic emissions	4.1 heat 4.2 sound 4.3 radiation, magnetic 4.4 radiation, radioactive 4.5 magnetic field	cooling-water traffic, industry light, infra-red, ultra-violet, radar, ether waves alpha-, beta-, gamma- high-voltage transmission lines
5. mechanical emissions	5.1 disturbance 5.2 small interruptions 5.3 substantial interruptions	treading on the ground, mowing, vibrations, up-rooting, digging ploughing, vandalism, clearing ground, building explosions
6. information emissions	6.1 visual 6.2 olfactory 6.3 others	horizon pollution bad smells misleading sounds
7. potential emissions	7.1 emission reduction 7.2 risk 7.3 variation in emissions	cloth filter, sedimentation plant, lpg (liquid propagaz) tank, (waste) storage day–night variations

Fig. 772 *Types of emission*

Further information is given briefly below about a few of these types of emission.

Material emissions
Metallic inorganic compounds can produce accumulating pollution that is heavily poisoned. For water pollution, mercury and cadmium, in particular, and compounds of these substances, are on the black list. The black list is a European list of the most dangerous substances for the environment that may not be released in any quantity at all.

The other inorganic compounds include: *carbon monoxide, sulphur dioxide, nitrogen oxides, halogen compounds, phosphates and arsenic*. These include, therefore, the quantitatively most important emissions and the majority of the combustion emissions. Special attention is given to a few of these below.

Carbon monoxide (CO) is formed when combustion is incomplete. It is a poisonous, colourless and odourless gas. The total amount of CO throughout the world remains surprisingly constant, despite increasing (industrial) production. In addition, CO occurs naturally in the atmosphere, due to the oxidation of hydrocarbons. However, CO is effectively oxidised to CO_2, so CO only remains in the atmosphere for 0.1 of a year.

Sulphur dioxide (SO_2) is a colourless gas with a suffocating smell. It irritates the mucous membranes and the lungs, but, apart from this, it is not so damaging. It occurs naturally in the atmosphere, among other things as a result of volcanic eruptions. A high concentration of SO_2 is indicative of pollution by tiny particles (aerosols).
Sulphur dioxide is extracted from the atmosphere by oxidation to SO_3 , which reacts with water to form sulphuric acid (H_2SO_4). Together with other substances, this is the cause of acid rain.
This is the reason why more and more lakes in Canada, Scandinavia and the Netherlands have become sterile, why forests have lost their vitality or have been declared as dead, why heather has been taken over by grass, why wood and agricultural yields have declined and why our cultural heritage has been irreversibly harmed. A small part of the SO_2 is immediately washed out and absorbed by vegetation and water. The time that SO_2 stays in the lowest part of the atmosphere is in the order of a number of days, and, under certain conditions, a number of hours.

Hydrogen sulphide (H_2S) is a smelly, poisonous, inflamable gas, that irritates the eyes and the respiratory tissues. It is released into the air by natural bacterial decomposition processes, but also by many industrial processes. It disappears from the atmosphere via oxidation to SO_2 or due to the activities of certain bacteria. It remains in the lowest part of the atmosphere from a few hours to a number of days.

The nitrogen oxides (NO_x, i.e. NO, NO_2 and NO_3) originate from nitrogen and oxygen in the air at temperatures higher than 800°C. NO occurs in the first instance, but as it cools, it is partly transformed in the atmosphere to NO_2. NO is a colourless gas that, in itself, is not harmful.
The reddish-brown NO_2, on the other hand, is much more harmful due to its irritating effect on the muscous membranes. NO_x is finally oxidised to nitrate and stays for about five days in the atmosphere. NO_x, in combination with hydrocarbons, can form all manner of new compounds in the atmosphere that can contribute to 'photo-chemical smog'. This results, among other things in *'PAN'(peroxide-acyl-nitrate) and formaldehyde (HCHO).*

Of the inorganic halogen compounds, it is mainly the compounds with fluorine (F) and chlorine (Cl) that are important.
Hydrofluoride (HF) is a very corrosive, poisonous fluid, that, due to its low boiling point (19.4°C), is easily emitted as a gas (of importance as a potential emission from storage sites). It is a cumulative poison, i.e. it builds up inside organisms.
Chloride gases enter the atmosphere mainly as a result of industrial accidents and leakages, as an insecticide, or due to burning plastics.
The phosphates are mainly important in water pollution. They can cause such an enormous richness of food in the water that it becomes devoid of oxygen.

Organic
Organic ammonia (NH_3) occurs especially in the bio-industry. It stays for about seven days in the atmosphere.

Of the *hydrocarbons* in the atmosphere, only about 15% originate from human activities. However, this amount has another composition, and is concentrated in a relatively small area. The natural hydrocarbons come from the decomposition of organic material and emissions from plants, especially certain trees. Above pine forests and citrus cultivations a haze can often be seen due to photo-chemical smog formation. The majority of hydrocarbons disappear from the atmosphere due to photo-chemical smog formation. They remain for quite a long time in the atmosphere; methane (CH_4), for example, remains there for about four years.

However, the length of time that these substances remain in the atmosphere is dependent on reactivity. A total of 150 different hydrocarbons have been identified in car exhaust gasses. They are released mainly due to incomplete combustion and by evaporation. From the many different hydrocarbon compounds, a number of examples are given below.

The group of *halogenic hydrocarbons* contains a large number of black-listed substances, such as alpha-, beta-, gamma- *hexachloro-cyclohexane*, the PCBs (polychloro-biphenyles) and *PCTs* (polychloro-therphenyles), hexachloro-benzene, hexachloro-butadiene, pentachloro-phenol and trichloro-phenol.

The chlorofluoro-hydrocarbons (CFKs, such as freon) belong to the halogenic hydrocarbons. They are used in cooling systems, as a propellant in spray cans, and are not poisonous in themselves. However, they can harm the ozone layer of our atmosphere, so that there would be no resistance any more to ultra-violet rays.[103 52]

The **other material emissions** include complex mixtures, aerosols, solid waste and free-coming bacteria, viruses (sick buildings!) or genetic material.

Mixtures
The complex mixtures include a large number of emissions from mostly organic material that can be largely biologically decomposed, and therefore their exact chemical composition does not need to be known. For these complex mixtures, standards are used such as BZV (biological oxygen consumption), CZV (chemical oxygen consumption) or the Kjehldahl method for measuring nitrogen.[104 53]
The aerosols are tiny solid and/or fluid air-borne particles that have such a slow rate of fall that they can be considered to float or drift. They originate naturally, enter the atmosphere through combustion processes, or are formed in the atmosphere by chemical reactions (e.g. by photo-chemical smog). Rain or snow is formed by condensation and sublimation, respectively, on the aerosols. Compared with the air over oceans, the average pollution of the air over rural areas by aerosols is ten times higher. Above small towns, air pollution by aerosols is 35 times higher, and above large cities 50 times higher than over the oceans. In unfavourable situations, this figure can increase to 4000 times or more.

Energetic emissions
Energetic emissions include warmth, sound, electromagnetic and radioactive radiation, and changes in the magnetic field. With the exception of radioactive radiation, in so far as it originates from radioactive substances that are dispersing, this is a form of emission, the spread of which is very predictable. If these emissions occur, it is known that almost all objects in the vicinity will be subjected to immediate exposure. Because of that, in measuring emissions (as in the case of sound), certain aspects of the exposure can already be included. The unwanted side-effects of energy-in-motion emissions can, on the basis of a named characteristic, best be controlled within the framework of spatial planning.[105 54]

Mechanical emissions
Mechanical emissions, such as disturbances, small and substantial interruptions, are, within the framework of environmental hygiene, not generally considered to be ‘emissions’. They are a part of the working field of spatial planning, ‘urban management’ and nature conservancy. However, logically and systematically, they fit in with an overview of types of emission and environmental stress, such as that shown in Fig. 772. These emissions can also be largely controlled using spatial planning regulations.

Information emissions
Information emissions include all influences that disturb the functioning of our ability to form images by sight, smell, taste, touch, balance, and voluntary movements. They are subjective, difficult to measure, and traditionally belong partly to the working field of spatial planning. However, a lot of research still needs to be carried out in this area. For example, if symptoms of psychiatric illness could be linked to urban living conditions (e.g. in the form of sensoric or motoric overloading or deprivation), then interesting new requirements could be placed on urban surroundings.

Potential emissions

Potential emissions include emission-reducing regulations, risks[a] and variations in emissions. Emission-reducing regulations and risk management are part of the continuing responsibility of all engineers.[b] The variation in emissions makes it somewhat more complicated to set standards than to fix an average. Local and temporary periods of peak stress are, after all, the most dangerous. Variations in stress can be cyclical, subject to trends, and/or can increase abruptly, in leaps.

7.3.4 References on Environmental hygiene

Boersema, J. J., J. W. Copius Peereboom, et al. (1991) Basisboek Milieukunde (Meppel / Amsterdam) Boom ISBN 90-6009-977-x.

RIVM (2001) Milieucompendum RIVM CBS URL http://arch.rivm.nl/environmentaldata/.

[a] De kans op effecten wordt risico (populair geformuleerd als kans x effect) genoemd. De risico-benadering is uitgangspunt voor de normering en komt uitgebreid aan de orde in het parallel-college veiligheidsbeleid (Hale).

[b] Notitie "Omgaan met risico's", gelijktijdig gepubliceerd met het Nationaal Milieubeleidsplan.

7.4 Transmission

Transmission is especially important for material emissions. It contains the propagation of energetic, mechanical, informational (noise) and potential influences (risk) and of material by air, water, the ground or via food-chains, mainly the territory of specialists and extensive computer programs. Transmission includes the transport, dilution, dispersion, conversion and removal of material in and out of the air, water, ground, food-chains and other relocating systems.[106][55]

We will go into the spreading of air pollution the most thoroughly below. In addition, ground and water pollution is partly a result of pollution in the air, so that, also from this view point, priority must be given to gaining a better understanding of air pollution. In this respect, it is important that a distinction is made between vertical and horizontal air movements.

Where there are no vertical air movements in a stable atmosphere, pollution stays at low levels and can become highly concentrated locally. Horizontal air movements are important in predicting where air pollution will occur. For water pollution, especially important are the horizontal displacements, and only in the case of deep lakes or seas do vertical displacements also play a role. The displacement of ground pollution is largely dependent on ground water currents, and possibly on human transport.

7.4.1 Vertical air movements

The sun's rays act as the motor for almost all air movements. They are partly intercepted by the atmosphere and, especially in the higher layers, warms it up. The lowest layers of air receive their heat mainly from the surface of the earth, which is warmed up during the day, releasing its heat again by radiation at night. Because of this, the lowest layer of air (to about a height of 10 km), the troposphere, has, in principle, an upwards-decreasing temperature. However, the stratosphere, that lies above it, becomes warmer in its higher levels. If rising air comes into contact with warmer layers of air, it stops rising. There is thus little exchange between the troposphere and the stratosphere, also with respect to air pollution. The troposphere is approximately 10 km high and contains about 80% of the total mass of the atmosphere. This is where almost all weather phenomena occur; this is where the largest warming up and cooling down takes place, and where the air pollution increases and decreases due, respectively, to emissions being released and washed away.[107][56]

Warm air rises until the surroundings become warmer, but, in retaining its own heat content, rising air also cools off due to expansion. This cooling off process amounts to about 1°C for every 100 m that the air rises. An air bubble warmed up by the surface of the earth that is 2 degrees warmer than its surroundings will thus rise 200m if the surroundings of the air bubble stay the same, and it will rise more than 200m if the surroundings become colder.
It is clear that if the lowest part of the troposphere has become relatively warm because of a number of hot days, there will be very little rising air, so that the air pollution will stay below. One can talk then of a stable atmosphere. Especially after the night time cooling off of the lowest layers of air due to radiation from the earth's surface, temperatures, that rise with height, can occur the following morning. If a chimney doesn't rise above the point where the temperature starts to go down again, as is normal in the troposphere, then the smoke stays held in the lowest layer of air, because the surroundings are too warm to allow the air to rise. Such a situation is called *inversion* (an inverse temperature gradient).

In the course of the day, a rise in temperature in the lowest layer of air can cause the inversion to disappear. However, that does not happen if there are clouds in the sky, or if the rise in temperature is insufficient to make the lowest layer of air much warmer than the layers above it. Because of this, an inversion can last for several days.[108]

The amount of moisture in the air is just as important for the development of vertical air movements. Moist warm air, rising from the surface of the earth, cools down by expansion and, above a certain height, loses its moisture by condensation. This condensation produces heat that causes the air to rise further and then to cool down further, thereby producing more condensation. The height at which condensation begins forms the flat underside of the cloud layer.[109][58] Thus, because of the heat development that then occurs, a loss of moisture can cause the air to rise even more.

7.4.2 Horizontal air movements

At ground level, the air is warmed up the most in the tropics and the least at the poles. Because the air in the tropics is continually rising, warm air moves northwards in the higher layers, partly due to it cooling down over the subtropics, and then it sinks to the lower layers of air in our latitude. The continually sinking air at the poles produces a cold northerly wind, that meets the warm humid air masses from the south in our latitude. This results in a lot of condensation and precipitation in our latitude, in cold polar air wedging its way under rising warm air until this too is heated up by the earth's surface. Because of this, the polar front in our latitude produces a much more turbulent weather pattern than elsewhere.[110 59] On the one hand, this is good for the mixing and dispersion of air pollution, but it also makes air pollution less predictable than in tropical or polar climates.

The sun rises in the east because the earth rotates eastwards. The atmosphere rotates with the earth. Therefore, in contrast to polar air masses, tropical air masses have a strong eastward impulse. As they move towards the north, this eastward tendency persists, so that tropical air in our latitude comes mainly from the southwest. As relatively stationary polar air masses move southwards, they become increasingly confronted with the earth's rotation and thus have a tendency to move westwards in relation to the earth's surface. Because of this, in our latitude, cold polar air masses come mainly from the northeast.[11160]

The eastward tendency of the tropical air and the westward tendency of the polar air, when they meet in our latitude (the 'polar front'), cause air movements that circulate in an anticlockwise direction.[11261]
In low pressure areas (depressions), into which the winds always blow, this is usual. That means, for example, that the winds are southerly if a depression lies to the west of the Netherlands, and northerly if the depression lies to the east. Based on this, a number of frequently occurring circulation patterns can be identified for Europe, and their frequency over the years can be established statistically.
From this, statistical indicators have been formulated of expected weather types, and these can be applied to dispersion models for air pollution.
A very frequently occurring type of circulation, on a smaller scale, occurs systematically in coastal regions. Because of the alternation between day and night, there is also an alternation here between sea and land winds. A sea wind occurs along the coast when the sun shines strongly and, due to this, the land warms up faster than the water, causing a difference in air pressure. At night, the land cools off faster than the sea, causing a wind to blow from the land, seawards.[113]

Based on climatological factors, regularity in wind direction, as mentioned above, applies to flat, open spaces, but not to built-up urban areas. Very many smaller circulations occur there that are summarised by the concept 'turbulence'. Where there are eddies behind buildings, the only way of predicting turbulent air movements in these urban areas to any extent, is to place maquettes in wind tunnels, on a revolvable platform. To carry out very exact tests on them, such maquettes must be built by specialists, because it is very important to simulate the roughness of the material and it is impossible to position gauge points on a normal maquette.[114 63]

For sources in relatively open areas, mathematical models can be applied. One can distinguish pollution-point sources, such as chimneys, line sources, such as main roads, and surface sources, such as an industrial sites. The most frequently used dispersion model is the Gaussic Plume model, of which there are a number of variations. In addition, there are 'grid models' and 'trajectory models' as described in KNMI KNMI De Bilt (1979). In the Gaussic Plume model, it is assumed that air pollution is dispersed perpendicular to the direction of the air movement, according to a statistical distribution.
Grid models divide the space into box-shaped units, by means of a co-ordinate system whereby the input and output is calculated per box.
Trajectory models are based on forward-moving box-shaped units of air, each unit of which has input and output values.[115 64]

7.4.3 Concentration

The concentration of air pollution substances can be shown in three different ways:[116 65]

?? volume/volume (unit ppm)
?? weight/weight (unit ppmm)
?? weight/volume (size?g/m^3)[a]

[a] Het begrip ?g/m3 staat voor 1 miljoenste gram (microgram) per m3.

