

# ***NERI***

## ***Report and activities 2000-2001***



**National Environmental Research Institute  
Ministry of Environment and Energy, Denmark**

National Environmental Research Institute  
Report and activities 2000–2001

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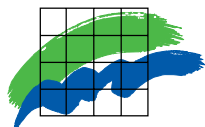
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***NERI***

***Report and activities  
2000-2001***



**National Environmental Research Institute, Denmark**  
Ministry of Environment and Energy  
April 2001

# Contents

Preface .....	3
Global climate changes and their impact on the Danish environment .....	4
NERI – An evolving institution .....	8
<b>Atmospheric environment:</b> Ultrafine particles are harmful to human health .....	14
<b>Aquatic environment and nature:</b> Mid-term evaluation of the Action Plan on the Aquatic Environment II .....	16
<b>Terrestrial environment and nature:</b> Rare plants and animals are threatened .....	18
<b>Arctic and global environment:</b> Satellite monitoring of marine mammals .....	20
<b>Risk assessment of chemical substances and biotechnological products:</b> Biotechnology and risks .....	22
<b>Cross-disciplinary research:</b> Environmental indicators .....	24
Green accounts .....	26
Economy and personnel .....	28
Organizational structure .....	30
Programme areas .....	32
<b>Annexes on NERI's Internet homepage:</b> • Publications 2000 • Annual accounts 2000 (in Danish)	

# Preface



In spring 2000, the Danish Government and Parliament finalized an agreement on research policy: One aspect of this was the termination of a number of programmes in the environmental area. The agreement mainly affected NERI through termination of the Danish Environmental Research Programme, which has spawned a number of networks within Danish environmental research. The parliamentary agreement has now transferred greater responsibility for financing environmental research to the Danish Research Councils. Discussions have therefore been initiated between the Ministry of Environment and Energy and the Research Councils aimed at ensuring future appropriate financing of environmental research. As the main research institution within this area, NERI plays an active role in these discussions.

The year 2000 brought about a number of new challenges for NERI as the Ministry of Environment and Energy decided to transfer overall responsibility for environmental monitoring to NERI. The new tasks have been gathered in a newly established Environmental Monitoring Coordination Section. One of its first steps will be to draw up proposals for overall prioritization of the monitoring activities.

One notable accomplishment during 2000 was the mid-term evaluation of the Action Plan on the Aquatic Environment II. The evaluation was carried out in collaboration with the Danish Institute of Agricultural Sciences and was published on 1 December. Together with a previously published report on ammonia pollution from the agricultural sector, the evaluation will serve as the basis for political discussions about the need for further initiatives to limit nitrogen pollution from agricultural sources.

The fusion between NERI and the former Greenland Environmental Research Institute was completed in 2000 with the transfer of the Department of Arctic Environment to a new extension at NERI's Roskilde premises. During the course of 2000–2001, NERI also appointed four

Research Directors and a new Director of the Secretariat in Roskilde. NERI is thus well prepared for the challenges of the coming years.

One of the major challenges for 2001 is publication of the quadrennial state-of-the-environment report. By way of follow-up on the Aarhus Convention, Denmark has decided to prepare the report in a transparent and open manner. NERI consequently conducted a wide hearing during the synopsis phase (in autumn 2000) and will submit the draft report to hearing in summer 2001. In both cases the material is placed on the Internet for the benefit of the public as well as organizations involved in the hearing. Preparation of the report should thus be as transparent and open as possible.

During 2001 the quality of our consultancy services will be evaluated as part of NERI's overall quality assurance policy.

The annual report provides a general account of NERI's work by presenting some of the year's key activities. Further detail of the progress made during 2000 can be found in the NERI annual accounts, which are available in Danish on NERI's homepage: [www.dmu.dk](http://www.dmu.dk). A brief description of all the projects planned for 2001 is also available on the homepage, as is a list of well over 900 publications and reports published by NERI scientists in 2000.



  
Henrik Sandbech  
Director General



  
Hans E. Zeuthen  
Chairman of the Board

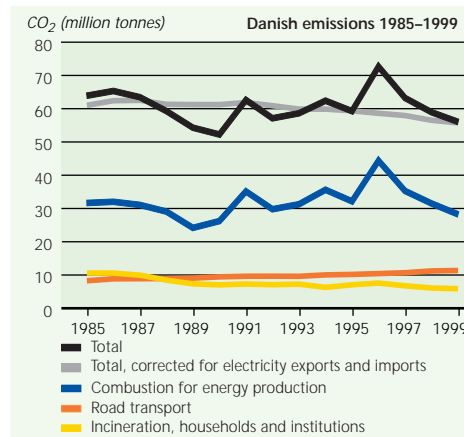
# Global climate changes and their impact

## NERI's perspective

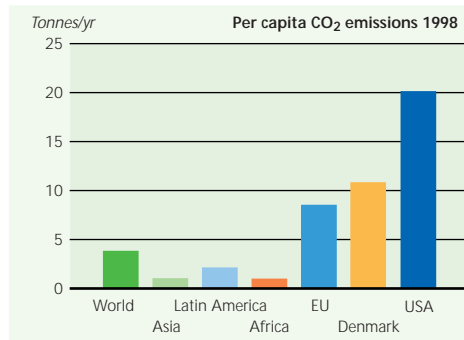
NERI has initiated a number of research projects to determine the impact of global warming on nature and the environment in recent years, not least in the Arctic. Our work there is based on NERI's special responsibility for and experience with Arctic environmental research. The Institute's Arctic activities have been described in several earlier annual reports.

The present section therefore focuses on the impact of global warming on nature and the environment in Denmark. The first changes in nature and the environment have already become apparent, and NERI will therefore study, monitor and advise on these and future changes in natural conditions.

*Development in Danish CO<sub>2</sub> emissions. Increasing consumption of natural gas and renewable energy as opposed to coal in recent years has led to a decline in CO<sub>2</sub> emissions. For the same reason, the majority of the CO<sub>2</sub> emissions now derive from the combustion of oil products. NERI is responsible for calculating Danish emissions, including emissions of the greenhouse gasses CO<sub>2</sub>, methane and nitrous oxide.*



*Per capita CO<sub>2</sub> emissions are relatively high in Denmark – higher than the EU average, but lower than in the USA. According to the latest IPCC assessment, CO<sub>2</sub> accounts for approx. 60% of the anthropogenic global warming. (Source: IEA)*



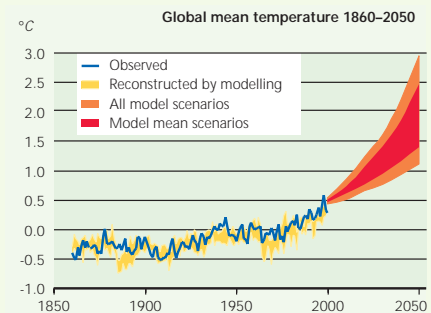
## Why is the temperature increasing?

It is well known that combustion of fossil fuels raises the carbon dioxide content of the atmosphere and that the agricultural sector emits methane and nitrous oxide. To this must be added industrial emissions of CFCs, etc. These so-called greenhouse gasses are decisive for the global heat balance. The Intergovernmental Panel on Climate Change (IPCC) estimates that a continued increase in the atmospheric concentration of greenhouse gasses will lead to anthropogenic global changes in the climate. The global mean temperature has already increased around 0.6 degree Celsius since 1860, when regular measurements began. Climate modellers can best explain this increase if the effect of anthropogenic greenhouse gas emissions and aerosols is taken into account.

As even the most optimistic scenarios predict considerable climate changes, society needs to prepare for these changes.

## The temperature is increasing

The global mean temperature has increased about 0.6 degree Celsius over the past century. Climatologists mainly attribute this to an anthropogenic increase in the atmospheric concentration of greenhouse gasses. The figure shows the global mean temperature over the period 1860–2050 expressed in terms of the deviation from the average for the period 1961–1990. (Source: IPCC)



# on the Danish environment

## What can we expect from the future?

When the global climate changes, there will be both winners and losers. Climate models predict that the temperature will increase more in some areas than in others. With regard to the changes in Denmark, there are several sources of uncertainty:

- Firstly, we do not know the future development in global emissions of greenhouse gasses.
- Secondly, the climate models have a limited spatial resolution and hence become increasingly uncertain as we move down to the national level.
- Thirdly, the impact of changes in extreme events is very difficult to determine because the forecasts of climatic extremes are uncertain (for the above-mentioned reasons) and little is known about the impact of climatic extremes on nature and the environment.

The models indicate that the climate in Denmark will become warmer and wetter, although the summers could become more continental (drier). How much the temperature will increase is uncertain, but the EU acknowledges that an increase of 2 degrees Celsius would be a politically acceptable compromise between the consequences of a temperature increase and the costs of preventative measures. The IPCC predicts that the increase in Denmark will exceed 2 degrees before the turn of the century.

## Agriculture and biodiversity

Denmark is located on the western side of the continent between the European mainland and the Scandinavian peninsula. The distribution limit of a relatively large number of plant and animal species thus runs through or near Denmark. These species will be particularly affected by continued climate change.

Agriculture and forestry exploit just under 80% of the Danish land area and are therefore of decisive significance for the wild animals and plants. In general, an increase in temperature and the carbon dioxide content of the air will beneficially affect agriculture in Denmark and other temperate countries, while the losers will



Photo: NERI/Jonas Teilmann

be the Third World countries in the warm and dry regions of the world.

Danish agriculture is sufficiently adaptable to be able to adjust to changed cultivation conditions. In contrast, tropical and subtropical agricultural systems are often restricted by water shortage, heat stress and lack of expertise and resources.

In Denmark, the higher temperatures and changed humidity will increase the risk that pathogenic organisms and pests can overwinter, however, thereby enhancing the need for disease and pest control. An example is the Colorado beetle, the northern distribution limit of which presently lies just south of Denmark. A temperature increase could also enable the Iberian forest snail to gain further ground in Denmark.



Photo: Lars Westerdal

Denmark is in the process of establishing major offshore wind farms to help reduce CO<sub>2</sub> emissions. The target is 4,000 MW of offshore wind power by 2030, corresponding to 8% of Denmark's energy requirements. One of NERI's present tasks is to help assess the possible effects of the wind farms on nature and the environment. In 2000, NERI thus contributed to the first three Environmental Impact Assessments of the impact of offshore wind farms on birds and marine mammals.

The planned doubling of the forest area in Denmark should sequester approx. 300 million tonnes of CO<sub>2</sub> in the wood itself over the next 100 years, corresponding to 5% of Denmark's current annual CO<sub>2</sub> emissions. Additional CO<sub>2</sub> will also become sequestered in the tree roots and in the pool of dead leaves, humus, etc. on and in the forest floor. (Source: Danish Forest and Landscape Research Institute)

Increasing temperatures and enhanced precipitation in the winter half year would also enhance the already excessive level of nitrate leaching from arable land that Denmark is trying to curb through the Action Plan on the Aquatic Environment (see pages 16–17). We generally know too little about the indirect impacts of climate changes, especially on organic farming – for example, on the occurrence of pests, diseases and weeds, on nutrient turnover and on soil fertility.

The climate is already too warm for the most numerous utility tree in our forests, the common spruce. This could advantageously be replaced with trees preferring higher temperatures, e.g. the beech. The opportunity already presents itself, in fact, since Denmark has decided to double its forest area from 11% to 20–25% over the next 70–100 years.

## Nature

Species whose northern distribution limit runs through Denmark or lies just south of the border will advance if the climate becomes warmer. This will initially be noticeable for the most mobile organisms such as birds, insects and mammals. An example is the southern European swallowtail butterfly. Plants generally advance more slowly, depending on their dispersal mechanisms.

What species will be affected by a climate change depends on whether future summers become drier (more continental) or wetter.

Among the bird species that have colonized Denmark within the past 150–200 years, too little is known to be able to decide whether temperature changes have played any role.

Species whose southern distribution limit lies in Denmark can be expected to move northwards. As mentioned earlier, this applies to the common spruce, which – thanks to planting – is our most common forest tree. In step with the expected retreat of the common spruce, the animals and plants associated with spruce forest will also be affected.

## Salt meadows and wetlands threatened

The most marked environmental changes in Denmark can be expected to occur along our low-lying coasts. According to the IPCC, a global sea level rise of some 40–50 cm can be expected over the next hundred years. The relative increase will be greatest in southwestern Denmark, where the country is concomitantly sinking. Around one quarter of the country's 7,400 km coastline is already protected by coastal defences of various kinds.

An increase in sea level will necessitate decisions on how best to balance the interests of nature, agriculture and coastal protection. For example, an increase in sea level will reduce the extent of wetlands and coastal areas in front of the dykes. Threats towards the dykes will increase with increasing sea level, a situation that could be aggravated by changes in the frequency, direction and duration of future storms. Our marshes and dyked-in areas will be particularly at risk (see the figure on page 7).

The increasing sea level could thus cause problems for the birds using our tidal flats, shoals and salt meadows, which are presently of great international significance as staging and breeding areas for ducks and wading birds. Enhanced loss of salt meadows will deteriorate the situation for a number of currently threatened breeding birds, e.g. the common sandpiper and the ruff.

