Arctic Monitoring and Assessment Programme (AMAP)

Norwegian Implementation Plan (01.09.00)

1. Trend Monitoring programme

1.1 Atmospheric

Temporal and spatial trends on concentrations in air of heavy metals, POPs and radionuclides.
Temporal trends in concentrations of air and precipitation and deposition of acidifying substances.

Parameters (contaminants, compartment/species, organ)	Frequency	Location of sampling/examination
PAH, HCH, HCB, PCB, cis- + trans-chlordane, cis- + trans-nonachlor, DDTs; in air [1]	Weekly	Ny-Ålesund (Svalbard)
- Hg, Cd, Pb, Zn, Cu, As, Cr, Ni, Co, Mn, V; - Hg , (all in air [1])	Weekly, Continuous	Ny-Ålesund (Svalbard) ---- " ------
SO_2/SO^{2-}_4, NO_2 , sum NO^-_3 +HNO_3, sum NH_3 +NH_4^+; in air [2]	Daily	Ny-Ålesund (Svalbard,) Karasjok (Finnmark county) Tustervatn (Nordland county)
SO^{2-}_4 , NO^-_3 , NH_4^+, Ca, Mg, Na, Cl, K, pH; in precipitation [2]	Weekly	Ny-Ålesund (Svalbard)
SO^{2-}_4 , NO^-_3 , NH_4^+, Ca, Mg, Na, Cl, K, pH; in precipitation [2]	Daily	Karasjok (Finnmark county) Tustervatn (Nordland county)
Pb, Cd, Zn; in precipitation [2]	Weekly	Karasjok (Finnmark county), Tustervatn (Nordland county)
SO_2 ; in air, meteorology [3]	Continuous	Svanvik (Finnmark county)
SO_2, NO_2 , sum NO^-_3 + HNO_3, sum NH_3 +NH_4^+; in air [3]	Weekly	Svanvik (Finnmark county)
SO^{2-}_4 , NO^-_3 , NH_4^+, Ca, Mg, Na, Cl, K, pH; in precipitation [3]	Weekly	Svanvik and Karpbukt (Finnmark county) Øverbygd (Troms county)
Cd, Pb, Zn, Cu, As, Cr, Ni, Co; in precipitation [3]	Weekly	Svanvik (Finnmark county) Øverbygd (Troms county)
SO_2 in air; meteorology [3]	Continuous	Nikel and Maajavri, Russia [4]
Radionuclides: γ-emitters in air	Weekly	Svanvik and Viksjøfjell (Finmark county), Skibotn (Troms county)

Supplementary explanations (to the table):
[1] established for the purpose of AMAP
[2] established for the purpose of EMEP
[3] other national or bilateral programmes
[4] Continuous monitoring of SO_2 is carried out at two stations (Nikel and Maajavri) in Russia, by the
   Norwegian institute for Air Research, as a continuation of the bilateral Norwegian-Russian monitoring
   programme.

1.2a Marine ecosystem (Abiota)

Spatial variation and temporal contaminant trends.

Parameters (contaminants, compartment/species, organ)	Frequency	Location of sampling/examination
POPs: HCHs, HCB, PCBs, DDTs, trans-nonachlor, toxaphene (Parlar Nos. 26, 50, 62) Metals: Cd, temporal contaminant trends Hg, Pb	Every third year	Barents Sea, Norwegian Sea: Haltenbanken, Lofoten
Radionuclides: γ-emitters in sea water	Monthly	Hillesøy, Tromsø, Troms county
Radionuclides: γ-emitters in sea water and sediments	Annual, but every third year in each ocean	Barents Sea, Norwegian Sea, North Sea with Skagerrak and Kattegat
γ-emitters, Pu-isotopes, ^{241}Am in seawater	Annual	7 chosen fjords with special attention to one fjord. Various fjords each year.

Spatial variation and temporal trends (OSPAR/JAMP programme).

Parameters (contaminants, compartment/species, organ)	Frequency	Location of sampling/examination
POPs: PCB, OCS, HCH, HCB, DDT, EPOCl, PAH in marine sediments	10 years	Approximately 10 sites in the Norwegian coastal AMAP area[1] (excl. Svalbard)
Metals: Hg, Cd, Cu, Pb, Zn in marine sediments	10 years	Approximately 10 sites in the Norwegian coastal AMAP area[1] (excl. Svalbard)

Supplementary explanations (to the table):
The monitoring programme is very complex and the specific compartments of the programme may vary from one year to another.
[1] not all samples/analyses are carried out at each station
The Northern part of Norway was included in the programme from 1992/93. A comprehensive base line/screening survey was carried out first , comprising approximately 30-35 sites. "Routine" monitoring is limited with respect to sites and activities.

