



report

IVL Swedish Environmental Research Institute

Regional marine and air pollution
problems in the Nordic Countries

Status and suggestions for further
work with the NMR's Sea and Air
Group

Peringe Grennfelt
in collaboration with the
Sea and Air Group and its Expert Group

Nordic Council of Ministers

B 1584
March 2004



norden

SUMMARY.....	2
INTRODUCTION	3
ENVIRONMENTAL OBJECTIVES FOR THE NORDIC COUNTRIES	4
ACHIEVEMENTS AND PROJECTS WITHIN THE NORDIC SEA AND AIR GROUP	5
STATUS AND TRENDS IN WATER AND AIR POLLUTION.....	6
CONSIDERED COMPOUNDS AND EFFECTS	6
ENVIRONMENTAL STATUS AND TRENDS	7
<i>Eutrophication of terrestrial ecosystems.....</i>	<i>9</i>
<i>Marine eutrophication</i>	<i>9</i>
<i>Particles.....</i>	<i>11</i>
<i>Heavy Metals</i>	<i>11</i>
<i>Persistent Organic Pollutants POPs.....</i>	<i>12</i>
POLICY PROCESSES AND ACHIEVEMENTS	12
THE CONVENTIONS.....	12
OTHER POLICY ACTIONS OF IMPORTANCE FOR THE STRATEGY OF THE SEA AND AIR GROUP.	17
ENVIRONMENTAL STRATEGIES TO COMBAT ENVIRONMENTAL POLLUTION.....	17
CONVENTIONS AND THE EU AS DRIVING FORCES AND INSTRUMENTS FOR ENVIRONMENTAL POLICY	21
A COMPARISON BETWEEN THE INTERNATIONAL CONVENTIONS AND THE EUROPEAN UNION	22
DIRECTIONS FOR THE FUTURE.....	24
WILL CLIMATE CHANGE POLICIES CONTRIBUTE TO THE SOLUTION OF THE REGIONAL POLLUTION PROBLEMS IN NORTHERN EUROPE?	25
NITROGEN – A NEED FOR A COMMON POLICY?	26
POSSIBLE DIRECTIONS FOR THE NORDIC COLLABORATION WITH RESPECT TO REGIONAL POLLUTION.	28
WHAT NEEDS TO BE DONE WITHIN THE DIFFERENT ENVIRONMENTAL FIELDS?	29
<i>Regional air pollution – acidification, nitrogen deposition, ozone and particles.....</i>	<i>29</i>
<i>Marine eutrophication</i>	<i>30</i>
<i>Heavy metals and persistent organic compounds.....</i>	<i>31</i>
<i>Other issues.....</i>	<i>32</i>
CONCLUSIONS	32
REFERENCES	33

Summary

The main objective of the Sea and Air Group under the Nordic Council of Ministers is to support the Nordic Countries in their work to control large scale marine and transboundary air pollution influencing Nordic countries and adjacent areas.

During its 10 year history, the Sea and Air Group has been successful in forming common views and strategies to combat atmospheric and marine pollution. The work has been undertaken in the perspective of the Nordic environmental strategies. During the last years new elements have been introduced into the strategies, such as sustainable development and actions to combat global change.

In the present report the different Nordic environmental strategies are briefly presented and discussed from the perspective of marine and air pollution. Status and trends for the main environmental problems are outlined. The policy processes, in particular those through international regional conventions and the European Union are presented and evaluated in terms of achievements, strengths and weaknesses.

The report also presents some possible directions for the Sea and Air Group; in relation to environmental problems and priorities as well as in relation to the policy development in Europe.

Sammanfattning

Den huvudsakliga målsättningen för Hav- och Luftgruppen under Nordiska Ministerrådet är att stödja de nordiska länderna i deras uppgift att begränsa de storskaliga havs- och gränsöverskridande luftföroreningar som påverkar de nordiska länderna och deras närområde.

Hav- och Luftgruppen har under sin 10-åriga historia varit framgångsrik i att skapa gemensamma synsätt och strategier för att begränsa havs- och luftföroreningar. Arbetet har genomförts med utgångspunkt från de nordiska miljöstrategier som tagits fram under denna period. Under de senaste åren har nya element inkluderats i strategin, främst kopplade till hållbar utveckling och åtgärder för att begränsa klimatförändringar.

In den föreliggande rapporten presenteras och diskuteras de aktuella miljöstrategierna översiktligt med utgångspunkt från havs- och luftföroreningar. Tillstånd och trender sammanfattas för de viktigaste föroreningarna. De politiska systemen för hav- och luftföroreningar, särskilt de inom regionala konventioner och inom EU, presenteras och diskuteras in termer av styrkor och svagheter och vad som de facto uppnåtts.

Rapporten pekar också på några möjliga inriktningar för Hav- och Luftgruppen i relation till olika problem och prioriteringar inom miljöområdet liksom i relation till utvecklingen i Europa.

Introduction

International marine and air pollution problems are of large concern for the Nordic Countries. Eutrophication, acid deposition, the dispersion and effects of toxic substances are environmental problems since long being known as real threats to the Nordic environment. Similarities in exposure and effects as well as a joint responsibility for common marine resources have made the environment to an area of particular interest for the Nordic Countries and Nordic collaboration.

Nordic collaboration in the field of environment has gone on for decades. In the early seventies acid rain was a topic for joint Nordic activities under *Nordforsk* and later the *Nordic Council of Ministers* set up groups on various environmental problems including marine and air pollution.

The commonalties between the Nordic countries have been expressed in several policy agreements. Policy action plans have also been developed, e.g. *Nordiskt Miljöprogram* (Nordic Environmental Program) from 1989 (NMR, 1989) and the *Nordic Strategy for the Environment* from 1994 (NMR, 1994). Both these strategies were agreed upon on a ministerial level. More recently common agreements and strategies were developed on Sustainable Development (NMR, 1998).

The practical environmental collaboration between the Nordic countries is organised in several Working Groups. One of these is directed towards marine and atmospheric pollution problems – The Nordic Sea and Air Group (Hav- och Luftgruppen). The Group was formed in 1993 through a fusion of two earlier groups directed towards marine and air pollution separately. The aim of the Group is to support the Nordic Governments with knowledge and with common bases for international actions. Regional air and marine conventions and EU's work on regional pollution have been the main focus of the group. Even if Iceland and Norway are not members of EU, these countries are strongly affected by EU legislation through the EES agreements.

Several international actions are today taking place, which will influence the environment in the Nordic countries and also the work of the Sea and Air Group. The group has therefore set up a project on its future strategies to create a better understanding of the role and priorities of the group. One part of this work was a seminar held in Göteborg in April 2002. Another part of the work has been a workshop on marine eutrophication in Göteborg in March 2003. The outcome of these meetings can be found on <http://nmr.ivl.se>.

The objective of this report is to briefly present and discuss the international pollution problems in relation to the Nordic Countries and examine the different activities and policies and, based on this examination, discuss and propose priorities.

Many of the environmental problems affecting the Nordic countries are common between the countries, both with respect to effects and sources. Similar effects occur over large regions within the Nordic countries and the surrounding seas. The sources are often outside the Nordic area, and common for both water and air pollution. A common understanding has through the years formed a Nordic basis for strategies and actions. The work has been successful and the joint Nordic efforts have significantly influenced negotiations and decisions under conventions and elsewhere. Nordic

initiatives have also been of importance for environmental investments in the former East Europe.

When assessing regional environmental problems of importance for the Nordic countries, it is of course necessary to include all the land areas from Finland in the East to Greenland in the West, but it is also important to take into account the surrounding marine areas. The marine areas include parts of the North East Atlantic, the waters surrounding Greenland, the Polar Sea, the North Sea and the Baltic Sea with sub-basins. Since the problems considered are of international origin, it is also important to take into account the development and environmental strategies in the non-Nordic countries in Northern Europe which have a large environmental impact on the above mentioned areas. Of particular interest is the development in Russia, the Baltic States, Germany and United Kingdom. Sources at sea (drilling systems, ships) are also of importance to consider.

Environmental objectives for the Nordic Countries

In 1998, the Prime Ministers from the Nordic countries adopted a declaration on Sustainable Development. It states that Sustainable Development is one of the most important challenges for the Nordic Countries (NMR, 1998). This declaration initiated the development of a strategy substantiated in the report *Baeredyktig udvikling. En ny kurs for Norden* (Sustainable Development. A new direction for the Nordic Countries) (NMR, 2001) and a declaration of the Nordic ministers of Environment in 1999. The strategy is a comprehensive document covering several crosscutting areas; Climate, Biodiversity, The Sea, Chemicals and Food Safety. In a second part the development within some sectors are discussed; energy, transport, agriculture, industry, fishing and forestry.

Sustainable development and the work within the Sea and Air group.

The 1998 Declaration of the Prime Ministers states *i.a.* that

- The generations of today and tomorrow should be ensured a safe and healthy life,
- The biodiversity and productivity of ecosystems should be maintained,
- Emissions of pollutants to air, soil and water should not exceed critical loads and limits,
- The principle of sustainable development should be integrated into all sectors in the society.

This statement thus clearly states that environmental threats to man and ecosystems are important issues under the sustainable development strategy and that work to combat environmental threats is of common concern for the Nordic countries.

The strategy report *Baeredyktig Udvikling* includes, as mentioned above, a specific chapter on the Sea, which points to the importance of solving the marine pollution problems. Marine projects and activities under the Sea and Air Group are well in line with the priorities in the strategy.

Air pollution was not given a specific chapter but it is mentioned several times in the sector chapters, where it is stated that emissions should be reduced to protect human health and environment and that the long term objective (2020) is that the critical loads should not be exceeded.

The short-term objectives have been substantiated in the *Nordic Environmental Action Programme 2001-2004* (NMR 2000). This program contains more clear objectives of relevance for the Sea and Air Group. It points to the importance of taking actions in order to solve the regional pollution problems using cost-efficient and effect-based (critical loads etc.) approaches. The action programme points in particular to the importance of sector integration and to supporting activities in areas, adjacent to the Nordic Countries. The most important adjacent areas are Northwest Russia, the EU accession countries and the Arctic.

Achievements and projects within the Nordic Sea and Air Group

Large-scale environmental problems are complicated in their nature. The relations between sources and effects are seldom obvious and successful control needs joint actions in many countries. In order to take appropriate measures there is a need for reliable data on environmental status and trends as well as a quantitative knowledge on relations between sources and effects. The Sea and Air group has in its work on the development of abatement strategies focused its work towards strengthening the knowledge about the problems, their causes and solutions. The work is done in close relation to the policy development in the Nordic countries, within different regional conventions and within the European Union. Since the final objective for actions is human health and welfare and sustainable ecosystems, the activities of the group have a given place in the Nordic strategy for sustainable development and the Nordic environmental action plans.