Among migratory birds, two groups are particularly likely to be affected: Wading birds that seek food in the wetlands and water birds that

*The hurricane that hit Denmark on 3 December 1999 caused considerable damage to Danish forests. In Lindet Forest District in southern Jutland, 15–20 years of normal felling was lost – primarily common spruce. However, the hurricane provided the opportunity for the forestry sector to plan for the future by planting new tree species that are better able to tolerate the expected temperature increase.*



Photo: NERI/Mads Hoymand



subsist off plant material, e.g. the brent goose and the wigeon. The latter will be particularly affected if the area of salt meadows diminishes. The birds utilize them when the sea level is high and they cannot reach the food on the bed of our shallow fjords. English and Dutch studies show that when conditions are adverse, the birds fly in over the dykes and exploit agricultural crops. This phenomenon is occurring more often in Denmark now, and can be expected to increase problems with crop damage and conflicts of interest.

Conversely, allowing natural dynamics to prevail – at least in selected areas – would yield a dynamic coastline characterized by coastal cliffs, new sand dunes, salt meadows, marshlands and wetlands.

## The sea

In Denmark and the Baltic region, increasing precipitation will affect the marine environment. Additional fresh water from rivers will reduce the salinity of the surface waters, thereby enhancing stratification of the saline bottom water and the more brackish surface layers. The majority of animals, plants and fish in the sea have adapted to higher salinity. A decline in the salinity of the Baltic Sea and the Kattegat will there-

fore have a negative impact on habitat conditions. Moreover, the enhanced stratification will increase the risk of serious oxygen depletion by hindering mixing of the water column.

The increased precipitation will also increase the leaching of nitrogen to the aquatic environment and increase ammonia deposition from the atmosphere. An increased inflow of nutrients will enhance the present eutrophication problems leading to algal blooms and oxygen depletion.

A temperature increase in the sea will lead to invasion of new species adapted to higher temperatures, but at the cost of the existing species. Just as importantly, there will be a shift in the dominance patterns in the biological systems. This could have major effects, for example on fishery.

## Coastal protection

Even though Denmark is a relatively low-lying country, an increase in the sea level of half a metre will not cause major problems. A number of areas will be at greater risk of flooding, though, as illustrated in the map opposite. The need for coastal defences will therefore increase, and our harbours and sewerage systems, etc. will have to be adjusted to the higher sea level.

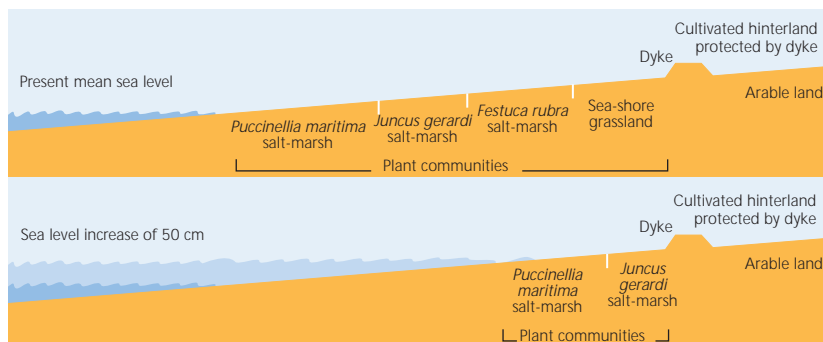
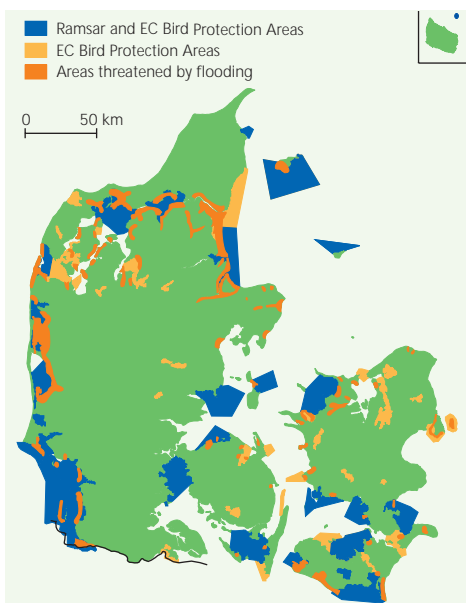
The expected sea level rise therefore needs to be taken into account when we construct new harbours and sewerage systems, as was done for example with the new Ørestad development south of Copenhagen, where the level of the future town squares and Metro entrances have been raised. When infrastructure is safeguarded for the future in the construction phase, the costs are usually marginal.



NERI scientist Jes Fenger, DSc, wrote two popular science books in 2000: An issue of the "Theme Report" series on CO<sub>2</sub> and a high school text book on the greenhouse effect and ecology published by Nucleus.

Left  
Map of threatened coastal areas. Many of the threatened areas are situated near bird protection areas.

Below  
Illustration of the loss of salt meadow should the sea level rise. Low-lying areas of Denmark will be threatened by flooding from storm surges following a global increase in sea level. Large parts of our coasts are protected in various ways. Decisions will have to be made whether to strengthen coastal protection or let nature take its course.



# NERI - An evolving institution

## ***New monitoring tasks assigned to NERI***

The Ministry of Environment and Energy has transferred overall responsibility for a number of environmental monitoring tasks from the Ministry's three administrative agencies to NERI. The new tasks have been gathered in a newly established Environmental Monitoring Coordination Section referring directly to NERI management. The new Section is located in Silkeborg.

The research institutions have long been responsible for the practical side of much of the environmental monitoring, and have built up considerable expertise in monitoring strategies and methods. By centralizing the tasks, NERI expects to achieve synergy from a more effective organization of the work.

NERI's initial responsibility is to coordinate monitoring activities within the Ministry and plan overall prioritization of the national monitoring activities. The next step is to ensure that the decisions are implemented in operational monitoring programmes within the framework of the agreed budget.

NERI has also taken over responsibility for the Ministry's cooperation with the Counties and the major Municipalities, who share a great deal of the actual monitoring work.

## ***National cooperation***

NERI accords great importance to playing an active role in the establishment of cooperation between Danish environmental research institutions. The Institute has consequently entered into a number of cooperative agreements over the years. There is also extensive collaboration at the scientist-to-scientist level, as reflected in the considerable number of joint publications (see the tables on p. 11).

In 2000, NERI entered into an agreement with the University of Copenhagen to establish a research school within the environment and climate areas called COGCI – the Copenhagen Global Change Initiative. NERI will also work towards new cooperation agreements with the Technical University of Denmark, the Royal Danish Veterinary and Agricultural University and the Geological Survey of Denmark and Greenland, and has already entered into a closer cooperation agreement with the Danish Institute of Agricultural and Fisheries Economics.

At the end of 2000 NERI appointed its second research professor (see p. 25). The Institute expects to receive permission to advertise another research professorship in 2001; the target is 4-6 research professorships by 2003.

## ***International cooperation***

NERI is heavily engaged in the international cooperation on the environmental front and is the National Focal Point in the cooperation with the European Environment Agency.

During 2000 NERI actively participated in the European Topic Centre for Inland Waters, which carries out tasks for the European Environment Agency, and the European Topic Centre for Marine Waters. From 2001 onwards these two Topic Centres have been merged as the European Topic Centre for Water. NERI contributes to the new Topic Centre with expertise on both inland waters and marine ecology.

NERI plays a major advisory role during formulation of the scientific foundation for EU directives and orders, as well as in connection with international environmental conventions. NERI also participates in a working group under the UN Economic Council for Europe (UN-ECE)

*Undergraduate students at NERI. NERI regularly has 50–60 undergraduate research students carrying out major or minor parts of their MSc thesis at the Institute – within NERI's programme areas.*



concerning assistance for environmental monitoring, especially in the former Soviet Union. The group is to submit its recommendations at the 4th Pan-European Environment Conference in Kiev.

NERI participates in the Management Committee for Environmental Research under the EU's 5th framework programme for research, technological development and demonstration, and is active in a number of European research networks in several of the programme's themes. In addition, NERI participates in a number of projects under COST and is a member of the Technical Committee for EU Environmental Research (TC-ENV).

In 2000, NERI's Board of Governors decided to enhance the Institute's involvement in international environmental cooperation, primarily externally financed. The background for the decision was the increasing level of Danish international environmental involvement, which is expected to



Photo: NERI

### Danish chairmanship of AMAP

Director of Research Department Hanne Petersen, NERI, is the Chairman of the AMAP (Arctic Monitoring and Assessment Programme) under the Arctic Council, which has members from eight Arctic countries. AMAP monitors the levels of anthropogenic pollution in all parts of the Arctic environment and investigates the effects of pollution and its transport pathways. The working group prepares reports on the state of the Arctic environment and advises governments in the Arctic countries as to what measures are necessary to improve the state of the Arctic environment. AMAP also participated in the formulation of the Arctic Climate Impact Assessment (ACIA), a programme aimed at collecting and assessing available knowledge on climate changes in the Arctic, i.e. an Arctic counterpart to the IPCC.

become increasingly knowledge-based. NERI will be able to contribute expertise, both in concrete projects and through the provision of advice to the administrative system.

In addition to participating in the implementation of concrete bilateral projects, NERI will be able to contribute in the areas international institutional cooperation and networks, as well as in scientific preparation and evaluation of programmes and projects. NERI mainly contributes expert knowledge, and does not primarily intend to send staff members abroad for longer periods. In 2000 and 2001, NERI is participating in development and cooperation projects in a number of East European countries, South Africa, Egypt and Southeast Asia at the request of both Danish and international administrators. Several of the projects in Eastern Europe should be viewed as a step in the recipient countries' move towards the EU.

In addition, NERI is highly involved in Arctic environmental research and development: NERI participates in the international monitoring programme AMAP, carrying out measurements and modelling of air pollution over Greenland and the transport of pollutants to the Arctic, as well as monitoring plants, animals, ecosystems and the occurrence of hazardous substances in biological materials, including the Greenlandic population.



Photo: NERI/Jens Christian Pedersen

### Danish chairmanship of SETAC-Europe

The Third SETAC (Society of Environmental Toxicology and Chemistry) World Congress was held in Brighton from 21–25 May 2000. Notable topics included life cycle analysis, risk assessment, connections between ecotoxicology and human toxicology, and the need for knowledge pertaining to sustainable development. At the congress, NERI Senior Scientist Betty B. Mogensen was elected Chairman of SETAC-Europe.



Photos: GELUS/Peter Appel

*NERI's investigations in Tanzania have shown that the goldmines contaminate workers and the environment with mercury used to extract the gold.*

## Production

As an indicator of productivity, the number of scientific articles, reports, publications, conference presentations and other tangible results of NERI's work is related to the effort expressed in man-years.

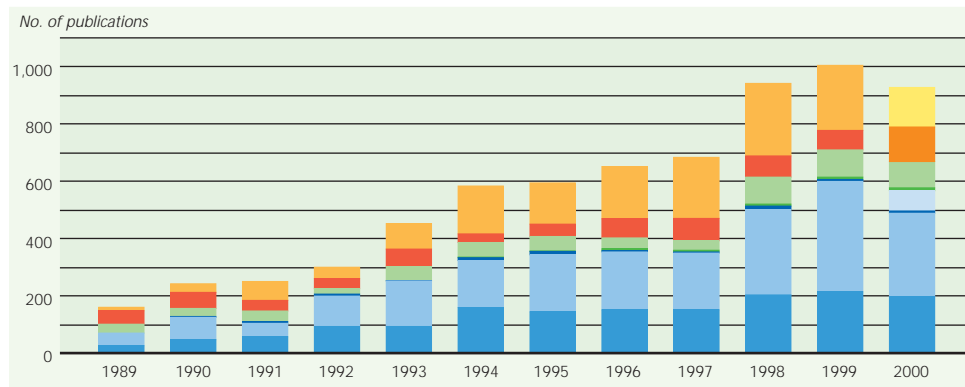
The main production figures for the period 1989–2000 are shown in the illustration below. The increase in annual production over the period as a whole is attributable not only to the increasing number of staff, but also to the fact that each individual member of staff now publishes around twice as many publications as in

1989. In 2000 the number of publications decreased slightly – primarily the conference presentations.

NERI's participation in the education of PhD students and undergraduate research students was enhanced considerably in the years immediately following NERI's establishment. In 1997, after several years with a declining number of new PhD projects, NERI decided to increase its involvement in researcher education. The goal is for NERI to have a permanent population of around 30 PhD students, which among other ways will be attained through cooperation on research schools such as COGCI.

