Limnologica **29** (1999) 339–345
http://www.urbanfischer.de/journals/limno

LIMNOLOGICA

Risk Assessment and Environmental Quality Division of the Ministry of Housing, Spatial Planning and the Environment (VROM), Den Haag, The Netherlands

The Biodiversity Convention and Coastal Regions

GERRIT P. HEKSTRA

With 4 Figures

Hierarchical policy background for the Netherlands' biodiversity strategy

Global and national indicators of biodiversity loss are often expressed in terms of declining species, notably the visible and attractive ones. For the Netherlands 25% of marine algal species, 10% of marine crustacean species, 20% of marine fish species, 78% of freshwater fish species, 40% of higher plant species, 52% of mushroom species, 40% of lichen species 62% of day-butterfly species, 30% of the breeding bird species and 49% of mammal species are in decline. These several hundred visible and often attractive species are by no means representative for the many thousands of 'unseen' or cryptobiotic species, which jointly maintain the biospheric 'life support system', the decomposition, production and stabilization functions in ecosystems. It is likely that with each disappearing 'higher' plant or animal species the life conditions for sometimes up to 50 others are threatened. On the other hand, climatic change in the next three to five decades will induce a great influx of marine species from the Central Atlantic and SW European coasts into the North Sea, and of continental species from France into the lowlands from Belgium to Denmark.

The Netherlands' biodiversity strategy has wilfully chosen a worldwide setting, as the Netherlands historically is an important worldwide trading nation – by ship, rail, road and plane between the Atlantic Ocean and the European inland. Our trade policy for timber, fiber, animal fodder, pets and dairy products is increasingly subject of discussion, among others from the angle of what it does to the sustainability of ecosystems and biodiversity abroad. Although many pieces of information are available, a more systematic quantitative assessment remains to be done. Global trade effects will not be discussed here.

The main objectives of the UN Convention on Biological Diversity are (1) conservation and (2) sustainable use of biodiversity and (3) equitable sharing of the benefits arising out of the utilization of genetic resources. In the view of the Netherlands' government environmental and nature conservation policy should converge in sustainability of the biosphere, its ecosystems and biota. The overall goal of the Netherlands' environmental policy is the maintenance of a 'general environmental quality' (GEQ), which should protect at least 95% of all species, including all parts of the foodweb from decomposers to top predators and the 'priority species' of nature conservation policy. Additionally, special conservation measures (e.g. areal policy) may be needed to protect those species which are not sufficiently protected by GEQ-95% measures (HEKSTRA 1993).

Local ecosystems – at land and in sea – reflect in their biodiversity the impacts of hierarchically higher levels. Therefore, strategic biodiversity policy development can also be structured hierarchically from the global to the local reach, as follows:

Cluster I: Natural and man-induced changes in the dominant abiotic biosphere conditions which decisively determine the **potential** future ecosystems and their biodiversity (long-term; i.e. centuries).

1. Stratospheric ozone layer and global UV-B radiation;
2. Global warming and destructive climate extremes;
3. Sealevel rise and change of speed and direction of ocean currents;
4. Continental hydrological cycles, catchment areas and river basins flows;
5. Continental and regional acid deposition: critical loads and buffering capacities.

Cluster II: Superimposed on Cluster I come human activities 6-9 which determine the **actual** ecosystems biodiversity (medium-term; i.e. decades)

6. Coastal change, mining, dyking, digging, draining and empoundment;
7. Catchment-wide landuse changes; spatial planning and landmanagement;
8. Urbanisation and infrastructure (roads, rails, canalisation, pipelines);
9. Soil and sediment quality management: erosion, compaction, exsiccation salinization, acidification, eutrophication and toxification.

Cluster III: direct human take of species for use and commercialization; short-term (years) with long-term consequences.

10. Hunting, gathering, poaching;
11. Crop and stock selection, growing and harvesting; gene manipulation;
12. Introduction of non-indigenous biota (exotes).