RIVMs national gauging network for air pollution was drastically modernised in 1985 and now comprises 68 gauge points. In addition, TNO manages ten more points, and the provinces and municipalities 80 and 20, respectively.

Apart from the dispersion of air pollution, the fall-out (deposition) of particles and the washing out of air polluting substances in rainwater, chemical changes in the air pollution itself also play a role in the total transmission of air. However, not much is yet known about these processes. Most of what is known concerns photo-chemical smog, in which mainly the chemical composition of combustion emissions changes under the influence of light.

Photo-chemical smog mostly occurs as a result of 'ground inversions' caused when the lowest layers of air cool down faster than the layers of air above. Because of this, condensation occurs in the lowest layers of air (fog), and, as there is an inversion, the pollution also stays trapped in these layers. Aerosols serve as nuclei for condensation and the drifting drops of water catch the remaining pollution, whereby all manner of reactions occur. The formation of ozone (O_3) under the influence of sunlight can play an important role in these reactions.
However, with respect to water pollution, chemical and biological reactions in air pollution do not play such a large role.

7.4.4 Water currents

Pollutants enter water by deposition from the air, by draining out of polluted ground and by direct discharge. Thus, in the pattern of currents in a river, one can find pollution-surface sources on the surface of the water, line sources along the banks and point sources at the location of the discharge. Apart from these sources of pollution, the following means of 'removal' also play a role:

- extractions, removal to groundwater, to tributaries;
- reactions of a physical, chemical or biological nature.

Based on this input and output, a balance can be drawn up for each stretch of river. As one can talk here of a one-dimensional current movement, the concentrations can be calculated using rather simple models. However, after 1965, models were developed that could also handle two-dimensional situations (as in shallow lakes, bays and harbours).

Insight into bio-chemical processes also became more advanced. Before 1965, already, the models took into consideration the deterioration of dissolved oxygen and the decomposition of organic material from waste water. Between 1965 and 1970, the oxidation of reduced nitrogen compounds was also included in the models. Between 1970 and 1975, three-dimensional situations, such as deep lakes and seas, were included in the models. The water masses were thereby divided up into layers (stratification). In addition, the growth and death of algae, and the physiological reaction of organisms to temperature, sunlight and the availability of food materials were described. After 1975, the behaviour of toxic substances in biological processes (among others, their accumulation in the food chain) was researched, as well as their transport on floating particles and sediment.[117]

Because of the increasing complexity of the models, it has to be recognised that their reliability is decreasing. For this reason, one-dimensional models are still being used.[118 67]

7.4.5 Ground pollution

Ground pollutants can be transported in the ground water. They can held and removed by absorption into soil particles, precipitated by chemical processes and dissolved again, and (partly) decomposed by micro-biological processes, especially in the thin zone that is not completely saturated with water. The speed, direction and depth of a groundwater current depends very much on the type of soil and the variation in subsoils. In principle, three-dimensional current models are available for this, but these need to be fed with an extremely large amount of detailed information about the subsoils. This information is largely unavailable, so one has to make do with simpler current models. For regional studies, in particular, taking the relatively limited depth of the water transporting systems into account in relation to the extent of the region, a calculation in two dimensions is usually sufficient.[119]

The speed and direction of groundwater currents are, of course, initially dependent on the type of ground. For removing pollution by absorbing it onto the surface of soil particles, the specific surface area of a solid soil particle is important. For clay, for example, this is larger than for sand. The more acid the environment, the more difficult it is for pollutants to attach themselves to the soil particles. Acidity, therefore, leads to some pollution of the groundwater. In addition, of course, as time goes on, the whole surface area can become saturated, so that larger amounts of pollution come to be transported in the groundwater currents. In that case, certain substances can still be precipitated out of the water or dissolved into it again. The solubility of chemical substances is also dependent on the acidity (pH) and on the 'redox potential' (Eh).

Micro-biological decomposition and conversion processes are generally the most effective in the thin zone that is not completely saturated with water. Especially in the transition zone, where the presence of oxygen may or may not still play a role, can anaerobic decomposition processes (without oxygen) be of great significance. Among the well-known micro-biological conversion processes are nitrification, denitrification and sulphate reduction.
For a quick orientation regarding the possible risks of extending pollution that has appeared on or in the (water) bed, reference can be made to archive information (van Duijvenbooden 1982). Among other sources of information, reference can be made to:

- geological maps
- ground maps
- topographical maps
- hydrographic charts
- geo-hydrological mapping (surface contour charts, seepage/infiltration charts, quality charts)
- geo-electrical mapping
- individual reports and data.

By studying the information listed above, a preliminary insight can be gained of the local direction and speed of the groundwater currents. If information on substances is available, then it is also possible to estimate their transport.
Attention should be given, among other aspects, to:[120]

- the structure and composition of the soils (clay/peat with low *k** and high CEC; sand with large *k* and low CEC, pH, redox; and the mud and organic-material content);[a][12170]
- the geological structure (presence of pockets of sand in contrast to layers of clay, heterogeneities, holes, stratification);
- the hydrological situation (seepage/infiltration, current direction and speed, location of the watershed, drainage or infiltration channels);
- topography (on the basis of height characteristics, gives a first impression of the probable current direction).
- If necessary, extra information can be collected in the field (van Duijvenbooden 1982).

7.4.6 References to Transmission

KNMI De Bilt (1979) Luchtverontreiniging en weer ('s-Gravenhage) Staatsuitgeverij ISBN 90-12-02444-7.
Duijvenbooden, van(1982)

Transmission is especially important for material emissions. The propagation of energetic, mechanical, informational and potential influences is so easy to calculate, that little needs to be said about it here.
The transmission of material by air, water, the ground or via food-chains
is mainly the territory of specialists and extensive computer programs.
Transmission includes the transport, dilution, dispersion, conversion and removal of material in and out of the air, water, ground, food-chains and other relocating systems.[12255]

The spreading of air pollution is of such great importance for purpose planning in urban architectural practise, that we will go into this aspect the most thoroughly, below. In addition, ground and water

[a] k en CEC zijn maten voor het adsorptievermogen van de bodemsoort. Voor k geldt: lage waarde betekent hoge adsorbtie. Voor CEC geldt hoge waarde betekent lage adsorbtie.

pollution is partly a result of pollution in the air, so that , also from this view point, priority must be given to gaining a better understanding of air pollution. In this respect, it is important that a distinction is made between vertical and horizontal air movements.

Where there are no vertical air movements in a stable atmosphere, pollution stays at low levels and can become highly concentrated locally. Horizontal air movements are important in predicting where air pollution will occur. For water pollution, especially important are the horizontal displacements, and only in the case of deep lakes or seas do vertical displacements also play a role. The displacement of ground pollution is largely dependent on ground water currents, and possibly on human transport.

7.4.7 Vertical air movements

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Warm air rises until the surroundings become warmer, but, in retaining its own heat content, rising air also cools off due to expansion. This cooling off process amounts to about 1°C for every 100 m that the air rises. An air bubble warmed up by the surface of the earth that is 2 degrees warmer than its surroundings will thus rise 200m if the surroundings of the air bubble stay the same, and it will rise more than 200m if the surroundings become colder.
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7.4.8 Horizontal air movements

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The eastward tendency of the tropical air and the westward tendency of the polar air, when they meet in our latitude (the 'polar front'), cause air movements that circulate in an anticlockwise direction.[12861] In low pressure areas (depressions), into which the winds always blow, this is usual. That means, for example, that the winds are southerly if a depression lies to the west of the Netherlands, and northerly if the depression lies to the east. Based on this, a number of frequently occurring circulation patterns can be identified for Europe, and their frequency over the years can be established statistically. From this, statistical indicators have been formulated of expected weather types, and these can be applied to dispersion models for air pollution. A very frequently occurring type of circulation, on a smaller scale, occurs systematically in coastal regions. Because of the alternation between day and night, there is also an alternation here between sea and land winds. A sea wind occurs along the coast when the sun shines strongly and, due to this, the land warms up faster than the water, causing a difference in air pressure. At night, the land cools off faster than the sea, causing a wind to blow from the land, seawards.[129 62]

Een veel voorkomend circulatietype op kleinere schaal treedt systematisch op in kustgebieden. Door de afwisseling van dag en nacht valt hier een afwisseling tussen zee- en landwind waar te nemen. Zeewind treedt langs de kust op wanneer de zon sterk schijnt en daarbij het land sneller opwarmt dan het water, waardoor een luchtdrukverschil ontstaat. 's Nachts koelt het land sneller af dan de zee en daaruit resulteert een wind vanuit het land naar de zee

Based on climatological factors, regularity in wind direction, as mentioned above, applies to flat, open spaces, but not to built-up urban areas. Very many smaller circulations occur there that are summarised by the concept 'turbulence'. Where there are eddies behind buildings, the only way of predicting turbulent air movements in these urban areas to any extent, is to place maquettes in wind tunnels, on a revolvable platform. To carry out very exact tests on them, such maquettes must be built by specialists, because it is very important to simulate the roughness of the material and it is impossible to position gauge points on a normal maquette.[130 63]

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Trajectory models are based on forward-moving box-shaped units of air, each unit of which has input and output values.[131 64]

7.4.9 Concentration

The concentration of air pollution substances can be shown in three different ways:[132 65]

?? volume/volume (unit ppm)
?? weight/weight (unit ppmm)
?? weight/volume (size?g/m^3)[a]

RIVMs national gauging network for air pollution was drastically modernised in 1985 and now comprises 68 gauge points. In addition, TNO manages ten more points, and the provinces and municipalities 80 and 20, respectively.

[a] Het begrip ?g/m3 staat voor 1 miljoenste gram (microgram) per m3.

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Photo-chemical smog mostly occurs as a result of 'ground inversions' caused when the lowest layers of air cool down faster than the layers of air above. Because of this, condensation occurs in the lowest layers of air (fog), and, as there is an inversion, the pollution also stays trapped in these layers. Aerosols serve as nuclei for condensation and the drifting drops of water catch the remaining pollution, whereby all manner of reactions occur. The formation of ozone (O_3) under the influence of sunlight can play an important role in these reactions.
However, with respect to water pollution, chemical and biological reactions in air pollution do not play such a large role.

7.4.10 Water currents

Pollutants enter water by deposition from the air, by draining out of polluted ground and by direct discharge. Thus, in the pattern of currents in a river, one can find pollution-source surfaces on the surface of the water, line sources along the banks and point sources at the location of the discharge. Apart from these sources of pollution, the following means of 'removal' also play a role:

- extractions, removal to groundwater, to tributaries;
- reactions of a physical, chemical or biological nature.

Based on this input and output, a balance can be drawn up for each stretch of river. As one can talk here of a one-dimensional current movement, the concentrations can be calculated using rather simple models. However, after 1965, models were developed that could also handle two-dimensional situations (as in shallow lakes, bays and harbours).

Ook het inzicht in chemisch-biologische processen vorderde. Voor 1965 werd reeds rekening gehouden in de modellen met het verloop van opgeloste zuurstof, en de afbraak van organische stof uit het afvalwater. Tussen 1965 en 1970 werd ook de oxidatie van gereduceerde stikstofverbindingen in de modellen opgenomen.
Insight into bio-chemical processes also became more advanced. Before 1965, already, the models took into consideration the deterioration of dissolved oxygen and the decomposition of organic material from waste water. Between 1965 and 1970, the oxidation of reduced nitrogen compounds was also included in the models. Between 1970 and 1975, three-dimensional situations, such as deep lakes and seas, were included in the models. The water masses were thereby divided up into layers (stratification). In addition, the growth and death of algae, and the physiological reaction of organisms to temperature, sunlight and the availability of food materials were described. After 1975, the behaviour of toxic substances in biological processes (among others, their accumulation in the food chain) was researched, as well as their transport on floating particles and sediment.[133 66]

Because of the increasing complexity of the models, it has to be recognised that their reliability is decreasing. For this reason, one-dimensional models are still being used.[134 67]

7.4.11 Ground pollution

Ground pollutants can be transported in the ground water. They can held and removed by absorption into soil particles, precipitated by chemical processes and dissolved again, and (partly) decomposed by micro-biological processes, especially in the thin zone that is not completely saturated with water. The speed, direction and depth of a groundwater current depends very much on the type of soil and the variation in subsoils. In principle, three-dimensional current models are available for this, but these need to be fed with an extremely large amount of detailed information about the subsoils. This information is largely unavailable, so one has to make do with simpler current models. For regional studies, in particular, taking the relatively limited depth of the water transporting systems into account in relation to the extent of the region, a calculation in two dimensions is usually sufficient.[135 68]

The speed and direction of groundwater currents are, of course, initially dependent on the type of ground. For removing pollution by absorbing it onto the surface of soil particles, the specific surface area of a solid soil particle is important. For clay, for example, this is larger than for sand. The more acid the environment, the more difficult it is for pollutants to attach themselves to the soil particles. Acidity, therefore, leads to some pollution of the groundwater. In addition, of course, as time goes on, the whole surface area can become saturated, so that larger amounts of pollution come to be transported in the groundwater currents. In that case, certain substances can still be precipitated out of the water or dissolved into it again. The solubility of chemical substances is also dependent on the acidity (pH) and on the 'redox potential' (Eh).

Micro-biological decomposition and conversion processes are generally the most effective in the thin zone that is not completely saturated with water. Especially in the transition zone, where the presence of oxygen may or may not still play a role, can anaerobic decomposition processes (without oxygen) be of great significance. Among the well-known micro-biological conversion processes are nitrification, denitrification and sulphate reduction. (See Mi20: *Water beds, transport mechanisms in the water bed*.)
For a quick orientation regarding the possible risks of extending pollution that has appeared on or in the (water) bed, reference can be made to archive information (van Duijvenbooden 1982). Among other sources of information, reference can be made to:

- geological maps
- ground maps
- topographical maps
- hydrographic charts
- geo-hydrological mapping (surface contour charts, seepage/infiltration charts, quality charts)
- geo-electrical mapping
- individual reports and data.
-

By studying the information listed above, a preliminary insight can be gained of the local direction and speed of the groundwater currents. If information on substances is available, then it is also possible to estimate their transport.
Attention should be given, among other aspects, to: [13669]

- the structure and composition of the soils (clay/peat with low *k** and high CEC; sand with large *k* and low CEC, pH, redox; and the mud and organic-material content);[a] [13770]
- the geological structure (presence of pockets of sand in contrast to layers of clay, heterogeneities, holes, stratification);
- the hydrological situation (seepage/infiltration, current direction and speed, location of the watershed, drainage or infiltration channels);
- topography (on the basis of height characteristics, gives a first impression of the probable current direction).
- If necessary, extra information can be collected in the field (van Duijvenbooden 1982).

7.4.12 References to Transmission

KNMI De Bilt (1979) Luchtverontreiniging en weer ('s-Gravenhage) Staatsuitgeverij ISBN 90-12-02444-7.

[a] k en CEC zijn maten voor het adsorptievermogen van de bodemsoort. Voor k geldt: lage waarde betekent hoge adsorbtie. Voor CEC geldt hoge waarde betekent lage adsorbtie.

