Radioactivity – a threat to the Arctic environment?

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Introduction

Over the last decades, the former image of the Arctic as a pristine environment unaffected by humans has been disturbed by reports on enhanced levels of radioactive and chemical contaminants throughout arctic ecosystems. As the Arctic is perceived as a wilderness of high ecological value which merits protection against contamination, the eight Arctic states initiated the International Arctic Environmental Protection Strategy and shortly thereafter the Arctic Monitoring and Assessment Programme (AMAP).

The first phase of AMAP was completed with a ministerial report in 1997 and a scientific report in 1998 [AMAP1998]. In 1999, the second phase of AMAP was initiated to follow up the work carried out during the first phase. During this phase, data and information have been collected to supplement the first phase and new assessments have been made or the existing information have been reevaluated, where applicable. Where the data series from AMAP phase I have been prolonged, in general, the new data have confirmed the gradual reduction in levels observed during the first assessment. The striking contrast have been the levels of ^{99}Tc in the north west Atlantic Ocean increasing due to continued releases from the Sellafield reprocessing plant.

One of the knowledge gaps that were identified in AMAP phase I, was the lack of information on doses to, and effects on, biota. In co-operation with other projects, this work has been initiated during the second phase.

Sources and Contamination

Since the phase I AMAP assessment, no new main sources of radioactive contamination have been identified. Anyhow, some information regarding changes of the behaviour of the existing sources, and some new minor sources have come to attention. [TSAT2002].

Main Sources

The main sources of radioactive contamination of the Arctic areas are past fallout from the atmospheric nuclear weapons tests and from the Chernobyl accident and releases from the European reprocessing plants for nuclear waste. Among these, the reprocessing plants are the only sources still releasing radioactivity into the environment. Especially Sellafield in the UK has received attention due to its increase in the releases of ^{99}Tc since the early 90'ies, The direct discharges of plutonium and caesium from Sellafield have decreased substantially since the peaks in the seventies and early eighties. But, as these releases have decreased, it has become evident that some of the radionuclides were being deposited in the sediments, and are now remobilised.

Levels, Trends and Vulnerability

During the second phase of AMAP, some of the data series that were presented in the first phase have been extended, and some new information has been made available. For most of the series, the declining trends from the former assessments have continued or been confirmed, with an important exception of the levels of ^{99}Tc in the North-West Atlantic Ocean as stated above [BROW2002].

Newly collected data has improved AMAPs database and thus allows estimates of geographical variation in transfer rates and ecological half-lives in Arctic pathways as well as variation in contamination between species. This information allows the estimation of vulnerability, or radioecological sensitivity, with respect to dose to man after a given radionuclide input. The work is still ongoing for the AMAP assessment. Further information on this topic is given in [HOWA2002].

Assessments of Human Exposure

In AMAP I, intakes of ^{137}Cs and the resulting doses for the average population and selected groups were calculated for most of the AMAP area and it was concluded that the Arctic population may receive a dose five times higher than that of the population in temperate areas with comparable levels of contamination. As radionuclide transfer rates and ecological half-lives varies geographically, the highest doses to the populations may occur at locations other than the most highly contaminated areas.

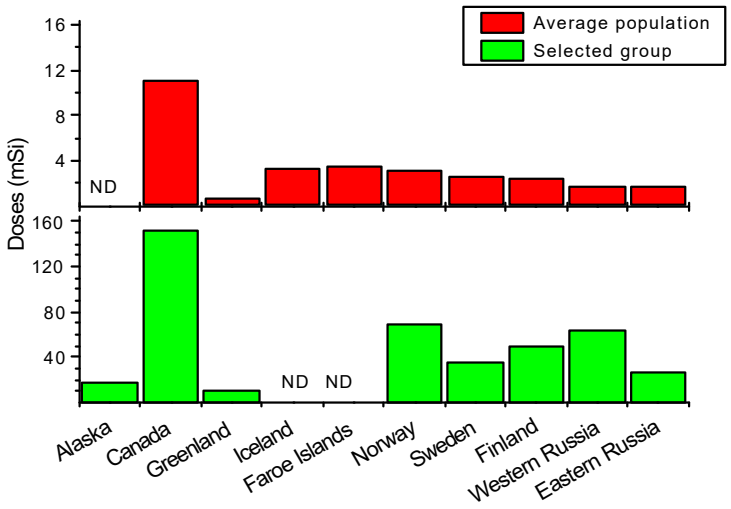

Figure 1 Calculated doses to Arctic population groups (ND: No Data)