Policies on Clusters I and II are formulated chiefly in the National Environmental Policy Plan and Spatial Policy Plan under the Ministry of Housing, Spatial Planning and Environment, and for 6 and 7 additionally also in the Land Management Plan under the Minister of Agriculture, Nature Management and Fisheries. Policies on Cluster III are chiefly in the domain of the latter Ministry, i.e. in several plans for agricultural production, crop protection, forestry and fisheries and most specifically in the Nature Policy Plan, with the 'National Ecological Network' and 'species protection plans' as important instruments. Policies regarding the North Sea Coast are coordinated by the Ministry of Public Works (Traffic and Water State).

Affection of global and continental abiotic biospheric conditions

Policy in this cluster is mainly source-oriented, i.e. reduction of emissions that affect the ozone layer and increase UV-B radiation, cause global warming and sealevel rise, and acidify catchments, soils and ecosystems. Impact on ecosystems and biodiversity is mostly implicit. However, in the Climate Convention, article 2, is an explicit reference to ecosystems, i.e. stabilization of concentrations of greenhouse gasses at a level to the extent that natural ecosystems can adapt naturally to global warming, changed storminess and sealevel rise (e.g. the adaptation of growth of tree species takes decades to centuries). No similar wordings are found in the Montreal protocol on the Ozone Layer and for good reasons, as natural adaptations to higher UV-B levels might require millions of years.

Acidification is no problem at sea. Adaptation of ecosystems to acidification at a continental scale is very difficult, but at local scale it depends largely upon technical management, such as liming and anti-erosion measures and occasional deep ploughing of acidified (and salinified) agricultural land.

Ecological knowledge relevant to climate and UV-B impact on global and continental scales is already best developed for effects on forest ecosystems (shifts of tree lines) and for managed crops. There is much less information about impacts on non-managed 'wilderness' and on marine ecosystems, although marine algae at the basis of the marine foodweb are very sensitive to UV-B. The scientific imput is still chiefly qualitative and descriptive, but from 1995 on UV-B impact, climate impact and acidification impact are studied more systematically for a coherently structured national Biodiversity Strategy. The studies are coordinated by the National Institute of Public Health and Environmental Protection, RIVM, as contributions to the World Climate Research Programme, the International Geosphere-Biosphere Programme and the Critical Loads Programme (acidification in Europe). Contributions from the Netherlands are the IMAGE modelling programme (risk assessment of climate change) and the TARGETS programme (systems analysis for sustainable development, a program which might be relevant to the newly formed UN Commission on Sustainable Development). The ecosystems and biodiversity components in these computer programmes have yet to be strengthened.

Though not yet fully modelled quantitavely from the global and continental levels down to the national ecodistricts, trends in UV-B, climate change and acidification make it likely that the GEQ-95% species protection level will not be met. It might even be more difficult to maintain this GEQ as the impact of UV-B, climate change and acidification is superimposed upon, and interacting with coastal and inland habitat destructions as discussed in Cluster II.

Habitat deterioration of coastal seas, river basins and landscapes

(Failure of spatial planning and land management)

Demographic and socio-economic trends related to urban-industrial, recreational and infrastructural spatial planning and agronomic landuse management have a strong influence on coasts and landscapes at large. The Ministry of Housing, Spatial Planning and Environment (VROM) has over the last year attempted with gradually increasing succes to integrate environmental, spatial, water management and building policies into transboundary assessments and ecodistrict policy views (Euregions), and into (trans-) provincial and multimunicipality cooperation plans (ROM-areas). But executive power is entirely in the hands of various national, provincial and municipal agencies, water boards, etc.

In the agronomically developed catchments of Elbe, Weser, Ems, Rhine, Maas and Schelde (the EWERMS Region from the Alps to the Wadden Islands) and the urbanised megalopolis triangle London-Berlin-Munich, to which the Netherlands physically belong, quasi-pristine nature is already for decades pushed back into restricted parks and re-

serves. Loads of heavy metals and chlorinated hydrocarbons in river basins and coastal sediments obstruct future use options ('chemical time bombs'; HEKSTRA 1995). Urban-industrial development of the North Sea coastline from Calais to Esbjerg is only outbeated by that of the East Atlantic coast of North America, from the Carolinas to New England.