The Nordic Sea and Air Group has during its last five years focused its work on two important environmental issues;

- marine eutrophication, where the environmental status and trends have been disappointing in view of the situation in many waters, and
- transboundary air pollution, where European countries are expected to negotiate further emission reductions in a near future.

There are a number of projects and activities through which the Nordic countries directly influence the international environmental policies. Areas where the results from Nordic activities have had an immediate influence on policy include

- The development and application of the critical loads concept for the control of air pollution in Europe
- the development of the multi-pollutant, multi-effect concept used in the Gothenburg Protocol and the EU NEC directive
- improved knowledge on the effects of anti-fouling agents in sub-arctic environments

Other projects of importance for international policy include

- The organisation of a workshop in 2000, at which the scientific and policy needs for the EU CAFE programme and the revision of the Gothenburg Protocol were outlined. The outcome of this workshop has to a large extent been followed by the international organisations.
- The development of theoretical models for formation, dispersion and deposition of particles.
- Development of models for abatement strategies for marine eutrophication.

Status and trends in water and air pollution

Considered compounds and effects

In this chapter the aim is to present a brief overview of the main regional marine and air pollution problems of concern for the Nordic Countries. It is not the aim to cover all environmental problems, neither it is the objective to present and discuss problems that are of concern for one country or a small region in the Nordic area. Several simplifications are made in order to form a background for a priority discussion. More comprehensive pictures of the environmental status and trends can be obtained through reports from e.g. EEA (State of the Environment reports), the regional air pollution and marine conventions, and through environmental authorities in the Nordic countries.

The environmental threats considered are compiled in table 1.

Table 1: A schematic compilation of the most important environmental effects from regional pollution in the Nordic areas and their causes in terms of emitted compounds.

	Sulphur	NO _x	NH ₃	N o P to water	VOC	Heavy metals	POPs
Acidification soils, streams and lakes	X	X	X				
Eutrophication of terrestrial ecosystems		X	X				
Eutrophication of marine ecosystems		X	X	X			
Tropospheric ozone (vegetation and health)		X			X		
Particles – health	X	X	X		X		
Ecotoxic./health Effects						X	X

VOC = Volatile Organic Compounds; POPs = Persistent Organic Pollutants;

As seen from the table, none of the effects can be allocated to the emissions of one single compound. Instead, all effects are caused by the emissions of two or more compounds. Abatement strategies need therefore to consider the different compounds and their relative importance in combination. In addition, for the regional effects considered in this report, it is not possible to make a simple source allocation. The complicated situation can be illustrated by the relations between sectors, emitted compounds and effects for regional air pollution. (Figure 1). Other effects (e.g. climate change) and compounds (e.g. methane, and metals) can be added to the figure.

How this situation has been handled and can be handled in connection with abatement strategies will be further discussed later in this report.

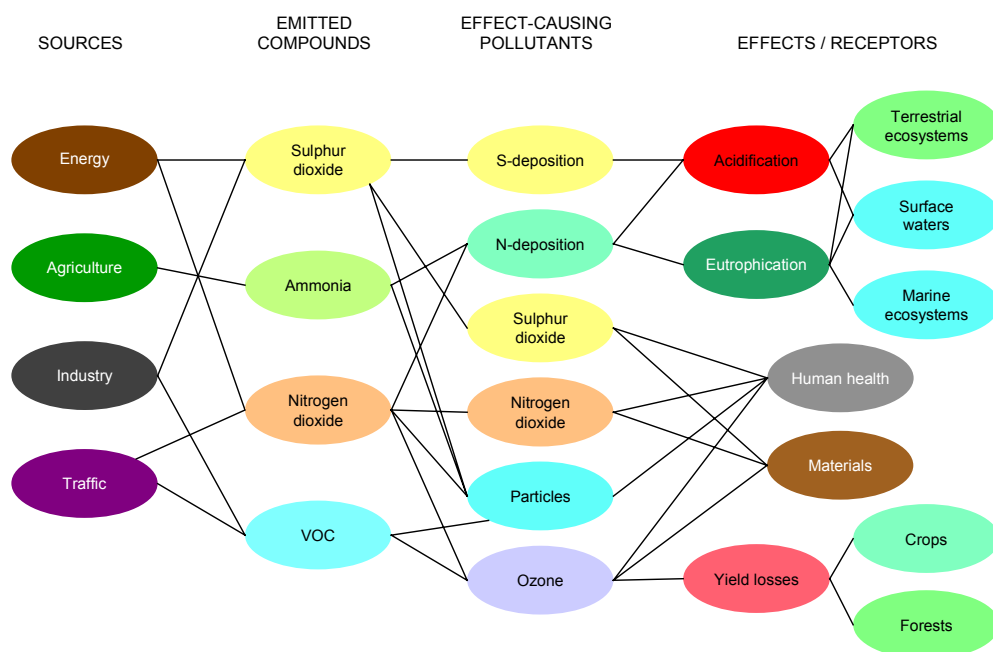


Figure 1 Connections between sources, compounds and environmental effects for regional air pollution

Environmental status and trends

Environmental status and trends are topics for a large number of studies and compilations under international conventions and through other processes, e.g. the European Environment Agency. In this report we are not going to repeat this work but rather draw some of the general conclusions, which later will form the basis for the strategy discussion.

All the environmental effects mentioned in Table 1 are today on the agenda in international conventions and topics for national and EU legislation. North European emissions are, according to statistics, in general decreasing and are expected to decrease further during the next 5-10 years. In some cases, as for acidification, recovery is observed in terms of biological and chemical improvements in the ecosystems. For other environmental problems, the situation is less promising and there may be questions if our overall understanding of processes is sufficient or if there are time lags that are much longer than we originally assumed. Marine eutrophication and the environmental risks of many persistent compounds are problems, where the situation is only partly improving.

In Table 2 an estimate is made of the development in *environmental and health effects* with respect to the situation in the Nordic area as whole. It maybe presumptuous to make such an estimate but the table should be used as an indication on where there are clear signs on improvements and where we still wait for such indications. The status table will also form a background for the further discussion on priorities for the Nordic Sea and Air Group.

The table also contains a judgement on the relative policy attention to the environmental problems. This judgement may be even more presumptuous and subjective but it is based on how the problem is handled within the Nordic Council Ministers, international conventions, EU and in national strategies. The table has also been subject for discussions within the Sea and Air Group and its Expert Group. An arrow behind the marks indicate if and in which direction the policy attention has changed significantly during the last five years.

Table 2 Regional environmental problems in the Nordic Countries. Extension, trends and policy attention. The judgement of policy attention is based on strategy documents within Nordic Council of Ministers, EU priorities and National interests. Conclusions are general and exceptions with respect to single pollutants and regions can be found. Further comments are given in the text.

	Extension of the problem	Trends in effects	Policy attention
Acidification of soils and waters	XXX	++	XX ↓
Terrestrial eutrophication	X	+	X
Marine eutrophication	XXX	- (+)	XXX
Ground level ozone - human health	X	+	X
Ground level ozone - forests and crops	X	0	X
Particles – human health	XXX	+?	XXX ↑
Ecotoxic. /health effects – heavy metals	X	++	X ↓
Ecotoxic./health effects– mercury	XX	+ (?)	XX ↑
Ecotoxic. /health effects– POPs	XX	?	XX ↑

Extension of the problem

XXX Very severe problem with negative effects affecting large areas in the North

XX Severe problem with negative effects affecting significant areas in the North

X Environmental problem of limited significance in the Nordic countries

Trends

++ Strong improvements during the last decade.

+ Significant improvements

0 No significant change

- Significant deterioration

-- Strong deterioration

Policy attention

XXX Highest priority for policy action.

XX High priority for policy action.

X Important environmental problem but not on the priority list for immediate action.

Acidification:

Trends: Emissions of sulphur dioxide from land-based sources in Northern Europe are down by approx. 70% since 1980. Similar reductions in atmospheric deposition are observed (EMEP, 2003). A remaining problem is emissions from international shipping. Emissions of nitrogen oxides and ammonia are also decreasing but with much smaller numbers than for sulphur dioxide. Even if there are clear positive trends, emission control under the Gothenburg Protocol and NEC Directive will however not be enough to reach critical loads for acidification.

Policy attention: The attention from policy has continuously decreased throughout the last five years, in particular since the Gothenburg Protocol was signed. The large control measures with further reductions until 2010 has certainly contributed to the lower interest and there is a tendency in opinions that the problem is solved. (Table 3)

Table 3. Reductions in European emissions between 1990 and 2010 according to the Gothenburg Protocol.

	SO ₂	NO _x	VOC	NH ₃
EU	- 75	- 50	- 56	- 15
Sweden	- 44	- 56	- 54	- 7
Remaining countries	- 49	- 31	- 28	- 20
Europe total	-61	- 42	- 44	- 18

Eutrophication of terrestrial ecosystems

Trends: Nitrogen deposition is the main cause of local and regional eutrophication of terrestrial ecosystems in the Nordic Countries. Emissions and deposition of nitrogen compounds are decreasing but not as fast as for sulphur and emission reduction objectives for 2010 are also less demanding than those for sulphur. Trends in atmospheric concentrations and deposition are also similar to those in emissions. Eutrophication effects are also obvious, especially in Southern parts in Scandinavia and in agricultural areas.

Policy attention: Terrestrial eutrophication was included in the development of the Gothenburg Protocol but with less attention than acidification and ozone effects. In international air pollution strategy discussions, terrestrial eutrophication is seldom highlighted as a problem that drives emission control. One may however remember that eutrophication from N deposition is considered to be the second largest cause to changes in biodiversity in Europe. Land use changes is considered the largest.

Marine eutrophication

Trends: At present it is difficult to obtain reliable data on trends in input to the marine areas around the Nordic countries. The marine conventions do not publish yearly input data and for the Baltic not even data separated on countries. A comprehensive evaluation of the 1988 ministerial declaration on the reduction of nutrient load to the Baltic was recently published (Lääne 2002) in which the authors compare estimates of land-based input to the Baltic Sea from late 1980:s with data from 1995. Their conclusion is that the total input of N has gone down from 916 000 tonnes in the late 1980s to 593 000 tonnes in 1995; a reduction of 35%. Corresponding figures for P are a reduction from 70 000 tonnes to 46 000 tonnes, also corresponding to 35% decrease. A deeper investigation of the underlying figures shows however large uncertainties and often lack in consistency.