1.2b Marine ecosystem (Biota)

Spatial variation and temporal contaminant trends.

Parameters (contaminants, compartment/species, organ)	Frequency	Location of sampling/examination
POPs: HCHs, HCB, PCBs, DDTs, trans-nonachlor, toxaphene (Parlar Nos. 26, 50, 62) Metals: Cd, Hg, Pb	Every third year	Barents Sea, Norwegian Sea: Haltenbanken, Lofoten
POPs: PCB, DDT/DDE, BPDPEs, Chlordane, dieldrin, Toxaphene in: - Polar bear (*Ursus maritimus*) - Glaucous gull (*Larus hyperboreus*) - Brünnich's guillemot (*Uria lomvia*)	3-5 years	Svalbard area, the Barents Sea
POPs: PCB, DDT/DDE, BPDPEs, Chlordane, dieldrin, Toxaphene in: - Ringed seal (*Phoca hispida*) - Harp seal (*Phoca groenlandica*) - Hooded seal (*Cystophora cristata*) - Beluga (*Delphinapterus leucas*) - Minke whale (*Balaenoptera auctorostrata*) - Walrus *(Odobenus rosmarus)* - Common eider (*Somateria mollissima*) - Black guillemot (*Cepphus grylle*)	7-10 years	Svalbard area, the Barents Sea

- Kittiwake (*Rissa tridactyla*) - Common guillimot (*Uria aalge*)		
Metals: Cd, Cu, Hg, Pb, Se in: - Ringed seal (*Phoca hispida*) - Beluga (*Delphinapterus leucas*) - Polar bear (*Ursus maritimus*) - Black guillemot (*Cepphus grylle*) - Kittiwake (*Rissa tridactyla*) - Glaucous gull (*Larus hyperboreus*)	10 years	Svalbard area, the Barents Sea

Supplementary explanations (to the table):

- Occasionally other species are also analysed for the above mentioned compounds: Herring (*Clupea harengus*), saithe (*Pollachius virens*), red fish (*Sebastes mentella, S. marinus*), polar cod (*Boreogadus saida*), capelin (*Mallotus villosus*), long rough dab (*Hippoglossoides platessoides*).
- A study of different OCs in different levels of the food web, from phytoplankton/ice algae to marine mammals has been carried out in the marginal ice zone in the Fram Strait and the Barents Sea from 1998 - 1999

Spatial variation and temporal trends (OSPAR/JAMP).

Parameters (contaminants, compartment/species, organ)	Frequency	Location of sampling/examination
POPs: PCB, OCS, HCH, HCB, DDT, EPOCl, PAH in marine organisms [1]	Yearly	Approximately 10 sites in the Norwegian coastal AMAP area (excl. Svalbard)[2]
Metals: Hg, Cd, Cu, Pb, Zn in marine organisms [1]	Yearly	Approximately 10 sites in the Norwegian coastal AMAP area (excl. Svalbard)[2]

Supplementary explanations (to the table):

The monitoring programme is very complex and the specific compartments of the programme may vary from one year to another.

[1] organisms analysed are: blue mussel (*Mytilus edulis*), cod (*Gadus morhua*), flatfish (dab (*Limandsa limanda*), flounder (*Platichthys flesus*), plaice (*Pleuronectes platessa*), lemon sole (*Microstomus kitt*). Not all organisms are analysed for all components.

[2] not all samples/analyses are carried out at each station. Northern Norway was incl. in the programme from 1992/93. A comprehensive base line/screening survey was carried out first , comprising approximately 30-35 sites. Monitoring is limited with respect to sites and activities.n

Parameters (radionuclides) (contaminants, compartment/species, organ)	Frequency	Location of sampling/examination
γ-emitters in seaweed	Annual	Tromsø, Troms county Spitsbergen
γ-emitters in seaweed and crustacian	Monthly	Norwegian coast
γ-emitters in fish, seawater and sediments (fish sp: Cod (*Gadus morhua*), Haddoc (*Melanogrammus aeglefinus*))	Annual, every third year in each ocean	Barents Sea, Norwegian Sea, North Sea with Skagerrak and Kattegat
γ-emitters, Pu-isotopes, ^{241}Am in seaweed and water	Annual	7 chosen fjords with special attention to one fjord. Various fjords each year.
γ-emmitters, Pu-isotopes, ^{90}Sr and ^{241}Am in fish (shrimp when needed)	Monthly	Samples from selected fisheries

1.3 Freshwater ecosystems

Water acidification, temporal and spatial trends.