There is, however, new hope for transformation of marginal agricultural land into 'nature', which may relieve some of the pressures on the coastline. Although at the inland certain river banks are being restored into semi-natural riverine forests (e.g. Biesbosch and Gelderse Poort in the Netherlands; Elbe and Weser 'Auenwälder'), there is strong economic pressure to turn marginal agricultural land into recreational areas (golf links, ski-pistes, playgrounds, lawns, estate gardens, garden centers and similar land consuming 'non-nature'). Municipalities re-allocate polluted areas (of former industrial and waste dumping sites) into 'new-nature', hoping to save the costs of clean-ups and safe managent. In the meanwhile they tend to expand residential and industrial areas on relatively clean expropriated agricultural land and into protected coastal areas. Signs of reversal of this trend, if any in Nortwestern Europe, are weak at best, as is shown in the policy analysis undertaken for the preparation of the Netherlands' Spatial Policy Plan.

Mining of gravel and sand for roads and concrete (less so of clay for bricks) will continue to grow for building purposes. Contractors, however, are now obliged to reconstruct in the meanwhile the area for 'new-nature'. The Spatial Policy Plan distinguishes developments in 'higher' and 'lower' Netherlands and in the coastal zone respectively. The higher lands (> 1m above sealevel) are increasingly vulnerable to acidification and exsiccation (sinking groundwater table), and hence also to eutrophication and toxification by mobilization of heavy metals (ad 9). The lower lands (from 1 m above to 12 m below sealevel) is vulnerable to seapage of salty groundwater, influx of polluted river water and sedimentation of polluted silt. The coastal dunes in particular suffer from extraction of great amounts of fresh water (in combination with suppletion by Rhine water) for the nearby megalopis (5 million people between larger Amsterdam and larger Rotterdam). Of the major three Netherlands' zones, biodiversity loss is by far greatest in the coastal areas.

Marine impact and risk assessment

An integrated international North Sea research programme was established in 1989 to support policies of the coastal

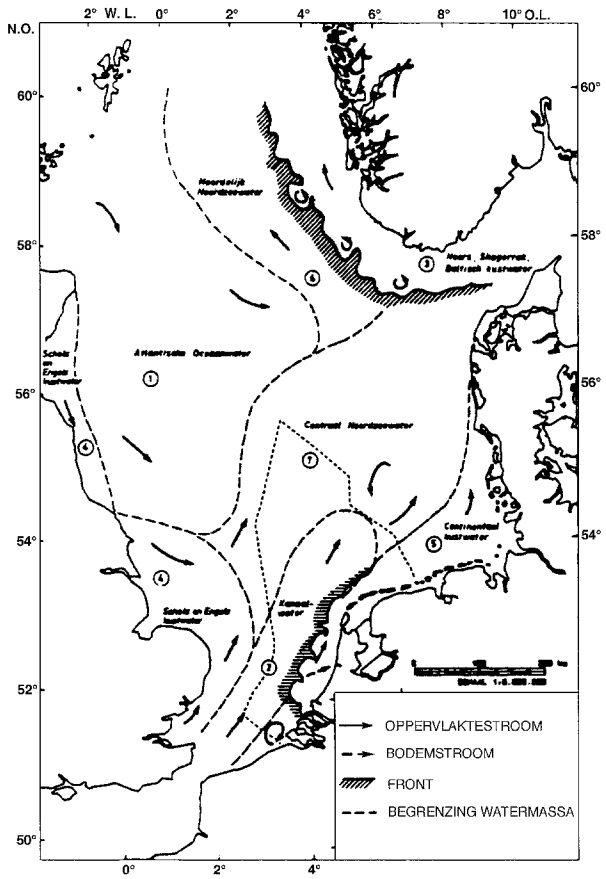

Fig. 1a. Residual streams, water masses and fronts in the North Sea in winter.