Looking at more recently published trends based on yearly data for the last decade of the 20th century show a much more scattered picture. Preliminary data for the HELCOM pollution load compilation (PLC) report indicate practically no trend between 1994 and 2000. In a report from the Polish Ministry of Environment, an increase in N input is indicated (The Environmental Protection Inspectorate 2001) (Figure 2). The recently published assessment report on the Baltic marine environment gives a mixed information on the input of nutrients to the Baltic (HELCOM 2003). On one hand data on discharges from agriculture indicate a positive development for both N and P in many countries based on data from 1985, 1995 and 2000. On the other hand yearly data on riverine discharges of N and P for the period 1994-2000 to the Baltic sub-basins do not show any significant trends with the exception for a positive development of the input to the Belt Sea and Kattegat.

For the North Sea, OSPAR agreed at its meeting in 2001 to publish an evaluation of the status of the 50% reduction target for nutrient input, which was called for in a PARCOM recommendation in 1988 (OSPAR 2001).

Policy attention: Eutrophication is today a problem of large policy interest. It has been on the international agenda with respect to control measures for many years and objectives were set out on reductions in nutrient loads within both HELCOM and OSPAR. Even if countries have undertaken measures to reduce input to the Baltic, there is limited evidence for reductions in input with one exception – the reduction in atmospheric input.

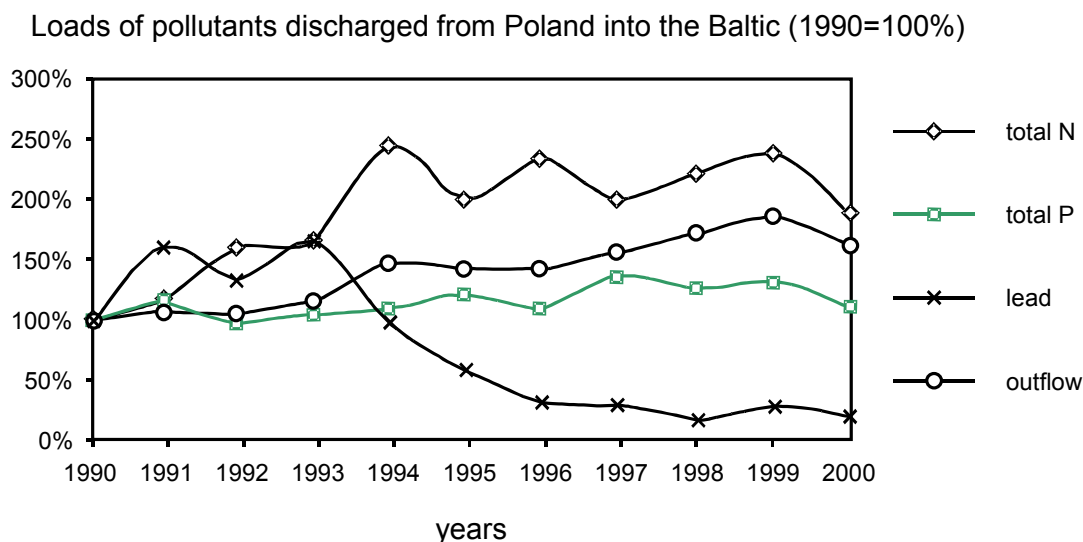


Figure 2. Load of pollutants from Poland to the Baltic Sea 1990-2000. The figure illustrates that the load of N has increased substantially during these years even if compensated for the water flow. Phosphorus has also increased but much less and the increase is less than the increase in water flow.

Tropospheric ozone:

Trends: A downward trend in episodic peak ozone concentrations has been observed in Europe since 1980's. Background concentrations show no significant trend or a small increase during the same time period. The decreased peak concentrations are assumed to be related to control measures within Europe, while the upward trend in

background concentrations is assumed to be related to increased precursor emissions outside Europe (Lindskog et al. 2002).

Policy importance: The policy interest has so far been limited within the Nordic countries, due to lower concentrations compared to Central and Southern Europe. More recent scientific findings may however change the picture. A stronger evidence for health effects (most recent results indicate a no threshold to health effects) is causing a stronger focus on total ozone exposure and less interest in the short-term peaks. New uptake-oriented approaches for the estimation of vegetation effects show also larger effects to forests and crops in Scandinavia compared to earlier concentration-based measures. Ozone is however still a compound of relatively small policy interest.

Particles

Trends: Particles in terms of PM10 and PM2.5 have not been systematically monitored in Northern Europe to an extent that it is possible to draw any certain conclusion on the long term trends. Most of the results indicate that concentrations are decreasing. A large fraction of the fine particles are transported over long distances, which leads to the necessity to consider particles as an international problem in the same way as acidifying and eutrophying compounds. Several studies show that more than 50% of the particle concentrations in Scandinavian urban areas are caused by regional background.

Policy importance: Particles are of an large concern in Europe due to an increasing evidence that particles are the main cause of the observed health effects from air pollution. The CAFE strategy will to a large extent focus on health effects.

Heavy Metals

Trends: Several investigations indicate a continuously decreasing atmospheric deposition and decreasing occurrence in terrestrial ecosystems of heavy metals (e.g. Rühling and Steinnes, 1998). For most metals the environmental risk in land-based systems are considered low and decreasing. Mercury and to some extent cadmium are exceptions, where there is still a concern about their environmental and health effects. The same is true for the antifouling agent tributyl tin (TBT), where there is an increasing evidence of negative effects to marine ecosystems.

OSPAR presented in their 2001 annual report a compilation of trends in water-transported input to the OSPAR area. The report shows that the changes in (riverine and direct) input of lead and copper have been small in the last 10 years. Mercury concentrations are however decreasing.

Policy importance: Mercury and cadmium are the only heavy metals that are considered to pose large scale regional environmental threats to land-based systems. Heavy metals are however of less political interest in the Nordic countries compared to 10-20 years ago. At the same time there has been an increasing interest in the rest of Europe, in North America and globally in the mercury problem. Due to still high and in some cases increased contamination of heavy metals in marine organisms, there has been an increasing interest in the heavy metal problem. The EU is developing a strategy on mercury to be presented in 2004 and UNEP has established a Global Mercury Programme. A very broad approach is taken in both cases including

e.g. mercury use, trade and waste issues, but driven by concerns for environmental contamination and human health effects.

Persistent Organic Pollutants POPs

Trends. Due to the many compounds included within the group POPs, it is almost impossible to give a general judgement in status and trends. There is however an increasing concern with respect to their occurrence in the Arctic (Webster 2003). Several epidemiological studies in the Arctic indicate higher incidence of certain effects on children (higher risk for infections, memory deficits etc.) when their mothers have higher levels of particular persistent organic compounds.

While some compounds like DDT and chlordane are waning in parts of Arctic, others like polybrominated diphenyl ethers (PBDEs) are increasing. A doubling of PBDE concentrations is observed in Arctic char between 1997 and 2002. It is very difficult to make simple statements and draw definite conclusions regarding the trends in concentrations and fluxes in Europe.

Policy importance. Persistent organic compounds are of a large and increasing concern for the Nordic countries. The evidence of enrichment and effects of POPs are highlighted in several international bodies. The EU strategy on chemicals REACH put an increasing pressure on the industry to avoid use and emissions of a broad range of chemicals. The problem is also of concern in the NMR group on chemicals.

Policy processes and achievements

The Conventions

International environmental problems have traditionally been highlighted and controlled through international conventions. The Convention for the International Council for the Exploration of the Sea (ICES) from 1964 is one of the earliest conventions in the field of environment. The Council is however much older. It was established 1902 and has been of large importance for the scientific research and investigations in relation to exploration and pollution of the Atlantic Ocean, in particular the North Atlantic. It contains however no framework for actions to protect the Sea. Instead, it is since long the main source of independent scientific information for the OSPAR, HELCOM and other conventions.

Action-oriented conventions were developed with a start in the 1970-ies. For the marine pollution the main conventions for the sea areas surrounding the Nordic Countries are the Helsinki Convention on Protection of the Marine Environment in the Baltic Sea and the OSPAR Convention – The Convention on the Protection of the Marine Environment of the North-East Atlantic. For air pollution the main convention of interest for the Sea and Air Group has been the Convention on Long-Range Transboundary Air Pollution (CLRTAP) signed in 1979. An additional convention of particular importance for the dispersion of toxic substances is the Stockholm Convention signed in 2001.

The European Union has become a much more important environmental actor during the last 10 years and the Union is continuously taking more and more decisions in order to improve air quality and the marine environment.

The Sea and Air Group has traditionally been strongly focused on the work within the above mentioned three regional conventions (and their secretariats); The Helsinki Convention for the protection of the Baltic Sea, OSPAR and CLRTAP. These conventions will be briefly described and compared. The Stockholm Convention on Persistent Organic Compounds and the European Union in the are also included as international actors of an increasing importance.

The Helsinki Convention on Protection of the Marine Environment in the Baltic Sea
Objective: Protection of the Baltic against all kinds of pollution.

Geographical limits: The Baltic Sea, the Danish Straits and Kattegat. Surrounding land areas are covered as far as land-based pollution is concerned.

Signed: 1974 and 1992 (entered into force 1980 and 2000)

Parties: 10 parties incl. EC.

Decisions: Meets once a year on ministerial level. Decisions only contain recommendations.

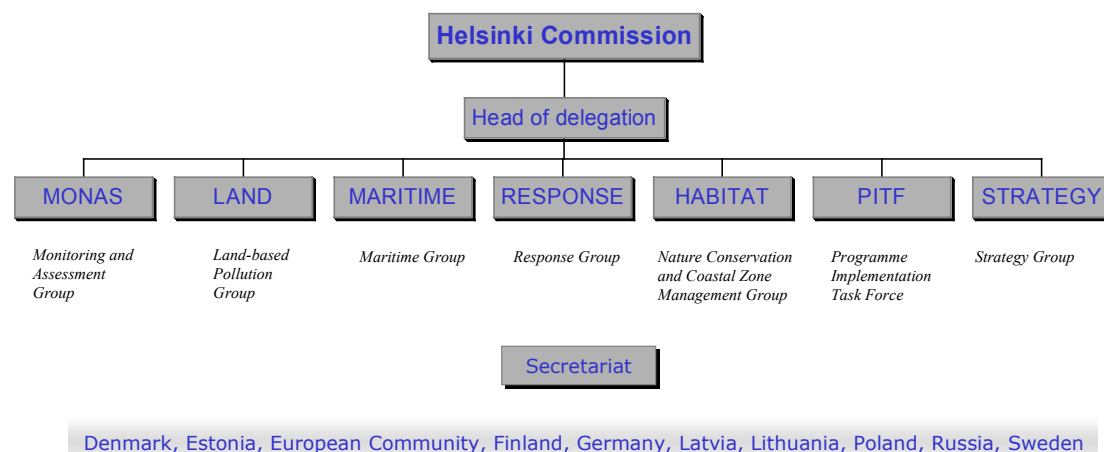


Figure 3. The organisation of the Helsinki Commission

The OSPAR Convention – The Convention on Protection of the Sea Environment in the Northeast Atlantic Area

Purpose: The main objective of the convention is to protect the sea environment against pollution from land-based sources, offshore activities and to avoid dumping and incineration at sea.

