Arctic Pollution Issues:
A State of the Arctic Environment Report

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Preface

This report is the product of six years of cooperation which began with the establishment of the Arctic Monitoring and Assessment Programme (AMAP) in 1991. At that time, Ministers from the eight Arctic countries requested AMAP to examine the levels of anthropogenic pollutants and to assess their effects in all relevant compartments of the Arctic environment. The Ministers further identified the families of pollutants upon which the assessment should focus.

This report is intended to be readable and readily comprehensible, and does not contain the extensive background data or references to scientific literature. The complete scientific documentation, including sources for figures reproduced in this report, is contained in a related report, 'The AMAP Assessment Report: Arctic Pollution Issues', which is fully referenced. For readers interested in the scientific basis behind the AMAP assessment, we recommend that you refer to the AMAP Assessment Report.

A large number of experts from the Arctic countries (Canada, Denmark/Greenland, Finland, Iceland, Norway, Sweden, Russia, and the United States), from indigenous peoples organizations, from other international organizations, and from Germany, the Netherlands, and United Kingdom, have participated in the preparation of the AMAP assessment.

AMAP would like to express its appreciation to all of these experts, who have contributed their time, effort, and data; especially those involved in the planning and conduct of the monitoring and research work that has been fundamental to this assessment. A list of the main contributors is included in the acknowledgements on the next page of this report. The list is based on identified individual contributers to the AMAP scientific assessment, and is not comprehensive. Specifically, it does not include the many national institutes, laboratories and organizations, and their staff, which have been involved in the various countries. Apologies, and no lesser thanks, are given to any individuals unintentionally omitted from the list.

Special thanks are due to the lead authors responsible for preparing the AMAP scientific assessment, and, in particular, to Annika Nilsson, who has written this report in close cooperation with the lead authors and the AMAP Secretariat, and who has managed the difficult task of summarizing more than 1000 pages of background scientific documentation in this comprehensive report.

The monitoring and research activities, and parts of the assessment, have been conducted as national contributions to the work of AMAP. However, the assessment would not have been possible without additional financial support for this work from Canada, Denmark, Norway, Sweden, the United States, the Nordic Council of Ministers, and the United Nations Environmental Programme (UNEP). These contributions have made it possible, amongst other things, for experts from Arctic indigenous peoples organizations to play an active role in this work.

The AMAP Working Group that was established to complete this work is pleased to present its assessment for consideration by governments of the Arctic countries. This report is prepared in English and translated into several languages. The English version constitutes the official version.

Tromsø, June 1997.

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Executive summary

Introduction

1. *The Arctic and the role of AMAP*

The Arctic is characterized by a harsh climate with extreme variation in light and temperature, short summers, extensive snow and ice cover in winter and large areas of permafrost. The plants and animals of the Arctic have adapted to these conditions, but these adaptations have in some cases rendered them more sensitive to human activities. Human activities both inside and outside the Arctic influence the physical, chemical and biological nature of Arctic ecosystems.

Arctic cultures remain vital and resilient, despite tremendous social, demographic, and technological changes during the twentieth century. The lives of indigenous and other Arctic peoples are closely linked to local resources, particularly by their dependence on wildlife harvesting, which form a basis for indigenous society, cultures, and economies. Spiritual ties to the environment are strong. A diet based on traditional foods has high nutritional benefit and provides the necessary dietary intake of most vitamins, essential elements and minerals. However, this assessment shows that certain Arctic population groups are among the most exposed populations in the world to certain environmental contaminants. Some of these contaminants are carried to the Arctic via long-range transport and accumulate in animals that are used as traditional foods. Some contaminants also have significant sources within the Arctic, giving rise to serious concerns in certain local and sub-regional areas.

The Arctic Monitoring and Assessment Programme (AMAP), established in 1991 under the Arctic Environmental Protection Strategy (AEPS), was given the responsibility to monitor the levels and assess the effects of selected anthropogenic pollutants in all compartments of the Arctic. This is the first AMAP assessment report, and it represents a collaborative effort involving over 400 scientists and administrators. It is based on AMAP-coordinated national and international monitoring programs within the eight Arctic countries, in combination with data and information from several research programs, including contributions from non-Arctic countries and international organizations. Details relating to the Conclusions and Recommendations presented here can be found in the following sections of this report and in 'The AMAP Assessment Report: Arctic Pollution Issues'.