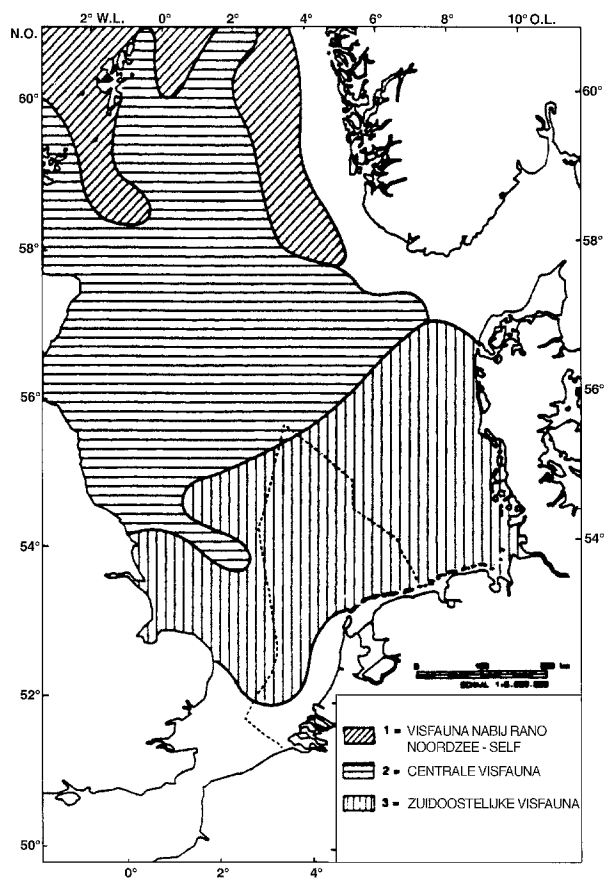

Fig. 1b. Fish fauna distribution in the North Sea, 1982–1986.

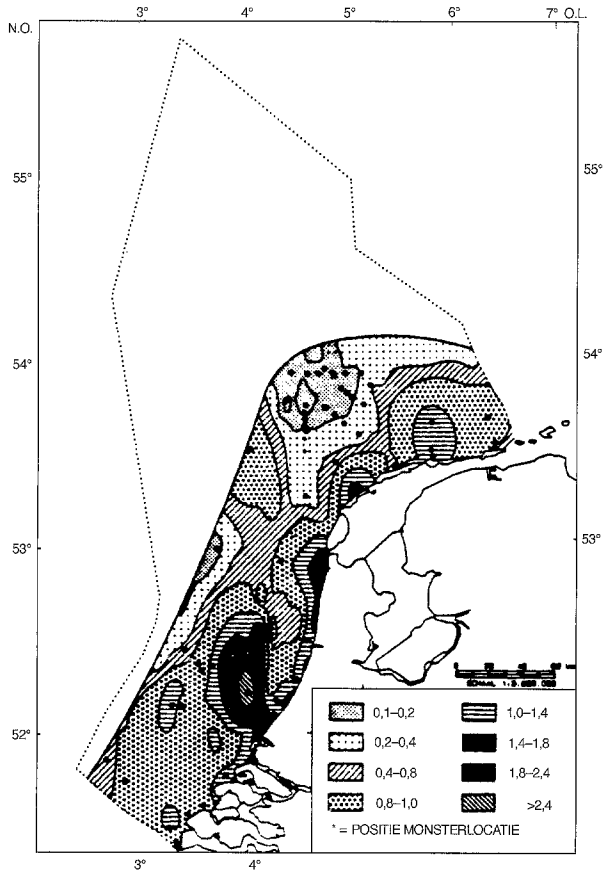

Fig. 2a. Cadmium distribution in the Netherlands' part of the North Sea continental flat.