Geographical limits: Northeast Atlantic and the adjacent Arctic Waters, including the North Sea and Kattegat.

Signed: 1992 (entered into force 1998)

Parties: 16 parties incl. EU.

Decisions: Decisions are taken by the OSPAR Commission. Meets every year. The decision levels are OSPAR Decisions and OSPAR Recommendations. OSPAR Decisions are legally binding.

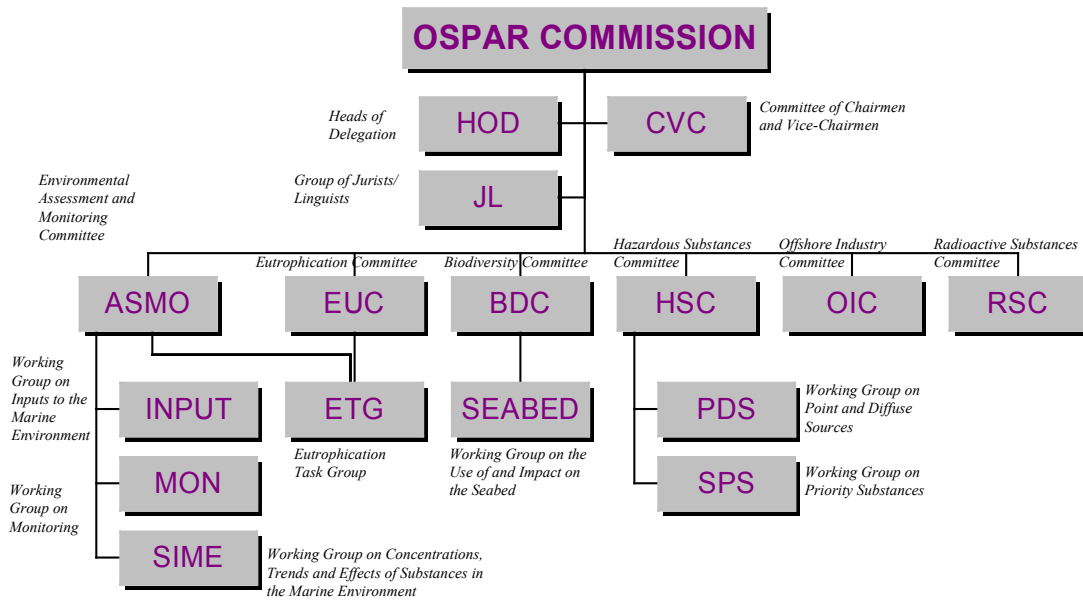


Figure 4. Organisation of OSPAR Commission

The Convention on Long-Range Transboundary Air Pollution (CLRTAP)

Objective: To limit and, as far as possible, reduce and prevent air pollution including long-range transboundary air pollution.

Geographical limits: Can be signed by all states within the ECE and after consultation of states outside the ECE.

Signed: Signed in 1979 (entered into force 1983)

Parties: Ratified by 49 countries

Decisions: Decisions taken by the Executive Body, which meets every year. CLRTAP is a framework Convention and decisions on measures are taken through Protocols. Seven protocols are signed. Protocols are legally binding.

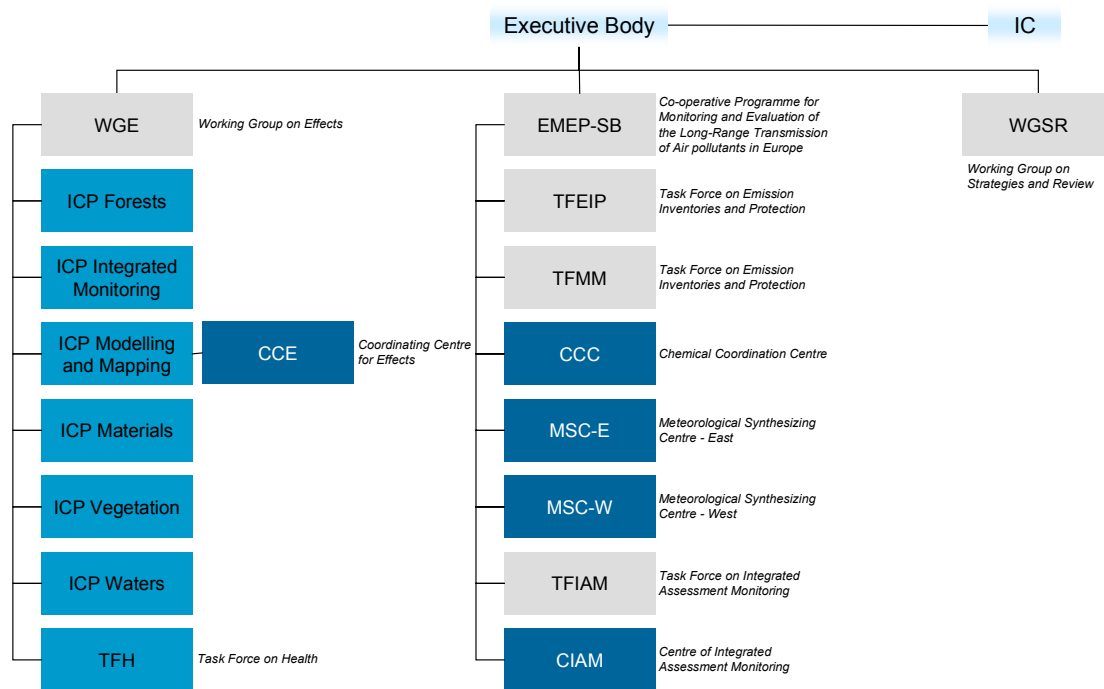


Figure 5. Organisation of CLRTAP.

The Stockholm Convention on Persistent Organic Pollutants (POPs)

Objective: To take measures to prohibit and reduce production and use of particular chemicals. The convention put limits on production, use and import/export of particular chemicals. It also contains regulations on disposal. Priorities are given to chemicals at two levels; a) elimination of chemicals and b) reduce and control production and use.

Geographical limit: Global convention

Signed: 2001-2002. (Not entered into force yet, 50 countries need to ratify)

Parties: 151 parties have signed; 46 countries have ratified (Jan. 2004).

Decisions: Decisions are legally binding. Meetings (Conferences of Parties) should be held regularly. Even if the convention is not entered into force yet, it is acting through various subgroups of which the Intergovernmental Negotiating Committee is the main acting body.

The European Union

Even if not all the Nordic countries are members in the European Union, its legislation influences all countries, e.g. through the EU-EEC agreements. There are however large differences between agreements under a convention and legislation under the European Union.

EU enforces its decision through EC Directives, which have a strong legal binding and has to be enforced in national legislation. EU legislation has however so far had less direct influence on regional pollution. One of the problems is that it can not enforce legislation outside its territories. It has however considered the regional environmental problems in its legislation through the National Emission Ceilings (NEC) directive and the protection of coastal marine ecosystems is included in the Water Framework Directive (WFD?). It has also highlighted the marine problems through the development of a Marine Strategy. The expanded EU will however be in a position to strengthen its role with respect to regional pollution – the Baltic Sea will almost be an internal EU Sea and the control of regional air pollution will, (at least for S and N deposition and health effects due to particles) be an internal EU (European) problem. Air pollution is presently considered in a separate programme called Clean Air For Europe or CAFE.

The overall objectives of European legislation have been outlined in the Commission's position paper *Environment 2010: Our Future – Our Choice* (European Commission 2001). The Commission points in the report to the importance of the protection of the environment and it sets out environmental objectives for 2010. In 2003 a strategy on environment and health was published in which the role of environment for the protection of health is highlighted and the strategy has the aim to establish cause effect relationships between environmental pollution and health (COM (2003) 338 final). The strategy should in particular look into problems related to complex exposure situations and sensitive groups, e.g. children. The strategy involves working groups on heavy metals, dioxins and PCBs and endocrine disruptors. Further information can be obtained at <http://www.environmentandhealth.org/index.php>.

Environmental policies within the European Commission are to a large part developed within a number of thematic areas. Of particular importance are those for air quality (Clean Air for Europe) and for the protection and conservation of the marine

environment. Others that can be of importance for the Sea and Air Group are dealing with soil protection and sustainable use of pesticides.

The European Commission presented in October 2002 a marine strategy, which was further discussed at a stakeholder conference in Denmark and presented for the Council during the Danish Presidency in December 2002 (European Commission, 2002). The document is the first communication from the Commission addressing a marine strategy to protect and conserve the marine environment. In March 2003 the EU ministers of Environment decided to further develop the strategy. The deadline was set to May 2005. The objective of the thematic strategy is to ensure healthy seas and oceans, as well as the sustainable exploitation of marine resources.

The thematic strategy on air pollution will also be presented in the summer 2005. The strategy is developed in a programme called Clean Air For Europe (CAFE). The main elements of CAFE was outlined in a Communication (COM(2001)245)). CAFE is expected to present a long-term strategy for the protection of human health and ecosystems from air pollution. CAFE has a close collaboration with CLRTAP.

In addition to the strategies the implementation of the EC Water Framework Directive should be mentioned as an area of importance for the Nordic Countries and for the Sea and Air Group.

Table 4. International actors of importance for the protection of Northern Europe against regional pollution. Some of these have focus on policy decisions and actions, while others are more directed towards scientific support to the policy development.

Topic	International body	Policy and action	Scientific support
General	European Union	X	(X)
	Nordic Council and NMR		X
	Baltic 21	X	
	Arctic Monitoring and Evaluation Programme (AMAP)		X
Marine	Helsinki Convention and HELCOM	X	
	OSPAR Convention and Commission	X	
	North Sea Conferences	X	
	ICES		X
Air	Convention on Long-Range Transboundary Air Pollution (CLRTAP)	X	X
POPs	Stockholm Convention on Persistent organic Pollutants	X	X

Other policy actions of importance for the Strategy of the Sea and Air Group

There are of course several other conventions and international initiatives of importance for the protection against regional air and marine pollution and some of these are compiled briefly in Table 4. Many of these are well described in an excellent compilation on environmental co-operation in the Baltic Region, put together and published by the Danish Environmental Protection Agency (2003). In this report we only want to mention two others; AMAP and Baltic 21:

Arctic Monitoring and Assessment Programme (AMAP).