Conclusions

In comparison with most other areas of the world, the Arctic remains a clean environment. However, the following conclusions illustrate that, for some pollutants, combinations of different factors give rise to concern in certain ecosystems and for some human populations. These circumstances sometimes occur on a local scale, but in some cases may be regional or circumpolar in extent.

2. *Contaminant sources and pathways*

2.1. *Sources of contamination*

Knowledge of sources of contamination of the Arctic is improving and in some cases the information is quantified. The pattern that is emerging is of two major types of source - sources remote from the Arctic and sources found within the Arctic.

Summary conclusions
concerning sources outside the Arctic:

- Outside of the Arctic, sources exist for a number of the persistent organic pollutants (POPs); the main contaminants of concern are: organochlorine pesticides (e.g., HCH) and their metabolites from agricultural activities/practices; industrial chemicals (e.g., PCBs); and anthropogenic and natural combustion products, e.g. chlorinated dioxins/furans and polycyclic aromatic hydrocarbons (PAHs).
- Over much of the Arctic, the levels of POPs cannot be related to known use and/or releases from potential sources within the Arctic and can only be explained by long-range transport from lower latitudes.
- Radioactive contamination has arisen from three primary sources: atmospheric nuclear weapons testing (1950-1980); releases from European nuclear reprocessing plants, e.g. Sellafield, which peaked in the mid-1970s; and fallout from the Chernobyl accident in 1986.
- Of the heavy metal contamination in the Arctic, industrial sources in Europe and North America account for up to one-third of the deposition, with maximum input in winter.
- Sulfur and nitrogen compounds from sources associated with industries, energy production and transport in areas remote from the Arctic result in low but widespread levels of these contaminants throughout the Arctic.
- Regulatory actions in Europe and North America are reducing the sources of some POPs, heavy metals, sulfur and nitrogen contaminants.

Summary conclusions concerning sources within,
or in close proximity to, the Arctic:

- PCBs from decommissioned DEW (Distant Early Warning) Line sites in Canada, and dioxins/furans from smelters in Norway are examples of identified sources of POPs within the Arctic; other such sources probably exist but are presently unknown.
- Two-thirds of heavy metals in air in the High Arctic originate from industrial activities on the Kola Peninsula, the Norilsk industrial complex, the Urals (outside the Arctic) and the Pechora Basin.
- At point sources such as mine sites, heavy metals may exceed local background concentrations at distances up to 30 km from the site.

- Mineralization of geological formations provides significant, non-anthropogenic local inputs of heavy metals.
- Industrial activities in northwestern Russia, including the Kola Peninsula, and at Norilsk are the dominant sources of sulfur north of 60°.
- Severe local and regional problems have occurred recently, associated with the exploration, development, and transportation of oil and gas.
- With the exception of catastrophic releases of oil, concentrations of hydrocarbons associated with anthropogenic inputs have been relatively low in the Arctic.
- Local sources of radionuclides, such as dumped nuclear waste, nuclear storage sites, accidents and past explosions, have led to local radioactive contamination.
- There exists a high concentration of radioactive sources in northwestern Russia. These sources represent a potential for release of considerable quantities of radionuclides.

2.2. *Contaminant pathways*

The Arctic is a focus for major atmospheric, riverine, and marine pathways which result in the long-range transport of contaminants into and within the Arctic. The Arctic is, therefore, a potential contaminant storage reservoir and/or sink. Various processes remove these contaminants from the atmosphere, oceans and rivers and make them available to plants and animals. Food chains are the major biological pathways for selective uptake, transfer, and sometimes magnification of contaminants by Arctic plants and animals, many of which are subsequently consumed by Arctic peoples.