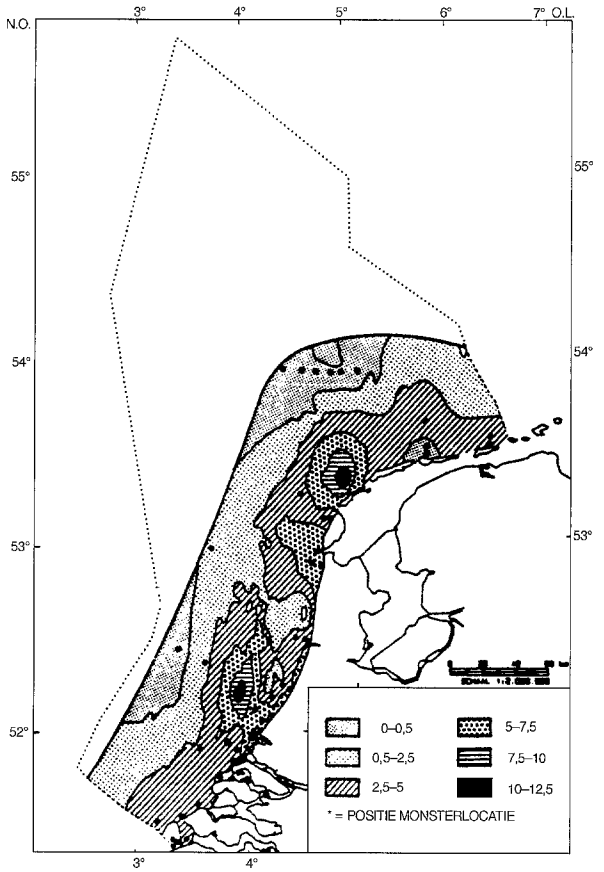

Fig. 2b. PCB distribution in the Netherlands' part of the North Sea continental flat.

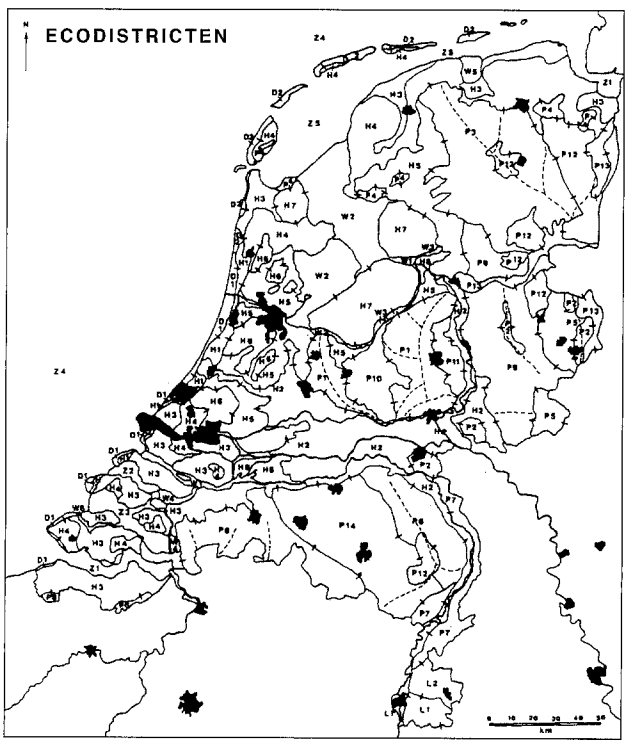

Fig. 3. Ecodistrict classification of the Netherlands (list of descriptions omitted).

states. It includes water system and ecosystem description and inventories (Fig. 1), analysis and monitoring of physical and chemical disturbances (mining, shipping, fisheries, pollution) (Fig. 2) and ecological and economic impact modelling and analysis. The Netherlands' part of it is called RAM (Risk assessment marine ecosystems). The Wadden Sea, Delta Area and other estuaries are important spawning grounds and nurseries for hundreds of species, including several commercial ones. Forty of them have been chosen as indicators for ecosystem fitness, together with physical and chemical parameters to indicate the abiotic environment.

Ecosystem health rosets

For government authorities and decision makers it is impossible to understand tables of monitoring data and read trend reports. Instead, a method of visualizing results in the form of an 'ecosystem health roset' (EHR) was developed.