*Visiting researchers, secondments abroad, PhD degrees awarded and MSc theses completed.*

	1993	1994	1995	1996	1997	1998	1999	2000
Visiting scientists (man-months)	37	55	57	60	78	77	51	88
Secondments abroad (man-months)	40	31	55	38	18	15	22	29
PhD degrees (No.)	1	10	13	6	4	11	9	7
MSc theses (No.)	14	23	13	22	16	18	17	33



*Development in the number of scientific publications, reports, conference presentations, etc. Note that the registration method was changed in 2000 such that the emphasis is now on the main aim of the publication, i.e. research, consultancy or dissemination of information.*

## Popular science information

In 1994, NERI launched a series of Danish language popular science theme reports entitled "TEMA-rapport fra DMU". By the end of 2000, NERI had published a total of 35 theme reports, the majority of which have been actively used in environmental education and debate. NERI aims to publish eight theme reports annually.

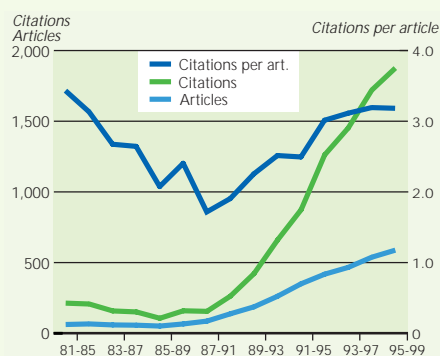
NERI strives for maximum transparency and openness in the Institute's work. As part of this policy, NERI scientists are encouraged to let their own and the Institute's knowledge about nature and the environment come to the benefit of society and public debate. In 2000, NERI has been particularly visible in the media on issues pertaining

to traffic, hunting, toxic algae, episodes of marine oxygen depletion and the mid-term evaluation of the Action Plan on the Aquatic Environment II (see p. 16–17).

NERI has had its own Internet homepage since the mid 1990s. New information is added regularly. In 2000, NERI improved the design and structure of its homepage so as to ensure more rapid and easy access to the desired information. New features have also been added. Approximately 250 publications are now available for downloading in printable form (PDF files), including all issues of the "Theme Report" series and all the more recent issues of the "Technical Report" series. As of 1 January 2001, all new NERI publications are available electronically.

## Analysis of NERI's international scientific articles

To obtain a detailed insight into our scientific production and a clearer impression of the impact of our research, NERI has commissioned a so-called Institutional Citation Report from the Institute for Scientific Information (ISI). ISI registers articles and their references in more than 4,000 peer-reviewed international scientific journals within the natural and technical sciences, as well as about 3,000 journals within the humanities and social sciences. The majority of NERI's international articles are published in journals covered by ISI. The Institutional Citation Report thus encompasses articles in ISI Source Journals in which NERI is listed as the institution of at least one of the authors.



*Development in the number of NERI international scientific articles and associated citations calculated as rolling 5-year intervals (based on data from ISI, Institutional Citation Report for NERI).*

Journal	Articles	Citations	Cit./art.
Marine Ecology-Progress Series	30	226	7.53
Atmospheric Environment	17	61	3.59
Science of the Total Environment	16	16	1
Chemosphere	15	43	2.87
Contact Dermatitis	13	42	3.23
Aquatic Microbial Ecology	12	39	3.25
Hydrobiologia	12	53	4.42
Environmental Toxicology and Chemistry	11	28	2.55
Limnology and Oceanography	10	50	5
Marine Pollution Bulletin	10	36	3.6

*Choice of journal. The 10 international scientific journals in which NERI scientists have published the most articles, 1995–99.*

Country	Articles	Citations	Cit./art.
Great Britain	61	152	2.47
USA	48	190	3.96
Sweden	44	171	3.89
Netherlands	31	171	5.52
Canada	24	75	3.13
Germany	22	90	4.09
Norway	21	48	2.29
Finland	13	28	2.15
France	11	19	1.73
Spain	7	26	3.71

*International collaboration. The 10 countries that coauthors of NERI articles most frequently come from, 1995–99.*

Organization	Articles	Citations	Cit./art.
University of Copenhagen	60	193	3.22
University of Århus	38	151	3.97
Risø National Laboratory	32	95	2.97
Technical University of Denmark	26	63	2.42
DHI Water & Environment	21	73	3.48
Roskilde University Centre	16	74	4.63
University of Odense	16	100	6.25
Royal Veterinary and Agricultural Univ.	15	87	5.80
Greenland Fisheries Research Institute	11	66	6.00
Danish Institute for Fisheries Research	8	30	3.75

*National collaboration. The 10 Danish institutions with which NERI scientists have published the most articles, 1995–99.*

*(Source: All three tables are based on data from ISI, Institutional Citation Report for NERI)*

Natur.dk is a new NERI initiative aimed at presenting information on nature and the environment in an easily accessible form on the Internet. The main target groups are primary and secondary schools and interested members of the public. The initial results of the initiative can already be seen at: [www.natur.dk](http://www.natur.dk) in the form of articles on toxic algae, hull paint, otter management, carbon dioxide, Danish seals and hazardous substances in sewage sludge. NERI's goal is to obtain financing for a four-year project during 2001 and to establish a broad cooperation behind [natur.dk](http://www.natur.dk) in which research institutions, museums and private associations will be invited to participate.



Summary of NERI databases that are to be made accessible via the Internet and regularly updated. All are expected to be accessible no later than by the end of 2003. The magnitude of the work is illustrated by the fact that the on-line atmospheric measurements comprise approx. 10 million items of data, the game bag statistics encompass data from 1941 to the present day, and the marine database system (MADS) contains data from just over 100,000 samples from 3,500 sampling stations.

## Data on the Internet

NERI is continually working towards expanding access to data holdings on the Internet. The work was initiated at the end of the 1990s, but has been made more topical by the Aarhus Convention's requirement of increased public access to information and data on environmental issues. NERI intends to make all its main databases publicly accessible by the end of 2003. Less popular data will be published in the form of regular reports or – in the case of very special data – *ad hoc*. The estimated workload associated with making the environmental data accessible is approx. two man-years annually for four years.

As is apparent from the table below, the work is progressing well. 19 databases are already publicly accessible and it is expected that a further four to six databases will become accessible during 2001.

Database	Established	To be established/expanded
<b>Air</b>		
Emissions to air (CORINAIR)	2000	
Air pollution prognoses	2000	2001
Air quality data	1998	2001-03
Official ozone prognoses <sup>1</sup> (also on text TV)		2001
<b>Water</b>		
Restoration of watercourses		2001
Key figures for nutrient leaching from arable land	2000	
Key figures for watercourses	2000	2001
Key figures for lakes	2001	
Daily updated water levels in 27 watercourses	2001	
Water flow in 27 watercourses		2001
Marine Database System (MADS)	2000	2001-03
Nutrient input to coastal waters	2000	
Oxygen depletion	2000	
<b>Nature</b>		
Wing studies	1999	
Game bag statistics	1999	
Botanical ecosystem quality (DANVEG)	2001	
Orchids		2001
Bird Protection Directive		2001
River Skjern nature restoration project	2001	
Areas important to wildlife in Greenland	1999 <sup>2</sup>	
Zackenberg biobasis	2000	
Reindeer and vegetation in western Greenland	2000	
Greenlandic seabird colonies		2001
<b>Society</b>		
National topic database	1998	2001
Areal Information System (AIS) (meta data and test data)	2000	2001

<sup>1</sup> In cooperation with the Danish Environmental Protection Agency and the Danish Meteorological Institute

<sup>2</sup> Via the Greenland Home Rule

# Highlights

*NERI's six programme areas are presented on the following pages through selected examples of the work carried out in 2000.*

1

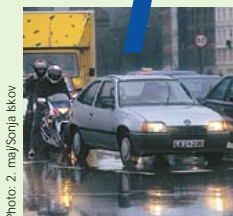


Photo: 2. maj/Sonja Ikkov

Atmospheric environment

2



Photo: NERI

Aquatic environment and nature

3

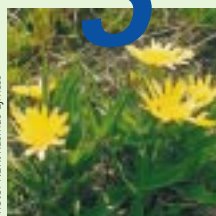


Photo: NERI/Rasmus Ejrnæs

Terrestrial environment and nature

5



Photo: NERI/Mens E. Johansen

Risk assessment of chemical substances and biotechnological products

4



Photo: NERI/Søren Rydgård

Arctic and global environment

6



Photo: NINA/Ole Malling

Cross-disciplinary research

## Activities in 2001

Budget DKK 18 million, of which DKK 7 million derives from contract income. 39 man-years.

### Tasks:

- Investigate air pollution and atmospheric chemistry, including the occurrence and fate of particles in the environment.
- Monitor air quality in Denmark, including exposure of the population to air pollution. Provide advice on air pollution issues.
- Maintain and develop models for the dispersal of air pollution at the local, regional and global scale for use in scenario calculations.
- Participate in national and international cooperation on specifying limit values, standardizing models and measurement methods, and in international environmental cooperation projects and system exports.
- Disseminate forecasts and monitoring results, among other means via the Internet and textTV.

## Ultrafine particles are harmful to human health

NERI's research shows that ultrafine particles stem from both petrol vehicles and diesel vehicles. The individual diesel vehicle pollutes far more than the individual petrol vehicle, but on busy roads, where there are many petrol vehicles, the contribution to ultrafine particle pollution from the two categories is roughly equal. The finding is also partly attributable to limitations on the sulphur content of diesel oil, which have more than halved emissions of ultrafine particles from diesel vehicles. Measurements carried out on city busses in Odense show that exhaust filters can further reduce particle emissions by up to 90%. NERI is currently involved in a number of activities aimed at determining the health risks posed by the ultrafine particles.

It is commonly known that the particles present in urban air are harmful to health, causing both acute effects such as allergy and irritation of the eyes, nose and throat, and long-term effects such as cancer. On the other hand, it is unclear how great a role the air pollution plays for these disorders, which also have a number of other causes.

In part this is due to the fact that the air pollution studies used in the statistical analyses undertaken throughout the world are extremely flimsy. In many cases they only rely upon a single urban monitoring station measuring only the total amount of suspended particles.

It is primarily the smallest particles – those less than 0.1 micrometre in diameter – that are harmful, however. These so-called ultrafine particles are completely overshadowed in measurements of the total weight of suspended particles.

In order to obtain a more realistic picture of this pollution and its effects on health, NERI is collaborating with a number of external partners to determine the air concentration of ultrafine particles and their effects on health. Possibilities for curbing emissions of ultrafine particles are also being examined.

## Small particles and diesel-driven vehicles

To measure the atmospheric concentration of ultrafine particles NERI has started using a so-called differential particle counter able to count air pollution particles by size fraction.

NERI has now used this equipment at a number of monitoring stations in Copenhagen and Odense in 1999–2000, and the first results are being published. The size distribution was found to be very similar in different streets. At roof level there were fewer particles, corresponding to a 3- to 10-fold dilution relative to street level. At the same time, though, there was a shift in the direction of larger particles, probably because of cohesion of smaller particles and the adsorption of gasses on the surface of the particles.

The results also show that the ultrafine particles mainly derive from diesel-driven vehicles. During the studies, emissions of small particles from



## Town dwellers exposed to more benzene than previously believed

In a recent issue of "Nature", NERI senior scientist Henrik Skov coauthored an article by Vincenzo Cocheo and others entitled "Urban benzene and population exposure". Studies of volunteers bearing portable monitoring equipment in six European cities show that the test persons were exposed to twice as much of the carcinogenic substance benzene as would be expected from the background level of benzene in city air. This was attributed to the fact that people are generally on the streets during the rush-hour, when the benzene concentrations in the air are highest.



diesel-driven vehicles decreased by more than half, probably due to a reduction in the sulphur content of diesel fuel from 0.05% to 0.005%. The particles in the air along the traffic artery Jagtvej in Copenhagen now derive almost equally from diesel-driven vehicles and petrol-driven vehicles (see the figure below). It should be noted that there are far more petrol-driven vehicles than diesel-driven vehicles on this road.

The measurements also show that the number of ultrafine particles (less than 100 nanometres) in busy streets closely correlates with the classical traffic pollutants such as nitrogen oxides and carbon monoxide.

NERI has made measurements on city busses in Odense showing that exhaust filters can further reduce the emission of the small particles by up to 90%.

## Measurements of individual inhalation levels

In order to obtain a realistic impression of how much air pollution individual citizens are exposed to, measurements need to be made in the places where people work and live. On average, Danes spend 90% of their time indoors and only very few people spend the whole day at home. A realistic impression of the exposure level is therefore best obtained using monitoring equipment worn by test persons all day from the time they get up in the morning, during their journey to work in the rush-hour traffic, etc. until they eventually go to bed again at the end of the day.

NERI has already used personal portable monitoring equipment on bus drivers and postmen to measure their exposure to nitrogen oxides and carbon monoxide. The technique also proved useful for measuring the exposure of town dwellers to benzene (see box).