Parameters (contaminants, compartment/species, organ)	Frequency	Location of sampling/examination
SO_4^{2-}, NO_3^-, Ca, Mg, Na, Cl, K, pH, Tot-N, conductivity, TOC, reactive and non-labile Aluminium; in freshwater [1]	Weekly	Dalelva river, Finnmark county
SO_4^{2-}, NO_3^-, Ca, Mg, Na, Cl, K, pH, Tot-N, conductivity, TOC, reactive and non-labile Aluminium; in lakes [1]	1 time per year	6 lakes, Nordland county 4 lakes, Troms county 32 lakes, Finnmark county

Supplementary explanations to the table:
[1] other (than AMAP) national or bilateral programmes

1.4 Terrestrial ecosystems

Spatial variation and temporal trends

Parameters (contaminants, compartment/species, organ)	Frequency	Location of sampling/examination
POPs: PCB, DDT/DDE, PBDPEs, Chlordane, dieldrin, toxaphene in: - Arctic fox (*Alopex lagopus*)	5 years	Svalbard
POPs: PCB, DDT/DDE, PBDPEs, Chlordane, dieldrin, toxaphene in: - Svalbard reindeer (*Rangifer tarandus platyrhynchus*) - Svalbard ptarmigan (*Lagopus mutus hyperboreus*)	10 years	Svalbard
Metals: Cd, Cu, Hg, Pb, Se in: - Arctic fox (*Alopex lagopus*) - Svalbard reindeer (*Rangifer tarandus platyrhynchus*) - Svalbard ptarmigan (*Lagopus mutus hyperboreus*)	10 years	Svalbard
Metals: Pb, Cd, Hg, Cu, Zn in - Willow ptarmigan (*Lagopus lagopus*) [1]	5-10 years	Several locations in northern Norway
POPs: PCB, DDT/DDE, HCB, HCH, Chlordane, dieldrin, mirex, Hg in: - Merlin (*Falco columbarius*) [1]	5-10 years	Several locations in northern Norway
Metals: As, Cd, Cr, Cu, Fe, Pb, Hg, Ni, V, Zn in - moss (*Hylocomium splendens, Pleurozium schreberi*) [1]	5 years	Several locations in northern Norway

Supplementary explanations to the table:
[1] other (than AMAP) national or bilateral programmes

Parameters (radionuclides) (contaminants, compartment/species, organ)	Frequency	Location of sampling/examination
Radionuclides: Measuring and special feeding of domesticated reindeer	Annual	Finnmark and Nordland counties
γ-emitters in Mushroom	Annual	Pasvik (Finnmark)

1.5 Human Health

The Norwegian Human Health Programme will be continued in agreement with the plans of the AMAP Human Health Group, focusing on delivering women and their newborn children

Objectives:

- Assessment of organic contaminants and dietary habits in indigenous population groups of northern Norway in cooperation with the program of the arctic areas of Russia - spatial trends of the selected organic contaminants and pregnancy outcome in the selected populations.
- Reproductive epidemiologic studies with special emphasize on the occupational exposed population of Kola Peninsula and the neighbouring Norwegian population - both spatial and temporal trends of the selected essential and toxic elements/metals, as well as pregnancy outcomes in the same population.

Parameters (contaminants, compartment/species, organ)	Frequency	Location of sampling/examination
POPs: PCBs, HCH, HCB, DDT/DDE, toxaphenes, dioxins (limited pooled samples) in: - Human blood, breast milk, and cord blood. - Placenta samples will be included for storage and possible future studies.	Every 5. year, additional sampling will be considered	Hammerfest hospital (Norwegian and Sami population) Kirkenes hospital (Norwegian and Sami population, Norwegian/Russian border area)
Metals: Cd, Pb, Hg, Se, Ni in: - Human blood, serum, urine, and cord blood. - Placenta samples will be included for storage and possible future studies.	Every 5. year, but yearly in selected risk populations	Hammerfest hospital (Norwegian and Sami population) Kirkenes hospital (Norwegian and Sami population, Norwegian-Russian border area)
Radionuclides: ^{137}Cs in human body	Every third year	Kautokeino, Finnmark county

Supplementary explanations (to the table):
Both monitoring programmes are integrated into comprehensive studies of the Barents region;

a. Assessment of dietary patterns and organic contaminants with main focus on indigenous populations in northern Norway, Finland and Russia
b. Reproductive study of industrial exposed populations of the Kola Peninsula and the Norwegian neighbouring areas.

1.5.1 Effect studies

Effect studies are included, based on the Human Effect Monitoring Programme:
1. Bio-physical indicators (e.g., semen quality, sex hormones)
2. Epidemiologic markers (e.g., birth weight, gestational age, malformations)
3. Molecular/genetic effect markers (e.g., estrogenic-, androgenic-, dioxin-like activities)

Details are discussed in the Human Effect Monitoring Programme.