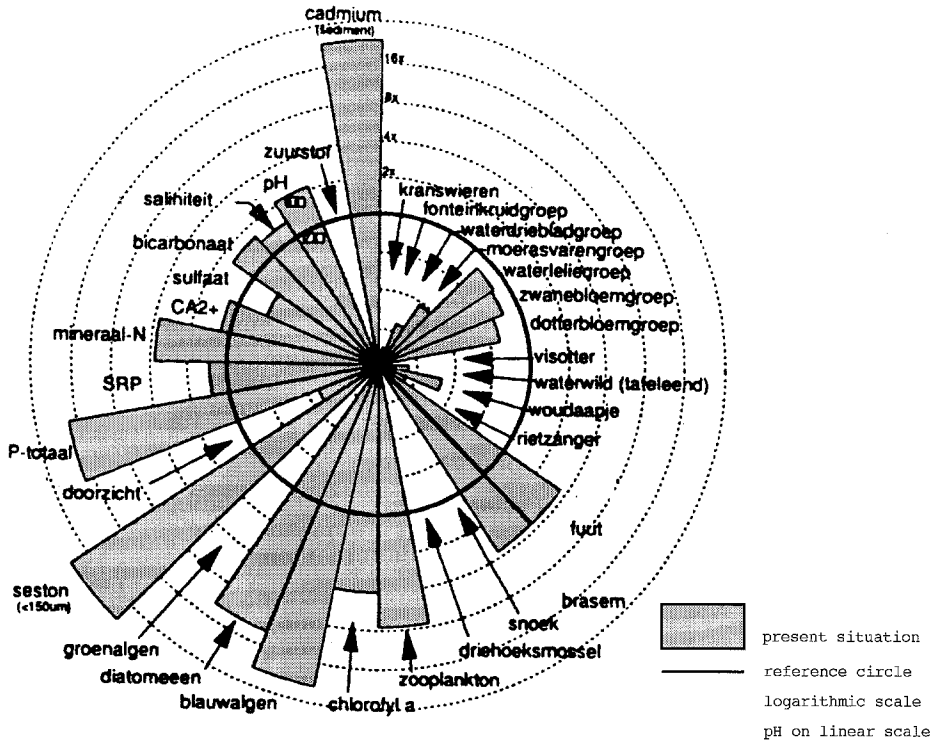

Fig. 4. Ecosystem health roset (EHR) for a representative lake Loosdrecht of the inland wetland/ moor district H5 in Fig. 3.

Present trends are depicted in relation to a reference point in the past. As the greatest environmental changes took place after 1930, any reliable description before 1930 of the physical conditions (temperature, sea currents, tidal flats etc.), chemical conditions (salinity, nutrients, pollutants) and of calculated population densities of the 40 selected species may serve as reference. In the EHR these values are put on the solid circle. The concentric stippled *outer* circles represent 2x, 4x, 8x, 16x in excess of the reference value and the concentric stippled *inner* circles 1/2x, 1/4x and 1/8x of the reference value.

The methodology is universal but for each ecosystem the chosen indicator species and physical and chemical parameters should be adapted. The Netherlands is now divided in 40 terrestrial and 10 aquatic ecodistricts for which EHRs are being established (Fig. 3). The EHR of the Loosdrechtse Plassen, a wetland moor district behind the coastal dune district, is shown here as an example which politicians (national and local) will easily understand (Fig. 4). It displays heavy eutrophication and cadmium poisoning and a great reduction of almost all selected higher plant, fish and bird species. Similarly dramatic was the EHR of the coastal dune district, but there are signs of recovery at some places in both, the dune district and the wetland moor district (HEKSTRA 1993).

For the other terrestrial ecodistricts detailed impact analysis and prediction **mo**dels on **ve**getation (MOVE) in relation to exsiccation, eutrophication, acidification and salinization were made and on effects of **c**ontaminants in **a**quatic and **t**errestrial **s**ystems (CATS). Contrary to the diversified land-linked ecosystems, where urban-industrial and infrastructural development have the greatest impact on higher plants and animals, and agricultural development on the 'cryptobiota' in soils and sediments, the by far greatest impact on marine ecosystem destruction and loss of biodiversity is by fisheries, not by oil spills, drilling, shipping and off-shore activities (HEKSTRA 1993).

The greatest marine ecotoxicological risk was from dumping of wastes, which is now forbidden. Diffuse pollution from atmospheric deposition and from river inputs are now the greatest ecotoxicological risk, in particular when in combination with eutrophication by nutrients from agriculture via the rivers into the sea. The ranking of human interferences and hence advice on policy measures is more easy for the marine ecosystems than for the land-bound ecosystems. In the coastal sandy dune districts, biodiversity loss is linked to the combination of decrease of fresh water and sinking freatic water table (exsiccation of vegetations by extraction for drinking water production), greater salt water penetration (which however can be kept to a minimum artificially) and a very great habitat destruction and fragmentation due to urban and traffic expansion.