- Strong south to north air flows, particularly over west Eurasia in winter, transport contaminants, e.g., sulfur and nitrogen compounds, POPs, and radionuclides, from lower latitudes. Special mechanisms selectively favor the accumulation of PCBs and certain pesticides in the Arctic.
- Arctic rivers are a significant pathway for contaminant transport to the Arctic, often associated with extreme seasonal fluctuations due to freeze-up and meltwater flushing characteristics. Suspended solids carry high levels of PCB and DDT in the Ob and Yenisey river deltas, as do sediments in the Indigirka and Pechora rivers. Sedimentation processes play a critical role in depositing particles in estuaries, deltas, and Arctic coastal shelves. These riverine pathways lead to local and regional dispersal of radionuclides, some heavy metals, and oil.
- Ocean waters are a major storage reservoir and transport medium for water soluble POPs. Sea ice may be important in transporting POPs and other contaminants from coastal sediments during the winter, and from deposition from the atmosphere, with subsequent redistribution during ice melt.
- Long distance marine transport of radionuclides from previous mid-latitude releases resulted in accumulations in Arctic sediments. Radionuclides from current releases from spent fuel storage and wastes dumped at sea, tend to remain local, although low-active liquid wastes dumped previously in the Arctic marine environment have been distributed more widely.

In marine, freshwater and terrestrial ecosystems, contaminants are selectively taken up by microorganisms and higher plants from water, sediment and soils. Consumption by herbivores and carnivores results in the transfer of contaminants, and in some cases increased concentrations (biomagnification), within the food webs. Food web structure and length of the food chain, therefore, significantly influence the transfer and redistribution of contaminants within the Arctic.

- Freshwater and marine ecosystems contain higher levels of POPs than terrestrial ecosystems due to longer and more complex food webs. Biomagnification of POPs is especially significant in food webs dominated by organisms with high fat contents. Many upper trophic level carnivores are long-lived and may transfer POPs to offspring during extended gestation and lactation.
- In several marine mammals, geographical differences in contamination, e.g., cadmium and mercury contamination, may be explained by differences in geology, diet, and growth processes related to temperature. Biomagnification of metals is often very selective, e.g., there is no indication that lead, and selenium, levels increase in higher trophic levels although cadmium and mercury clearly do.
- Some species and/or their prey contain large metal and POP burdens from overwintering at lower latitudes and deliver these to the Arctic on their return in the summer.
- Terrestrial and freshwater ecosystems contain higher levels of those radionuclides that are important in relation to human exposure, than do marine ecosystems.

The combination of long-range transport processes, climate conditions and physical, chemical and biological properties results in the accumulation of some contaminants in traditional foods at levels often exceeding those in foods from outside of the Arctic.

3. *Contamination levels, trends and effects*

3.1. *Sensitive species, processes, and systems*

Low temperatures, extreme seasonal variations in light, and lack of nutrients are some of the physical and chemical characteristics which cause environmental stress to organisms, limit productivity of Arctic ecosystems, and make them potentially more vulnerable to environmental contaminants. There is considerable variability among species in their exposure and response to different contaminants, and their rate of recovery from the effects of exposure. Apart from areas of intense local contamination, the major concern at present is focused on PCBs and pesticides, mainly because of the sensitivity of species to these contaminants and the biological processes which enhance levels and effects.

- The most exposed animals to many contaminants are those high in the food webs, such as marine mammals, including polar bears, and birds of prey, but also some fish species.
- Contaminant levels in some Arctic birds and mammals exceed some thresholds associated with reproductive, immunosuppressive, and neurobehavioral effects in laboratory animals and some studied wildlife species. Besides eggshell thinning in some Arctic predatory birds from DDE , other subtle biological effects have been

seen in a few studied Arctic mammal species. These effects appear to be associated with high levels of POPs, particularly PCBs.
- Biomagnification is a major factor influencing species exposure, with the long, marine-based food webs being particularly vulnerable. In contrast, migratory birds are vulnerable through overwintering in polluted environments at mid-latitudes and/or from consumption of other contaminated migratory birds.
- Based on a few dated sediment core studies and long-term temporal trend monitoring in fish and seabird eggs, levels of PCBs and DDT decreased in the subarctic from the 1970s to the 1980s. However, trends for the 1980s to 1990s are less obvious and more difficult to interpret. Long-term data on time trends in the High Arctic are lacking.
- Cadmium levels are high enough in some terrestrial and marine birds and mammals to pose a threat of kidney damage.
- Mercury seems to be increasing in aquatic sediments and in marine mammals. It is biomagnified but its effects appear to be suppressed by current levels of selenium.