7.5 Immission and exposition

Determining the end effect (see **Table 1**) is the final and most difficult part of every environmental-impact statement.
The first thing that has to be established is which objects situated in the neighbourhood of the environment-damaging activity are the ones on which the effects have to be determined. In this section, the types of object distinguished are materials, people, plants and animals, (eco)systems, or entire areas. When there is no clear prior agreement regarding on which objects the effect has to be reported, there will always be criticism afterwards on the effect report that is delivered.
If one already has a list of objects on which one has to report, then the question still remains of which effects have to be reported. If the object is people, then one can still distinguish absolute effects (such as the mortality rate) from gradual effects (such as the illness rate). To be able to view the effects against each other and against the useful effect of an environment-damaging activity, it is desirable, though usually impossible, to quantify it to a common denominator. Of course, especially in the United States, frequent attempts have already been made to express the damage caused by environment-damaging activities in terms of money. The table below pictures this for the Netherlands (1978).

Damage to	mln.guilders	no. guilders per inhabitant
materials	110	8
health	1000	71
commercial crops and livestock	85	6
lost residential value	1400	100
total estimative damage	2600	185

Jansen en Olsthoorn (1982), Jansen et al (1974)

Fig. 773 *Damage due to air pollution in the Netherlands in 1978*

The most reliable datum in this table is 'damage to materials'. The way in which 'damage to health' is calculated is already indicative of the dubious assumptions that have to be made when expressing this damage in terms of money. The costs of early death were estimated as the (discounted) income that the deceased would have earned had there been no air pollution. The amounts used to arrive at the costs of illness were 'loss of production' and 'the costs of curative care'.

There are, though, three methods of approach for damage due to death:

1. The 'human capital' approach;
2. The 'costs of risks' approach;
3. The comparison with costs made to prevent unnecessary death.

The method used in Fig. 773 is the 'human capital' approach. For the second approach, wage differences – that can be interpreted as 'risk surcharge' – are used as the point of departure. To determine the value of a life, the extra wage paid for a 1% higher death risk is, for instance, multiplied by 100. The third approach ought to be based on the amount that the Dutch society is prepared to spend on 'the most expensive patient in the Netherlands'.
For example, a vaccine should not cost more then € 18 000,- per life year gained (NRC Handelsblad 2003-07-06).

It must be clear that, even if the nature of the effect can be described clearly and unambiguously, it is usually difficult to quantify[138].
In addition, it is difficult to separate the effects of environment-damaging activities from other influences. In this way, the 'lost residential value' in Fig. 773 is estimated on the basis of differences in house prices observed in transactions in Rijnmond. However, the house-price differences are also dependent on house characteristics (type of home, house size, year of construction, with garden, etc.) and the characteristics of the district in which the house is located (green facilities, nearby shops, noise levels, accessibility, etc.)

To be able to determine the effect of a home located in a foul-smell zone from these fixed variables, complicated regression analyses and daring assumptions are necessary. Instead of 1.4 billion guilders, a few changes in the assumptions would have given 1.7, 2.4 or 3.3 billion guilders as the lost residential value in the Netherlands.[139]

The effect of environmental pollution on living organisms can be shown in the form of a dose-response diagram (Fig. 774).

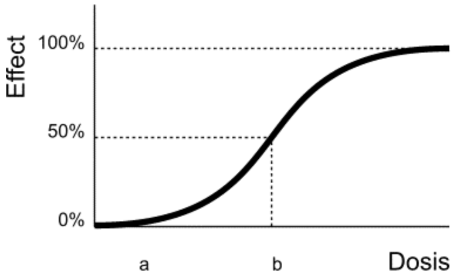


Fig. 774 Dose-response relation

A similar diagram can be drawn for poisoning a large number of individuals with different doses. The dose that causes death in 50% of the cases, within a given time, is called 'the lethal dose at 50%' (LD50).[140]
It is clear that dose-effect relations are only known for a small number of substances on a small number of organisms. It is, of course, difficult to establish the dose-effect relations for human beings empirically, so there are still many knowledge gaps in this area.

7.5.1 Materials

Research has established that the worst damage to materials is brought about by the action of SO_2 on painted steel, galvanized steel and on zinc foil. Research (Fig. 775) was set up by Jansen and Olsthoorn (1982) consisting of:

- Measuring the concentration of SO_2;
- Determining the exposed quantity of materials;
- Establishing the dose-effect relations;
- Making an economic evaluation of the effects.

In this research, only maintenance costs, the costs resulting from reduced economic lifespan and substitution costs were taken into account. Indirect costs (for example, those resulting from the failure of affected parts) were not taken into account.
The costs listed above were estimated using a number of formulas by which, if the concentration of SO_2 in the air is known, the reduction of the galvanized layer, the length of protection of the paint layer, or the lifespan of the construction part were derived. These sorts of formula, in fact, represent dose-effect relations. Recalculated as costs and added up, it is possible to give a dose-effect relation for the whole of the Netherlands.

Doses in mln.kg SO2	Effect of damage in mln. guilders.	Dose per inhabitant kg SO_2	Effect per inhabitant Damage in guilders.
1300	225	93	16
1200	177	79	13
1000	151	71	11
900	123	64	9
800	92	57	7
700	74	50	5
600	56	43	4
500	40	36	3
400	25	29	2
300	18	21	1

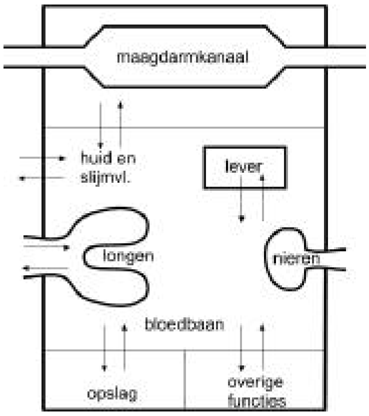
Figures per year, calculated according to Jansen and Olsthoorn (1982)

Fig. 775 Dose-effect relation of SO_2 on a range of metal constructions in the Netherlands (1978).

This dose-effect relation is thus composed of different dose-effect relations that are only related to a certain part of the damage.[141]

7.5.2 People

For people, the lethal doses of a lot of poisons are known, as well as many of their clinical characteristics and side-effects (the absolute and gradual effects). The branch of medical science that concerns itself with poisonings is 'toxicology' see: Sangster (1987).[142] The process by which humans take up, re-absorb, transform, apportion, store and excrete poisons can be summarised in the following diagram.[143]



Verberk and Zielhuis (1980)

Fig. 776 Toxicological access routes into the human body

Contrary to materials, human beings, animals and plants can develop resistance to repeated exposure to poisons. However, a slow build-up of toxins is equally likely to have sudden, serious consequences. In addition, the effects of different types of pollution can be increased by their interaction. One example of this is evidenced by smokers' increased susceptibility to the adverse effects of air pollution. As a rule of thumb, one can say that if air pollution increases by 10%, the mortality will increase by approximately 1%.[144]

As the literature on toxicology is fairly easy to access, we will restrict ourselves here to human exposure to a few historical cases of severe air pollution (*Source*: KNMI 1979)

In December 1930, the narrow and heavily industrialised Meuse valley, in the neighbourhood of Leige, experienced weather conditions, which – for almost a week – hindered the spread of the pollution produced there. The result was that a large number of people became ill due to respiratory problems, and, before the end of that week, 60 people had died. It is not clear whether very high concentrations of sulphur or florides were the cause of the disaster, because no pollution measurements were taken at that time.

A disaster that *has been* extensively researched is the one that hit the small town of Donorain in the valley of the River Monongahela in the State of Pennsylvania in the United States in 1948. Also here, unfavourable meteorological conditions, together with the hills that encircle this industrial town, hindered the dispersal of air pollution. The result was that thousands of people became ill, mainly with respiratory complaints and problems with the eyes, nose and throat. During this 7-day period, 20 people died.

Even worse was what happened in London from 5-9 December 1952. The majority of Great Britain was covered in fog at that time. Elderly people, in particular, became ill, suffering from heart problems or respiratory difficulties, and had to be taken to hospital. Even after the worst period of pollution had subsided, more deaths occurred than was usual for December.
The total number of deaths rose to between 3,500 and 4,000 above the usual number of deaths in December.

The extremely high concentrations of soot and sulphur dioxide were probably the cause of this disaster

In the Netherlands, air pollution has not led to a demonstrable number of deaths, but there were obvious increases in the numbers of both illnesses reported and hospital admissions, such as in the period 26-30 January 1959 and 4-6 December 1962. In Rotterdam, in 1959, the amount of smoke in the open air, and, in 1962, the sulphur dioxide concentrations, reached extremely high levels. In both these cases, too, it was long periods with no wind and bad vertical exchange that caused increasing concentrations of toxins in the air.

7.5.3 Plants and animals

Hardly anything is known about the extent to which material pollution has caused the disappearance of plant and animal species. For a number of species, such as lichens, a clear link can be made with air pollution. The extinction of plants and animals is largely due to the loss of their biotope. This is mostly caused by light and heavy mechanical interferences, such as agriculture, urbanisation and road building. For instance, lowering the water level of ditches can cause a significant reduction in the diversity of vegetation.

However, a correlation does not always have to be a causal relation. The distance to a farm and the related reduction in agrarian activities can also offer a better explanation for local diversity, even if there is already a correlation with the water levels in drainage ditches. Water levels in themselves can correlate with the distance to the farm, if that farm is situated on higher ground so that the water level in the nearby drainage ditches is deeper than in those further away.
Why is the pollution prevention insufficient for retaining plant and animal species?

7.5.4 Systems and areas

The effect of various forms of environmental stress on eco-systems and related geographical areas or utility zones is largely unknown. The effect of the 'mechanical emissions' named in **Fig 133**, such as treading on the ground, mowing, up-rooting, digging, ploughing, clearing the ground, and building, is the easiest is to determine.

The vulnerability of different geographical units to light or heavy interferences is recorded on environmental charts. Vulnerability charts are compiled to show the vulnerability for each environmental theme. More will be said about this in the following chapter. The old objections to environmental charts are that these divert attention away from the interferences, their alternatives and effects, so that only alternative locations are discussed. These are less of an issue now that the instrument of environmental effect reporting is available. Although by far not everything is known about the environmental effects on plants, animals and ecosystems, an interesting part of the MER series has been published, entitled: Effect prognoses. Part V: 'Plants, animals and ecosystems'.VROM/LNV (1987)

7.5.5 References to Immission

KNMI, D. B. (1979) Luchtverontreiniging en weer (Den Haag) Staatsuitgeverij ISBN 90-12-02444-7.
Sangster, B. (1987) Klinische toxicologie (Wageningen) Pudoc ISBN 90-220-0929-7.
Verberk, M. M. and R. L. Zielhuis (1980) Giftige stoffen uit het beroep (Alphen aan den Rijn) Stafleu ISBN 90.6016.131.9.
VROM/LNV, M. v. (1987) Milieu-effect Rapportage. Effectvoorspelling van planten, dieren, ecosystemen, 23 (Den Haag 1987) SDU ISBN 9034610888.

7.6 Creating norms

7.6.1 Effect-directed norms

In the three previous sections, the unwanted side-effects of the activities summarised in **Table 3** are described. Effect reports can be compiled along these lines.
However, in this section, the focus is no longer on ascertaining the effects, but on the policy-wise reduction of those effects

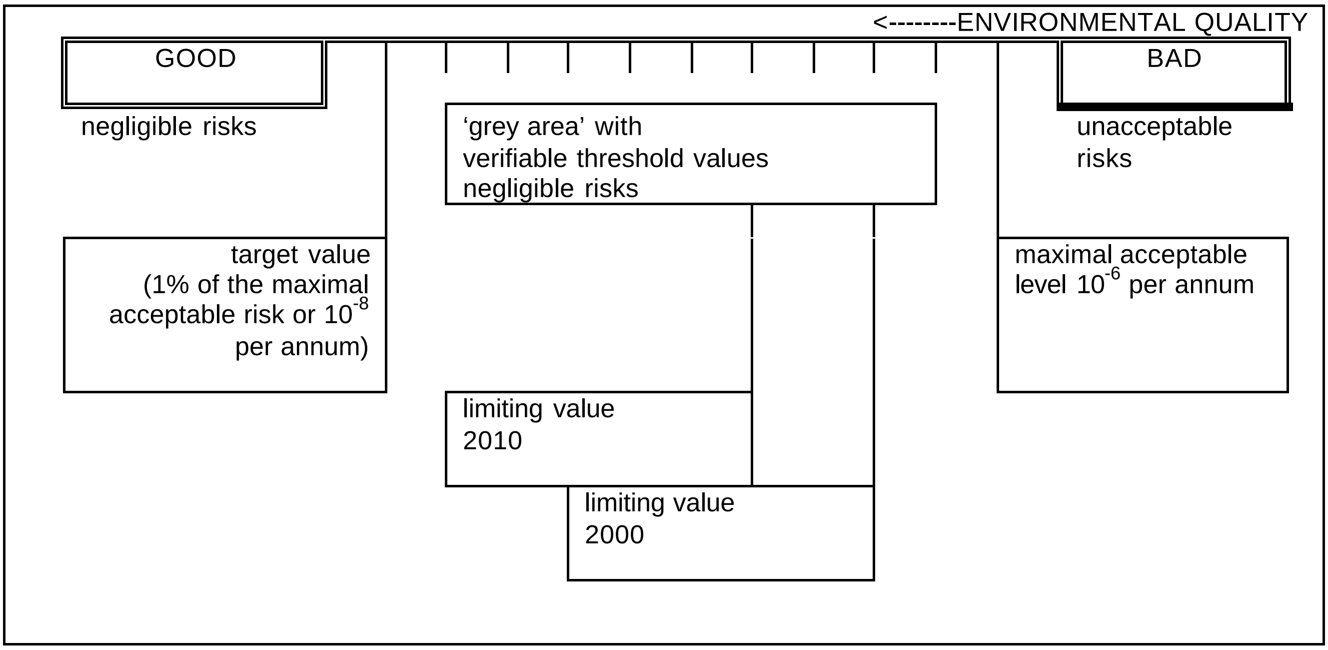


Fig. 777 *Limiting values and target values*

The starting point is the end effect on people, ecosystems and economic functions, as shown in the previous diagram. In the totality of risks, to human beings an individual chance of dying of 10^{-5} per annum is accepted by government; the *maximal acceptable level of risks*. For each single activity or substance, the maximal acceptable level is 10^{-6} per annum. For illness (effects with a threshold value) comparable levels are given, as well as for disturbance resulting from noise or foul smells. For ecosystems, a similar sort of approach is developed. The maximal acceptable level is achieved when the concentration of a substance is the same as the calculated concentration, whereby protection is offered to 95% of the species in an ecosystem. However, in many cases these norms appeared to be unattainable (RIVM 2003).

It is assumed that below 1% of this maximal acceptable level the effects are negligible. This marks the target value of all emissions and environmental effects: the value that should be eventually achieved. Between both levels there is a so-called 'grey area' within which targets for a certain period can be formulated using verifiable threshold values.
As soon as these threshold values have gained the legal status that they may not be exceeded, they are referred to as 'limiting values'. If such values may only be exceeded when reasons are given, then they are referred to as 'guide values'. Before these values are fixed, one can refer to them as environmental quality targets, and after that, as environmental quality requirements.