Species utilization

Commercial fisheries is still of great economic interest and an ever greater ecological disaster (overfishing of commercial species and increasing destruction of all bottom life by

beam trawling for demersal fish. Almost all 'by-catch' and among them many rare species once brought on board is so heavily damaged that they cannot survive when set back into the sea. They feed the gulls at best. Large segments of the North Sea should become sanctuaries for declining and endangered species. But they stil fail to be established. Mariculture for mussels and oysters is practiced in the Delta area and the Western Wadden Sea and like other monocultures have some disease problems. The dune district is almost free from commercial hunting (except of poaching), but large former agricultural areas on poor sandy soils, if not built-over by towns or roads, are now occupied for highly commercial flower production (an export commodity of high value but ridled with pesticide problems) (HEKSTRA 1993).

Prospection

Under the name 'Flora and Fauna 2030', a series of expert valuation studies was started on a still growing number of taxonomic groups. For each relevant species in the Netherlands an expert judgement is given on what the future will hold in the face of realistic scenario's of climate change, exsiccation (including change of redox potential), acidification, eutrophication, sealevel rise, salinization, and habitat fragmentation. The scenario's are based on formulated policy and on irreversible 'autonomous' development. The project, started in 1992, has yielded already surprising results for higher plants, dragon flies (Odonata), beetles (Coleoptera), butterflies (Lepidoptera), breeding birds, bats and rodents, crabs and shrimps (Crustaceans), mussels (Lamellibranchia), snails (Gastropoda), mushrooms (Fungi), eelworms (Nematodes), bugworms (Isopodes) and springtails (Collembola); other soil 'cryptobiota' are in preparation. Ultimately all these studies will be incorporated in the National Environmental Assessment and Prognosis Programme, coordinated by the RIVM at Bilthoven, in close cooperation with the Information and Knowledge Center for Nature Policy at Wageningen and the newly established European Center for Nature Conservation at Tilburg. This Centre is among others collecting all over Europe information on socio-economic and spatial planning relevant to nature conservation and development.

Further research

Probably of even greater concern than the integrated impact of pollution (including eutrophication, acidification and redox change) is the problem of habitat fragmentation. A growing network of infrastructure, which is expected to expand till at least 2010 is progressively transsecting all regions. The disruptive impact on the transected ecosystems is many times larger than the mere hectares occupied by the infrastructures themselves. A major research programme on the impact on biota of the fragmentation of ecosystems has been started and is getting well coordinated and to a large extent funded by the Roads and Waterworks Reseach Agency at Delft, in close cooperation with various ecological branches of universities and other institutes. The project deserves extension on the European scale.

Quantitative results with regard to the future of biodiversity, integrating impacts of pollution and habitat losses due to activities under Cluster II have not yet been achieved, neither in the Netherlands nor in neighbouring countries. The expert judgement of flora and fauna is that habitat fragmentation and loss at the moment is a greater threat to the 95% environmental quality objective than is the collective pollution, but this is not yet substantiated quantitatively. Following a guidance document of the Research Council on Environment and Nature it is envisaged that relevant governmental, academy and university research institutions will join in an integrated strategic research plan for systems ecology and toxicology, thus putting more weight on quantitative ecological impact assessment, scenario building for biodiversity loss, biomonitoring and policy and management oriented modelling.

Conservation

In the Netherlands all policies regarding plant and animals production and breeding, fisheries, hunting and nature conservation, including the protection of the Wadden Sea and parts of the North Sea as spawning grounds for fish, fall under the coordination of the Ministry of Agriculture, Nature Management and Fisheries. The effectivity of conservation is more easily controled on the land than at sea. Patrolling of the North Sea is handled by the Ministry of Public Works (Traffic and Water State).

Nature policy *per se,* as apart from the general environmental quality GEQ (warranting environmental health to at least 95% of all species), is formulated in the Nature Policy Plan, which interact with the respective policy plans for agriculture, crop protection, forestry and fisheries. The most direct instrument for nature policy is the Nature Conservation Act, but other laws as on forestry, with different main goal have a strong component of nature conservation. The Wadden Sea is an official nature reserve, but that does not exclude oil and gas exploration and exploitation terminals and pipelines, shrimp and flatfish fisheries, mussel mariculture, a tremendous recreational fleet, beech tourism etc. of which planning and control is in conflict with nature. It lacks well founded calculations of the carrying capacity.