In addition to assessing the potential effects of contaminants on Arctic ecosystems, increases in UV-B radiation represent a new challenge. Arctic organisms are particularly susceptible because they normally live with low radiation levels and, unlike alpine species, are not adapted to resist damage. Additionally, repair processes are slower than damage, and adaptation is slow in long-lived organisms. Thus, 1) algae and other microrganisms in terrestrial and aquatic systems are sensitive to UV-B, but can adapt through short generation times; 2) fish larvae are vulnerable when they are exposed to UV-B in shallow waters, and fish can show skin and gill lesions; and 3) terrestrial mammals, like humans, are sensitive.

3.2. *Geographical areas of concern*

Contaminants are widely, but not uniformly, distributed around the Arctic. Geographical variation in levels results from point sources of contamination, which result in high local pollution concentrations, and from environmental convergence mechanisms, e.g., convergence of physical pathways or areas of sediment accretion. Geographical variation in sensitivity for effects results from environmental conditions which make similar concentrations bioavailable in one area but not in another, and, among humans, variations in production, harvesting and utilization of traditional foods.

- Industries on the Kola Peninsula, Norilsk, and eastern Finnmark emit a wide spectrum of major local pollutants, resulting in strong spatial gradients along atmospheric, terrestrial, riverine and marine pathways. Effects can be locally catastrophic and subregionally damaging, e.g., areas adjacent to nickel smelters.
- PCB and DDT levels in suspended solids in the Ob and Yenisey river deltas and sediments in the Indigirka and Pechora rivers are high, even compared to urban areas in temperate regions.
- Levels of PCB and DDT seem to be higher in both biotic and abiotic media around Svalbard, the southern Barents Sea, and eastern Greenland than in the Canadian High Arctic. Levels of HCH seem to be higher in the Canadian Arctic. Causes and mechanisms in focusing these and similar important contaminants are not fully understood. Other such regions may exist, but inadequate data coverage, in particular for Alaska and parts of Russia, may mean that all such areas have not yet been identified.
- Soils and freshwaters are particularly sensitive to acidification in areas where the soils are acid, shallow and poor in bases. Most of northern Fennoscandia, the northern part of the Kola Penninsula, and parts of the Canadian Shield are therefore vulnerable to relatively low inputs of atmospheric sulfur and nitrogen.
- Areas with surface organic layers, subject to little mixing with underlying mineral layers, show much higher transfer of radionuclides into food chains than do areas with mineral-rich soils in which the radionuclides are immobilized.

3.3. *Human exposure*

Several groups of people in the Arctic are highly exposed to environmental contaminants. Persistent contaminants, derived from long-range transport or local sources, accumulate in animals that are used as traditional foods. Thus, variation in human exposure depends on a combination of (1) varying environmental concentrations of contaminants, (2) local physical and biological pathways which make the contaminants available, and (3) the local dietary habits of the people.

- Exposure to persistent organic pollutants is the primary concern. People are most exposed to PCBs and certain pesticides through the long marine food webs which result in high concentrations in mammals, birds and, to a lesser extent, fish. The use of different foods determines contaminant intake. Some indigenous groups are exposed to levels that exceed established tolerable intake levels. Transfer to infants can result in levels in newborns which are 2-10 times higher than in regions further south.
- Exposure to radionuclides is mainly through atmospheric transfer and deposition to terrestrial ecosystems. Particular soil and vegetation characteristics concentrate some radionuclides, enabling high concentrations to develop in plants and animals (reindeer/caribou, game, mushrooms). Arctic people are generally exposed to higher levels of radionuclides than people in temperate zones.
- Of the heavy metals, both cadmium and mercury tend to accumulate in the long marine food webs. Methylmercury, partly because it is fat-soluble, is efficiently taken up following consumption and therefore poses the main potential risk. Like POPs, methylmercury can be transferred to the fetus and to breast-fed children, and in certain areas, levels are high enough to indicate a need for public health measures. Although mercury levels can be high, interaction with selenium may reduce the risk to people.
- Enhanced UV-B radiation, resulting from pollution at lower latitudes, directly exposes humans. The main concerns relate to possible ocular damage and additional immunosuppressive effects and dermatological disorders.
- Controls on emissions have resulted in measurable

reductions in input of some contaminants (e.g., lead, radionuclides, atmospheric sulfur, and possibly PCBs and DDT). There is considerable variation across the Arctic, however, and recycling of accumulated pools of long-lived contaminants can result in continued exposure long after controls have been enforced.