AMAP is an activity under the Arctic Council with the aim to provide reliable and sufficient information on the status of and threats to the Arctic environment, and providing scientific advice on actions to be taken in order to support governments in their efforts to take remedial and preventive actions relating to contaminants. AMAP was established in 1991 and is a main organisation for the supply of information on Arctic environmental problems.

Baltic Agenda 21.

Objective: The objective of Baltic Agenda 21 (often called Baltic 21) is to develop strategies and perform activities in order to promote sustainable development in the Baltic area. It is directed towards sector development and each sector has its own programme.

Geographical limit: Countries surrounding the Baltic Sea.

Formal framework: The Baltic Agenda 21 was approved in 1998.

Signatories: All countries surrounding the Baltic Sea, Norway, Iceland, EU and a large number of international organisations including IBSFC, NMR, ECE, ICC, WWF WBCSD and five international investment banks.

Baltic 21 was initiated by the prime ministers of the Baltic countries at a meeting in Visby in 1996 and the programme and its activities were decided in 1998.

Achievements: Baltic 21 is at large a system of networks for the development of sectors in a direction towards sustainable development. As such it will not immediately and with large quantities reduce pollution load in Northern Europe. None of the activities has a quantitative goal in emission reductions. The sector approach urges more for collaboration with the NMR's sector groups than with the Sea and Air group. In particular Baltic 21 has shown a high interest in agriculture, fishery, transportation and energy. Within the energy sector, Baltic 21 has given priority to renewable energy, a fact that can be of importance for the Sea and Air group. Further information can be found in the last progress report (Baltic 21, 2003)

The work under Baltic 21 is of large interest for NMR since the work covers priority areas within the Nordic Strategy for Sustainable Development (NMR 2001). The sector approach makes it however of larger interest for the Sector Groups under the ÅK-M than for the Sea and Air Group.

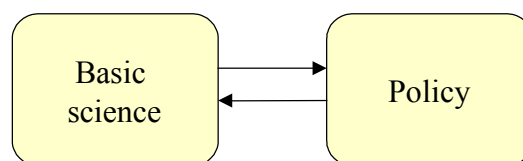
Environmental Strategies to combat environmental pollution

Looking back at the international environmental work during the last 20 years, it is obvious that for some environmental problems large improvements are achieved while for others, the outcome is far from what has been intended. Some international conventions and other organisations have been successful while others have failed to

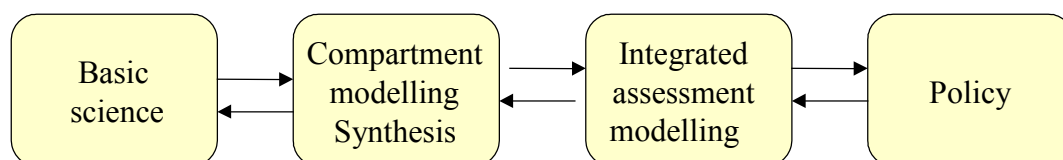
reach expected objectives. The Montreal Protocol and its amendments have been very successful in combating the threat to the stratospheric ozone layer. The CLRTAP has been successful in decreasing transboundary air pollution in Europe, even if many countries may have problems in achieving their objectives with respect to the Gothenburg Protocol. There are also areas where achievements have been less promising. Eutrophication was mentioned in previous chapters and for oil spills there seem still be large problems.

From the experiences of success and failure, it is important to investigate if there are any underlying reasons that can be taken into account in order to achieve better environmental control in the future. Are there experiences from successful convention work that can be transferred to the less successful and to what extent are other processes more efficient than agreements and other activities under the conventions? Issues like these are of particular importance for the Sea and Air Group since the group was originally set up in order to transfer experiences between the fields of marine and air pollution. These issues are not less important today and the strengthened position of the European Union as a policy actor offers new possibilities for actions.

International environmental problems do not normally have a simple cause-effect relationship (one single source). Instead effects seem to occur due to interplay between various emissions, dispersion and climatic factors, and sensitivities of physical, chemical and biological systems. Scientific research is therefore a necessary ingredient in the development of abatement strategies. The strategies for combating regional pollution problems mostly undergo a development in its relation to policy from the discovery of the problem to a more mature situation with more advanced control strategies. When a problem is discovered there are simple relationships between science and policy. Successively when the knowledge improves, the environmental problem is divided into a subsystem (compartments), each will develop its own scientific area and part of policy. Then there will be a need for systems to keep the subsystems together – assessments and so called integrated assessment models. A more complicated way of the relations between science and policy is then developed (Figure 7)



For new environmental problems there is a direct communication between scientists doing the basic science and the policy makers



For mature environmental problems, the communication between science and policy goes through several integration steps

Figure 7. The relation between science and policy for new and mature environmental problems.

The development from the discovery of the problem to more advanced models and finally the solution of the problems can be described in terms of four phases:

1. *Discovery.* The first phase is discovery. This phase is characterised by large uncertainties in the understanding of processes and mechanisms behind the effects as well as their causes. Scientific results are discussed and often questioned and there is often a vigorous scientific debate on the results. Policy actions are dispersed and uncoordinated.
2. *Con census.* As the science evolves, disagreements about main causes and effects normally become smaller and after some time there will be a general agreement on the main causes and effects. We can talk about a phase of *con census*. On the policy side co-ordinated actions begin to take place. For international problems, actions are mostly in terms of percentage reductions, general agreements on best available technology or best available practice.
3. *Cost-efficiency.* When understanding develops, scientific knowledge develops towards quantification of processes and mechanisms and towards the development cost-efficient strategies. Development and application of of theoretical computer-based models, so called *Integrated Assessment Models* gives new possibilities – the development of more advanced strategies, where environmental benefits can be evaluated in relation to control measures and costs. We can talk about a third phase in the development of control strategies.
4. *Solution.* Finally we have a fourth phase, which we can call the phase of implementation of proposed measures and a solution of the environmental problem. At this phase the large and most important steps in order to solve the problems are taken. Important scientific issues during this phase are whether the assumed models and strategies are right, if the objectives are achieved and if it is necessary to revise the strategies in any direction.

The environmental problems under consideration in this report can now be sorted in relation to how mature our knowledge is according to these four phases (Figure 8). The figure only intends to give a general picture and we are aware that environmental problems not always fit to a model like this. For groups of pollutants such as heavy metals and persistent organic pollutants (POPs), the range is very large from problems, which in principle we do not know the existence of yet, to problems which, are well investigated even in quantitative terms. The figure will however help us to understand needs for further support from science and expertise.

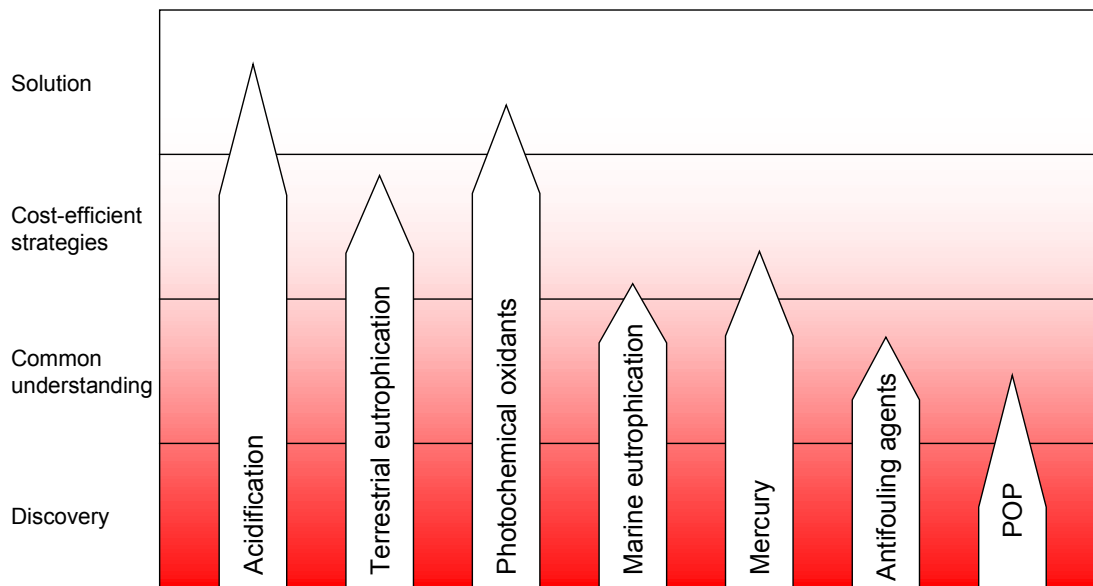


Figure 8. Environmental problems in relation to their maturity in control strategies.

Acidification. The problem has been fully described and quantified in theoretical process-oriented models linking the activities in the society with environmental effects. The quantitative understanding has been used in Integrated Assessment Models for the development of international air pollution policies, in particular the Second Sulphur Protocol, the Gothenburg Protocol and the EC National Emissions Ceilings Directive. The more recent strategies do not only include acidification but also

Photochemical oxidants effects to crops and forests, for which also our understanding is equally good and for

Terrestrial eutrophication, for which the full quantification between doses and responses still lack.

Particles and health. For particles, the ambition from the policy side, as expressed in the present work under CAFE, is to develop a full effect-based cost-efficient strategy similar to that used for acidification etc. the Gothenburg Protocol. However, there is still a lack of knowledge on which particle parameters that are causing the effects. At present control strategies will therefore be developed with respect to a simple particle parameter – particle mass. Two particle mass metrics are at hand; particles with a diameter of less than 10 μm , PM10, and particles with a diameter less than 2,5 μm , PM2.5. Recently a decision was taken to use PM2.5 as the metric for the development of the strategies.

Marine eutrophication. There has been a substantial increase in knowledge during the last five years and also attempts to develop strategies and methodologies towards the third phase – cost-effective, effect-based strategies. In the Swedish research program MARE (<http://www.mare.su.se>), a complete abatement strategy model is put together for the Baltic Sea. The model allows analyses of environmental consequences of different control scenarios. The application of integrated assessment models has however not yet been officially accepted as a policy tool and there are still questions if the underlying science and availability of data will be enough. Leaching from agriculture and forest soils are still sources of large uncertainties as well as the efficiency of various emission control measures. Another issue of concern may be the

needs for a more dynamic description of the marine transport of nutrients and the underlying mechanisms and processes for algae blooms. There is probably a large difference between understanding and quantification of the closed Baltic system compared to the open North Sea system.