As a target value can only be reached in the longer term, for the shorter term, one can fix lower limiting values for what must be achieved during a certain year as an interim step towards the year in which the target value has to be achieved. An example of environmental quality targets is the table of target and limiting values of priority substances from the first National Environmental Policy Plan (**p.141**).

substance	target value	limiting value	average	concentration around the sources	% reduction for the benefit of the target value	% reduction for the benefit of the limiting value	reference
trichloro-ethene	50	50	0.65	80	35-40	35-40	IMP
surface water	0,1		2,0		95		1987
tetrachloro-ethene	25	2000	1,0	30	20		IMP
surface water	0,1		3,5		98		1987
benzene	1	10	2	40	97,5	75	base
				(185)			doc
phenol	1	100	0,008	2	50		MP
etc							

VROM (National Environmental Policy Plan) (1989) page 141

Fig. 778 *Target and limiting values of priority substances and the percentages of necessary reductions in emissions that result from this. Amounts in ?g/m^3 for air (or ?g/l for water).*

Regarding the priority substances, after thoroughly studying the effects of each substance, target values will be prepared in a 'basic document' for the general environmental quality of water, ground and air. In the grey area, for phasing the policy, limiting values must be fixed that indicate how far the protection will extend during the period agreed. This takes place on the basis of an economic consideration.[145]

The costs of this protection increase progressively with the quality of the environment that we want to achieve in this way. It is not always possible to achieve an immediate recovery of environmental quality to the target value. One only has to think of the amounts of money involved in soil decontamination to understand that complete recovery of environmental quality not only financially, but also technically, takes time to achieve.
Limiting values include a consideration whereby the damage to exposed objects is weighed against the economic interests associated with the activities involved.[146]
In so far as this damage can be expressed in terms of money, this consideration is rather simple. After all, the costs of the damage can be added to the costs of protecting the environmental quality for every protection level imaginable. From this, for a certain threshold value, an economic optimum is obtained.[147]

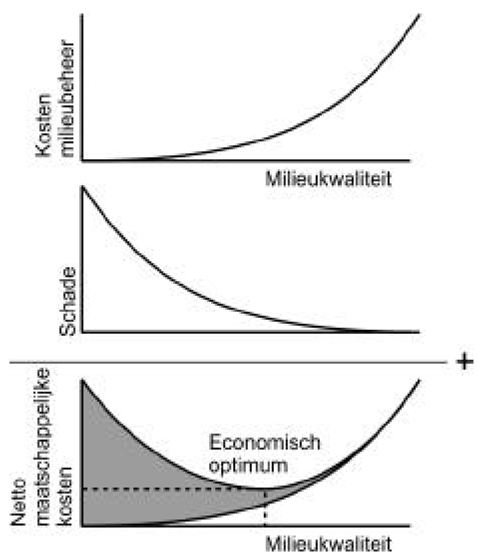


Fig. 779 *Net societal costs after deducting environmental damage*

However, in section **1.3.6**, it becomes clear how open to interpretation the concept 'damage' is, and how dependent this is on the value we place on the protected objects. In addition, the graph does not

run as continuously as in the above figure. Locally, a small additional protection effort can suddenly save a species of fish. These sorts of quality aspect are therefore expressed as verifiable threshold values. For example, a threshold value can be established for the oxygen content of water, above which a species of fish will certainly survive.
A legally established limiting value will go further than the economic optimum, as other values are also taken into consideration than those that can be expressed in terms of money.
The limiting value can be established regionally; it can also be differentiated according to different functions (special environmental quality). Special environmental quality is the opposite of 'general environmental quality'. Based on separate general protection levels for drinking water, inland fisheries and shellfish, norms were established in, for instance, the Indicative Long-term Water Programme (IMP Water). Each of these protection levels is based on different criteria.

The criterium for fishing water can thus be a dose-effect relation for a certain species of fish and a certain form of pollution. Also the consumability of the fish that will be caught can be used as a criterium for the quality of the water in which the fish will have to be caught. It is clear that the criterium for drinking water will be different again from that needed for fish.

Setting norms takes place on different managerial levels, beginning with the European level. The higher the managerial level and the larger the area over which the norm must apply, the more flexible the norm has to be to encompass all eventualities and to maintain a certain feasibility.[148]

The length and frequency of exposure are essential considerations when setting norms. Certain norms may be exceeded for a short while, but not too often. In addition, it can be established that excesses, if they take place at all, may not follow each other within a certain interval of time. Human beings or organisms need time to recover from a certain excess. From this it appears that, in many cases, setting norms demands a statistical approach. This approach, whereby norms can be given an average value, must not lead, though, to ignoring periods of peak stress. Exact values remain necessary, therefore, not only as a means of evaluation, but also especially because of their role as an indicator and as a maximum value for incidents ('98 percentile, and similar).

An example of these sorts of peak sensitive exposure norms are the so-called EPEL and MAC values.[a].
The MAC values are hygienic values for companies, fixed by the national MAC commission under the terms of the Working Conditions Law (ARBO). The MAC values are the Dutch version of the American Threshold Limit Values (TLV).[149]

7.6.2 Source-directed norms

The development of environmental quality requirements originates from the exposed objects (risk criteria, dose-effect relations). From this end effect, limits can be set on the indirect and direct effects of activities and on the activities themselves (see **tables 1 and 2**).

Non-accepted exposure effects result in limiting values for the media air, water and the ground, from which environmental quality norms can be derived.
Emission limiting values and emission ceilings follow from this, as well as requirements and norms for products and processes towards which the activities lead.

The advantages and disadvantages of norms on the source and emission side compared with norms on the exposure and environmental quality side lie, on the one hand, in the area of the practical applicability of issuing licences and, on the other hand, in the possibility of objective under-pinning and the mutual consideration of different environmental stresses.

Applying quality and imission norms can, after all, in principle, prevent the sum of all sorts of different activities (e.g. industry, traffic and home heating, as sources of air pollution), even though reasonably clean in themselves, from causing, nevertheless, an unwanted or unacceptable situation. On the other hand, they do not help to grasp the specific possibilities that can exist in an individual pollution-reducing source. Process and product norms have the advantage that they tackle pollution at source. However, they make an approach based on regional conditions impossible. Emission norms and ceilings have a sort of intermediary position between both.

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[a] MAC betekent Maximaal Aanvaardbare Concentratie.

7.6.3 Zoning

The association of Dutch municipalities (Vereniging van Nederlandse Gemeenten VNG) made a list of approximately 600 business categories and the reach in metres (zone) of their environmental impacts intolerable for quiet residential areas Peters (2001). The businesses are categorised in column 1 of Fig. 780 (for complete Dutch list see page 533) according to the SBI classification of CBS (1993), comparable with BIK-codes (Bedrijfsindeling Kamers van Koophandel), NACE-codes (Nomenclature générale des Activités économiques dans les Communeautés Européennes) from European Community and ISIC-codes from the United Nations.

In its columns the list distinguishes zones for smell (4), dust (5), noise (6), danger (9), traffic (10), and visual impacts (11). The largest of them is critical and repeated in column 12. Column 13 gives a category of impact based on the largest zone (category 1 has a largest distance of 0 or 10m, category 2 a largest distance of 30m and so on). These categories are used in zoning plans.
Column 7 shows whether the impacts are expected to be present continuously (C) or not. Column 8 shows whether they were subject of earlier regulations (Z) or not. In the last columns 14-16 is indicated whether you can expect soil (B) and air (L) pollution and whether the impact is very diverse (D) in different cases depending on the business size and technology used. Anyway, the list has to be adapted to local conditions by municipalities using it in their zoning plans.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
SBI-code	Serial number	Description	Smell	Dust	Noise	C	Z	Danger	Traffic	Visual impact	Critical distance	Category	B	D	L
01	-	AGRICULTURE AND AGRICULTURAL SERVICES													
0111, 0113		Arable farming and fruit culture (industrial buildings)	10	30	30	C		10	1	1	30	2	B		L
0112	0	Horticulture:													
0112	1	- industrial buildings	10	30	30	C		10	1	1	30	2	B		L
0112	2	- greenhouses without heating	10	10	30	C		10	1	1	30	2	B		L
0112	3	- greenhouses with gas heating	10	10	30	C		10	1	1	30	2	B		L

Peters (2001)

Fig. 780 *Zones of impacts around businesses intolerable for quiet residential areas (see page 533)*

Some spatial functions are more sensitive (!), others less (-) then quiet residential areas (Fig. 781).

	Indicative sensitivity by environmental aspect						
	smell	dust	noise	danger	traffic	visual	soil
Environment							
A quiet residential area							
B busy residential area			-	!	-		
C mixed area			-		-	-	
D rural area without dwellings	-	-	-	-	-	!	
E rural area without dwellings	-	-	!	-	-	!	
D business	!	-	-	-	-	-	
G protected soil or groundwater area							!
H noise protected area			!		!	!	
I Natural reserve	-	-	!	-	!	!	
J Reside area				-		!	

Fig. 781 *Sharpening or moderating environmental claims according to sensitivity of affected functions*

In case of less sensitive functions a municipality can choose a lower zoning category.
When a business deviates from the average of the classification by special storage or installations (Fig. 782) larger zones can be necessary.

Description	Smell	Dust	Noise C Z	Danger	Traffic	Visual impact	Critical distance	Category	B D L
STORAGES OF DANGEROUS MATERIALS									
butane, propane, LPG:									
- aboveground, < 2 m3	-	-	-	30	-	-	30		
- aboveground, 2 - 8 m3	-	-	-	50	-	-	50		
- aboveground, 8 - 80 m3	-	-	-	100	-	2	100		
- aboveground., 80 - 250 m3	-	-	-	300	-	3	300		
- ondergronds, < 80 m3	-	-	-	50	-	-	50		
- underground, 80 - 250 m3	-	-	-	200	-	-	200		
Non reactive gasses (incl. oxygen), cooled	-	-	-	50	-	2	50		
gas cylinders (acetylene, butane, propane and suchlike):									
- < 10.000 l	-	-	-		30	-	-	30	D
- 10.000 - 50.000 l	-	-	-	100	-	-	100		
- >= 50.000 l	-	-	-	200	-	-	200		
inflammable liquids:									

Peters (2001)

Fig. 782 *Zones of impacts around installations intolerable for quiet residential areas (see page 618)*

7.6.4 References to Norms

CBS (1993) Standaard Bedrijfsindeling (SBI), (Rijswijk) Centraal Bureau voor de Statistiek (CBS).

Peters, J. A. V. F. M., Ed. (2001) Bedrijven en milieuzonering Milieu reeks 9 (Den Haag) VNG Uitgeverij ISBN 90 322 7326 4 URL www.vnguitgeverij.nl.

RIVM, Milieu- en Natuurplanbureau (2003) Nuchter omgaan met risico's (Bilthoven) RIVM rapport 251701047/2003

VROM, M. v. (1989) Nationaal milieubeleidsplan 'kiezen of verliezen' (Den Haag) SDU uitgeverij.

7.7 Environmental criteria for evaluation

There are four national policy documents with environmental criteria for plans on different levels of scale from the Ministries VROM[a], LNV[b] and V&W[c]:

- The 5th National Plan of Spatial Policy VROM (2000),
- The National Plan of Nature Policy LNV (2000),
- The 4th National Plan of Environmental Policy VROM (2001),
- The 4th National Plan of Watermanagement PolicyV&W (1998) (stressing environment), and
- its last successor 'Anders omgaan met water' V&W (2000) (stressing security).

Some of these policies are elaborated in a regional policy. The RIVM[d] is supposed to test plans on the subjects of health, environment and nature. I will summarize some of the criteria.

[a] http://www.minvrom.nl/minvrom/pagina.html
[b] http://www.minlnv.nl/
[c] http://www.minvenw.nl/cend/dco/home/data/index.htm
[d] See http://www.rivm.nl/

Fig. 783 *Four current national plans concerning the environment*

7.7.1 Space

Claims as mentioned in the 5^{th} National Plan of spatial policy VROM (2000) are summarized below left. The expected shrinkage of agriculture surface cannot compensate the growth of other claims to the needed zero on the fixed surface of Deltametropolis. So, many claims will not be satisfied or perhaps be solved in space-saving combinations. From the drawing on page 135 of the mentioned plan one can count the claims in the Deltametropolis. Below right these claims are expressed in km2 and in circles of 1 and 3km occupying the same surface[150].

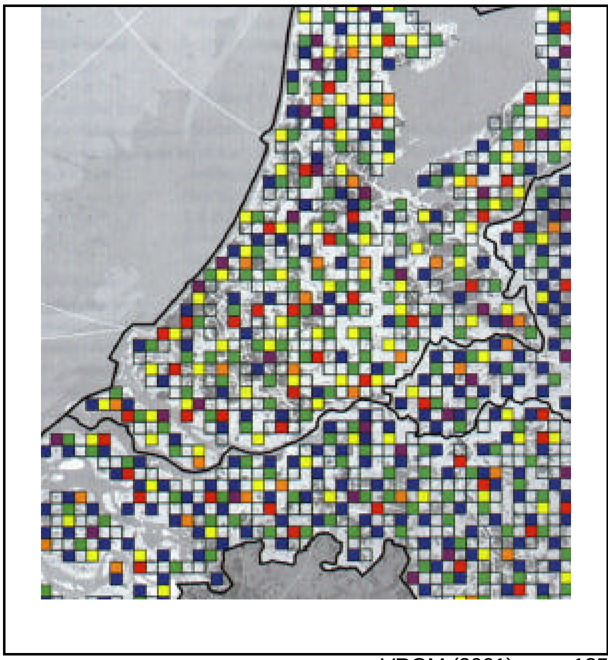
	Nederland				Deltametropolis		
	1996	claims			claims	km radius	
	km2	low	high		high	*3*	*1*
					km2	*number*	
living	2242	390	850		210	7	3
working	959	320	540		120	4	2
infrastructure	1340	350	600		90	3	1
nature, recr & sport	5439	4770	4770		970	34	2
water	7653	4900	4900		380	13	3
agriculture	23508	-1700	-4750		-1050	-38	7
	41141	**9030**	**6910**		**720**	**23**	**18**

Fig. 784 *Claims derived from the national plan*

These circles are drawn at size in the figure below right. So, 10 circles of 3km radius are put together to 1 circle of 10km radius. In the same way one can 'decompose' any circle in 10 smaller ones to picture more precisely the location, eventually till the picture has reached a photographic halftone appearance with countable spots in different colours (pointillistic representation). This representation for instance shows at a glance the living environments of metropolitan, agglomeration or urban centre (1km☞[a] or 10,000 people surrounded by 30, 10 or 3km urban area), urban outskirts (1km☞ outside the centre in at least 3km☞ urban area not bordering on green areas of the same size), green urban

[a] ☞ means 'radius' or 'around'

areas (such an urban outskirt bordered on at least 1km☞ green area), village (1km☞ surrouded by green areas of the same size) or rural (0.3km☞ or 1.000 people surrouded by green areas of at least 1km☞) and the number op people enjoying such living environments[151].