Photo: NERIOle Hertel



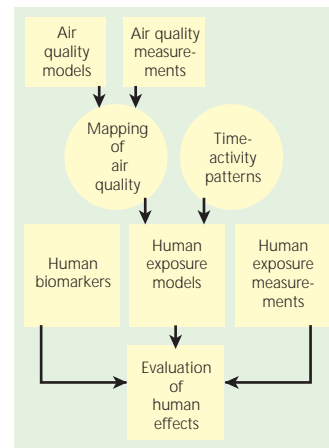
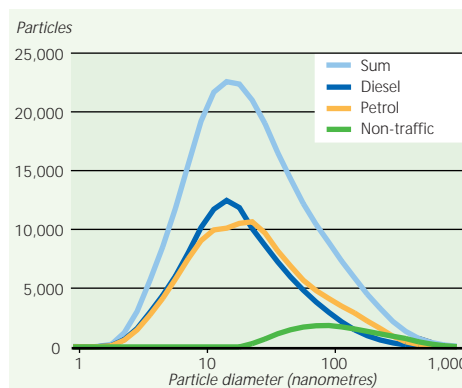
Photo: NERIOle Hertel

The measurements and calculations of the pollutant levels to which people are exposed are correlated with so-called biomarkers, i.e. substances in the blood and urine known to react to specific environmental pressures. The markers can either reveal information about the number of harmful substances that the person takes up or be a direct expression of damage, for example to a gene. In this way the markers can serve as a strong supplement to the exposure data. The biomarkers are measured by a number of scientific collaborators, for example at the University of Copenhagen.

## Strategy for future work

NERI is engaged in broad research cooperation aimed at determining the health effects of ultra-fine particles and other air pollutants within the framework of the Danish Environmental Research Programme, the EU research programmes, the Ministry of Health's Research Centre for Environmental Health, and funds earmarked in the 2001 Government Budget for initiatives on air pollution and health.

In a number of projects, NERI will thus calculate the air pollution exposure of persons included in present and past epidemiological studies, the aim being to determine the relationship between exposure and for example the development of various forms of cancer, cardiac and vascular disorders, asthma and allergies. The studies will be carried out during the next three years.



*The studies of the harmful effects of air pollution on health involve broad cooperation between NERI scientists, who can determine the nature and levels of the pollution and establish models, and external collaborators with expertise in the health sciences.*

*Mean size distribution of airborne particles alongside the major traffic artery Jagtvej in Copenhagen. The particles derive roughly equally from diesel-driven and petrol-driven vehicles despite the fact that there is considerably more petrol-driven traffic than diesel-driven traffic. The measurements were made in January–March 2000. The photographs on the left show the portable monitoring equipment.*



Photo: 2. maj/Sonja Iskov

## Activities in 2001

Budget DKK 57 million, of which DKK 23 million derives from contract income. 109 man-years.

### Tasks:

- Develop models for nutrient transport and cycling.
- Provide competent scientific advice in connection with nature rehabilitation projects, including assessing the environmental consequences of aquaculture, fishery and raw materials extraction.
- Develop tools for assessing the quality of aquatic nature and environment.
- Implement the Danish Aquatic Environment Monitoring and Assessment Programme (NOVA-2003), including assessing the effects of political measures aimed at improving the aquatic environment.

Prince Joachim inaugurated the remeandered River Skjern on 30 October 2000. The project is the largest nature restoration project hitherto carried out in Denmark – and one of the largest in northern Europe. NERI estimates that the remeandering of the river, in which 20 km of channelized river were restored to a 31 km meandering river, and the gradual transformation of 2,200 hectares of agricultural land to uncultivated semi-natural ecosystems will together reduce nitrogen runoff by approx. 210 tonnes per year. NERI participated in the pilot studies and is monitoring the recolonization of the river valley by plants and animals.

## Mid-term evaluation of the Action Plan on the Aquatic Environment II

The Danish Government's efforts to reduce nutrient pollution of the aquatic environment – the Action Plan on the Aquatic Environment – are having the desired effects. Annual nitrogen leaching will need to be reduced by a further 7,000 tonnes if the reduction target of 100,000 tonnes per year is to be achieved by 2003, however. This is one of the conclusions of the mid-term evaluation published by NERI and the Danish Institute of Agricultural Sciences (DIAS) at the end of 2000. The new calculations also show that the level of nitrogen leaching in the mid 1980s was probably higher than hitherto presumed.

The mid-term evaluation was part of the political agreement on the second Action Plan on the Aquatic Environment, VMP II. NERI and DIAS were assigned the task of assessing whether the reduction in leaching of nitrogen from the rhizosphere would be more or less than 100,000 tonnes by the end of 2003.

The first Action Plan on the Aquatic Environment and the Action Plan for Sustainable Agriculture are now estimated to have reduced nitrogen losses from agricultural sources by approx. 66,000 tonnes nitrogen per year.

At the mid-term evaluation of VMP II, NERI and DIAS estimate that the measures encompassed by VMP II and the anticipated development in the agricultural sector will reduce annual leaching by a further approx. 27,000 tonnes nitrogen by



Photo: NINA/Sven Wodschou

2003, giving a total reduction of 93,000 tonnes per year compared to the target of 100,000 tonnes per year. Agriculture thus needs to reduce leaching by a further 7,000 tonnes nitrogen annually to attain the target stipulated in VMP II.

One of the conclusions of the mid-term evaluation is that utilization of nitrogen by the agricultural sector has improved considerably. This is documented in reports on the agricultural sector's nitrogen balances. The annual surplus in the agricultural nitrogen budget has fallen from 510,000 tonnes in 1980 to 385,000 tonnes at present.

The following factors weighed on the "plus" side of the budget:

- Changes in the assumptions on which the plans are based, especially the fact that set-aside acreage is not being phased out as anticipated. This will reduce leaching by approx. 3,000 tonnes nitrogen per year more than anticipated.
- General developments in agriculture up to the end of 2003, including Agenda 2000. This is expected to reduce nitrogen leaching by approx. 2,000 tonnes nitrogen per year.
- Improved utilization of livestock feed, which is expected to reduce nitrogen leaching by approx. 700 tonnes nitrogen per year more than anticipated.

Other factors weighed on the "minus" side of the budget:

- Less new wetlands will have been established by 2003 than expected. The annual reduction in nitrogen leaching by 2003 will thus be approx. 3,500 tonnes nitrogen less than anticipated.
- Expectations as to the amount of farmland that will have been converted to agri-environmental measures in environmentally sensitive areas in 2003 have been reduced. As a consequence, the reduction in nitrogen leaching will be approx. 1,000 tonnes nitrogen per year less than anticipated.
- With current agricultural practices, the various fertilizer-related measures implemented are expected to have less effect by 2003 than anticipated. Consumption of commercial fertilizer will also decrease less than expected. The annual reduction in nitrogen leaching by 2003 will thus be approx. 8,600 tonnes nitrogen less than anticipated.

The scientists have re-estimated nitrogen losses to the aquatic environment in the 1980s. The old figures probably underestimated the extent of the problem. Thus it is now estimated that the total losses were in the order of 300,000 tonnes nitrogen as compared with the estimate of 260,000 tonnes on which the action plans were based. The calculations are not directly comparable, however. If the revised figure for nitrogen losses is used as the starting point, the reduction target will have to be redefined and the effect of the measures needs to be recalculated.

## A long-term endeavour

The scientists' estimate of the reduction in nitrogen leaching is the anticipated long-term effect. It takes many years before a change in agricultural practice is detectable in our watercourses and not least in our estuarine fjords and open marine waters.

This is partly due to the fact that nitrogen turnover in the soil is complicated and that it can take many years before a change in cultivation practice leads to a detectable change in leaching of nitrogen from the rhizosphere, and partly to the fact that it can take many years before these changes in the rhizosphere become detectable in the watercourses and hence in the estuarine fjords and coastal waters – not least on sandy soils, where the majority of the water passes through the groundwater before it reaches the watercourses.

Happily, though, we can see that things are starting to move in the right direction. The results of the Danish Aquatic Environment Monitoring and Assessment Programme show that leaching of nitrogen from the rhizosphere is decreasing and that nitrogen transport in the watercourses that run through agricultural land seems to be declining.

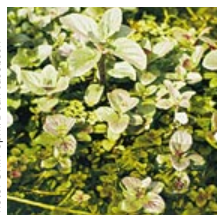


Photo: Unik, Cph /Dean Jacobsen



Photo: NFNA/Bent Laugesen

## The future

NERI and DIAS presented the evaluation reports at a well-attended press conference on 1 December 2000. The topic received intensive press coverage both beforehand and afterwards. The conclusions have subsequently also been presented at a number of scientific meetings. The reports have now been submitted to the parliamentary politicians, among other means at a closed hearing. In the subsequent process, NERI and DIAS have answered a large number of questions, and the two institutions are expected to have to evaluate the effect of the necessary further measures.

In 2001, NERI and DIAS will publish the essence of the mid-term evaluation in a popular science booklet.

NERI and DIAS will carry out the closing evaluation of VMP II in 2002/2003. In the interim period, NERI will follow agricultural development at the national level and through the Agricultural Catchment Monitoring Programme under the Danish Aquatic Environment Monitoring and Assessment Programme. In addition, modelling will be carried out to describe nitrogen leaching and transport to the surface waters.



Photo: NFNA/Omar Ingerslev

*Re-establishment of wetlands is an important element of the Danish Action Plan on the Aquatic Environment II.*

*Summary of the expected reduction in leaching of nitrogen (tonnes per year) in 2003 according to the mid-term evaluation carried out by NERI and DIAS. The anticipated reductions at the time the Action Plan on the Aquatic Environment II was adopted are shown for comparison.*

Measure	Prognosis for the development up to 2003 (Mid-term evaluation)	Expected according to VMP II	Difference
Attained effect of VMP I and Action Plan for Sustainable Agriculture	66,000 <sup>2)</sup>	ca. 63,000 <sup>1)</sup>	3,000
Restoration projects financed by Counties and the state	200	0	200
<b>VMP II</b>			
Wetlands	2,100	5,600	-3,500
Afforestation	900	1,100	-200
Environmentally Sensitive Areas	900	1,900	-1,000
Organic farming	1,600	1,700	-100
Better utilization of fodder	3,100	2,400	700
Stricter livestock density requirements	15,800	300	-8,600
Catch crops on a further 6% of arable land		3,000	
Reduced nitrogen fertilization norms		10,500	
Improved utilization of livestock manure		10,600	
<b>VMP II total reduction</b>	<b>24,400</b>	<b>37,100</b>	<b>-12,700</b>
General development and Agenda 2000, 1998–2003	2,000		2,000
<b>Total reduction in nitrogen load</b>	<b>92,600</b>	<b>100,000</b>	<b>-7,400</b>
<small>1) Based on 1995/96 data extrapolated to 1997</small>			
<small>2) Reassessed at the mid-term evaluation on the basis of 1997/98 data</small>			

### Activities in 2001

Budget DKK 36 million, of which DKK 21 million derives from contract income. 71 man-years.

#### Tasks:

- Develop indicators for terrestrial nature quality and sustainable nature management principles.
- Investigate the effects of among other things organic farming on the species diversity of soil organisms and nitrogen turnover in the soil.
- Monitor selected biotopes and populations of plants, animals and insects, among other things in relation to the EC Habitat Directive, and present the results on the Internet.
- Provide advice on the effects on nature of agriculture and other land uses, air pollution and recreational activities.
- Provide advice on the effects of wind turbines on the fauna, in particular the seabirds and marine mammals.

Thanks to a comprehensive management plan, the Danish otter population is now doing well. The population is estimated to have increased from approx. 200 individuals at the beginning of the 1980s to perhaps four times as many today.



Photo: NERI/Aksel Bo Madsen

#### EXAMPLE

### Rare plants and animals are threatened

A number of rare plant and animal species and some of Denmark's natural ecosystems are on the retreat. This is one of the conclusions of a status report on natural ecosystems and species protected by the 1992 EC Habitat Directive. On the other hand, though, the study also shows that a concerted effort can reverse the trend.

The study was initiated to provide us with knowledge about the areas of Danish countryside designated as worthy of preservation under the EC Habitat Directive. Denmark has selected a total of 194 so-called habitat areas for inclusion in the European network of preservation areas, Natura 2000.

The Habitat Directive requires Denmark to designate preservation areas for 60 types of natural habitat and 40 species of special significance for the EU area as a whole. The preservation areas are designated to ensure a favourable preservation status. In addition, a number of species are to be safeguarded through general protection.

The Directive also requires Member States to monitor the designated areas and the habitat types/species they encompass. As an initial step in this monitoring, NERI has determined the current state of 13 habitat types and 79 species. The results are collated in a status report prepared by NERI in collaboration with the National Forest and Nature Agency and the Danish Counties.



Photo: NERI/Aksel Bo Madsen

### Nature is under pressure

The report concludes that Danish nature is under considerable anthropogenic pressure. Of the 13 habitat types, two are classified as having "Favourable preservation status", while six are classified as "Uncertain", three as "Unfavourable preservation status" and two as "Unknown status".

The two habitat types considered to have a favourable preservation status are "Coastal dunes with juniper" and "Forest-covered peat bogs". Both primarily arise as a result of the areas becoming overgrown. They have become more common in the Danish landscape because sheep no longer graze the dunes and the peat is no longer cut for fuel. Conversely, our rare "active raised bogs" are one of several habitat types threatened by drying out and by nitrogen deposition from the atmosphere.