Heavy metals. Our understanding on atmospheric emissions and atmospheric processes is fairly good. Models have been developed and tested for some metals in particular for mercury and cadmium. The understanding of metal transport and effects for marine pollutants is however less well developed, partly due to a less expressed interest for approaches based on integrated assessment models. For two of the most discussed elements, mercury and cadmium, the knowledge on anthropogenic sources is well established as well as on atmospheric dispersion and deposition. Less knowledge does however exist on processes in terrestrial and marine ecosystems and there is still a problem to establish a full quantitative relationship on which cost-efficient control strategies can be developed. For mercury, factors limiting the possibilities to develop quantitative source-receptor relationships valid for longer time scales are re-emissions from land and soils, fate and mobility in soils and the role of global cycling in the regional problems.

Persistent Organic Pollutants. The persistent organic pollutants are today a focus for several international actions. The strategies take their starting-points in identifying the compounds of largest concern with respect to environmental and health risks and then through international agreements ban or minimise their use. Strategies are therefore based on scientific research and other information that can shed light on sources, transport and conversion processes in the environment and effects to humans and the environment. Compartment modelling, mainly based on fugacity, is widely used but primarily for a better understanding of how compounds are expected to be transferred between different media. Modelling techniques are however developing fast and fully quantitative integrated assessment models may become available within a near future.

Antifouling agents. The Sea and Air Group has supported several projects on environmental effects and assessments of antifouling agents. For antifouling agents the sources are well known as well as the mechanisms for many of the effects. The understanding on how to link the sources with quantitative estimates of environmental effects on a regional level is however still lacking.

Conventions and the EU as driving forces and instruments for environmental policy

Where will the strong action in solving the international pollution problems take place in the future? The question is important for the Nordic countries and their collaboration under NMR. Should, as until now, a large effort be directed towards the international conventions (primarily HELCOM, OSPAR and CLRTAP) or will other actors such as the European Union and Baltic 21 take over? Conventions have advantages in their legal status and the inclusion of all actors of importance for solving the problems. The decisions need normally to be unanimously, which sometimes is advantageous sometimes disadvantageous. They also have a given agenda, which forces countries to participate and take actions. The formal structure of the conventions may also cause problems. There may be difficulties to adapt the work to new situations – actions may be late when new problems appear. Some of the

organisations have however been able to change and modernise their work. The Oslo and Paris Conventions joined about 10 years ago to the more efficient OSPAR Convention and the LRTAP Convention reorganised its work after the signing of the Gothenburg Protocol in 1999.

A comparison between the international conventions and the European Union

Observers often note the success of the CLRTAP in its ability to negotiate and implement large emission reductions, especially when comparing it with the outcome of the regional marine conventions or the Climate Convention. Various explanations have been put forward and there have been studies on the success of the different strategies, e.g. Miles et al Eds. (2002), but these studies have made comparisons from an outside perspective and mainly also from a perspective of social science and policy negotiations and not from a perspective of scientific support to policy. In this report we will make some simple comparisons in relation to support to the Nordic Countries in their aim to form strategies for the coming 3-5 years.

One important issue for the Sea and Air Group is to analyse how efficient the existing conventions are and to what extent EU legislation may be in a position to take over the development of policies. For the protection of the marine areas, EU countries will almost entirely surround the Baltic Sea (Russia remains outside) and for OSPAR, Norway and Iceland are the only non-EU countries within the Convention. For the LRTAP convention, the situation is similar even if EU will not dominate in the same way, as it will within the marine conventions.

In June 2003 a *Swedish Governmental Commission on the Sea Environment* published its final report (The Swedish Commission on the Sea Environment, 2003). In this report the Commission discusses the lack of success of the marine conventions in comparison with the air pollution work and it points to four important differences:

1. Scientific consensus: Scientists working within the field of air pollution have been able to make common assessments over wide areas of disciplines, which has not been the case for marine pollution. CLRTAP was already from the beginning directed towards development of models to understand, assess and support decisions and monitoring was primarily a way to develop and verify the models. Marine scientists have according to the Commission report, primarily been working within their own disciplines and using monitoring data to make assessments, establish trends etc.
2. Environmental objectives: The marine conventions show generally a lack of clear effect-based quantitative objectives, while CLRTAP has had a clear environmental objective for more than 15 years.
3. Flexibility in control measures: CLRTAP has through its negotiations agreed upon national emission ceilings and it has been up to the countries to decide upon which sources to control. The marine conventions have instead often taken decisions on detailed regulations within sectors or on certain types of industries.
4. Legal aspects: CLRTAP decisions are legally binding and it has motivated countries to analyse control measures and costs before signing agreements and also to take more formal national decisions to meet the required control levels. Within HELCOM the decisions have not been legally binding (although a few

countries have confirmed decisions through their own legislation). OSPAR have two forms of decisions – binding agreements and recommendations.

Conventions are products of joint interests but also products of intense negotiations, where countries' different interests are taken into account. The conventions for the Baltic Sea, the North Sea and the transboundary air pollution show several similarities in terms of aims and organisations but also some crucial differences, which may influence the efficiency of the conventions. The organisation of the conventions looks very similar from outside with an Executive Body on ministerial level, a Secretariat and Working Groups directed towards topics; measurements and data collection, abatement strategies and techniques and negotiations. In table 5 some important characteristics of the policy development within the conventions and EU are further elaborated.

Table 5. Characterisation of environmental conventions of importance for the Sea and Air Group and EU in relation to some aspects of relevance for policy development and implementation. The judgements are made to give a relative ranking between the policy instruments.

Policy framework	Openness and transparency	Structured use of data	Internat. scientific support	Scientific involvement in organisation	Legally binding decisions
CLRTAP	High	High	High	High	Yes, weak
HELCOM	Low	Low	High	Low	No
OSPAR	Intermediate	Low	High	Intermediate	Yes, weak
EC Directives	Intermediate	High	Low, but increasing	Intermediate	Yes, strong

The table needs some comments:

Openness and transparency. HELCOM is still suffering from the closed system that was established during the Cold War. It is still today, almost 15 years after the political changes in East Europe, difficult to get data on national pollution loads from the countries surrounding the Sea. This should be seen in contrast with the CLRTAP, where all data on emissions, concentrations and all documents are available via Internet. The European Commission and OSPAR falls between, where the earlier closed EU/EC system becomes more and more open. The Commission has changed its attitude towards openness and today almost all information about the work on different strategies and revision of Directives is open and available via Internet.

Structured use of data. Under this headline we have looked at how the Conventions (or EC) are using existing information in their development of policies. The marine conventions mainly use their data to describe status and trends while the CLRTAP also uses data in a structured way for the development of strategies and the support of agreements as well as for the assessment of compliance of the signed emission reductions.

Scientific support. All the Conventions have an almost inexhaustible source of scientific information. Hundreds of papers of relevance for the actual environmental problems are published every year. Countries are obliged through the signing of the conventions to conduct research. Scientific research is also a way of establishing a common scientific understanding between countries. For the European Union the situation is different. There is no natural scientific support to the development of policy – at least there has not been such a support. In the 6th framework programme, however, a new form of projects has evolved, so called STREPs (Scientific and Technical Research in support of European Policy), through which DG Environment or other Directorates can get a policy issue scientifically investigated. The amount of money is however small. The request of national scientific research and scientific collaboration between countries is also absent in the Directives.

There may certainly be other factors than those mentioned here, which may have influenced the success/failure in the solution of environmental problems. One factor that is worth mentioning is that there is a fundamental difference in controlling emissions of compounds that are necessary components for the anthropogenic activity and those that are caused by trace impurities or malfunctions in the activity causing the emissions. Carbon dioxide is an unavoidable rest product of the use of fossil fuels and nitrogen and phosphorus are necessary to apply to agricultural land to obtain a (sustainable) agricultural production. On the contrary, sulphur in fossil fuels causing sulphur dioxide emissions is an impurity and cadmium is an impurity in fertilisers. Both could be controlled without any significant influence on the anthropogenic activity itself. From this perspective, terrestrial and marine eutrophication will be more difficult to control than other regional environmental problems.

Another factor that may be important in the assessment of the possible success of the different international bodies is the acceptance and legal forces that can be applied to those (industries, farmers, communities, households) causing the environmental problems. National emissions from well-defined large sources, which are under governmental regulations, are much easier to control than those that are caused by small sources and not well defined activities. Agriculture and households (e.g. small scale wood combustion) will therefore be much more difficult to control than emissions from large industrial plants or from cars, where yearly inspections can be applied. Also emissions outside national borders (international transport and activities in marine areas) are difficult to regulate. Agricultural development is also driven by strong European policies which may be stronger driving forces for change than international conventions or environmental policies.

Directions for the future

Will the problems handled by the Sea and Air Group be solved with present agreements and strategies? The answer is certainly *No* and there is a need for further development of more efficient control strategies – in particular for the solution of the problems connected with marine eutrophication and the dispersion of persistent organic compounds. The present strategies for these compounds are as pointed out above lacking in support of scientific understanding, quality assured environmental data and efficient strategies.

The problems of solving international environmental problems are in general not lacking in international organisations (conventions, EU, multilateral initiatives) with a focus on the problems. Several of the conventions and the initiatives have been efficient but there is still much more to do. We have earlier in this report pointed towards the importance of scientific support, openness and also to some extent to the importance of legally binding decisions. But are there other issues that should be taken into account. The role of initiatives related to Agenda 21 has been discussed previously but there are also other processes of importance. Two of these will be mentioned and discussed here; policies under the Framework Convention on Climate Change (FCCC) and some recent initiatives on a broader approach to solve problems related to environmental effects of nitrogen compounds.

Will climate change policies contribute to the solution of the regional pollution problems in Northern Europe?

There are several links between the control of greenhouse gas emissions and the control of emissions of pollutants causing effects in the Nordic countries. Using less fossil fuel will reduce emissions of nitrogen oxides and for oil and coal also sulphur dioxide. For all fuels, with the exception of natural gas, emissions of particles will also be reduced. The benefits of using less fossil fuel depend strongly on the fuel replaced and on the installed control equipment. If energy savings will reduce uncontrolled use of coal, the benefits will be substantial.

Table 6. Emissions of carbon dioxide in some countries in Northern Europe in relation to the requirements according to the Kyoto Protocol and the distribution of the emission reductions within the European Union.