VROM (2001) page 135

Fig. 785 *Claims dispersed over the surface*

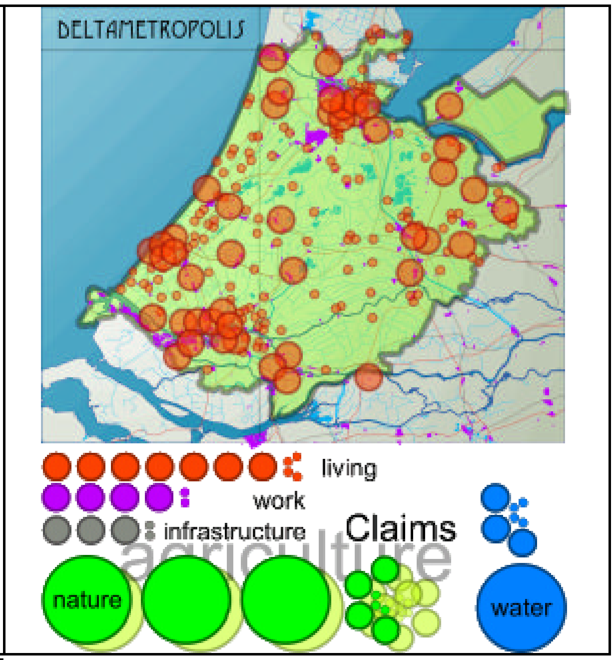
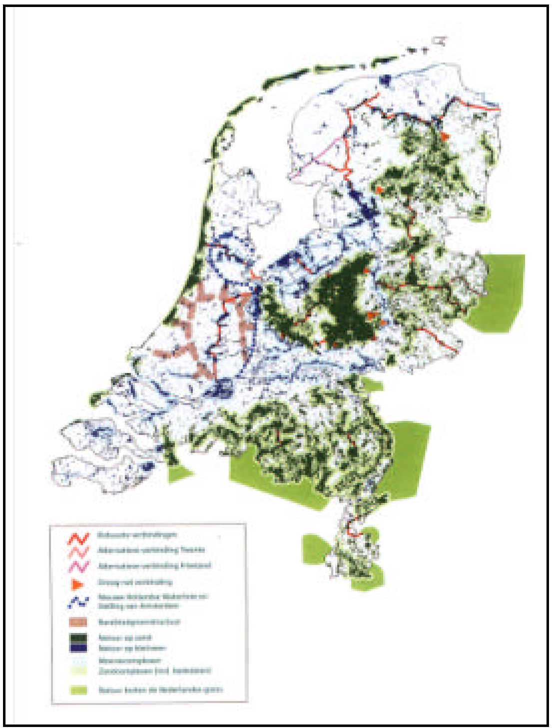


Fig. 786 *The same claims compared with the existing sprawl of cities and villages in Deltametropolis*

With the stock of too much paint indicated in the right figure below we can picture many different perspectives of a future Deltametropolis. We necessarily have to omit claims. The perspectives will not only differ in the specific claims they accept or disappoint, but also in the way each colour is concentrated in larger units in favour of their own function or dispersed in smaller ones in favour of synergy with other functions. projects should support this own function or on the other hand synergy.

7.7.2 Nature



LNV (2000) page 25

Fig. 787 *Map of the National Plan of Nature Policy*

The National Plan of Nature Policy LNV (2000) publishes on page 25 of its programme the newest version of the accompanying map.

Deltametropolis counts three robust connections[152]:

?? randstadgroenstuctuur,

?? Nieuwe hollandse waterlinie en stelling van amsterdam, and

?? the robust ecological connection between Biesbos and IJmeer.

The biological identity of dispersed natural areas and projects in a large part of Deltametropolis from this programme and their role as aimed nature type (natuurdoeltype) is elaborated by the Province of Zuid-Holland and clearly represented on the Internet http://home.wanadoo.nl/w.heijligers/Start/ndtkrt1.htm by W. Heijligers. On the accompanying map one can zoom in to the level of the nature projects[153].

Perspectives and projects are evaluated in the way urban areas in the Deltametropolis reflect this diversity and biological identity.

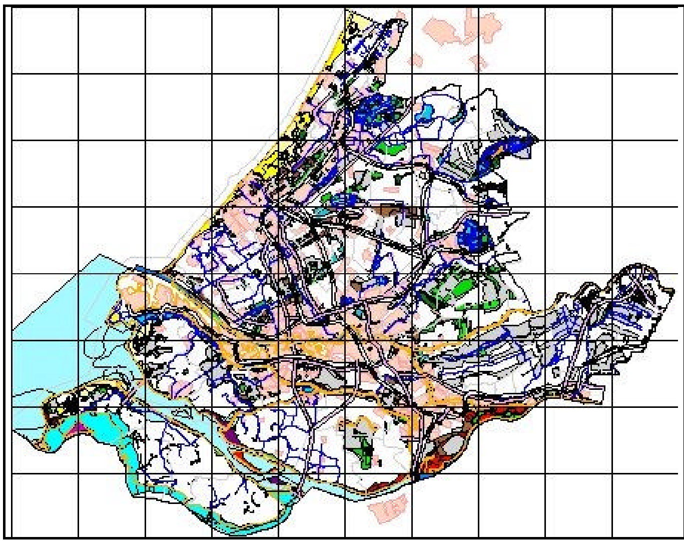
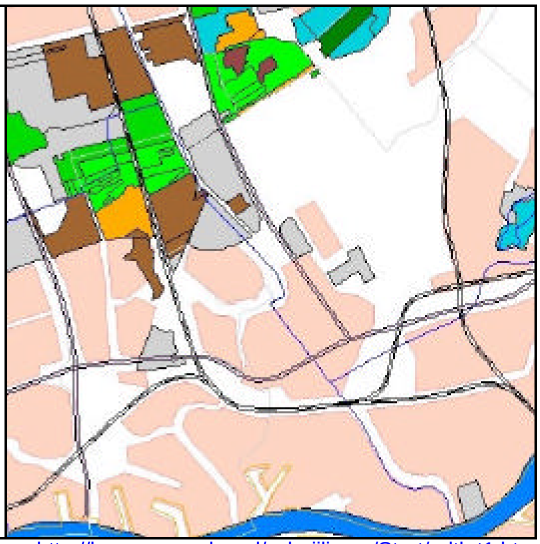


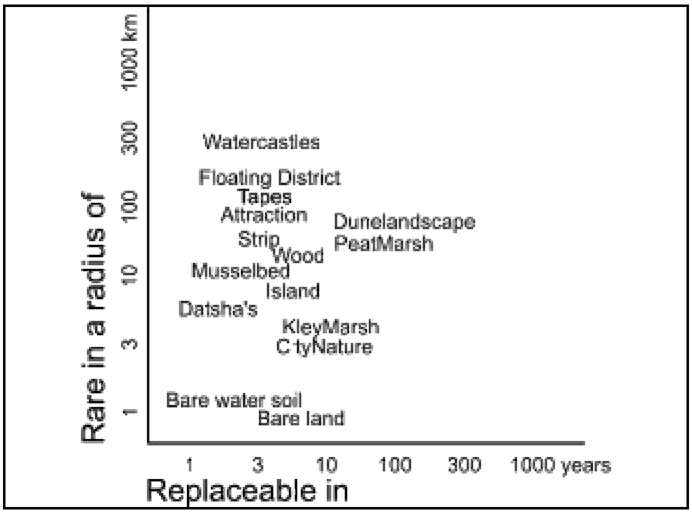
Fig. 788 *Ecological infrastructure in South-Holland*



http://home.wanadoo.nl/w.heijligers/Start/ndtkrt1.htm

Fig. 789 *Quadrant South-East Delft*

The basic ecological criterion for evaluation is global diversity lo leave possibilities open for future life. Diversity on a high level of scale is operational as rarity (as strong identity) on a lower level[154].



Perspectives and projects are evaluated on the preservation and production of worldwide (10,000km☞), European (1000km☞) and national (100km☞) rarity of objects[a]. So, rarity can be expressed in km☞. The second criterion, important for planning and design is replacebility of removed objects, expressed in years. It evaluates the possibility of compensation of rare objects. Once rarity of natural and artificial objects is determined on different levels of scale, they can be evaluated with regard to their replacebility.

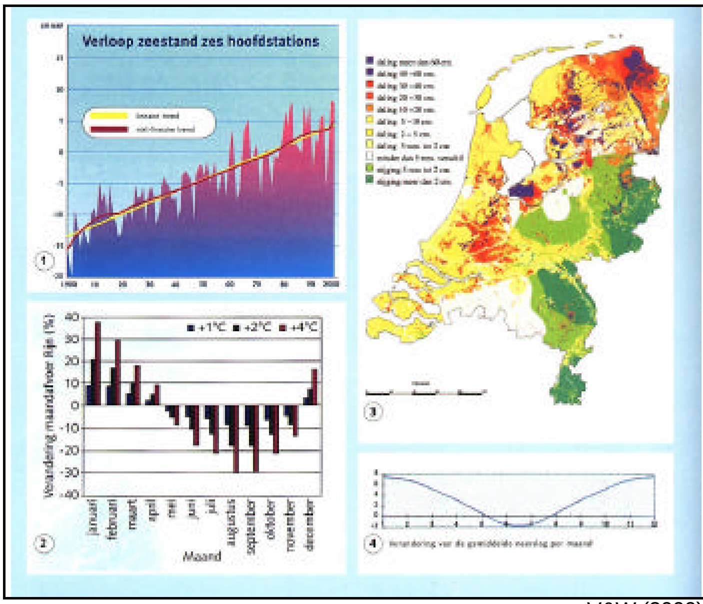
Fig. 790 *Rarity and replacebility of natural and artificial objects*

In Fig. 790 living areas of 1km☞ or 0.3km☞ designed and named by TKA TKA (2001), Hosper Hosper (2001) and H+N+ H+N+S (2001) in Almere Jong (2001) are located in a diagram for evaluation. The product of both gives an ecological value for comparison and subsequent evaluation. Natural areas are represented generally more right in the diagram, because they are less replaceble than the mentioned artificial objects.

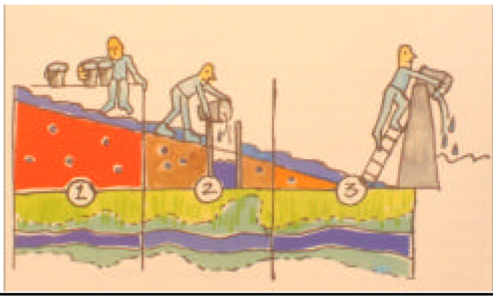
[a] The objects can be ecosystems on different size of 100m☞, 300m☞, 1km☞, 3km☞, 10km☞, or 30km☞.

7.7.3 Physical environment and water

The 4th National Plan of Watermanagement Policy V&W (1998; V&W (1998; V&W (1998; V&W (1998) (stressing environment), and its last successor 'Anders omgaan met water' V&W (2000) (stressing security) mark a change from accent on a clean to a secure environment, just as the 4th National Plan of environmental policy VROM (2001) compared with its predecessors[155]. Several floodings in The Netherlands and elsewhere in Europe has focused the attention on global warming and watermanagement. The future problems and proposed solutions are summarized in the figures below[156].



In Fig. 791 above most left, global warming, in the figure right the ground descend of the western and northern part of the Netherlands are shown.
Bottom most left, different scenarios of temperature increase, right of it, the expected increase of precipitation in winter and decilne in summer are shown.



V&W (2000)

Fig. 791 *Expected problems*   Fig. 792 *Strategies: 1 care, 2 store, 3 drain*

The storage of water requires heavy surface claims. The lowest areas collect water and pollution, so local altitude lines, waterlevels and drain systems fix the possibilities and risks for nature and human living. They have to be listed. Relatively high locations favour both as concurrent functions. Lower areas are more suited for water.
In the short term energy saving by concentration is important to stop global warming, in the long term sunlight will provide enough electric energy to sustain the current worldwide demand several times. The best indicator of a clean environment is the presence of rare nature. Its greatest threat is no longer the city but intensive agriculture.

7.7.4 References to Environmental criteria

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Hosper (2001) Almere Pampus (Haarlem) Bureau Alle Hosper landschapsarchitectuur & stedebouw.
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VROM, M. v. (2001) Een Wereld en een Wil. Werken aan duurzaamheid.Nationaal Milieubeleidsplan 4 - samenvatting (Den Haag) Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer ISBN vrom 010294/h/09-01.

VROM, M. v. (2001) Samenvatting Ruimte maken, ruimte delen. Vijfde Nota over de Ruimtelijke Ordening 2 000/2 020. (Den Haag) Ministerie van VROM.
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7.8 Environmental gains and losses due to building

Sustainable development assumes that we leave at least as many possibilities for future generations as we have encountered as 'Brundtland Committee' World commission environment and development (1990) declared. This observation gives a completely different view of the task of building to achieve a sustainable development from the perception of the environment that the government has held since the publication of the first National Environmental Policy Plan (Ministry of Traffic, Spatial Planning and Environment (NMP) VROM (1989). The core aim of this environmental policy was the preservation of possibilities for sustainable environmental stress (milieugebruiksruimte, environmental-usage space) by reducing its loss[157].

The gain by producing environmental-usage space by (urban) architecture is thereby overlooked. The proper task of building is to increase the utility and experiential possibilities of the space for human beings.

However, this means not only gains for human health, but also gains in terms of biodiversity in the built-up environment (Jong 2000):[158] Biodiversity can be measured on various scale levels as the number of genetic variants within a species, the number of species, populations, communities, ecosystems or abiotic potentials for ecosystems (Zoest 1989). When one measures the effectiveness of accepted conservative environmental aims in the building industry, such as balancing the careful management of resources against more fundamental values of biodiversity and human health, then one could well arrive at disappointing conclusions. Do exemplary environmental projects really contribute more to biodiversity and human health than normal building projects? This question must first be answered separately on every scale between local and global before one can ask oneself, as Van Hal (2000) did in her thesis, why such exemplary projects are not imitated. Van Hal takes environmental effectivity in these exemplary projects for granted, but disbelief is perhaps an inhibiting factor for imitation. A support base begins with credibility.

That requires, though, a form of expensive longitudinal comparative research of the same level of complexity as epidemiological research. Such evaluating research has little chance of being scientifically convincing, because no topic is so context sensitive, and therefore scale sensitive, as ecological and health-technical value. Context sensitive research, such as that in ecology (Dieckmann, Law et al. 2000), business administration (Riemsdijk and NOBO 1999) and research connected with urban architectural, architectonic and technical design (Jong and Voordt 2002), has growing problems with the current statistical–empirical model, because it cannot lead to the generalisation of conclusions without (*ceteris non paribus*) mentioning the essence of diversity (Jong 1978). Therefore, Tjallingii is right when he gives more attention in his thesis (Tjallingii 1996) to generating, rather than to generalising, environmental utility space. However, in the guiding principles that he formulates, presuppositions are nevertheless hidden concerning the customary environmental policy that has not been convincingly evaluated. In addition, as an extension of this, they have more of an operational than a conditional character, such as is the case in the generation of improbable–possible futures (designs) (Jong 1992). The conditional, provisional thinking introduced by the the ecologist Van Leeuwen at the beginning of the '70s in his lectures at Delft was particularly successful with designers, because, instead of giving causally loaded probabilities, it opened up possibilities. The title of Tjallingii's thesis is 'Ecological Conditions', but, in elaborating design resources, it is more operational than conditional.

Since the '70s, ecology and environmental science, both in Delft and elsewhere, have followed noticeably separate paths. Because of the possible societal risks, something had to be done, although, ecologically, nothing was certain. This led to governmental policy being based more on environmental science than on ecology. Ecologists continued to be hesitant. Even when the National Institute for Nature Conservancy (RIN) was established at the beginning of the '60s, Dutch ecology was still unable to give the government an unambiguous answer to the question of what should be done with our nature areas. For the first time, it became obvious that the field of ecological research was split into four lines of thought. More can be read about the history of this development in Mechtild de Jong's thesis (Jong 2002), in which she characterises the four lines of thought as holistic-vitalistic (Nijmegen, Wageningen), dynamic (Leiden, Groningen), cybernetic (Delft) and chaos-theoretical ( ). The 'dynamic' (Leiden, Groningen) school avoided non-verified presuppositions that resulted in simple policy strategies — a scientific integrity that probably caused them to lose government assignments. Following van Sloep's thesis (Sloep 1983), in which the critique directed towards the cybernetic school could just as well be applied to the holistic-vitalistic school, the government exchanged its conditional-cybernetic line of approach (RPD 1966) for a more operational holistic-vitalistic approach that, in Mechtild de Jong's opinion, was also characteristic of international policy (UN 1992). Although the

holistic-vitalistic model received critical commentary from one of its prominent authors (Held and Clausman 1985), nature target types have nevertheless been elaborated with a presupposition concerning the 'completeness' of living communities (Bal 1995; Bal, Beije et al. 1995; Schaminee and Jansen 2001). These nature target types now determine national nature policy.
I sometimes get the impression that, by analogy, environmental policy is based on human target types.