One of the main reasons for the negative state of affairs is changes in agricultural practice – especially since 1950. There are now far fewer meadows, ponds and small lakes than previously and ammonia continues to be emitted, placing pressure on our raised bogs and dunes.

### Rare plants and animals

The study shows that several rare animals and plants are in danger of completely disappearing from the Danish landscape. Examples are the isolated population of the freshwater pearl mussel in the river Varde, the marsh fritillary butterfly and the fen orchid, whose habitats have been destroyed or deteriorated. Several beetles are also threatened. Of the 79 plant and animal species examined, the preservation status of 14 is assessed as favourable, 22 as uncertain, 17 as unfavourable, 13 as unknown and 13 as disappeared. With 49 of the species, though, the available data is not completely satisfactory.



Photo: NERI/Rasmus Ejre



Photo: NERI/Rasmus Ejre

These findings can be compared with the Red List published by NERI in 1998, which encompassed 11,000 species. Of these, 1,500 were assessed as being so much on the decline due to anthropogenic pressures that their continued existence in Denmark is threatened. A further 1,500 species were so rare that their survival is also uncertain.

It is thus obvious that the 79 species dealt with in the report on the Habitat Directive cannot be considered as an overall assessment of Denmark's nature, among other reasons because there is a natural preponderance of Central European species on the EU lists. Such species that are at the limit of their distribution range could be affected by a change in our climate, as discussed earlier (see p. 6). It is nevertheless a fact that many of the 79 species listed in the Habitat Directive's annexe have previously been more common and might now be on the way to disappearing from the Danish nature, whereas no new species included in the Habitat Directive's annexe have established themselves in Denmark.

Biodiversity is generally diminishing at present. The number of plant and animal species in Denmark is decreasing. Birds are a positive exception, though. Thus more new bird species have become established than have disappeared, among other reasons because hunting has become more sustainable.

## It pays to take action

The picture is not only black, however. The study thus shows that it pays to take action to save threatened species. A few years ago, for example, the otter population in Denmark had declined to only a couple of hundred individuals. Thanks to effective protection measures the population has now increased four-fold, however. The fire-bellied toad and the houting (a salmonoid fish) still occur in Denmark thanks to active preservation efforts.



Photo: NERI/Martin Søndergaard

Help is on its way to some of the threatened areas. Upkeep of open ecosystems by livestock grazing, the establishment of untouched forest and reduction in nutrient loading of watercourses and lakes will help provide rare species with the possibility to survive. There is still a long way to go, however. It is easier to destroy nature than to restore it and it will therefore take many years before we will know whether the rare species will survive here in Denmark.

## New activities

In 2001 the status report on rare species will be included as an annexe to the first overall Danish report to the European Commission on implementation of the Habitat Directive in Denmark.

In autumn 2000, the Danish Government decided to draw up a national action plan to safeguard biodiversity in Denmark. The task has been assigned to a committee led by the former Minister of Trade and Industry, Nils Wilhjelm. NERI is participating in this work together with a number of authorities, research institutions and interest groups. The committee is to submit its report and the outline for an action plan during summer 2001.

NERI contributes to the committee's work in the form of scientific memoranda, reports and other inputs. Together with the Nature Council, for example, NERI has drawn up a proposal for an overall strategy for integrated monitoring of the environment and nature.



NERI has just published an issue of its popular science "Theme Report" series concerning the conflict between agriculture and nature interests in the Tønder Marshes. The area is an example of how scheduling provisions are not always specified in a way that safeguards the interests that is actually intended. In 2000, a number of NERI scientists also contributed several chapters to a new hunting handbook.

Semi-natural grasslands are among the types of ecosystem in which the greatest number of species are threatened.



Photo: NERI/Rasmus Ejrnæs

### Activities in 2001

Budget DKK 21 million, of which DKK 14 million derives from contract income. 34 man-years.

#### Tasks:

- Advise on the impacts of raw materials extraction on nature and the environment, including regular monitoring of the fauna in and around Greenland.
- Monitor and model trans-boundary pollution of the Arctic region, and in particular investigate the risk of the accumulation of heavy metals and persistent organic pollutants as part of the Arctic Monitoring and Assessment Programme (AMAP).
- Forecast and analyse expected effects of global climate changes, including continued monitoring of the development in the overall ecosystem in Northeast Greenland (Zackenbergl).
- Integrate and publish new knowledge on the expected effects of climate changes on freshwater and marine food chains, including the significance of CO<sub>2</sub> and nitrogen exchange between the air and the sea.

Map indicating the migration of 10 female narwhals from Creswell Bay on Somerset Island in Canada to Greenland during August–December 2000.



Photo: NERI/Rune Dietz

#### EXAMPLE

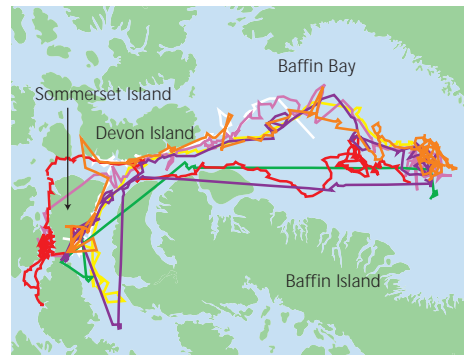
### Satellite monitoring of marine mammals

The large marine mammals are subject to many anthropogenic pressures such as hunting, fishery, oil exploration and extraction, navigation, etc. In order to assess their reaction to the various pressures, NERI scientists tag the animals and follow them via satellite. It is thereby possible to follow the animals in their migration over long distances and to answer such questions as whether the various populations are distinct and whether the animals occur in areas where human activities are planned.

Whales and seals are important to Greenlanders and other Arctic peoples, both culturally and as prey items that can be exploited for food, clothing, hunting tools and jewellery.

An understanding of the distribution and movement of whales is necessary to help identify the areas and periods of importance to them. At the same time, knowledge about how much time the animals spend at the surface can be used to correct population counts for the submerged animals. In this work NERI scientists increasingly use telemetry, i.e. satellite tracking of animals equipped with a transmitter.

NERI started to use this technique in the Arctic region at the beginning of the 1990s. Since then the technique has been continually improved: Satellite coverage is improving and the transmitters are becoming smaller and better designed with improved batteries and a lower energy consumption, thus giving them a longer *in situ* working life. NERI's use of telemetry now also



encompasses the migration of pilot whales near the Faeroe Islands, possible conflicts between fishery and the harbour porpoise in Danish waters, and the consequences of offshore wind farms for grey seals, harbour seals and harbour porpoises.

### Common Greenlandic-Canadian narwhal population

In 2000, 10 narwhals were tagged at Creswell Bay on Somerset Island in Canada, an area where narwhals have not previously been tagged. NERI has now participated in the tagging of 37 narwhals in Greenland and Canada in cooperation with the Greenland Institute of Natural Resources in Nuuk and the Department of Fisheries and Oceans in Winnipeg, Canada. The study showed that the 10 narwhals that were tagged in 2000 inhabit considerably shallower water than those previously investigated.

At the end of September the narwhals left Somerset Island and migrated out through Lancaster Sound. Here they surprised the scientists by travelling across the deep parts of Baffin Bay. Despite taking different routes they reached the same winter quarters, an area on the Greenland side of the continental shelf where the depth is 500–1,500 metres. Depth meters on the satellite transmitters revealed that the narwhals are able to dive to these depths.

It also surprised the scientists that this wintering ground lies more northerly than the common wintering ground revealed by satellite tracking of narwhals five years earlier. The results clearly demonstrate that Canada and Greenland share a common population of narwhals in that area. The results will now be compared with genetic information from the tagged animals.

The scientists intend to follow the whales the whole winter through and identify their spring migratory routes in order to determine whether they return to the areas where they were tagged, or whether they instead choose some of the many other known summer grounds for narwhals in Greenland and Canada. This will necessitate the use of satellite transmitters able to transmit the whole winter through.

## Whales and oil exploration

In 2000, the oil company Statoil carried out test drilling in the seabed west of Fylla Banks, 150 km northwest of Nuuk. In connection with this the NERI scientists investigated the use of the concession area by the humpback whale. Apart from traditional methods such as photographic registration of their tails and dorsal fins, telemetry was also employed. In connection with the latter, skin samples were collected from the whales for biological analyses. In cooperation with the Greenland Institute of Natural Resources, six humpback whales were tagged with satellite transmitters, thereby enabling the migration and diving behaviour of these whales

to be investigated for the first time in Greenland. Mounting of transmitters on these large whales is carried out from a distance using a long pole while the whales are swimming. At present the transmitters do not last as long as those on the smaller whales, and it was thus only possible to follow the humpback whales for up to one and a half months. Preliminary analysis of the results shows that there is contact between the whales observed within the archipelago and those observed in other summer grounds along the west coast of Greenland. This indicates that the whales along the west coast of Greenland comprise one single population that moves between the various areas along the coast, and hence will not be so vulnerable to local oil pollution.



Photo: NERI/Rune Dietz

*NERI's investigations indicate that the humpback whales inhabiting the west coast of Greenland comprise one single population.*

## Satellite tracking



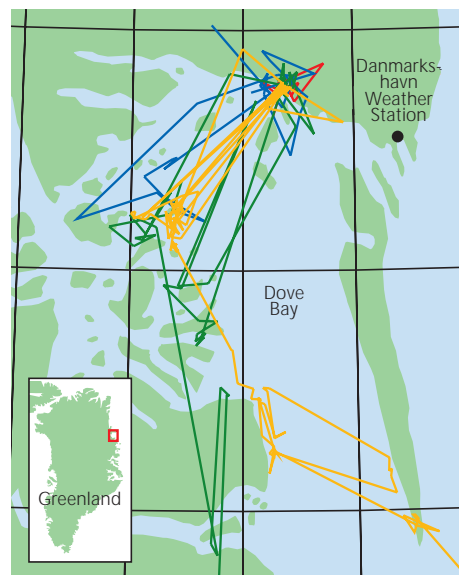
Photo: NERI/Mario Acquarone

In Northeast Greenland, scientists from NERI and the Greenland Institute of Natural Resources have tagged eight walrus with satellite transmitters and time depth recorders as part of a study of energy metabolism in this conspicuous Arctic species. This is done by comparing data on their activity with data on their energy metabolism as determined from the turnover of non-radioactive isotopes of hydrogen and oxygen in water. The mixture is injected into the animals and after an appropriate interval, blood samples are collected for determination of their CO<sub>2</sub> production, and hence energy metabolism.

Among other things, the satellite tracking data showed that male walrus from the area migrate to the "Nordøstvandpolyniet" (an all-year open water area), probably to meet females that inhabit the area the whole year round. The results of the studies of walrus energy metabolism are correlated with studies of algae and mussels, etc. as part of a project, CAMP, aimed at determining the effect of global changes in temperature on production in a High Arctic fjord ecosystem.

## The future

The successful application of satellite tracking to a large number of marine mammals in recent years has provided detailed information on their behaviour – knowledge that cannot be obtained by other means. In the coming years the projects on satellite tracking of whales, seals and walrus in Greenland and Denmark will continue in order to be able to provide answers concerning their behaviour and vulnerability. Such information is vital for the protection and management of these large mammals.



*Satellite tracking of walrus in the Dove Bay area in summer 2000.*



Photo: GINR/Erik Born

## Activities in 2001

Budget DKK 48 million, of which DKK 22 million derives from contract income. 102 man-years.

### Tasks:

- Investigate and provide advice on the occurrence, availability, conversion and degradation of chemical substances in the environment, as well as their effects on the flora, fauna and ecosystems as a basis for risk assessment.
- Further develop methods for analysis and sampling, including control activities in connection with a number of monitoring programmes.
- Refine models for ranking chemical substances.
- Investigate the fate of microorganisms and transfer of genes, establish test systems and develop methods for risk assessment of genetically modified plants.
- Assess the environmental risks associated with the deliberate release of microorganisms and genetically modified plants and animals into the environment.

Activity of the chitin-degrading enzyme (chitinase) in the soil during growth of barley plants treated with the bacterium *Pseudomonas fluorescens* DR54 or the fungus *Clonostachys rosea* IK726, both of which are potential biopesticides. It can be seen that the addition of the fungus resulted in enhanced enzyme activity in the rhizosphere as well as in the bulk soil, but that the effect was temporary: After 100 days the chitinase activity had returned to the same level as in the control experiment.

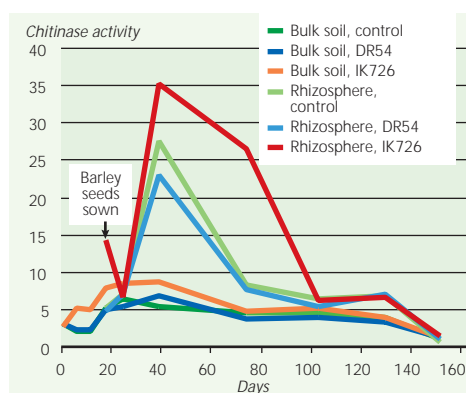
### EXAMPLE

## Biotechnology and risks

As part of the Danish Environmental Research Programme, NERI has participated in investigations to improve our knowledge of factors relevant to risk assessment of the agricultural use of microbiological pesticides. The active organisms in these agents are usually able to survive in the soil, and several can inhibit the indigenous bacterial and fungal communities. The central question, however, is whether the organisms have negative effects in the environment. NERI's investigations have shown that the soil microflora is extremely robust towards the addition of new microorganisms since only short-lasting effects have hitherto been identified.