4. *Potential threats*

Emerging potential changes in contaminant sources and pathways include:

- Production and use of 'new' organic chemicals, including new generation pesticides.
- Increased emissions of heavy metals and other elements or compounds from increased development of industries within the Arctic and developing regions outside the Arctic (e.g., Southeast Asia).
- Release of radionuclides, hydrocarbons, and POPs through accidents during production, transport, waste disposal, and storage, including existing dumps (e.g., leakage from landfill sites).
- Unexpected natural events, e.g., floods, storms, volcanic eruptions, and earthquakes, which cause release, mobilize, or redistribute contaminants.
- Unexpected interactions between contaminants, or between a contaminant and particular environmental conditions, may significantly change contaminant mobility through food webs.
- UV-B, which is the main toxic exposure showing an increasing trend in the Arctic. This affects Arctic organisms and humans directly. Additionally, the response of organisms may alter the structure, composition and functioning of ecosystems with consequences for humans.
- Climate change, which is of immediate interest to the Arctic. There is considerable uncertainty in the predicted long-term climate change, and thus the consequences of these changes, whether due to natural or anthropogenic influences, remain unknown. The mobilization/immobilization of contaminants following warming; altered redistribution of contaminants through changes in oceanic and air currents; changes in biological pathways through changes in species composition of plant and animal communities, etc., are all examples of possible consequences which cannot yet be determined.
- Accidental releases, for which the extreme environmental conditions and isolated localities in much of the Arctic greatly increase the difficulties of detection and taking remedial measures.

5. *Gaps in current understanding*

Current understanding of transport processes and the ability to quantify them is inadequate. In particular, determination of transport processes and their relative importance or magnitude within and between compartments (air, land, water, ice, sediments and biota) is essential. Specific gaps and needs concern:

- Contaminant inputs to the Arctic from various sources and pathways, including increased knowledge of local sources within the Arctic, which may as yet be unknown or insufficiently quantified.
- Poor understanding of pathways of transport and deposition of heavy metals, POPs, petroleum hydrocarbons and radionuclides, from land to rivers, estuaries, deltas and the continental shelf. In particular, determining contaminant focusing zones (i.e., zones of convergence of contaminant transport pathways) and understanding the processes of sequestration by sediments need further attention. The use of natural and anthropogenic tracers to mimic contaminants and distinguish sources has been underutilized.
- Ocean transport processes for different contaminants, including ice transport and subsequent contaminant release in melting (focusing) zones.
- Improved understanding of the influence of Arctic conditions, especially temperature and light, on the transformation and fate of contaminants.
- Understanding of the changes in contaminant concentrations, transformations, and interactions that occur within food web pathways, including dynamics of the transfer of radionuclides into traditional foods arising from both terrestrial and freshwater pathways.
- Information on contaminant levels and trends, which is still lacking for certain contaminants and media in certain areas.
- Long-term trends in levels of contaminants in different compartments, especially in biota.
- Better understanding of physiological and toxicological effects of contaminants on humans and species identified as most at risk, especially on development of offspring, and/or immunosuppression and endocrine disrupting properties
- Detailed information on the diet and food consumption patterns of specific Arctic populations, including necessary information on other factors (e.g., smoking) which can influence contaminant exposures, to allow better estimates of dietary intakes of contaminants and permit more reliable estimates of associated risks.
- Integration of physical and biological models with information on environmental measurements of sources and pathways, to aid the design and implementation of monitoring, research, and management , including mitigation.
- Assessment of the probability and impact of release from operations involving radionuclides, other than waste dumping at sea, and identification of appropriate management options.
- Knowledge about combined effects of contaminants on biota and humans, both at the individual and ecosystem level.
- Knowledge about combined effects between climate change and contaminant pathways, including improvements of models for assessments. Existing models on climate change and transport processes do not have the resolution and accuracy needed to fully assess environmental consequences of anthropogenic emissions to the Arctic.