As data from the Faroe Islands have become available, doses have been assessed in a similar manner to AMAP phase I. (Figure 1) In North West Russia, a large amount of new information on contamination of foodstuffs, dietary habits and whole body measurements have been collected in the Kola and Nenets areas allowing for more specific dose assessments for the last years. The results of those two assessments have been compared with the assessments for various areas in AMAP I and show a good correlation. The selected group is the reindeer breeding indigenous population, with exceptions for Greenland using a hypothetical group with similar attributes and Canada, having a narrower definition. [AMAP1998]

Protection of the environment from the effects of radiation

There is a growing awareness that radiation risk management needs to address the question of effects on the environment. The present system is based on the protection of man, as stated by ICRP “The ICRP believes that if man is adequately protected, then other living things are also likely to be sufficiently protected” [ICRP1977]. However, there might be situations, especially in the sparsely

populated Arctic areas, where pathways to man do not exist or are very long and therefore biota might be exposed to harmful doses even though the doses to man are well below the internationally recommended dose limits.

Thus, the goal of a system for protection of the environment will be a framework that allows regulators to explicitly and transparently demonstrate a commitment to environmental protection and provide a basis for developing standards against which to test for compliance for current and future practices. This framework will include environmental transfer and dosimetry models, and tabulated dose- response relationships. Requirement of the system are also sets of reference organisms, *i.e.* group of organisms that are selected due to their radiosensitivity, accumulation potential, ubiquity or importance to the ecosystem, and derivation of relevant quantities and units. The Arctic needs special attention when it comes to the selection of reference organisms due to its higher vulnerability and lower abundency of species. The Inco-Copernicus funded research project EPIC (Environmental Protection from Ionising Contaminants) is aiming towards developing a methodology for the protection of natural populations of organisms in the Arctic. So far, has EPIC produced a list of Arctic specific reference organisms based on their ecological niche, radiosensitivity, likely exposure to radioactivity and suitability for monitoring and research.

Nuclear Safety Initiatives and Risk Management

As one of the greatest risks for severe radioactive contamination of the Arctic environment is posed by nuclear power plants within, or in the vicinity of the Arctic, a number of programs are ongoing to improve the safety at the at the Bilibino, Kola and Leningrad nuclear power plants in Russia.

An effort is underway to launch a series of projects related to remediation of the Andreeva Bay site that contains the largest concentration of radioactive wastes in northwest Russia.

Accident Scenarios

Nuclear power plants

The resulting short- and long term doses have been calculated for a number of release and weather scenarios at the Kola Nuclear Power Plant. In all cases, the short term doses were too low to cause any acute radiation injuries. The total long term doses were strongly dependent on the amount of fallout in reindeer production areas and on the time of year for the accident. Under all accident scenarios, reindeer keepers annual ingestion doses are predicted to exceed 1mSv for at least 40 years after deposition in the Murmansk Oblast given no countermeasures are initiated.

Nuclear weapons

Nuclear weapons are handled on a number of locations within the Arctic, but due to the strategic nature of these weapons, it is not possible to obtain information to carry out any accident assessments. Accidents involving nuclear weapons have happened, such as at Thule in Greenland in 1968 and substantial clean-up operations had to take place.

Conclusions

The work of AMAP phase I has further documented the vulnerability of the Arctic environment and how it varies spatially, temporally and between species. New knowledge has been made available on the behavior of radionuclides in the environment and on the needs of protection of the environment towards radioactive contamination. Work should be done to refine this knowledge so that it can be implemented by the applicable authorities. The work within AMAP has made a good basis for further development of strategies for emergency preparedness and reduction of the consequences of radioactive contamination in the Arctic.

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