	CO ₂ -emissions 1990 [MT]	Kyoto reduction [%]	Target CO ₂ -emissions according to Kyoto [MT]	CO ₂ -emissions 2000 [MT]	Emission red needed from 2000 [MT]
Denmark	52.6	-21	41.6	52.9	11
Estonia	38.1	-8	35.1	16.9	-18
Finland	62.5	0	62.5	62.3	0
Germany	1 015	-21	801.9	858	56
Iceland	2.1	10	2.3	2.4	0
Latvia	23.5	-8	21.6	6.8	-15
Lithuania	39.5	-8	36.3	-	-
Netherlands	159.6	-6	150.0	173.5	23
Norway	35.2	1	35.6	41.2	6
Poland	477	-6	448.4	315	-133
Russian Federation	2 372	0	2372.0	-	-
Sweden	56	4	58.2	55.9	-2
United Kingdom	584	-12.5	511.0	543	32

In order to get an idea of the potential for emission reductions through climate change policies, the present status of the fulfilment of the Kyoto Protocol for the countries in Northern Europe has been compiled (Table 6). From the table it is obvious that there are a few countries (Denmark, Germany, Netherlands, Norway, and United Kingdom) that need to reduce their CO₂ emissions between 2000 and 2010. If these countries will meet the requirements through less combustion of fossil fuels, there will also be a reduction in the emissions of sulphur and nitrogen oxides and of particles. However, the full achievement will probably not be met through emission reductions since it is expected that these countries at least partly will meet the requirements through other

actions possible under the Kyoto Protocol. Denmark has for example declared that they expect to meet some of the requirements through such methods.

Kyoto is of course only the first step in the process of combating the climate change problem. Negotiations and agreements on further reductions are expected and the second implementation period of the Climate Convention is expected to be more demanding than the Kyoto Protocol. These strategies will in general have a positive and probably larger effect on the emissions and effects of traditional pollutants. To what extent is impossible to estimate. There is however a need for a closer collaboration on the policy development between regional and global pollution.

Nitrogen – a need for a common policy?

Emissions of nitrogen are causing a large number of negative environmental effects. (Figure 3 and Table 7). Although the number of sources is almost indefinite, the source categories are in reality four:

- Uncontrolled emissions of nitrogen from agriculture to air, soils and waters;
- Sanitary emissions
- Stationary combustion
- Mobile combustion

Other sources such as fertiliser industry and nylon industry are of minor importance.

Table 7. Environmental effects, sources and international legislation of nitrogen-containing compounds. L = Local; R = Regional; G = Global

Effect and scale	Emitted compound	Source categories	International legislation
NO ₂ health (L)	NO _x	Traffic & energy	Air quality standards (EC, national)
Ozone health and vegetation. (R)	NO _x	Traffic & energy	Air quality standards (EC, national)
Terrestrial eutrofication (R)	NO _x o NH ₃	Traffic, energy & agriculture	EC's NEC directive EC's habitat directive
Nitrate in ground water (L)	N _{aq} , NO _x o NH ₃	Traffic, energy agriculture & wastewater	EC-directive
Acidification (R)	NO _x o NH ₃	Traffic, energy & agriculture	NEC directive
Marine eutrofication (R)	N _{aq} , NO _x o NH ₃	Traffic, energy agriculture & wastewater	Marine conventions
Climate change N ₂ O (G) ozone	N _{aq} , NO _x o NH ₃	Traffic, energy agriculture & wastewater	Climate change convention
Stratospheric ozone (G)	N ₂ O	Traffic, energy agriculture & wastewater	Vienna Convention Montreal Protocol

A rough estimate of the emissions of nitrogen from the above mentioned sources indicate that the overall anthropogenic addition of nitrogen within the EU(15) countries is of the order of 12 million tonnes (**Table 8**).

Table 8. Estimated nitrogen emissions to the environment within the European Union (million tonnes). Estimates are based on data from EEA, EMEP and OECD and reflects the situation at the turn of the century.

Source	Million tonnes
Agricultural emissions of ammonia to the atmosphere	3.0
Agricultural losses of N to soils and waters	3.7
Stationary and mobile combustion emissions of NO _x to the atmosphere	3.0
Sanitary emissions of N to waters (and soils)	2.0
Total emissions	11.7

Abatement strategies have so far mainly been developed effect by effect with the exception of the Gothenburg Protocol and the NEC Directive, in which acidification, eutrophication of terrestrial ecosystems and regional photooxidant formation are considered in parallel. The new EU CAFE takes a step further and will also include health effects from particles and probably also health effects from nitrogen oxides. Still lacking will be eutrophication effects to marine ecosystems, the role of background (inter-continently transported) ozone and the direct and indirect contribution from nitrogen compounds to global warming and stratospheric ozone depletion. It is also worth noting that nitrogen also has positive effects – nitrogen is of crucial importance for the agricultural production and nitrogen enhances carbon sequestration and will thus counteract global warming.

During the last years there have been an increasing awareness that nitrogen must be considered in a more holistic way. New strategies need to be developed that can combine the positive effects of nitrogen as a fertiliser and an amplifier of carbon sequestration and all the negative effects from nitrogen as a pollutant. More and more people are today talking about nitrogen management. As a result of this, a global initiative has been taken – the International Nitrogen Initiative (INI)– with the objective to make assessments of the nitrogen problem and propose actions. In this respect the initiative has much in common with the IPCC but with so far no back-up form international conventions. Since many of the aspects connected with nitrogen are regional or local, INI is supposed to work on regional scales. The initiative may be of interest for the Nordic countries.

There are also initiatives taken on national levels. The Swedish research foundation MISTRA, which gives support to several research programmes with nitrogen on its agenda, considers at present a broader activity with similarities to INI but limited to the Nordic area.

Possible directions for the Nordic collaboration with respect to regional pollution

The Sea and Air Group has throughout its 10 years of operation and through its prehistory contributed to the progress of the policy process for regional pollution in the North. Even if its essential purpose was to support international bodies and international negotiations with scientific knowledge, it has played an important role for discussions and policy development of the Conventions themselves. The Critical loads concept was originally developed through Nordic projects, the presently used Gap Closure concept and the multi-pollutant, multi-effect strategies were first discussed and agreed upon within the Sea and Air Group. The mixture of policy and science discussions has formed an advantage for the Nordic countries in policy formation, which was frequently used in relation to CLRTAP. New concepts and methods were often tested and evaluated before they were put forward to the Convention and ideas and results put forward under the umbrella of the Nordic Council of Ministers were often felt more reliable than if they had been presented by single countries. If the Sea and Air Group should motivate its future existence and budget, it is important that this science – policy link remains.

Within the marine pollution, the ambition has also been to support the development of strategies based on source-effect relationships and cost-efficiency. So far these ambitions have mainly been directed towards the support of advanced eutrophication models and workshops. The outcome has so far not been very successful, although the needs for more advanced strategies were expressed in policy documents from HELCOM and OSPAR. Reasons are probably that there has been difficult to achieve a scientific agreement and a limited interest from national participants to push the system. The limited budget may also be a reason. National interests in joint Nordic actions have also failed and there has often been a larger interest in promoting national models/concepts than develop strategies and tools that could be presented and pushed as joint Nordic ideas.

When the Sea and Air Group now is evaluating its progress in the area, it has to ask whether its efforts have been valuable and if it is necessary to change directions. Is there a need for the advanced models and is the policy community ready to accept such models? If so, how to ensure a wider acceptance for the use of advanced science-based models for the development of policies? How to achieve a wider participation from scientists and countries?

Even if the topics and the experts involved in the projects are important, the Sea and Air Group itself is of crucial importance for the success. Internal discussions and formation of joint policies are important steps for a success on a wider international level. In order to achieve this, there are some important prerequisites:

1. The Sea and Air Group should contain representatives from the Nordic countries that are actively participating in the international organisations and are involved in forming national policies with respect to international pollution problems.
2. Scientists and experts involved in NMR projects should be aware of and, if possible, participate in the international framework that is the intended end-user of the results.
3. Workshops, assessments and policy seminars should remain an important part of the agenda. These activities should promote further development and implementation of strategies.

4. The secretariat should have close contacts to the development in the different policy bodies and have a capacity to lead important workshops and assessments.
5. With the limited amount of money available, the Group should focus on projects where the money can direct research and work in Nordic co-operation (seeding and catalysing money).
6. The Group should be active as a link between science and policy and promote results, concepts and thoughts to the international bodies.

What needs to be done within the different environmental fields?

The Sea and Air Group has always had the intention to influence environmental policy processes at an early stage. The early initiatives have been very efficient and set the agendas for how the conventions and to some extent also EU have handled different problems. If the Group wants to maintain this role, it is necessary that the Group has a clear objective and vision of where to go and how. Otherwise there is an obvious risk that the Group instead will finance projects of immediate needs and lacking financial support, instead of trying to be a step ahead in the science-policy project.

The Group should develop its work in close relation to the overall policy development in Europe in particular with respect to

- Enlargement of the European Union
- The climate change policy
- European legislation and agreements within the fields of Air Quality, Water Framework Directive, EC Strategy on Environmental and Health, Marine strategy and to some extent also on chemicals.

Climate Change is probably the most important issue and it will set frames for the Sea and Air Group in many different ways. Even if Climate Change at present is not a topic for the Group it is necessary that the Group is well informed on new knowledge and the development of policies. A closer collaboration with the Group on Energy may be beneficial for the group as well as for Nordic collaboration as whole.

Regional air pollution – acidification, nitrogen deposition, ozone and particles

During the next couple of years there will be an intense work on the revision of the Gothenburg Protocol and the EU CAFE initiative. New concepts and new more advanced models are developed for almost all subsystems of the integrated assessment models. There is still a strong Nordic interest to support far-reaching achievements. Due to decreasing scientific interest in many countries, there is a risk that the proposed strategies will not build on concepts that are scientifically sound and that the overall approaches will be questioned by stakeholders having less interest in solving the problems. Therefore there is still a need for Nordic activities in the area. Due to the ongoing activities there are difficulties in suggesting projects but areas of concern would certainly be:

- The role of intercontinental transport and emissions at Sea. North America has been much less successful in controlling emissions than Europe and the influence from emissions outside the European continent (including marine activities) will play an increasing role for the European air quality. Projects may lead to more solid basis for control of emissions from ships but also to a harder pressure on North America on further reduction of in particular sulphur and nitrogen oxides.

- Particles. Human health and particle is of top priority for CAFE and the Sea and Air Group has already supported several projects of crucial importance (EMEP model development, harmonisation of measurements, emission factors and abatement costs) but there are still a large number of problems to be solved.
- Other problems. Acidification has been the main topic for Nordic co-operation and there may still be a need for projects in the area. Such projects may focus on recovery processes and future liming strategies, the outcome of proposed strategies, further refinement of effect-based assessment tools etc.
- Strategy development. Integrated Assessment Models for CAFE and CLRTAP will take a European perspective. It may however be of interest to make assessment and support strategies on a sub-continental level. National IAMs have been developed for some of the Nordic countries and there are some national activities going on in some of the Nordic countries. NMR may consider a regional initiative, in particular due to internationalisation of the sectors.