Agriculture is facing a number of new possibilities to employ bacteria and fungi to reduce consumption of commercial fertilizer and chemical pesticides. The question of whether this will be beneficial to the environment is one of the key issues NERI scientists have been trying to clarify.

To answer the question it is necessary to determine what effects the use of individual fungi or bacteria might have on agriculture, health, the environment and nature. For example, we would like to know whether their use could lead to enhanced leaching of nutrients, emission of greenhouse gasses or to changes in the species diversity of the soil organisms.



## Survival

Numerous studies have shown that bacteria and fungi can survive when applied to the soil. The same applies to the bacteria and fungi used as biopesticides – in fact it is virtually a precondition if they are to have the desired effect. Laboratory experiments traditionally start with high concentrations of microorganisms, which then falls by a factor of 10–1,000 before the population stabilizes or decreases to a size below the detection limit. New experiments at NERI with the bacterium *Pseudomonas fluorescens* DR54 show that the end result is the same whether one starts with very few or very many bacteria, however, i.e. the bacterium is able to establish itself in the soil in any case.

## Environmental impact

Although survival plays a key role in a risk assessment, it is not in itself a problem. The decisive factor is whether the released bacterium or fungus has any detrimental effects in the soil environment.

Laboratory studies at NERI have shown that several of the bacteria used as biopesticides can potentially inhibit a large part of the soil bacterial community – provided, though, that large numbers of bacteria are applied and that their growth conditions are optimal.

Under such conditions a commonly occurring amoeba that normally feed on bacteria was found to survive poorly when it had to eat organisms suitable as biopesticides such as the bacterium *Pseudomonas fluorescens* DR54. This could be a desirable effect by promoting survival of the introduced bacterium and hence prolonging the effect of the microbial pesticide. However, inhibition of bacterivorous organisms will potentially bring the soil microflora out of balance.

The question, though, is whether the marked effects seen on the microorganisms in the laboratory also occur under more natural conditions.



# and biotechnological products

## Large-scale experiments

In order to investigate this issue, NERI collaborated with the Royal Danish Veterinary and Agricultural University on a number of large-scale greenhouse experiments. Pots containing barley plants were treated either with a fungus (*Clonostachys rosea* IK726) or a bacterium (*Pseudomonas fluorescens* DR54), both of which have proven well suited to protecting plants against root-borne fungal diseases. These organisms can be applied to the seed grain prior to sowing. The roots then become colonized by "good" organisms, thereby protecting the plant against attack by pathogenic fungi and bacteria.

In the experiments the scientists tried to maximize the effect of the applied organisms by applying them in large numbers – not only to the seed grain but also directly into the soil. This had virtually no effect on the enzyme activity or composition of the soil microflora, though. One of the few effects observed was an increased level of the enzyme chitinase in soil treated with *Clonostachys rosea* IK726) (see the figure on the opposite page). However, formation of this chitin-degrading enzyme is part of the antagonism of this fungus against pathogenic fungi whose cell walls can contain chitin. The effect was thus a simple consequence of the large number of the applied microbial pesticide at the beginning of the experiment. All the effects observed by the scientists were temporary in nature: After less than 80 days, for example, the level of chitinase had returned to that in the untreated soil.

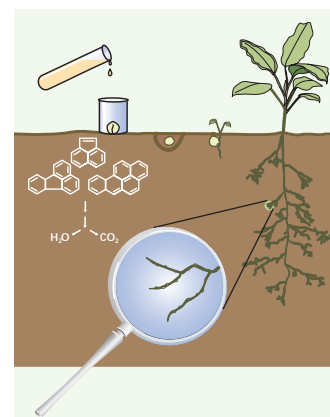
## No risks?

Even though the experiments have demonstrated some effects of releasing a bacterium or fungus into the environment, no evidence was found to indicate a potential for irreversible damage to the environment.

The experiments have shown that the soil microflora is very robust towards the addition of large numbers of microorganisms as these only had a transitory effect on the composition and activity of the soil's natural bacterial and fungal communities. At the same time, the studies have provided the scientists with a greater understanding of the possible unwanted environmental effects associated with the use of fungi and bacteria as pesticides. Among other things, this knowledge will be used in risk assessment when new microbial pesticides are being developed against root and stem diseases in our agricultural crops.

## New activities

The focus within risk research will henceforth shift from the microbial pesticides towards the potential effects of genetically modified plants on the natural soil microbial communities. NERI's expertise in the microbial aspect of a risk assessment will continue to develop as NERI will participate in the Danish Centre for Bioethics and Risk Assessment to investigate the effects of selected genetically modified plants on the biodiversity of the soil microorganisms and on their degradation and transformation of the soil organic matter.



NERI has just been granted a patent for the technique of releasing pollutant-degrading bacteria on plant roots – a patent that was applied for in 1994.



Photo: NERI/lens E. Johansen



Photo: NERI/lens E. Johansen



Photo: NERI/lens E. Johansen

NERI scientists Niels Bohse Henriksen and Bjarne Munk Hansen have just completed rewriting and editing a new WHO monograph on *Bacillus thuringiensis*, the world's most used biopesticide.



## Activities in 2001

*Budget DKK 23 million, of which DKK 7 million derives from contract income. 36 man-years.*

### Tasks:

- Prepare a new "state-of-the-environment" report describing the current state and developmental trends for nature and the environment in Denmark.
- Further develop the "Centre for Analysis of Environment, Economy and Society".
- Collate data, and develop models and knowledge at a high level of aggregation, primarily in relation to land use, agriculture, traffic and energy.
- Develop tools for assessing consequences and priorities in the traffic, agriculture and environment areas.
- Draw up proposals for an overall strategy for monitoring nature and the environment.

*Data and information are largely obtained from NERI's other programme areas supplemented with social science knowledge and data.*

*How is the environment doing? The use of environmental indicators is an attempt to develop a set of indicators that can tell politicians, civil servants and the general public how the environment is doing.*

### EXAMPLE

## Environmental indicators

NERI has played a key role in the development of environmental indicators since 1990. The work has shown that highly aggregated environmental indices, e.g. a green Gross Domestic Product, are unsuitable for assessing environmental trends. In order to provide a sound basis for decision making it is necessary to include several indicators and examine them in a cause and effect context.

For environmental control and regulation to be effective, we need to know where we are and where we want to go, i.e. we need a sound basis for decision making. Coherent sets of indicators therefore need to be developed for assessing all the links in the so-called environmental policy cycle, DPSIR, i.e. Driving forces, Pressures, State, Impacts and Responses (see the figure on the page opposite).

NERI is actively developing environmental indicators and is the scientific heart of a network cooperation within the Ministry of Environment and Energy in this area. In 2000, for example, NERI played an active role in improving the indicators used for environmental assessment of the Danish Finance Act, and participated in the selection of indicators for the national strategy for sustainable development. NERI is also closely following international development in the indicator area, where not least the European Environment Agency and the OECD are active.

NERI recently published a Danish-language report entitled "National and international environmental indicator systems – methodological considerations". The report attempts to review the work done so far on indicator systems – an area that has grown markedly in recent years.



Photo: NINA/Ole Malling

The report is therefore of interest to anyone working with the development of indicator systems, or wanting an overview of the field. The report re-sults from a project on the development of inte-grated environmental indicator systems and na-tional accounts being carried out jointly by NERI and Statistics Denmark. The work is financed by the Danish Environmental Research Programme.

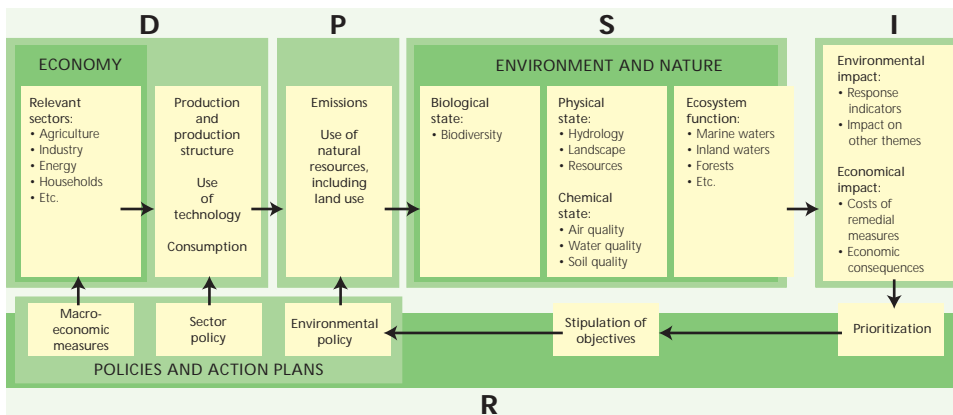
## More than just taking the temperature

Around 1990, when the Ministry of the Environment initiated the work on the development of indicators for the first national indicator report, the politicians wanted to be able to summarize development on the environmental front using a small number of indicators that could be integrated in environmentally - corrected national accounts (or a green national budget). Conversely, there was also a need to find out how economic information and indicators could be better integrated in environmental indicator systems.

The parallel to the health care area was clear: It should be possible to take the "patient's" temperature with the aid of a few simple figures or indices, in this case the patient being nature and the environment.

The analyses show that in practice, the green Gross Domestic Product and other extremely simplified indicators are unsuitable as tools upon which to base environmental decisions. There is no short cut in the form of a single figure or index of development, and in practice it is more appropriate to include several indicators of development and view these in a dynamic perspective that reflects cause-effect relationships in the DPSIR cycle (see the figure on the page opposite).

The report also examines the various classification and information systems that utilize indicators, and analyse the possibilities for setting up and developing various types of aggregated environmental indices. In addition the report focuses on the DPSIR model and the possibilities for making this more dynamic by placing more weight on the relationships between indicators for driving forces, pressures, state, impacts and responses, and on the significance of the time factor for these relationships.



The environmental policy cycle. The so-called DPSIR model describes the interplay between environmental state (S), anthropogenic pressures (P) and the causal direct and indirect driving forces (D). Coupling between environmental state and society can be described by the environmental objectives and measures (R) initiated to counteract unwanted impacts and consequences (I).

## A dynamic indicator system

Dynamic indicator systems of the DPSIR type are systems where the indicators are more actively incorporated as coupled elements in the decision-making cycle, and which describe the relationship between such aspects as the development in the main sectors of society, development in environmental pressures and state, and the effects of specific environmental regulations (see the figure above).

The DPSIR model is increasingly being used as a strategic and analytical tool for solving a number of cross-disciplinary tasks. For example it was used as the structuring framework for the Ministry of Environment and Energy's latest state-of-the-environment report (The State of the Environment in Denmark, 1997). The European Environment Agency also uses DPSIR to couple indicators in its annual indicator reports. More-

over, the system is being used to select indicator sets for the forthcoming Danish national strategy for sustainable development.

NERI is also considering applying the DPSIR concept when planning an integrated monitoring programme for nature and the environment. The scientific core of the monitoring programme will comprise the PSI elements (pressures, state and impacts), the pressures on nature being seen as the result of the general developmental trend in society (driving forces) and as the positive outcome of environmental policy measures (response).

## New activities

In the coming year the focus will be on the development of the indicator term and indicators for selected sectors and environmental themes. More specifically, NERI will participate in the continued work on selecting a set of indicators for the national strategy for sustainable development – indicators in the form of figures and numbers that will illustrate the strategy's objectives and describe its content. The indicators will also be used to determine whether Denmark is moving in the right direction in accordance with strategy objectives.

NERI Senior Scientist Flemming Møller and colleagues from the National Forest and Nature Agency have written a set of guidelines on "Economic Assessment of Environmental Projects". The book, which is directed at Danish governmental agencies, county and municipal authorities and consultancy firms, is part of the Ministry of Environment and Energy's efforts to promote economic prioritization and effectivization.



Photo: NERI/Ann-Katrine Christoffersen

## Research professorship in policy analysis

On 1 January 2001, Dr. Mikael Skou Andersen took up a research professorship attached to the Department of Policy Analysis. The position is a five-year tenure with the possibility for extension for a further three years. Establishment of the professorship is part of efforts to strengthen NERI's competence within analysis of the relationships between societal activities and pressures on nature and the environment. The topic of the professorship is policy analysis, with the main focus being on environmental regulatory measures, environmental economics and environmental policy measures.

# Green accounts



In recent years NERI has intensified internal environmental management on the basis of the Institute's environmental action plan. The main emphasis is on the consumption of energy, water and paper, but waste and purchases of chemicals have been included since 1997. The transport area was added in 1998 by analysing staff commuting between home and work. In 1999, this analysis was followed up by a transport plan aimed at minimizing the environmental impact of commuting and official journeys.