7.8.1 Back to ecological values

Meanwhile, many new ecological insights have become available. After Odum (1971), other standard works were published, such as Krebs (1994), Pianka (1994) and Begon (1996). They define ecology as the science of the distribution and abundance (density) of species, populations and communities. 'Form' supposes state of distribution, and that is precisely what concerns urban architectural designers. In addition, attention has been given to scale partitioning (Kolasa and Pickett 1991) and the limited explanatory capacity of the statistical-empirical model (Dieckmann, Law et al. 2000). Finally, an impressive series of ecological atlases have been compiled for the Netherlands based on ever better documented observations by local volunteers and professionals. This has provided designers with an unexpected and comprehensive grip on their design-oriented search for genius loci, in other words, establishing the identity of the area that they have to design. Atlases have been published of plants and plant communities (Mennema, Quene-Boterenbrood et al. 1980; Denters, Ruesink et al. 1994; Weeda, Schaminée et al. 2000), toadstools (Nauta and Vellinga 1995), butterflies (Tax 1989; Bink 1992), birds (Hagemeijer and Blair 19??; Bekhuis, Bijlsma et al. 1987; Beintema, Moedt et al. 1995), amphibians and reptiles (Bohemen, Buizer et al. 1986), bats (Limpens, Mostert et al.1997), and freshwater fish (Nie 1996).

As far as I know, no start has yet been made to combine these distribution charts to give a more general ecological insight into diversity in the Netherlands, its rarity, and the role of urbanised space within it. My view is that a careful ecological doubt should again be placed on the presuppositions that have been taken too much for granted in current environmental policy (Jong 2002). I have not encountered this doubt in theses so far. To find a more direct ecologically motivated direction for the design of an urban area, I personally only accept the target of a reduction by factor 20 (to 5%) of environmental pressure per unit of prosperity (Speth 1989; Ehrlich and Ehrlich 1990; Jansen and Heel 1993). However, it makes lot of difference if one chooses 1990 as the year of reference, or 2000. If, after a period of undisputed success, the added benefits of current environmental policy begin to decrease, then it will be more laborious to effect all future advances. It is then time to investigate the presuppositions anew. Therefore, in this chapter, as an experiment, I will use as a point of departure the following less customary presuppositions:

1. The only ecological problems are those based on the damage inflicted on global biodiversity or human health. Every other problem definition, for example in terms of diminishing environmental utility space, can be derived from this. Derived targets run the risk of taking on a life of their own.
2. In the very long term, there is also enough energy. Compared with the energy from the light of the sun, our use of energy is negligible. Six thousand times more energy from the sun falls on the earth than is currently used by the entire world economy (Jong 2002).
3. Raw materials (including fossil fuels) will not be exhausted, but they are transformed into less useful or even life-threatening forms. Upgrading is merely a problem of energetics.
4. Pressure on the environment from the building industry can never be brought back to 5%, only by taking reduction measures.
5. However, the building industry produces environmental utility space and so can reduce pressure on the environment much more effectively, than by reducing its already small negative effects.
6. The one-sided emphasis on saving obstructs design-oriented thoughts about solutions.

The LCA method, for example, is misleading in connection with these assumptions. I shall first sketch a picture of the consequences of the negative perception that arises from reducing loss, and will contrast this with a positive perception that is based on enlarging the profit.

7.8.2 Reducing environmental loss by building

According to a feasible interpretation of Ehrlich and Speth's formula, to achieve sustained development in the coming 50 years, the global occupation of environmental utility space per unit of prosperity must be brought back by a factor 20 to 5% of the current claims (Jansen and Heel 1993). If, thereafter, the world population continues to grow, from 2050 onwards, the environmental pressure per person must be reduced even more. The development is envisaged in three phases — 'environmental care', environmental technique' and 'sustainable technology' — each with its own breakthrough and diminishing returns..[159]
Most building materials have hardly any toxic effect, and there are toxic effects that increase biodiversity, locally, even though they are disadvantageous for human health. The biggest problem is VOS emission from paint (CBS and RIVM 2001). On the basis of such conclusions, I estimate that most of the environmental regulations in the building industry, as a whole, do not go further than 80%[160].
To choose a few such regulations without specifying their ecological effect and to call that 'sustainable building' or 'building ecologically', is nonsense.

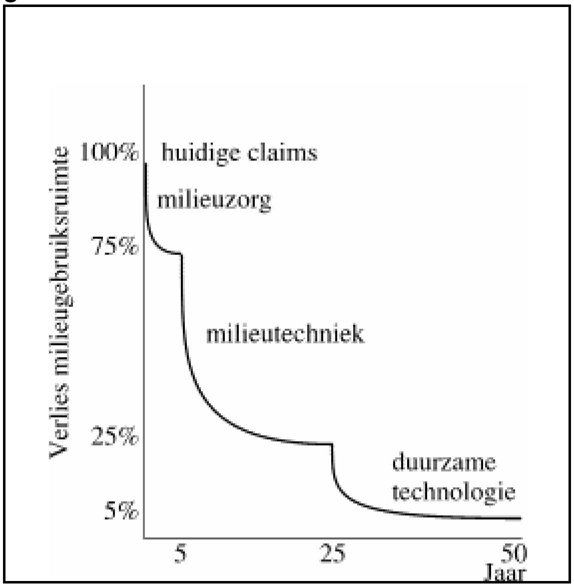


Fig. 793 *Reducing environmental loss, according to Jansen en Van Heel*[159]

It is no more than 'environment friendly building', and, as such, it can be highly valued[a]. However, this has nothing to do with ecology, the science of conditions for life in all its multiplicity and distribution. A satisfactory way of calculating the ecological effect of such conditions has not yet been found, so myths about it continue to spread, without restraint[161]. These environmental friendly regulations may make sense from the view point of publicity, but from the point of view of ecology and the environment it is better to direct that effort towards making effective regulations. For example, if it were possible to improve urban architectural quality to such an extent that a building could stand for a 100 years, instead of having to be demolished after 25 years, then one would already have achieved a reduction to 25%, and a reduction in all environmental aspects and building parts. However, how architecture will be valued in the future (how users will experience the building, how they will value the uses to which it is put, and the range of choices it offers) is difficult to predict, and so the future value is difficult to measure. However, one can gain a grip on the conditions (in terms of possibilities) for attaining such quality (Jong and Ravesloot 1995).(zie noot **Fout! Bladwijzer niet gedefinieerd.**). (Urban) architectural quality, robustness, and offering conditions for different possibilities are, in themselves, conditions for every measure that follows. Building in an environmentally friendly manner that leads to demolition after a few years is worse than building in twice as environmentally unfriendly a manner with a write-off period that is more than twice as long.

7.8.3 The one-sidedness of the present environmental perception

Jong (1994) argues there are no other ecological problems than those based on the damage to global biodiversity or human health. Every other problem definition, for example in terms of dwindling environmental uitility space, can be derived from these. Derived targets run the risk of taking on a life of their own. One might already have come to this conclusion from the problems defined by the National Institute for Public Health and Environmental Management prior to the formulation of the national environmental policy (RIVM and Langeweg 1988, 1991; RIVM 1993).

With the introduction of the themes wasting, removing, disturbing, drying up, spreading, acidifying, over-manuring (the 'VER-thema's' in Dutch), the view taken about these basic problems is clouded by a perception that originates from the protest generation. [162].

a. "Milieuvriendelijk bouwen" zou men dan kunnen definiëren als het bouwen dat minder belag legt op de milieugebruiksruimte dan het normale bouwen, maar niet minder dan 80%.

A conditional analysis of these (VER-) themes " (zie Fig. 794)[163] shows that wastage has been tacitly presupposed as an environmental problem in all them. If that is true, than sun, rain, and leaf-fall in the autumn should also be forbidden. The theme words are interpreted here according to their meaning in everyday language[164]. In a professional sense, a clarification of that is presupposed, but is sometimes forgotten. What is meant by 'dispersion' is the dispersion of environmentally toxic substances, excluding CO_2 (climate). The tacit presupposition is thus: 'in so far as it is not connected with the dispersion of acidifying or manuring substances, or CO_2 . However, in everyday language, one cannot imagine climate problems, acidification and over-manuring without the dispersion of substances responsible for this.

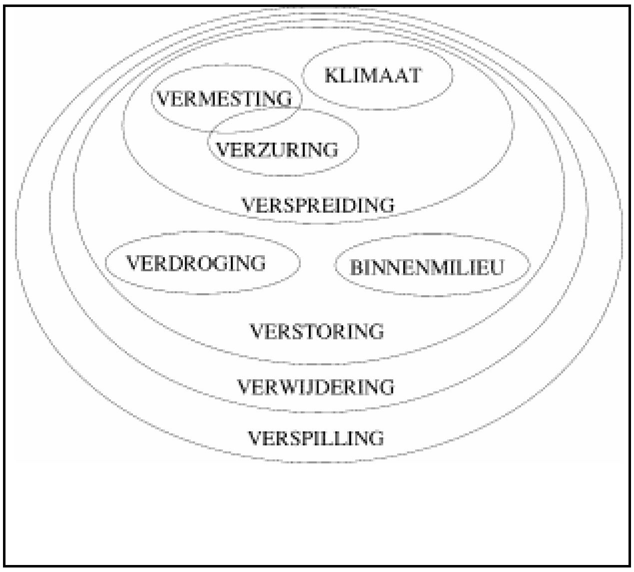


Fig. 794 *Environmental themes from the NMP, shown according to their conditionality*

Ecologically, this dispersion is irrelevant, in so far (again, according to everyday language) as it causes no disturbances. However, 'disturbance', in professional language refers mainly to disturbance of the living environment due to noise, foul smells, insecurity, and is thus, in contrast to climatic problems, very local. The tacit presupposition is then: disturbance in so far as it is not connected with drying up, interior environmental problems and dispersion.
The government prefers to convert environmental effects into these themes. That means that, in effect analysis, there is a very great danger of double counting, due to environmental sizes that presuppose each other. In methods such as LCA, an attempt is made to add up the effects, but if a certain environmental pressure has more than one effect, it is unjustifiable to include that pressure several times in the calculation. For each theme, the RIVM repeatedly asked itself the same question: 'and why is that bad?'. The conclusion remained unchanged, that it is hardly possible in the Netherlands to determine the effects on health, but that, for each theme, 'a possible loss of biotopes' should be regretted.

Since Agenda 21 (UN 1992), we call that 'loss of biodiversity'. This perception also offers possibilities to bring gains to health and biodiversity to the fore.

Building is good for human health, because, without buildings there would be distinctly fewer survivors. In addition, buildings can increase the biodiversity of an area[165].
In 1994, it was established for the first time that the biodiversity per km^2 in Amsterdam. By Denters, Ruesink et al. (1994) and Vos (1993; Vos (1996) and Zoetermeer (Vos 1993, 1998) is up to five times higher than in the agrarian surroundings of these cities. In saying this, of course, it should be noted that the richness of species in urban ecosystems differs from that of the classical nature areas[166]. The agrarian surroundings of Amsterdam and Zoetermeer are not nature areas, but are a series of monocultures closely oriented to economic production. It is no wonder that the large cities show a more diverse range of species. Nevertheless, the potency of the 'urban district' should not be underestimated.

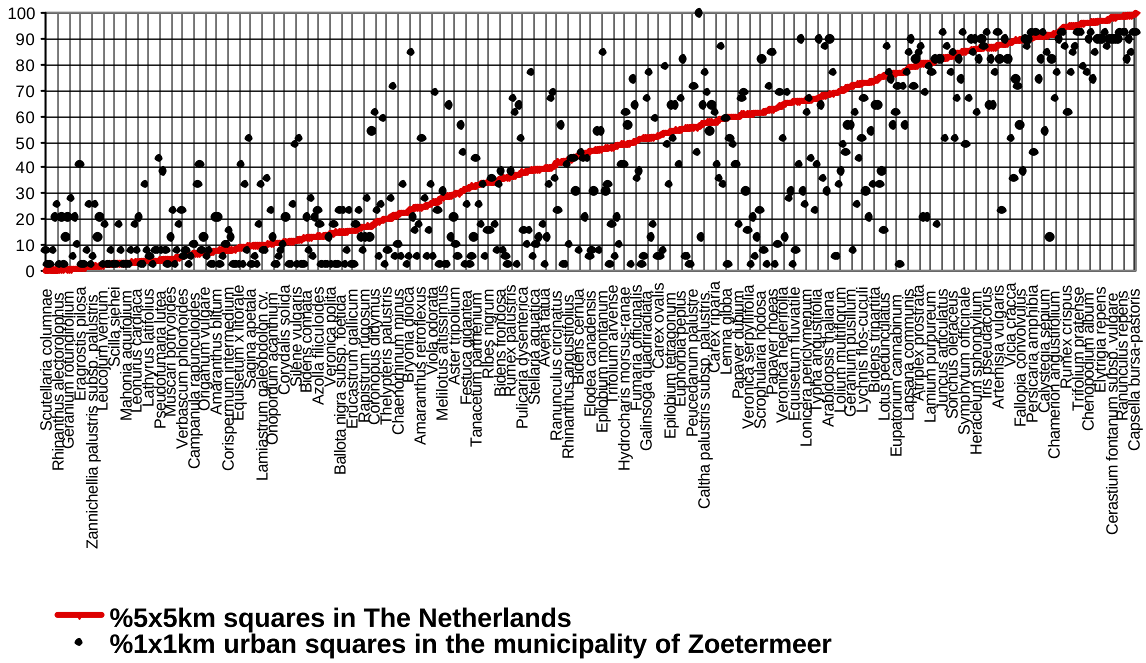


Fig. 795 *Local rareness (100% is very common) of approximately 500 plant species (only partly named) in a sequence of national rareness*

From the 500 wild plants that are found in Zoetermeer, Fig. 529 shows, above the line, the species that already occur more frequently in urban areas than on average in the Netherlands. Thus one can conclude that building not only takes over existing environmental utility space, but also produces — and to a much greater extent — environmental utility space for human beings, plants and, in some cases, even for animals. If one doesn’t include that environmental effect in the calculation, then the bookkeeping of the environmental utility space is incomplete.

7.8.4 Increasing environmental gain by building

How can we give the environmental gain from building a position that will induce a more positive contribution to combating the ecological crisis through building? In Fig. 796, the diagram in Fig. 793 is reversed and extended. This presentation gives a positive picture of the development towards real sustainable building, in other words, extending above the factor 20 of Ehrlich and Speth's formula. It has a provisional conditional construction: there is not much point in environmental care, if one pays no attention to urban architectural quality, conversely it has, and there is not much point in environmental technical regulations if one ignores environmental care, conversely it has, etc[167].

Thus the scheme gives not so much a true picture of the historical course of events, but of the ideal conditional sequence. Inherent in the scheme is the opinion that the effect of environmental care and environmental techniques in building is overestimated, and the other phases underestimated.

I will give further information about each phase in this scheme and will work out which forms of investigation are the most advisable at each level. Surprisingly enough, my demonstration ends again with (urban) architectural quality. In my opinion, esthetics can be brought to the same denominator as ecology. This denominator is diversity. Thereby is the circle of real sustainable building brought to a close.