Marine eutrophication

Marine eutrophication has been a main topic for NMR during the last five years and much efforts have been directed towards the support of more sophisticated strategies. At the workshops held in Göteborg in April 2003, it became obvious that there is still limited interest in the development and application of effect-based cost-efficient control strategies of the same type as for air pollution, although such approaches have been on the agenda for the international conventions since 1990 (Hägerhäll, 2001). The problem has a scientific dimension and a policy dimension. From a scientific point of view there is still a lack of general agreement on the needs for an integrated approach and what such an approach should need in terms of scientific credibility and compartment models. The Swedish MARE project has developed an integrated assessment tool for the Baltic Sea similar to that of IIASA for European air pollution but the approach has not received a very wide acceptance as a policy tool. Recent initiatives may however change the situation and it may reach necessary acceptance.

The North Sea is more complicated due to its open borders. The NMR has supported the development of advanced models for the establishment of source-effect relationships but the models have not so far been linked to policy-related issues.

What should the Sea and Air Group do in this perspective? Marine eutrophication is still an urging problem. A lot of national research and EU-projects are run with a focus on marine eutrophication but still there is a lack of overall international strategies to combat marine eutrophication in a long term. Even if control measures are made in many countries, our understanding of their efficiency is still vague.

The Swedish Commission on the Sea Environment (2003) has pointed to the needs of a revision of HELCOM as a policy instrument. It also points to the needs of the development of cost-efficient strategies based on effects in the ecosystems.

The Swedish MARE project has the potential of being a tool for policy development but needs further activities to achieve acceptance and also probably improvements of the compartment models (runoff systems, advanced marine models for eutrophication etc.). It may also need further activities to reach acceptance in the the international systems. National projects with more limited approaches (Finnish Bay and Danish waters) have proven that alternative approaches are important but their results need to

be put in the perspective of the overall marine eutrophication problems in the Baltic Sea and the North Sea.

The Water Framework Directive, The EU Marine Strategy and the changes in the organisational structures of HELCOM and OSPAR may form new bases for development of efficient strategies for the marine areas. The Sea and Air Group has certainly a role to play in this perspective but there is need from the national representatives to give a stronger support to the Nordic collaboration as a basis for development of policies. Otherwise collaboration on marine eutrophication under NMR can be questioned.

If there is a positive interest in taking stronger actions from the Sea and Air Group, there will be many areas and projects that would benefit from a Nordic collaboration:

- Establish links between national programmes and the overall needs and development within the marine conventions. This should be done through workshops, synthesis projects etc.
- Further develop and adapt regional marine models to the needs in control strategies. The advanced 3D models available within the Nordic countries are at present possible to use for abatement strategies. A further development in this direction is necessary but needs further discussions and possibly a collaboration between the Nordic countries
- Support the development of the European Marine strategy.
- Support consensus formation between Nordic scientific community with the aim of forming international strategies. The main problem is not the scientific knowledge but rather the interest from the community to contribute to a superior objective – a science-based strategy for the marine environment.

Heavy metals and persistent organic compounds

The Sea and Air Group has in lack of resources given less priority to heavy metals and POPs compared to the regional air pollution and marine eutrophication. There is also a NMR group particularly directed towards chemicals. The Sea and Air Group has mainly directed its interest towards environmental consequences of mercury and antifouling agents. A few projects have been support on POPs. The POPs projects have however not had the same immediate need for policy application as projects directed toward other environmental problems.

As mentioned in earlier chapters, environmental effects due to heavy metals and POPs are still of large concern, in particular for the Arctic. Much of the problems related to the Arctic are today taken care of through AMAP but they have fewer possibilities to take into account issues related to control strategies.

There is a great deal of overlap when it comes to heavy metals and in particular POPs. Marine conventions, CLRTAP, EU legislation on chemicals, the Stockholm Convention cover to a large extent the same areas. So far the Conventions have been quite well co-ordinated in terms of priority lists and overall requirements but there is still problems in terms of implementation and follow-up of control measures.

Future work within the Sea and Air Group should be directed towards

- Mercury. The revisions of the CLRTAP protocol and discussions on the development of effect-based strategies will still need Nordic collaboration to

achieve European acceptance. The close links between marine and atmospheric processes in the mercury cycle make the Sea and Air Group particularly suitable for activities. Links should also be established to AMAP.

- POP cycling in the Nordic and Arctic area. The situation is in many areas alarming with adverse effects but our understanding of sources, their changes over time, future development and sinks are still at an infancy for many compounds. The Sea and Air Group may be an important contributor to this area through initiating projects and support co-ordination of work within the Nordic countries. The support will with the present budget and priorities be limited.
- Antifouling agents have been an important topic and may still remain as a topic for the Nordic collaboration.

Other issues

In addition to the topics mentioned, it is important for the Sea and Air Group to take into account issues that are related to the overall Nordic environment policies. One area of particular concern is the environmental problems in the adjacent area to the Nordic countries – in particular the North-West Russia. The group should consider its role in the development of this area.

Sustainable development is still of large concern for the Nordic countries. The strategies in this area have a strong sector approach and they are probably mainly a topic for the sector groups. There is however continuously a need to follow the development in the area in order to understand and evaluate the outcome of different SD initiatives. Activities within the field of sustainable development are mostly taken from a bottom-up perspective and they are seldom evaluated in terms of overall cost-efficiency. The Sea and Air Group could make an important contribution in evaluating projects and help sectors setting priorities.

Conclusions

Nordic countries have a large common interest in controlling international pollution for the long-term protection of the environment. The Sea and Air Group under Nordic Council of Ministers has through its projects a good insight in the processes and activities and can through strategic projects make important contributions to the policy development.

The group has played an important and natural role in the development of the regional strategies on air pollution and may also in the future be able to do so. Priorities should also in the future be given both to the needs within the EU CAFE process and the CLRTAP.

The Group has played a less important role for the development of the marine strategies on eutrophication. Although intense activities from the Group there have been difficulties in forming common Nordic positions on projects and results in support of policies. The Group needs to reconsider its role in the policy development.

The Group has within limited areas (mercury and anti-fouling agents) played an important role in the support of international policies for the control of these problems. This role should be maintained in the future.

The Group has not been of large importance for the development of strategies within the field of POPs. Even if the problem is large for the Nordic environment, the Group will have difficulties to give a wide support to projects within the area.

One of the main objectives of the Group has been strengthen the scientific knowledge and form consensus on environmental objectives and strategies. This role should be maintained and further developed.

References

Baltic 21, 2003. Baltic 21 Report 2000-2002. Towards Sustainable Development in the Baltic Sea Region. Baltic 21 Series No 1/2003. Stockholm.

Danish Environmental Protection Agency 2002 Environmental Cooperation in the Baltic Region. Danish Environmental Protection Agency Report. Copenhagen.

EMEP 2003 National evaluations and reports to the EMEP Assessment report, expected to be published in 2004. Reports and data can be found on www.emep.int/index_assessment.html

European Commission 2001 *Environment 2010: Our Future – Our Choice. The Sixth Environment Action Programme of the European Community*. European Commission, Brussels. 68 pp.

European Commission 2002 *Towards a strategy to protect and conserve the marine environment* Communication document from the European Commission (COM(2002) 539 final)

HELCOM (2003) The Baltic Marine Environment 1999-2002. Baltic Sea Environment Proceedings No 87. Helsinki Commission, Helsinki 46 pp.

Hägerhäll, B. (2001) Scientific information and knowledge for decision-making in international marine conventions, particularly the Baltic Sea Area. Ardea Miljö AB. Report 66pp.

Lindskog, A., Beekmann, M., Builtjes, P., Monks, P., Roemer, M., Shuepbach, E. and Solberg, S., 2003, TOR-2 Tropospheric Ozone Research, Final Report. Eurotrac 2, GSF - National Research Center for Environment and Health, Munich, Germany

Lääne, A., Pitkänen, H., Arheimer, B., Behrendt, H., Jarosinski, W., Lucane, S., Pachel, K., Räike, A., Shekhovtsov, A., Swendsen, L.M. and Valatka, S. Evaluation of the implementation of the 1988 Ministerial Declaration regarding nutrient load reductions in the Baltic Sea catchment area. Finnish Environment Institute. Report Helsinki, 2002.

NMR 1989 Nordiskt Miljöprogram (Nordic Environmental Program). Nordic Council of Ministers Report 1989:3, Copenhagen.

NMR 1994 Nordic Strategy for the Environment April 1994 – March 1996.
TemaNord 1994:632. Nordic Council of Ministers, Copenhagen.

Nordic Council (1989) Nordeuropas hav Nordeuropas Miljö. The Nordic Council's Report to the International Conference on Marine Pollution 16-18 October 1989. Stockholm.

NMR (2001) Baeredyktig Utvikling. En ny kurs for Norden. TemaNord Report 2001:505. Nordic Council of Ministers, Copenhagen. 203 pp.

NMR (2000) Det Nordiske miljøhandlingsprogram 2001-2004. Nordic Council of Ministers Copenhagen.

Miles, Edward L., Arild Underdal, Steinar Andresen, Jørgen Wettestad, Jon Birger Skjærseth and Elaine M. Carlin, (Eds.) (2001) Environmental Regime Effectiveness: Confronting Theory with Evidence. Cambridge, MA: MIT Press, 2001. 491 pp.

OSPAR, 2001. Annual Report 2000 –2001. OSPAR Commission for the Protection of the Marine Environment of the North-East Atlantic. London.

Rühling, Å. and Steinnes, E. (1998) Atmospheric Heavy Metal Deposition in Europe 1995-1996. NORD Environment, NORD 1998:15.

The Environmental Protection Inspectorate (2001) *The Main Problems for the Environment in Poland*. An indicator-based Report. Chief Inspectorate for Environmental Protection Warsaw.

The Swedish Commission on the Sea Environment 2003. The Sea – time for a new strategy. Statens Offentliga Utredningar SOU 2003:72.

Webster, P. 2003. For precarious populations, pollutants present new perils. *Science* 299 (5613). 1643-1644.

Ærtebjerg, G., Andersen, J.H. and Hansen O.S. (Eds.) 2003 Nutrients and Eutrophication in Danish Marine Waters. National Environmental Research Institute. 126 pp.



IVL Svenska Miljöinstitutet AB

P.O.Box 210 60, SE-100 31 Stockholm
Hälsingegatan 43, Stockholm
Tel: +46 8 598 563 00
Fax: +46 8 598 563 90

IVL Swedish Environmental Research Institute Ltd

P.O.Box 470 86, SE-402 58 Göteborg
Dagjämningsgatan 1, Göteborg
Tel: +46 31 725 62 00
Fax: +46 31 725 62 90

Aneboda, SE-360 30 Lammhult
Aneboda, Lammhult
Tel: +46 472 26 77 80
Fax: +46 472 26 77 90

www.ivl.se