1.5.2 Supporting studies

- A screening study of asthma and allergy of children in northern Norway is extended to Kola Peninsula
- Air monitoring inside the large nickel plants of Kola Peninsula
- Isotope-marking of blood-lead particles to trace source of the high lead-levels of certain areas of Kola
- Integration with a Canadian Dietary survey of Inuit populations of northern Canada and Alaska to include Sami population of Finnmark and different indigenous populations of arctic Russia
- A clinical intervention study to integrate the pregnancy care of Finnmark County (Norway) and the Kola Peninsula (Russia) and reduce the perinatal mortality of the Kola Peninsula to the Norwegian level.

2. Effects monitoring programme

2.1 Effects on marine ecosystems

Effect of climate on biological population parameters.

Parameters (endpoints, compartment/ species,)	Frequency	Location of sampling/examination
Recruitment, growth, migration, distribution of fish (cod, herring, capelin, haddock)		Barents Sea, Norwegian Sea
Production, distribution of plankton		Barents Sea, Norwegian Sea
Species composition/community analysis (bottom benthic fauna, fish)		Selected localities in the Norwegian Sea, Barents Sea, Norwegian coast

2.2 Climate variability/change

Spatial and temporal trends in marine abiotic environment.

Parameters (endpoints, compartment/ species)	Frequency	Location of sampling/examination
t, S in sea water	2-6 times yearly	Standard sections in the Nordic and Barents Sea
t, S in sea water	2-4 times monthly	Standard stations along the Norwegian coast
t,S in sea water	Twice a year	Regional coverage (Norwegian Sea, Barents Sea) (Horisontal distribution of properties)
SST (sea surface temperature	Twice a week	Coastal water, Bergen - Kirkenes

Supplementary explanations to the table:
Temperature and salinity are the key parameters for studies of climate variability. Regular observations are necessary in order to study potential changes

Atmospheric Climate change parameters.

Parameters (contaminants, compartment/species, organ)	Frequency	Location of sampling/examination
CH_4, CFC, HCFC, HFC, HALONs, Methylbromide, PFC, SF_6, CO, N_2O, particles	Daily	Ny-Ålesund, Svalbard

2.3 Effects on terrestrial ecosystems

Pollutant effects (P), Climate effects (C)

Parameters (contaminants, compartment/species, organ)	Frequency	Location of sampling/examination
Eggshell thickness in (P) - Merlin *(Falco columbarius)* [1]	5-10 years	Several locations in northern Norway
Community analysis [1] - ground vegetation (P, C) - epiphytic lichens (P, C)	5 years	Dividal, Troms County
Community analysis [2] - ground vegetation (P, C) - epiphytic lichens (P, C)	5 years	Pasvik (Finnmark county, Norway) Nikel (Murmansk oblast, Russia)
Population studies [1]: (C) - Willow ptarmigan *(Lagopus lagopus)* - Passerine birds - Small rodents	Annual	Dividal, Troms County
Forest vitality (P, C) - discoloration, defoliation [1]	Annual	Svanvik, Finnmark county and Øverbygd, Troms county

Supplementary explanation to the table:
[1] other (than AMAP) national or bilateral programmes
[2] part of the joint Russian-Norwegian environmental cooperation

3. Supporting studies

3.1 Atmospheric

Parameters (contaminants, compartment/species, organ)	Frequency	Location of sampling/examination
Stratospheric ozone (total)	Continuous	Ny-Ålesund (Svalbard), Tromsø, Oslo
Toal UV-B	Cont.	Ny-Ålesund (Svalbard), Tromsø Trondheim, Bergen, Kisa, Østerås, Oslo, Landvik/Grimstad
Tropospheric ozone (total)[1]	Cont.	Ny-Ålesund (Svalbard), Karasjok (Finnmark), Tustervatn (Nordland)

Supplementary explanations (to the table):
[1] established for the purpose of EMEP

3.2 Marine environment

- A survey of **TBT** in *Nucella*/*Littorina*, incl imposex/intersex studies will most likely be carried out during a 3-4 years period along the Norwegian coast.

- 3 year programme on uptake and transport of contaminants through the foodweb of the Barents Sea.

- **Effect studies** will be conducted on **polar bear** (*Ursus maritimus*), and **glaucous gull** (*Larus hyperboreus*). These species are studied both as individuals (biochemical, physiological and immune studies) and as populations in order to reveal effects of OCs.