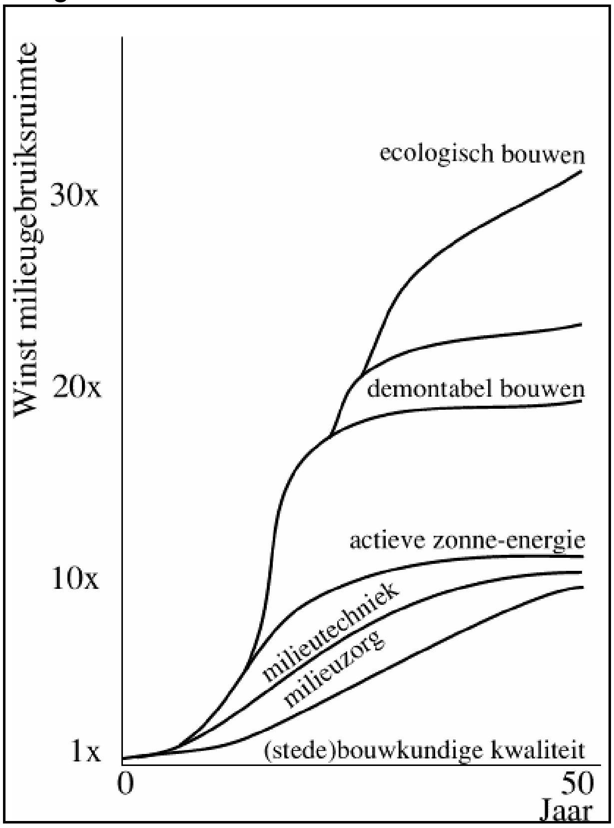


Fig. 796 *Increasing environmental gains*

7.8.5 (Urban) architectural environmental quality

Increasing (urban) architectural environmental quality leads, on the one hand, to a reduction of loss and, on the other hand, to an increase in gain for biodiversity and human health. The negative and positive space that is taken up by this loss and gain is[168], under changed presuppositions, something different from what is generally understood by environmental utility space. When one leaves out ecologically less relevant criteria, such as exhaustion and loss of energy, and adds ecological gain, then, maybe, it would be better to talk of ecological space.

In the first perspective, already, raising the (urban)architectural quality leads to extending the write-off period of built-up surroundings. If demolition is delayed twice as long, the appropriation of environmental utility space is halved, assuming that environmental care, techniques, energy supply and manner of construction remain the same. Conversely, early demolition brought about by low quality, and consequently a short write-off period, disempowers every environmental regulation.

I prefer to think of (urban) architectural quality mainly as freedom of choice for future generations. Unfortunately, we cannot forecast their needs. Earlier generations were also unable to do that for us. Even so, we use a large part of their architectural inheritance. We have had to break up or reconstruct the part that was designed too specifically to meet their needs[169]. All we can do is to construct limiting conditions for a multi-styled and multi-faceted life. The magic word here is flexibility. However, this concept is poorly understood and used misleadingly by designers. A few anecdotes are relevant here.

7.8.6 Flexibility

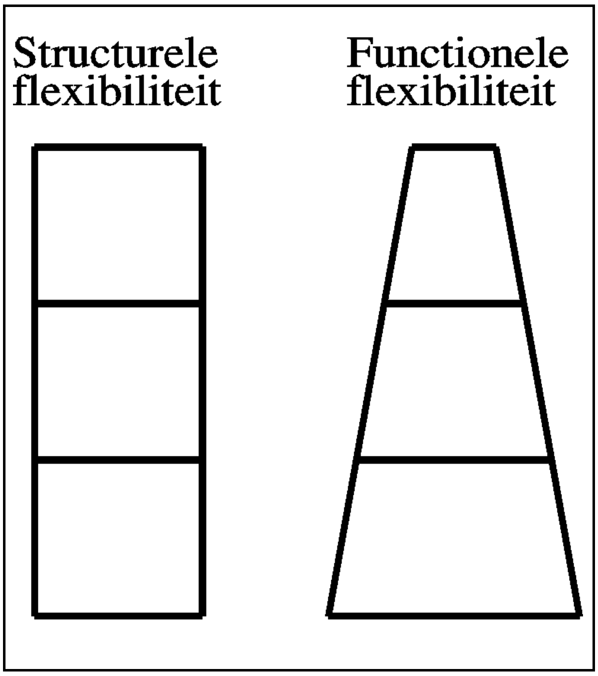


Fig. 797 *Two kinds of flexibility*

Jong (1996):The subject of Cindy Vermeulen's graduation project was a visitors' centre in a nature conservancy area. We discussed her design with Wiek Röling. The building had receding walls, and, because of that, rooms of different increasing sizes. So Wiek asked Cindy what the advantage of this was, compared with regularity. 'Flexibility!' was the reply. 'If, for example, the library of the centre becomes too small or too large, then you move it to the next room or back to the one before.'
Wiek thought, on the contrary, (just as many others before him) was that it is rooms of the same size that give evidence of flexibility. Hein Struben, for example, defends the idea that the greatest urban flexibility is achieved if all homes have a room of 4 x 4 m. The *grid fetishism* (the tacit preference for squared patterns in urban architecture) is based on the same misconception.
Even Hubert de Boer, our encyclopedia of local identity, once defended his grid in Amsterdam North on the grounds of alleged flexibility.
He had to admit that for a single use (a swimming bath, if I remember correctly), he needed more than one and less than two squares, but that, apart from that, it was very flexible. I asked what was flexible about it.
His reply was: 'Everything is exchangeable, cables, piping and wiring can be laid straight ahead.' Suddenly, I understood that what Hubert and Wiek meant by flexibility was the flexibility of the technical realisation and not the functional flexibility! A grid is easy to draw, the details are repeated in a similar way, and, accordingly, the execution is cheap and can be checked easily. The building bricks are exchangeable and it is from this that the preference of the pressurised designer's brain derives its association with flexibility. Viewed functionally, however, one could see it more as rigidity. Every amendment that introduces exceptions into the pattern encounters raised or frowning eyebrows. That is, perhaps, to the advantage of designers and implementors. In the negotiations, it naturally gives fewer problems, saves time and money, and thus brings success for the designer. After all, everyone accepts as obvious in this prefabricated solution that every function is too spaciously or too restrictedly housed. Moreover, that instills a nice feeling of dissatisfaction in the users, thus promoting the tendency to go on holiday, move house and demolish, to the satisfaction of every right-minded builder and designer[170]!

For the grid fetishists, designing is a matter of finding the correct size for the pattern. At the site itself, a thorough search is conducted to find the 'structuralizing elements' (such as building-plot patterns, the descent perpendicular to the contour lines, intersections, outlets, parallel barrier bars, in other words: grids) and to find in the programme of requirements, the square root of the average of the various spatial needs. A compromise is sought between both, that converts the terrain into the familiar squared pattern as if with a magic wand, and that is then the design. In such a design, the culturally well-educated Dutch person recognises their unmatched pattern of ditches and the art of Mondriaan. Present-day urban architecture complies with the laws of agrarian management of 1050 or 1830, without any self-esteem.

Designers then mumble something about Barcelona, Cerda, naturalness and architectonic clarity and rush on to the next job, leaving behind them as few differences of opinion as possible. Designers who want more, always encounter difficulties. There are the designers who attempt 'to break' the grid with an obligatory sloping line or with figures that, on their own, can compete with the chequered pattern: the circle and the triangle. 'Organic' architecture is, of course, completely out of the question: every deviation costs extra money, extra motivation during meetings, and is this not 'natural' and is thus, by definition, considered to be 'ugly'. The time is long past since we were able to give our zoo the motto:

‘*Natura artis magistra* [Nature is the teacher of art]’ and the art that followed, Jugendstil/Art Nouveau, is outmoded’ (Jong 1996).

7.8.7 Quality, variation and scale

However, freedom of choice also immediately presupposes (without the notion ‘flexibility’intervening) variation. After all, without variety, one cannot make a choice. That applies not only to the use of an environment, but also to how it is experienced. Without variation ‘everything is boring’.
(Urban) architectural quality as a function of physical and mental freedom of choice is thus also a function of variation. (Urban) architectural quality also places an upper limit on variation. Too much variation reduces both the utility and the visual quality of the surroundings.
There is an optimum somewhere, around which daily life oscillates within a certain ‘amplitude’ from monofunctional to multifunctional facilities, and from restful to busy surroundings.

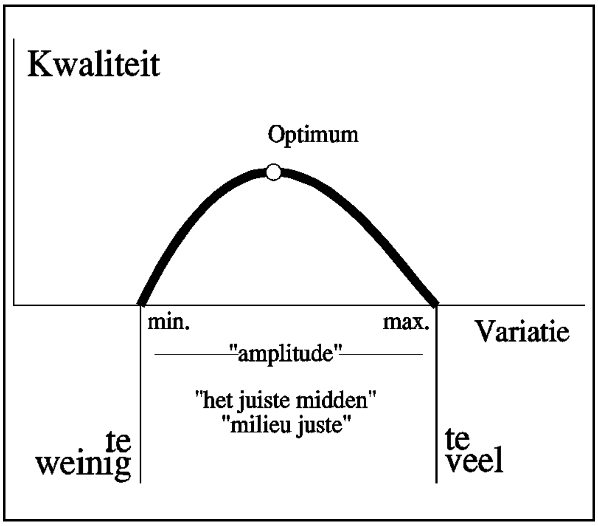


Fig. 798 Quality = f(variation)

If the discussion about quality can be visualised so simply, why then has that not happened earlier? In verbally reproducing spatial phenomena, substituting one scale for another during the argumentation can produce paradoxes that make the discussion impossible. I summarise this phenomenon under the term ‘scale paradox’ (Jong 1992).

When one looks at Fig. 799, with the smallest field of vision, one cannot fail to notice ‘difference’. For each black dot, there is a white dot nearby. However, if one looks, with a field of vision that is three times as big, then one notices everywhere identical groups of seven dots, six white dots to each black one. Then one has to conclude that there is ‘similarity’[171].

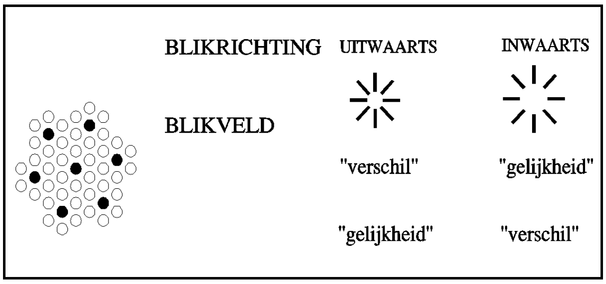


Fig. 799 *The scale paradox*

One can thus have an argument about nothing when one reasons on different scale levels, but one can also seem to be fully in agreement, while, in fact, one holds an opposite point of view that will have adverse consequences later. In Fig. 799, the change in the conclusion can already take place when there is a difference in scale level of a linear factor 3[172].
In order of size, approximately 10 decimals lie between the grain of sand (10^{-3}m) and the whole earth (10^{7}m), so there is a lurking possibility of approximately 20 conclusion changes (‘difference’ or ‘similarity’). Many discussions about architecture and urban architecture, also elsewhere, even in scientific considerations, fall prey to these notion confusions (‘scale falsification’). The figure shows another paradox, too. When one looks (outwards) from inside to outside, then one sometimes comes to conclusions that are contrary to those that one reaches when one looks (inwards) from outside to inside (Jong 1995a,1995b). This becomes clear when one starts a discussion about differences of opinion as to whether a ball is concave or convex. A tired discussion leader can conclude that both points of view contain a core of truth, and may suggest a compromise, that the ball has a wave-like exterior. In so doing, he has moved further away from reality than either points of view expressed before he made the compromise.

7.8.8 Variation and repetition arranged according to scale

Jong and Ravesloot (1995): ‘Variation on one scale level (e.g. between the components) thus allows unimpeded monotony to govern on the other scale level (e.g. between the details within a component). It is the application of different principles on different scale levels that brings 'tension' into a picture[173]. One can now arrange the design strategies into 'accords' between variety (V) and repetition (R), depending on scale level, for example

ACCORDS	*A*	*B*
between buildings:	Repetition	Variety
between components:	Variety	Repetition
between details:	Repetition	Variety

The 'traditionally hand crafted' architectonic accord A (Repetition on the level of the building and the detail, but Variety on levels in between, 'RVR') contrasts with the modern industrial accord B ('VRV'). Present architecture is, after all, mainly valued for the unique contour (V) of the building as a whole, and the originality (V) of the details, while, in between both these scale levels, repetition (R) is valued as 'architectonic clarity'[174].

In the visual quality plan for the Amsterdam district De Baarsjes, we can identify the following images by their details, components and framework (the radius is given in metres):

detail<	*>component*	framework	*ACCORD*
district image	100	1000	R
neighbourhood image	30	300	V
ensemble	10	100	R
street image	3	30	V
gable image	1	10	R
house image	0,3	3	V
finished-off image	0,1	1	R

In De Baarsjes, the neighbourhoods within the district image look alike (R), but within each neighbourhood, the squares, block aand street groups ('ensembles') vary a lot (V). Within each separate ensemble, the blocks and streets again strongly resemble each other (R), but the façades vary within each block and street (V). The appartments are repeated within the façades (R) [a], but the finished-off image (V) varies in each house image. Berlage spoke of a 'family warehouse'. Thus, the very first question is: on what scale level do we accept variation, and on what other level of scale do we accept repetition in the design[175].With these methodological points of departure, a field of research lies unexplored in the areas of architectonic and urban quality. It is not until (urban)architecural quality can be guaranteed on these grounds, for example, that one will be able to move on to a further phase of sustainable building:
environmental care and environmental technique. For those who are under the impression that this is only a matter of esthetics, I would like to point out that the same discussion is applicable to every form of diversity. Diversity, then, determines the freedom of choice in experiencing and usage for future generations, and the usage possibilities for any form of living phenomena.

a. Berlage sprak van "familiemagazijn".

7.8.9 Environmental care and technique

Jong (1993) and Jong (1994): In a supplement of the NMP (Ministry of VROM 1990) for the building industry, it has been established what 'contribution' this 'target group' (other target groups are: agriculture, traffic and transport, industry and consumers) makes to each field of problems (theme) within the estimated total for the Netherlands:[176]:

THEME	SPECIFICATION	CONTRIBUTION
Climatic change	air conditioning, isolation foam energy from fossil fuels for commuter traffic, the production of building materials, and heating	23% of the total CFC use > 33% of the total CO_2 production
Acidification	commuter traffic, building materials, heating	>16% of the total NO_x and SO_x production
over-manuring	household waste water, emissions into the ground and into groundwater	24% of the total nitrogen and phosphorus production
Dispersing environmentally damaging substances	solvents, preservation, upkeep, asbestos, heavy metal emissions when insufficiently re-cycled	9% of the volatile organic substances, 40,000 tons of heavy metals, 7,000 tons of pigments
Removal of waste materials	building and demolition waste	20% of the total waste
Disturbance	noise and foul smells due to traffic, building, production and quarrying building materials	2.85 million homes suffering from (serious) disruption due to traffic, 25% of the population in small towns irritated by foul smells
Wastage	careless use, not much re-cycling	120 milliom tons of raw materials per year, 90% of which are primary raw materials
Internal environment	health effects due to building materials, moisture, quality of the internal air, sound, vibrations	number of homes above the reference value: 90% NO_x, 80% radon, 80% airborne sound insulation, 60 % respirable substances, 15% moisture problems, 6% carbon monoxide, 40% of the offices are 'sick' buildings
Damage to ecologically functioning area	building surface with isolated ground ecology, quarrying for building materials	3,100 km^2 of hardened surface, 1,000 ha/year open-cast mining, of which 500 ha of definitive changes in destination

Fig. 800 *The contribution of the building industry to environmental problems in the '90s*

The building industry was able to bring about reductions of spare parts of more than 20%, for example, by not applying foam containing CFCs to insulation material or by not basing air conditioning on these compounds, or by rendering them totally redundant! This applies to more of the contributions named in this table. In 'Environmentally considered building' started by the Ministry of Traffic, Spatial Planning and Environment (VROM), discussions took place with the industrial branch as to which reductions in the different types of environmental pressures could be achieved in the long term (target values) and various shorter term limiting values that had to be met before a certain year[177]. 'At right angles' to these themes, the NMP used the following policy outlines as an agenda to the discussions with target groups:

<table>
<tr><td colspan="3">effect oriented (main emphasis of the '70s: ground, water, air)</td></tr>
<tr><td rowspan="5">source oriented (the '80s)</td><td colspan="2">emission oriented (removal at source)</td></tr>
<tr><td colspan="2">volume oriented (less consumption and production)</td></tr>
<tr><td rowspan="3">structural</td><td>energy saving (energy)</td></tr>
<tr><td>integral chain management (material)</td></tr>
<tr><td>quality improvement (information)</td></tr>
</table>

Fig. 801 *Outlines of environmental policy*

In these 'policy outlines', environmental care is recognisable within effect, emission and volume oriented policy[178]. It is only when it comes to 'structural' policy that innovational environmental techniques are dealt with.