Recommendations

6. *Arctic residents*

6.1. *Human health advice*

Weighing the well-known benefits of breast milk and traditional food against the suspected but not yet fully understood effects of contaminants, it is recommended that:

- Consumption of traditional food continues, with recognition that there is a need for dietary advice to Arctic peoples so they can make informed choices concerning the foods they eat.
- Breast feeding should continue to be promoted.

6.2. *Indigenous Peoples*

To ensure the interest and active involvement of Arctic indigenous peoples and other Arctic residents, the Arctic countries should:

- Improve the use of indigenous knowledge in environmental research, including local participation, and policy.
- Establish a long-term communication program to provide public information concerning environmental contaminants, linked to AMAP, which gives access to sound and regularly updated information in an understandable language.
- Integrate contamination issues for different educational levels in order to raise general environmental and scientific literacy among Arctic residents, including indigenous peoples.

7. *Source–receptor relationship*

To develop international strategies to protect the Arctic from environmental contamination, the input to and the significance of the different pathways to the Arctic must be better quantified:

- Procedures for source apportionment of contaminants need to be further developed to better identify the magnitude and relative contribution over time from natural and anthropogenic sources.
- Procedures for the improved quantification and reporting on anthropogenic emissions need to be developed to better quantify inputs to the Arctic, including potential releases from nuclear sources.
- Procedures need to be developed to identify the fraction of contaminants entering the Arctic as the result of current usage or recent emissions.
- The significant transport processes distributing contaminants within the Arctic need to be quantified; in particular, the contaminant transformations and interactions within the food web pathway need to be better understood and, if possible, quantified.
- Improved information is needed on potential releases of radionuclides and their subsequent behavior in the terrestrial and freshwater environments.
- Further development of existing models (atmospheric and oceanographic) to simulate/predict the transport of and exposure from contaminants to and within the Arctic and their use together with appropriate analytical tools (such as Geographical Information Systems), is required to better define action plans and priorities (e.g., emission controls, critical loads, dietary advice, etc.).

8. *Contaminant levels, trends and effects*

There exists uncertainty as to whether or not the levels of some environmental contaminants are decreasing. It is essential that temporal trends be intensively monitored in appropriate abiotic and biotic media at a few key locations, and occasionally over wider areas. Such programs necessarily imply a long-term monitoring commitment. In this context, the next phase of AMAP should promote the design and establishment of a coordinated circumpolar network of long-term reference monitoring sites to include:

- Consideration of the establishment of additional air monitoring master stations to fill geographical gaps and complement existing sites.
- Continuation of existing time trend series which have proven to be useful and informative, while replacing those that have generated less useful data with more appropriate monitoring strategies.
- Investigation of levels and trends of radionuclides in flora and fauna relevant to assessing the radiation exposure and effects on ecosystems, and not only those biota relevant to human exposure.
- Retrospective time trend techniques (e.g., soil, sediment and ice-core studies, analysis of specimen bank samples).
- The use of specimen banks for archiving abiotic and biotic samples.

Processes behind trends for heavy metals should be studied to resolve the relative impacts of significant natural or anthropogenic sources.

There is a need to obtain a spatial distribution of the magnitude of contaminant levels on a circumpolar basis. Priority should be given to:

- Significant data gaps, particularly from the United States and Russian sites.
- Metals (mercury and cadmium), and POPs in organisms for which there are concerns for biological effects.

Chemical and biological effect monitoring should be encouraged:

- In Arctic species having body burdens of POPs, cadmium and mercury levels at or above levels of concern.
- In small Arctic streams where acidification is considered most likely to occur first.

There is a need for improved information on spatial and temporal trends to clarify the adverse effects of POPs, methylmercury, and cadmium on human populations, especially on child development. The relative importance of local and distant, and natural and anthropogenic sources of heavy metals in the Arctic that are causing elevated dietary exposures should be determined.