Integrated policy frameworks

Nature conservation, environmental protection and water management are closely interlinked, but many instruments are more or less directly used for conservation and restoration of biodiversity:

- instruments for protected areas through the Nature Conservation Act;
- nature development outside protected areas by subsidies for the owners;
- ex-situ: research, education, public information and support of NGOs;
- special habitat protection/restoration of rare and endangered species;
- regulation of hunting and fishing;
- (re)introduction of species.

Biological diversity is a public concern. Our biggest NGO is 'Natuurmonumenten' with about 700,000 family memberships. WWF has about the same amount of contributors. Furthermore, many other NGOs are active in the field of nature and the environment, the most influential with regard to coast and sea are the 'Wadden Vereniging', 'Stichting Reinwater' and 'Stichting Duinbehoud'.

At the national level three ministeries are directly responsible, the Ministry of Agriculture, Nature Management and Fisheries, the Ministry of Housing, Spatial Planning and the Environment and the Ministry for Public Works (Transport and Water State). Provincial authorities play a key role in the spatial planning process, the realization of environmental policies, and water management policy. There is a tendency to decentralize tasks with regard to nature conservation and environmental policy from the national to the provincial level. Municipalities are responsible for spatial planning at the local level. Water boards are directly responsible for water quality and quantity. Municipalities and water boards are implementing projects.

Conclusions

a. Although global environmental changes will enhance major ecosystem changes (acidification within decennia; UV-B radiation, climate and sealevel rise in one to several centuries) their impact on sustainability of ecosystem and biodiversity is not yet quantitatively assessed by the international scientific community. It needs strengthening of international research to which the National Research Programme on Global Air Pollution and Climate Change is contributing.

b. In the EWERMS fluvial catchment area and the urbanized Northwest European region to which the Netherlands belong, polluting emissions are likely to decrease drastically, thus providing chances for restoration of ecosystems. However, demographic and socio-economic forces behind land use changes, including set-aside of agricultural land, all tend to further fragmentation of habitats and to further encroachment into areas potentially open to new 'nature development'.

c. Use options of environment and space will increasingly meet limitations by loads of pollution in soils and sediments, socalled 'Chemical Time Bombs'. The biodiversity in polluted soils and sediments is only a small fraction of unpolluted environs. Pressure on relatively clean areas for further development will increase. Local governments tend to allocate presently polluted areas to socalled new-nature. Spatial and biodiversity consequences need study on basin-wide scales in Europe.

d. Exploitation of harvestable species and commercialization of genes is likely to continue at the cost of existing wild species and genes, both locally and abroad. The impact of trade on the sustainability of ecosystems and biodiversity remains to be assessed more quantitatively.

e. Protection of nature and key species in main ecological networks over Europe need to be attuned to a general environmental quality policy that protects 95% of the species outside specific nature areas; the socalled cryptobiota that maintain the life-support system.

f. The concern that many forthcoming socio-economic developments will increasingly hamper the sustainability of ecosystems and biodiversity beyond state borders compells to a critical review of world trade, starting within the OECD member countries. But this is not discussed here.

References

HEKSTRA, G.P. (red.) (1993): Ecologische inpasbaarheid van het omgaan met stoffen: beoordelingssystemen voor stoffen in ecosystemen – het ecologische geweten achter de normstelling – Eindrapportage PEIS, Publikatiereeks SVS 1993/14. Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer, VROM, POBox 30945-655, 2500 GX Den Haag, NL.

HEKSTRA, G.P. (1995): Delayed effects of pollutants in soils and sediments: understanding and handling of chemical time bombs in Europe. Ecoscript 56 of the Foundation for Ecodevelopment – Mondiaal Alternatief. At the author's address.

Author's address: Dr. GERRIT P. HEKSTRA, Harichsterdyk 62, 8571 RM Harich, The Netherlands; Tel./Fax: 0031/ 514 / 602063