From the beginning of the '70s, already, Duijvestein (1993) and Tjallingii (1992) started developing (urban)architectural design strategies with respect to emission and volume restriction, integral chain management, and energy saving, especially within the framework of the study groups City Design and Environment (SOM) of the Faculty of Architecture of the Technical University of Delft. They are supported by the system theoretical insights of C.G. van Leeuwen, Professor of Ecology at this school in the ‘70s. Many consultancy firms have emerged from this school which have contributed to a large number of practical experiments.

For design, Duijvestein uses a ‘three-staged strategy’[179]:

- stage 1: prevent unnecessary usage (volume oriented),
- stage 2: use infinite sources (energy saving, chain management),
- stage 3: use the finite sources sensibly (clean and with a high yields, emission restriction, energy saving, chain management)

and a ‘four variant method’ for discussions with the construction team, in which the ‘autonomous’ A variant serves as the highest achievable target value for the environment, and the normal situation (D variant) is considered as the lowest. The themes thereby are, for example, energy (target value: 0-energy), building materials (target value: inland and biological), water (target value: completely autonomous), waste (target value: complete re-cycling on as small a scale as possible), food (target value: completely autonomous). The method resulted in a long checklist (Municipality of Dordrecht 1992) of suggestions for solutions in every phase of the building process from urban architectural design via adding detail to the outer space, to the sketched design of the homes, to the final design, addition of details/builders’ estimate, realisation, finishing, management and use[180].

This environmental perception, viewed from policy and science, which is primarily oriented towards preserving environmental utility space and operating on thriftiness within a small-scale autonomous economy, has little in common with the environmental perception of spatial quality (e.g. in terms of utility value, experiential value and future value in the sense of ecological space) that is more oriented towards design, and thus towards conditional change and integration. At the beginning of the ‘80s, Tjallingii tried to find a compromise in his more design oriented PROSA method described in (Duijvestein 1993). He suggested giving successive attention to the Programme, Natural Rythmns, Orientation, Situation and Apparatus in the design process. By doing this, he arranged the order of the design stages too rigidly and adhered to an environmental perception oriented towards thriftiness, conservation and small-scale autonomy. However, the conditional approach is innovative and implementable with other perceptions of the environment.

The thriftiness concept with respect to raw materials offers no sustainable solution, even within accepted environmental perceptions, but only ‘postpones the execution’. These finite resources will not become exhausted until later, and that is not so much a solution of the environmental problem as an industrial interest, but it was presented as an environmental strategy, especially by the (industrial) Club of Rome[181]. The image of the earth ‘burning up’ is misleading. Raw materials will not actually become exhausted, but will be dispersed. What will become ‘exhausted’ is quality. Dispersal and mixing is a big ecological problem, in so far as it equalises biotopes. Because of this, one of the most important conditions for the continuation of life that we now know and value is damaged: the biodiversity. In that perspective, thriftiness (volume policy) is, of course, a good temporary strategy, as long as we have not mastered the technique of complete recycling (structural policy). However, if this thriftiness is not viewed within the broader framework of essential ecological problems, but as an aim in itself, we create a barrier for simpler and definitive solutions that fit in with one’s own discipline (Jong 1993). ‘These are: quality management, active solar energy, dismountable construction, and someday, perhaps, real ‘ecological construction’.

7.8.10 Active solar energy and dismountable construction

The first phases of environmental quality improvement concerned ‘(urban) architectural quality’, ‘environmental care’ and ‘environmental technique’. However, these phases are not sufficient to reach a situation of ‘sustainable building’. For that, the problem of fossile fuels must be solved. It is a problem that will be solved by increasingly implementing active solar energy. This is the condition for the energy-intensive phase of ‘dismountable construction’. Only when the problem of demolition waste has been solved in this way, can we perhaps think of a way of ‘constructing ecologically’ that really has got something in common with ecology.

Almost as much energy from sunlight (an annual average of 100 MW/km^2: 8 TW) falls on the Netherlands, including the Continental Shelf (say, 80,000 km^2), as is used by the entire world economy (10 TW). The Netherlands uses less than 1% of that (0.075 TW) [182]. If a photovoltaic cell has an efficiency of 10%, then for the present national energy supplies, 10% of the surface area of the Netherlands would be sufficient. The agricultural surface area is 30% at present, of which only 20% is needed for agrarian self-provision. Agriculture can be considered as the exploitation of biological solar cells with an efficiency of 1% [183]. If, after a billion years, evolution has not been able to discover a higher overall efficiency, why should we as human beings be able to achieve that? A similar question applies to the invention of the wheel, compared with legs. At the same time, one must, of course, ask oneself, whether the efficiency of the entire life cycle will not be less. That is now perhaps the case, but if one looks at the history of technical innovations, then a long series of efficiency improvements can still be expected. Since 1975, the photovoltaic cell has fallen in price by a factor of 14 (from $70 to $5 for each installed watt). With a further factor 4, this will exceed the economic gain from fossil fuels. The last few tasks are the most difficult to complete and this revolution would be a disaster for the oil industry and its shareholders. Most of the patents are therefore in its hands. However, these concern a type of technical problem (cutting sand into successive slices) that, for the last two centuries, has never remained unsolved for very long. As far as efficiency is concerned, the conversion of solar energy into electricity (certainly in the perspective of combining it with an environmentally friendly variant of the heat pump) leaves every other solar option (including wind as converted solar energy) far behind [184]. The challenge for (urban) architecture is to make surfaces suitable already for collecting solar energy: roofs, roads, covered exterior spaces, even though this is only a small part of the surface area required. New (urban) architectural possibilities also arise from this: covered parking facilities, cycle paths, spaces for markets that, with their energy production, could pay for themselves [185].

Taking the solvability of the energy problem as a starting point, the only option that can bring a factor 20 within reach is dismountable construction, i.e. designing parts of buildings in such a way that they can be used again in various future architectural conceptions. The Roman building brick has been re-used for thirteen centuries. Why should that not be possible with other building components? A write-off period like this is more than twenty times that of a modern building. However, dismountable construction is material and energy intensive, and it is allowed to be. This solution thus easily falls outside an environmental perception that is primarily based on thriftiness [186]. The re-use of building materials depends completely on standardisation, and thus on repeating components. Immediately complementary to this is the question: On which other scale level is variation desirable, taking the scale paradox into account?. In the ‘traditional craftmanship accord’ (see page 541), the builders’ brick could function as a standardised repetitive detail, because variation mostly occurs on the higher levels of the façade and ground-plan components. If, meanwhile, in larger buildings, less variation is necessary in these aspects (e.g., to accentuate variation between parts of the building), one can repeat these components as a whole, and thus standardise. In this way, there is a relation between the scale systematics of the architecture and the possibility for standardisation. Another system of construction will be needed for each scale system, because the scale of the repeated elements, and thus those that can be standardised, differs [187].

7.8.11 Building ecologically

Ecological building is constructing with an eye to expanding local biodiversity. At present, we know of approx. 1.7 million forms of life (Zoest 1989). There are probably 10 million, and according to some people, 80 million. As far as that is concerned, we live on an unknown planet. Since the time of Linnaeus, we have probably lost 100,000 species. At present, three species a day disappear, and according to some people, six species an hour, and that increases exponentially. It is estimated that one new viable species is formed each year. The question is whether this massive rate of extinction is bad, or not. What function did these species have for the biosphere as a whole, and what function did they have for us human beings, or could have in the future? We don’t know. However, it is reasonable to assume that with biodiversity, the risk coverage for life, is being undermined. In the course of evolution, life forms have already survived many catastrophes, because there have always been species, or members of a species, that have been able to survive in the changed circumstances [188]. From an ecological point of view, the probable future is so risky, that we can only hope for the improbable, though possible, and in any case more desirable, futures. We cannot forecast what these futures will be, because they are improbable: we can but design them. One single design is insufficient. The limits to what is possible can only be clarified by designing various improbable possibilities that are as far removed from each other as can be imagined. Within the span of current conceivable possibilities lies tomorrow’s freedom of choice [189].

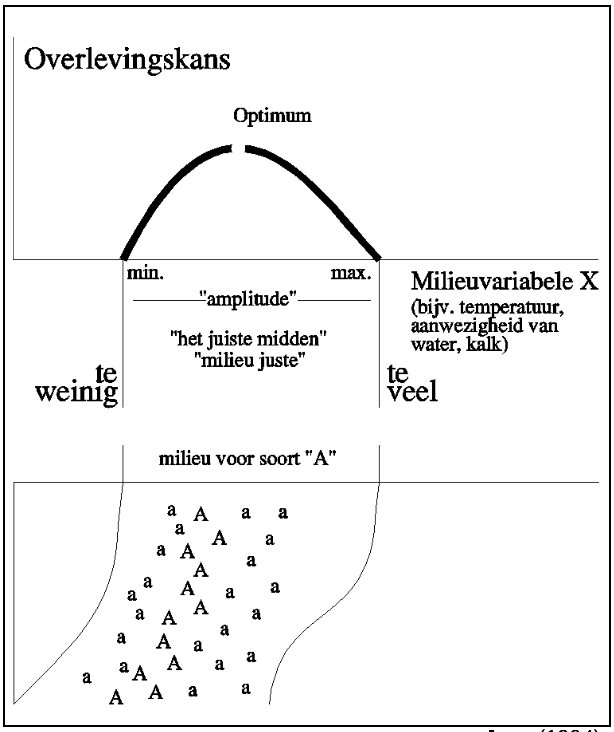
The future is unpredictable as long as we believe in freedom of choice. After all, we cannot predict future choices, but we can facilitate them through diversity[190].

Diversity makes unpredictability manageable[191]. By increasing biodiversity, evolution has also ensured the future of life. Are we going to let this go to waste, or are we going to contribute to it? Now that our species numbers six billion (we were three million not so long ago), there is no way back to the nature of olden times. This is why the fear of technique is a bad advisor[192]. Progress in active solar energy and recycling shows that in actual innovative technological developments, nature is still 'the teacher of art'.

In Greek, *oikos* means 'house'; so oikology literally means 'house knowledge'.

In the ecological tolerance curve (Jong 1997), an organism's chance of survival is set against and an environmental variable such as the presence of water[193].

If there is too little water, and also if there is too much, then the chance of survival is nil. The 'correct environment' for plant, animal or human being lies somewhere between the two extremes of dehydration and drowning. The optimum and the limits are different for each species. One can sometimes recognise the ecological tolerance of a species in the field, for example, by the distribution of a plant species down a slope from dry and high to low and wet. One sees the optimally flourishing specimens growing on the contour line of the optimum for that species. On the dry and wet side of this line, one finds marginal specimens on a contour line which, for that species, is somewhat too dry or too wet. These marginal specimens, though, are of great importance for the survival of the species. Suppose, for example, that there is a longlasting drought, then the specimens that were flourishing optimally at first will become marginal. The specimens whose habitat was previously too wet will now begin to flourish. Variety in the environment appears to offer species a risk coverage against catastrophes[194]. The same is true of genetic variation and when more species to come together.



Jong (1994)

Fig. 802 *Ecological tolerance*

Marginal specimens are not only of great significance for the species itself, but also for other species, as a source of food. Optimally growing specimens defend themselves against being eaten. One sees cows leaning over the fence of their own matured pasture to eat the lush grass of the neighbouring, unmanured, pasture. It is these marginal situations that appear to produce a great richness of species. Nowhere else does one encounter so many different insects as in areas where food is scarce, where marginal specimens of many species are present as sources of food, and nowhere else does one find so many insect-eaters and animals of prey which have directed their attention to insect-eaters. Rare butterflies appear to be dependent upon the occurrence of marginal plants. Marginal plants, though, are less interesting for human beings. We do our utmost to give our food crops an optimal habitat. To this end, we level and drain the ground, sow genetically homogeneous seed, selected for optimal production and competitive strength, to which all other species there have to defer. However, by doing this, we undermine the richness of species, and the natural resistance to change. My predecessor, Van Leeuwen (1973) made a pioneering connection between variation and sustainability that, for architectural design, seemed to be directly accessible. However, what was still missing was differentiation into scale levels. On each scale level anew, the design-like treatment of diversity leads to the question of what sort of diversity is desirable[195]. For example, how special is nature conservancy within a Dutch, European, or global framework? From the point of view of European diversity, the preference would be to make of the Netherlands one big wad or mud flat, but for the

Netherlands itself, that would mean less diversity. Contrary to this, should one strive, within the Netherlands, to bring together as many biotopes as possible, and should every other country follow that example? If everyone did this, it would be to the detriment of European diversity s a whole. Joosten (Joosten and Noorden 1992) proposed a system for valuing nature, whereby, on each separate scale level, the uniqueness of an area could be established[196].

Thus, discussion about scale also plays a role in the problem of biodiversity. On which scale levels (town, district, neighbourhood, etc.) do we have to promote diversity in the inanimate environment (and on which levels, repetition) to facilitate maximal global biodiversity? As soon as the optimal 'ecological accord' for each location has been established by research, one can derive from that (urban) architectural requirements for environmental variation. By doing this, a location-linked visual quality is achieved at the same time. Could this be the real meaning of the notion 'genius loci'? This relation between esthetics and ecology is not so surprising when one realises that, in the last million years, our sensoric–motoric system has come into existence due to an interaction of natural ecosystems such as the tropical rain forest and the savanna[197].

7.8.12 Conclusion

As stated in the introduction already, sustainable development assumes that we will leave at least as many physical, biological and cultural possibilities for future generations as we have encountered ourselves. If the world population doubles, then the space available per person will be halved (Don, Meadows, etal. 1992). Its quality, measured in freedom of choice, will at least have to double in the same period. Since the invention of agriculture (the Neolithic revolution) we have now had approx. ten periods like this. In what sense has our freedom of choice been extended by the Neolithic revolution, the occupation of the Netherlands in the 11th century, the industrial revolution, and the expansion of urban areas after 1960? Have we done more with less space? What freedoms have we lost, and which ones have we gained? Which of these can be influenced by spatial design? I realise that it is dangerous to question generally accepted presuppositions and that this can produce a feeling of uneasiness. At the same time, it is a scientific duty. This is why my great appreciation for environmentalists' results is accompanied by the equally great appreciation for including a plea like this in a collected work focused on explaining these results. It is all the more fitting to extend a word of thanks to Canters, Boersema and Pulles, who, by their intensive editing guided me away on many occasions from lack of clarity and mistakes.

Abiotic, biotic and cultural quality
For each environmentally relevant regulation, the following question should always be asked: 'How important is this regulation for really sustainable development?'. For such a consideration, the effect of all regulations must be brought under the same denominator: that of global biodiversity, or that of human health. 'How many species, or lives, does this regulation save?'. The painful political consideration that remains is the one that lies between these two: 'Are you prepared to sacrifice your life to save one species?'. The contribution of eminent (urban) architectural quality to sustainable building is probably just as important as all the environmental regulations combined that are currently being put forward by the government with respect to the building industry. However, the largest contribution can be expected from active solar-energy and dismountable construction. Whether we will ever be in a position to build 'ecologically' depends on how our engineering skills develop. The building plan of a mosquito is worth more than the entire content of an architectural museum. For architectural skills to approach the geniality of nature, in the long run, but in time, our architectural faculties would need to deliver 1000 Leonardo Da Vinci's every year.

7.8.13 References to environmental loss and profit

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