## Initiatives in the transport area

The transport plan resulted in the implementation of two specific initiatives in 2000. Firstly, NERI purchased three sets of video - conference equipment to save staff time and reduce the environmental impact of journeys between NERI's premises on Zealand and in Jutland. This has been installed at our Roskilde, Silkeborg and Kalø premises and is primarily used for internal meetings. The equipment can also be used for external meetings with colleagues all over the world, though – provided they have access to similar video conference equipment.

The first experience with the video conference equipment shows that it has an environmental potential. Fifty-six video conferences were held during the first half year of operation. Of these, 13 were with participants from other institutions, while 43 were internal meetings between NERI premises. These video conferences are estimated to have saved between 62,000 and

94,000 person-kilometres as compared with corresponding meetings held in the traditional manner. Moreover, any increase in meeting activity arising from possession of the equipment is environmentally neutral – and beneficial for communication between NERI's premises.

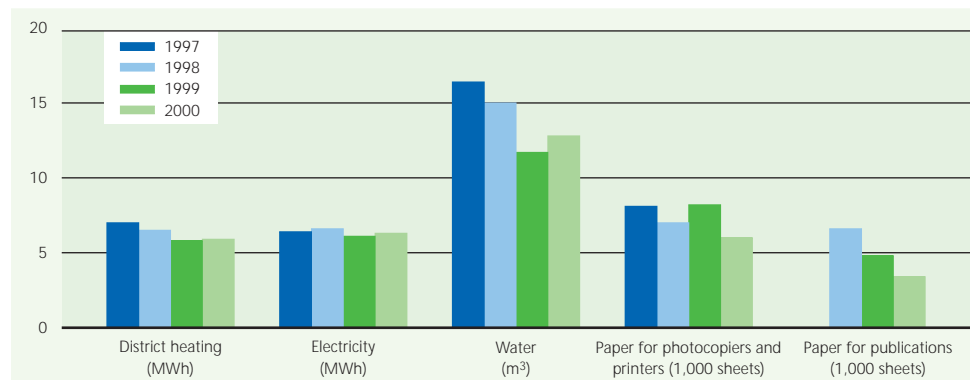
NERI will further promote use of the video conference system in 2001.

In 2000, NERI also established a car pooling database to enable NERI staff to find colleagues to drive to work with. Apart from NERI's own staff, interest has also been shown by the Freshwater Centre, which is NERI's neighbour in Silkeborg. Four members of the Freshwater Centre staff now participate in car pooling facilitated by the database.

## Consumption and trends

The development in NERI's consumption of energy, water and paper is shown in the figure below. More detailed green accounts are included in NERI's annual accounts.

Consumption of water and heat expressed per square metre continues to fall. Following several years of decrease, absolute energy consumption seems to have stabilized or increased slightly. In addition to normal interannual variation, this is attributable to the fact that the total heated area has increased by approx. 700 m<sup>2</sup> due to the new extension at the Roskilde premises and transfer of the Department of Arctic Environment to Roskilde.



Development in NERI's consumption of heat, electricity, water and paper.

Registered consumption of paper for photocopying and printing varies from year to year because it is normally purchased in relatively large quantities. Seen over the period 1995–2000, consumption seems to have remained roughly constant. The paper used is 100% recycled paper.

Additional paper is consumed by NERI in the form of publications printed externally – at environmentally certified printing firms. NERI expects paper consumption for this purpose to eventually fall as our publications are increasingly being published exclusively in electronic form. Up to 2003, NERI plans to reduce the amount of printed publications (excluding the "Theme Report" series and theses) to 20% of the level in 1999. In 2000, ten of NERI's Technical Reports, Working Reports and Technical Instructions were published solely in electronic form, corresponding to 17% of that year's reports in these series.

The development in waste generation by NERI is shown in the table below. The total amount of ordinary waste is unchanged compared with 1999. The trend for the more problematic waste fractions seems to be characterized by variation attributable to marked differences in experimental activity.

With regard to chemicals, NERI continues to replace hazardous substances with less hazardous substances.

## New activities

The work in the coming year will concentrate on the formulation and implementation of a new environmental action plan for the period 2001–2004 based on a common action plan for the various segments of the Ministry of Environment and Energy. The focus will continue to be on energy, green procurement, transport, waste and the phase-out/substitution of unwanted substances such as PVC and lead.



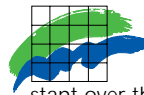
Photo: NERI/Bernhard Fabricius

*NERI's IT Section is among the most frequent users of the new video conference equipment. The Section has staff in all three NERI premises – Roskilde, Silkeborg and Kalø – and they use the equipment to "meet" with each other more than previously – and concomitantly save considerable transport between Zealand and Jutland.*

Ordinary waste	1997	1998	1999	2000
Combustibles	23,855	26,520	34,340	27,120
Noncombustibles (landfill)	560	6,680	4,800	4,800
Recyclable paper	9,458	10,420	4,900	14,190
Recyclable cardboard	4,442	6,240	13,340	9,093
Glass		300	200	200
Electronic scrap	350	1,070	560	2,916
Maculate	39	100	155	100
<b>Ordinary waste (total)</b>	<b>38,704</b>	<b>51,330</b>	<b>58,295</b>	<b>58,419</b>
Microbiological waste	1997	1998	1999	2000
<b>Microbiological waste (total)</b>	<b>2,703</b>	<b>3,800</b>	<b>3,490</b>	<b>3,580</b>
Chemical waste	1997	1998	1999	2000
Mineral oils	28	0	0	0
Organic chemicals containing halogens or sulphur	354	158	342	881
Organic solvents lacking halogens or sulphur	718	1,025	854	528
Organic chemicals lacking halogens or sulphur	1,888	1,070	2,218	2,128
Mercury-containing waste	33	26	33	140
Reactive waste	-	18	0	0
Pesticide-containing waste	181	3,868	778	414
Inorganic chemicals	1,257	972	709	401
Other	1,587	852	2,011	2,353
<b>Chemical waste (total)</b>	<b>6,046</b>	<b>7,989</b>	<b>6,945</b>	<b>6,845</b>

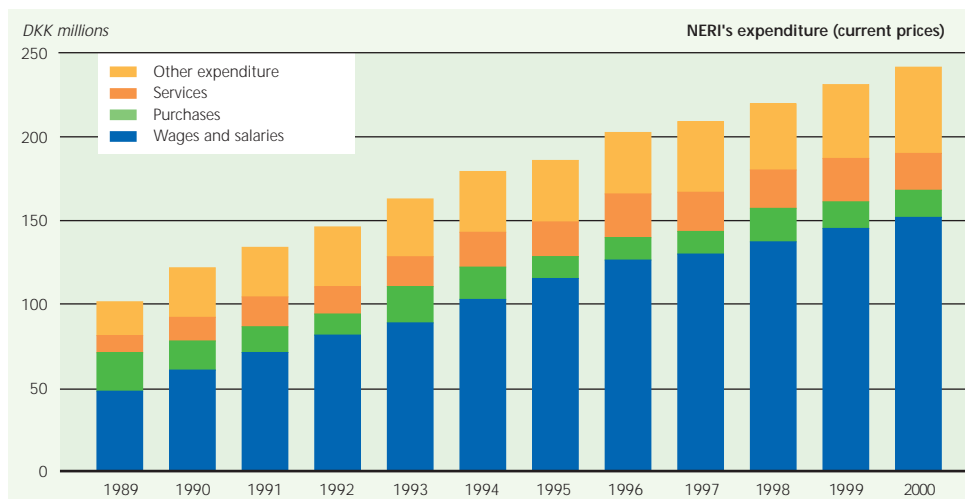
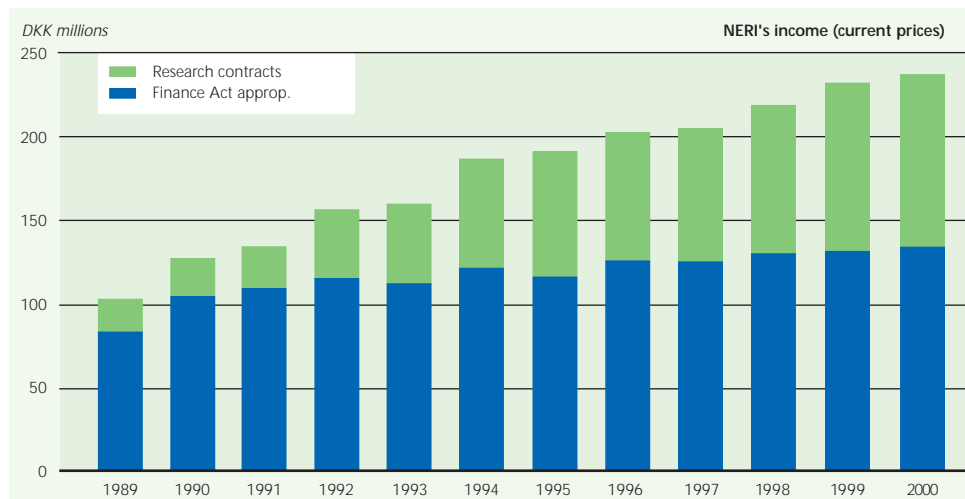
*Waste generation by NERI in 1997–2000 (kg).*

# Economy and personnel



Expressed in real terms, NERI's appropriation under the Danish Finance Act has remained largely constant over the period 1991–2000. The appropriation has only been maintained at this level, however, due to the addition of new tasks and the associated funding, for example the merger with the Greenland Environmental Research Institute in 1994, project contracts from 1996–99, and a special appropriation for pesticide research for 1998–2001. During 2000 NERI was assigned responsibility for a number of new tasks concerning the agricultural use of pesticides. The Institute has been allotted DKK 12 million for these tasks.

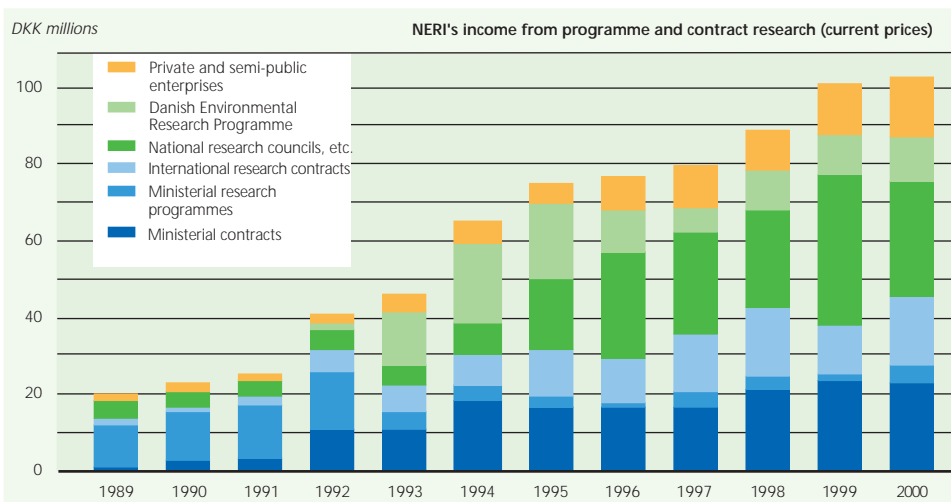
Since NERI's establishment in 1989, external financing in the form of programme and contract research has more than tripled expressed in real terms. NERI's appropriation under the Danish Finance Act was DKK 134 million in 2000, while external financing amounted to DKK 103 million, both figures being almost unchanged relative to 1999. Total operating costs were DKK 241 million, which represents a 4% increase relative to 1999. Of this, 2.5% was accounted for by inflation in the form of price and wage increases. NERI's staff has grown from 270 man-years in 1991 to 444 man-years in 2000, roughly the same as the preceding year.



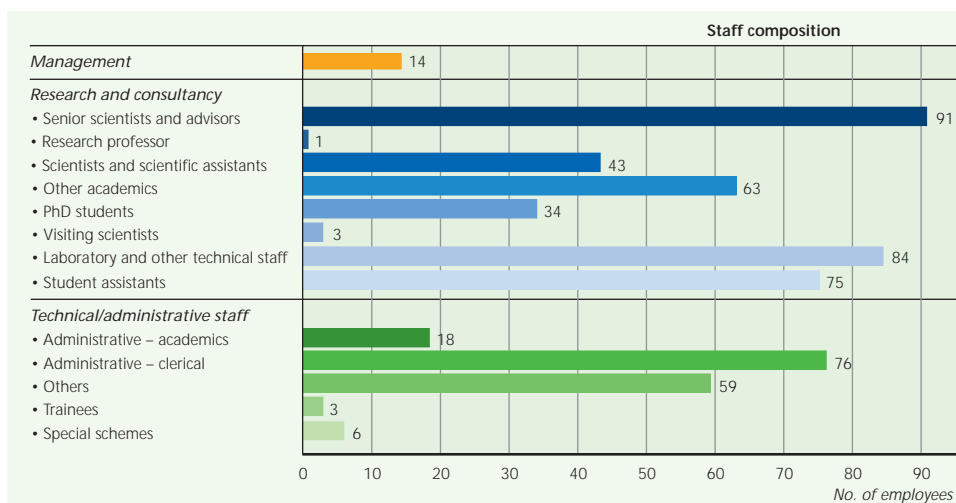
NERI's income totalled DKK 237 million in 2000. Of this, DKK 134 million was NERI's appropriation under the Danish Finance Act while the remaining DKK 103 million derived from programme and contract research, etc. Total operating costs in 2000 amounted to DKK 241 million, excluding interest, depreciation and expected VAT reimbursements. The budget deficit of DKK 4 million will be carried forward to 2001.