Surveys of tributyltin (TBT) in harbor sediments in the Arctic should be carried out to assess the extent of TBT contamination.

In regions of existing or developing oil and gas exploitation and transportation in the Arctic:

- Steps should be taken to harmonize the monitoring of petroleum hydrocarbon levels and effects.
- It is recommended that nautical charts and environmental sensitivity mapping for the Arctic area be improved as an important counter-measure for oil spills.

- Methods and techniques for combating oil spills in ice-covered areas should be developed to reduce damage when spills occur.

To ensure intercomparability, future AMAP monitoring programs should continue to address and include improved quality assurance/quality control protocols, possibly linked to other international programs, for:

- Sampling and analysis, including interlaboratory comparison; storage and archiving of samples; and handling, reporting and analysis of data.

For emergency preparedness, it is important to identify areas vulnerable to contamination, especially oil and radioactive contamination. Environmental sensitivity mapping should be improved and completed.

9. *Remedial actions relating to contaminants*

The Arctic countries should take all necessary steps to ensure that their domestic responsibilities and arrangements to reduce contaminant inputs to the Arctic region are fully implemented. If these responsibilities and arrangements are not addressed in an appropriate manner, the justification for recommending actions aimed at reducing transboundary contaminants with sources outside of the Arctic will be accordingly diminished. There is a need for actions to clean up contaminants from industrial and military sites and to reduce risk of nuclear accidents and radioactive releases and oil pollution in the Arctic.

The AMAP countries, all being parties to the Convention on Long-range Transboundary Air Pollution (LRTAP), should work vigorously for the expeditious completion of negotiations for the three protocols presently being prepared. These include a second nitrogen protocol, a protocol to initially focus upon the heavy metals cadmium, mercury, and lead, and a protocol on POPs. The protocols should apply throughout the full extent of the geographic area covered by the Convention, and not be restricted to the areas covered by the European Monitoring and Evaluation Programme (EMEP). In addition, the AMAP countries should strongly support the work of the international negotiating committee, to be established early in 1998 following a decision of the Governing Council of the United Nations Environment Programme (UNEP), to prepare an international, legally-binding global agreement on controls for twelve specified POPs.

All Arctic countries should demonstrate leadership by ratifying the second sulfur Protocol under the LRTAP Convention.

The LRTAP protocol under negotiation for heavy metals can only address emissions to the atmosphere from anthropogenic sources. Where there are cases of transboundary effects in the Arctic resulting from releases to the aquatic or terrestrial environment, AMAP countries should explore other appropriate mechanisms to address these concerns, including other legal mechanisms. AMAP countries which are party to other international agreements aiming at reductions in releases to the environment of heavy metals, hydrocarbons, and POPs should strongly support implementation plans of those agreements where these actions will lead to improvements in the Arctic environment (e.g., the London Dumping Convention, the International Maritime Organization's MARPOL Convention, the Oslo-Paris Convention for the North East Atlantic Ocean, etc.).

Compliance with existing legal instruments appears to be an issue for contemporary international agreements, and guidance on radiation protection, nuclear safety, radioactive waste management, and emergency preparedness should be rigorously adhered to by all Arctic countries to minimize the probabilities and consequences of accidents. In addition, international recommendations regarding the improvement of nuclear and radiation safety in the nuclear industry, which cover reactor refueling, decommissioning and associated spent fuel storage and disposal operations, should be extended to, and implemented in, all nuclear fleet operations. Efforts to reduce risk for nuclear accidents and radioactivity releases should be continued and strengthened. Nevertheless, it is recommended that the Arctic countries cooperate to ensure that existing regulations are followed in future developments and are reviewed to ensure full accounting for the extreme conditions found in the Arctic.

Arctic countries should support the implementation of the Montreal Protocol (on ozone-depleting substances) and the Framework Convention on Climate Change.

Levels of many contaminants in the Arctic are likely to remain at or close to existing levels for decades because of their resistance to degradation, the slow rate of degradative processes, and the recycling of existing accumulations. Thus, ameliorative actions to reduce exposure to humans and to protect wildlife are an essential adjunct to emission controls.