## The following obtained the PhD degree in 2000:

- Romi L. Burks
- Henrik Gudmundsson
- Anne Jacobsen
- Henrik Levinsen
- Anne Lise Middelboe
- Bo Normander
- Tenna Riis.

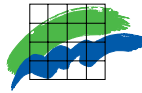


*Development in NERI's total income from research programmes and grants apportioned by source.*

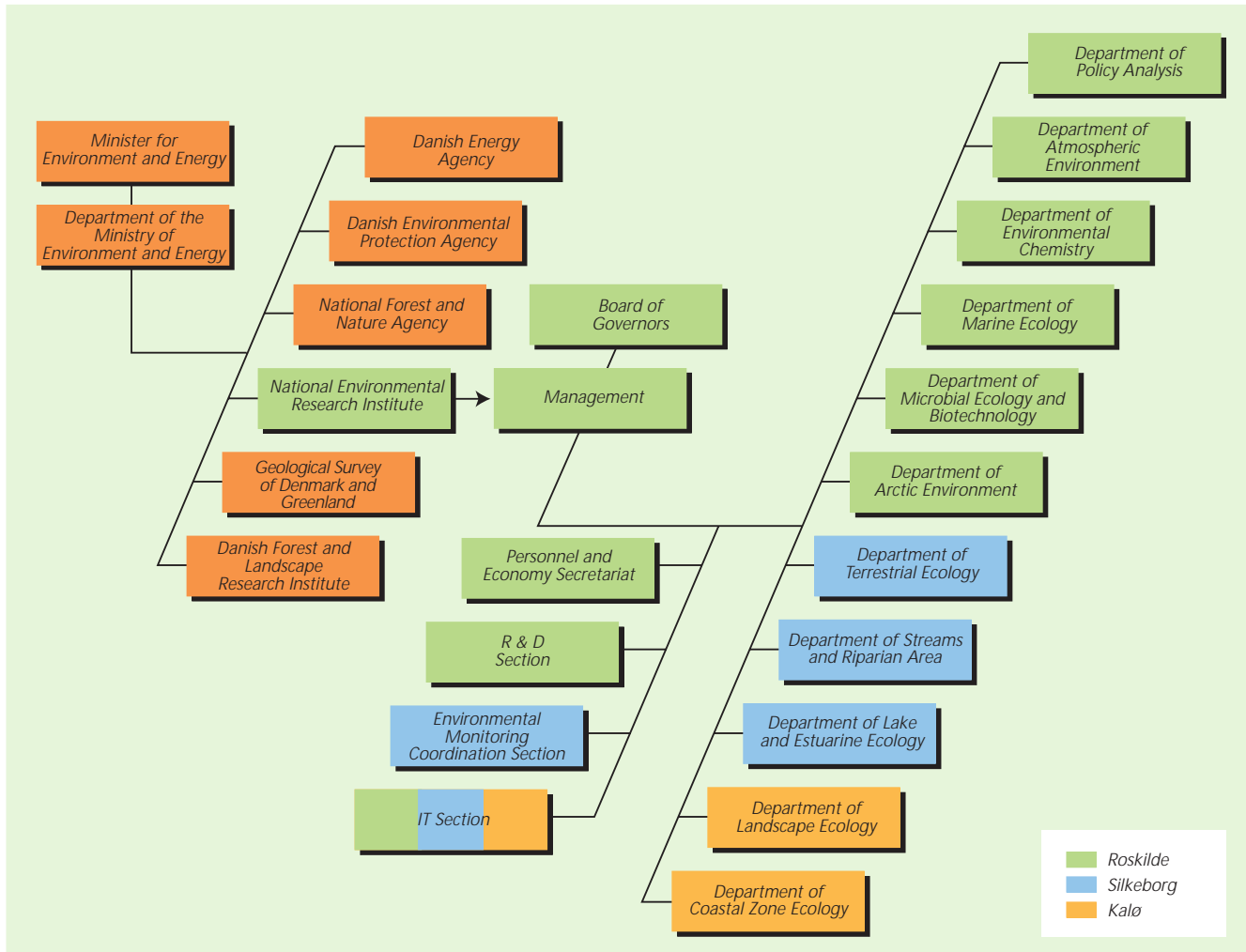


*The number of employees as of 31 December 2000. Total manpower in 2000 amounted to 444 man-years.*

# Organizational structure



NERI is an independent research institute under the Danish Ministry of Environment and Energy. Strategic management is the responsibility of NERI's Board of Governors while day-to-day management is the responsibility of the Director General. The scientific activities are organized under 11 research departments.



■ Roskilde  
■ Silkeborg  
■ Kalø

## NERI's Board of Governors

*Steen Gade*  
 Director General  
 Danish Environmental Protection Agency

*Arne Helweg*  
 Director of Research  
 Danish Insti. of Agricultural Sci.

*Ole Hertel*  
 Senior Scientist, NERI

*Jytte Heslop*  
 Environmental Director  
 Aarhus County Council

*Henrik Høeg*  
 Farmer  
 Danish Farmers' Union

*Iben Koch*  
 Deputy Head of Division  
 National Association of Local Authorities in Denmark

*Svend Krarup*  
 President  
 I. Krüger A/S

*Jens Peter Simonsen*  
 Deputy Director General, PhD  
 National Forest and Nature Agency

*Birgit Søborg*  
 Technician, NERI

*Hans E. Zeuthen*  
 Professor,  
 Chairman

*Katherine Richardson Christensen*  
 Professor  
 University of Aarhus



## **NERI's Management**

*Henrik Sandbech, Director General, MSc*  
*Peter Koefoed Bjørnsen, Deputy Director General, PhD*  
*Torben Moth Iversen, Deputy Director General, MSc*

## **Personnel and Economy Secretariat**

*Director of Secretariat: Ole Bjørn Hansen, MA*

**Responsibilities:** Economy; legal aspects of funding; budgets; legal assistance; personnel management; organizational development; real estate management; records; switchboard; internal service functions.

## **Department of Policy Analysis**

*Director of Research Department: Hanne Bach, MSc*

**Research activities:** Analysis of cross-disciplinary environmental problems involving environmental, technological and economic aspects; development of models, methods and tools within the fields of nutrient and organic matter cycling, environmental economics and sector analysis; National Focal Point for Air Emissions Data; part of the "Centre for Analysis of Environment, Economy and Society".

## **Department of Atmospheric Environment**

*Director of Research Department: Gerald L. Geernaert, PhD*

**Research activities:** Development of meteorological dispersion models; pollutant transformation and deposition; vehicular emissions; charting of air pollution levels; greenhouse effect; air pollution in the Arctic; exposure of the general public.

## **Department of Environmental Chemistry**

*Director of Research Department: Jytte Molin Christensen, DSc*

**Research activities:** Investigation, analysis and modelling of the occurrence, transport and fate of hazardous substances in the environment; control analyses of substances and products for the Danish Environmental Protection Agency; analyses in connection with the Oil Pollution Contingency Task Force; reference laboratory for xenobiotics; development of sampling and analysis methods.

## **Department of Marine Ecology**

*Director of Research Department: Bo Riemann, DSc, Professor*

**Research activities:** Environmental monitoring; National Focal Point for Marine Data; studies on marine ecosystem structure and function, eutrophication of marine and estuarine waters, fate and effects of environmentally hazardous substances, biological oceanography, modelling of marine ecosystems and coupling between sediment and the water column.

## **Department of Microbial Ecology and Biotechnology**

*Director of Research Department: Niels Kroer, PhD*

**Research activities:** Risk assessment of genetically modified organisms and microbial pesticides; survival, activity and effects of released microorganism; gene dispersal; microbial diversity; microbial remediation of pollution.

## **Department of Arctic Environment**

*Director of Research Department: Hanne Petersen, MSc*

**Research activities:** Environmental assessment and monitoring of mineral resource activities in Greenland; baseline studies, fate and effects of hazardous substances; charting of areas of significance for mammals and birds; effects of disturbances on the flora and fauna; responsibility for the biological part of the Climate Monitoring Programme at Zackenberg; studies of Danish marine mammals.

## **Department of Terrestrial Ecology**

*Director of Research Department: Hans Løkke, PhD*

**Research activities:** Investigation of the risks associated with the release of genetically modified plants; organic farming; terrestrial ecotoxicology, including the effects of pesticides and other chemical substances; determination of critical loads; charting of the effects of air pollution on sensitive ecosystems.

## **Department of Streams and Riparian Areas**

*Director of Research Department: Jens Møller Andersen, MSc*

**Research activities:** Investigation of biological, physical and chemical conditions in watercourses and riparian areas, including stream restoration and the development of watershed models; National Focal Points for Freshwater Data, Agricultural Catchment Data and Hydrometric Data; European Centre for River Restoration.

## **Department of Lake and Estuarine Ecology**

*Director of Research Department: Kurt Nielsen, MSc*

**Research activities:** Investigation of relationships between nutrient turnover and biological structure in freshwater lakes, brackish lakes and estuarine fjords; development of restoration methods; National Focal Points for Freshwater Data and Marine Data; coordination of NERI's remote sensing and GIS activities, including development of an Area Information System (AIS).

## **Department of Landscape Ecology**

*Director of Research Department: Jesper Fredshavn, PhD*

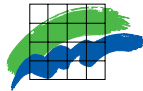
**Research activities:** Investigation of the effects of land use and production practices on wild animals and plants in the agricultural landscape; development of methods and models within population and landscape ecology, including remote sensing and telemetry; classification of habitat quality; development of integrated landscape models for describing the quality of the natural environment.

## **Department of Coastal Zone Ecology**

*Director of Research Department: Henning Noer, PhD*

**Research activities:** Investigation of coastal water bird populations in relation to human activities; managing international databases for goose and seaduck monitoring data; species and habitat monitoring; development of population ecology models; development of strategies for the exploitation and preservation of coastal zone species and habitats.

# Programme areas



The programme areas form the framework for the scientific work in NERI's research departments. They are a central element in NERI's strategy, result targets agreement and annual work programme. The programme areas cut across NERI's departments.

PROGRAMME AREA DEPARTMENT	Atmospheric environment	Aquatic environment and nature	Terrestrial environment and nature	Arctic and global environment	Risk assessment of chemical substances and biotechnological products	Cross-disciplinary research
Policy analysis	No/modest activity	No/modest activity	No/modest activity	No/modest activity	No/modest activity	Major activity
Atmospheric Environment	Major activity	No/modest activity	No/modest activity	Considerable activity	Considerable activity	No/modest activity
Environmental Chemistry	No/modest activity	No/modest activity	No/modest activity	Some activity	Major activity	No/modest activity
Marine Ecology	No/modest activity	Major activity	No/modest activity	Some activity	Considerable activity	Some activity
Microbial Ecology and Biotechnology	No/modest activity	No/modest activity	No/modest activity	No/modest activity	Major activity	No/modest activity
Arctic Environment	No/modest activity	No/modest activity	No/modest activity	Major activity	No/modest activity	No/modest activity
Terrestrial Ecology	No/modest activity	No/modest activity	Some activity	No/modest activity	Major activity	No/modest activity
Streams and Riparian Areas	No/modest activity	Major activity	No/modest activity	No/modest activity	Some activity	Some activity
Lake and Estuarine Ecology	No/modest activity	Major activity	No/modest activity	Some activity	Considerable activity	Considerable activity
Landscape Ecology	No/modest activity	No/modest activity	Major activity	No/modest activity	Some activity	No/modest activity
Coastal Zone Ecology	No/modest activity	No/modest activity	Major activity	No/modest activity	No/modest activity	No/modest activity

No/modest activity

Some activity

Considerable activity

Major activity

## ***National Environmental Research Institute (NERI)***

The Institute's Danish name is Danmarks Miljøundersøgelser (DMU).

The National Environmental Research Institute (NERI) is a research institute affiliated to the Danish Ministry of Environment and Energy. NERI's mission is to provide a sound and informed scientific basis for environmental decision-making at the political, administrative and commercial levels.

### ***Visit our homepage at [www.dmu.dk](http://www.dmu.dk)***

NERI's homepage provides information on the Institute's activities concerning the environment and society, xenobiotic substances and GMOs, the aquatic environment, the terrestrial environment, air pollution and the Arctic and global environments. State-of-the-environment information is also presented. Information about the Institute includes:

- Current projects
- Organization, departments and staff
- How to find NERI
- NERI publications: A database of all the publications published by NERI scientists; NERI reports in full text version (PDF).

**National Environmental Research Institute  
Ministry of Environment and Energy, Denmark**