- **Pathways, modelling, foodwebs**

  Models both for studies of ocean circulation, heat exchange, transport of contaminants, biological production and understanding the processes are included. There are both large scale and small scale models, depending on the topic of interest. The areas included are the Northeast Atlantic, the Arctic Ocean and the shelf seas along Norway and Russia. IMR are presently involved in several national and international projects on modelling (VEINS, RegClim and pathway studies in the Barents and Kara Seas)

- **Hydrographic observations** are carried out in the Nordic and Barents Sea several times per year. In addition current measurements, both from fixed mooring and drifting buoys, take place. Presently, an intensive measurement programme takes place between Norway and Bear Island as part of a large international programme.

- **Climate change**

  Reconstruction of decadal-scale sea-surface temperature variability during the late Holocene. The project is a part of the International Marine Past Global Changes Study (IMAGES).The project seeks to obtain information on the variability of the Nordic heat pump on a North Atlantic Oscillation (NAO) time resolution by extending the instrumental records of the last 50 years through the late Holocene (couple thousand years back). The long time series of NAO variability will be reconstructed using sea-surface temperature reconstructions based upon diatom transfer functions from areas of extremely high sediment accumulation in the Nordic Seas.

Other climate projects:

Climate variability

Objective: Understand relations between global and regional climate change, and develop methods that permit an assessment of the precision and reliability of climate forecast.

Variation in space and time of cod and other gadoids: the effect of climate

Objective: To increase the understanding of temporal and spatial dynamics of cod and other commercial gadoid species, including the influence of environmental variability on population parameters.

The role of plankton in climate change

Objective: Establish quantitative relations between climatic parameters and plankton, and assess the importance of plankton on growth, recruitment and migration of fish.

Effects of climate on fish population parameters

Objective: Establish quantitative relations between climate and fish population parameters and make this knowledge available in assessable form for fisheries management.

NOClim

The overall objectives of the project are to contribute in a coherent and rational way with Norwegian resources and expertise to:

A) improve and enhance our understanding of rapid changes in the thermohaline circulation in the Northern seas

B) improve and enhance our understanding of ocean and ice processes related to climate, and mechanisms causing significant variability in the hydrography, circulation and ice cover in the Northern seas

C) develop schemes for early detection of climate change in the Northern seas

RegClim

There are two overall aims of the project. The first is to estimate probable changes in the regional climate in Northern Europe, bordering sea areas and major parts of the Arctic ("our region"), given a global climate change. The second is to quantify, as far as possible, uncertainties in these estimates, inter alia, by investigating the significance of regional scale climate forcings pertaining specifically to our region. This includes processes determining sea-surface-temperature (SST) and sea ice cover in the Nordic Seas, and processes related to radiatively active atmospheric contaminants with a regional distribution (direct and indirect aerosol effects, and tropospheric ozone).

Bjerknes Collaboration on Climate Research

The Bjerknes Collaboration has defined the following key scientific objectives:

- Quantify seasonal to decadal climate variability of high-latitude regions and understand their causes

- Estimate changes in this variability in the past, present and future

- Assess possibilities for changes in ocean circulation due to global warming and the possible feedbacks of changing ocean circulation on the climate system

- Identify climate evolution of the Arctic, and establish an understanding of the possible implications of reduced sea ice cover

- Identify natural climate variability, and understand its causal mechanisms. Use this knowledge to improve the predictability of future climate

- Assess the marine carbon sink, how it will be influenced by climate change, and how this may feed back on climate change.

Radioactivity

Other ongoing projects of relevance for AMAP

ARCTICMAR - Radioecological assessment of consequences from radioactive contamination of arctic marine areas.

This is an EU-funded project where NRPA is the co-ordinator. The project started 01.10.98, and will last for 3 years.

Objectives

The overall aim is to integrate our present knowledge, e.g. extensive data-bases from AMAP and new information from model-orientated experimental work in order to further develop a model which predicts the behaviour and fate of radionuclides (including ^{3}H, ^{60}Co.

^{63}Ni ^{137}Cs, ^{90}Sr and the actinides ^{239,240}Pu and ^{241}Am) in estuarine and marine environment.

It should be possible, from an assessment of the output from this model, or via input into ancillary sub-models, to calculate the radiological consequences (primarily dose) to man.

AVAIL - Arctic vulnerability to radioactive contamination.

This is an EU-funded project where NRPA is the co-ordinator. The project started 01.09.98, and will last for 3 years.

Objectives

The main aim of this project is to assess the consequences for man and the environment from radioactive contamination scenarios in the Arctic environments.

This includes considering the distribution and levels of radioactive contamination arising from different accident scenarios and studying the long-term radiological consequences (doses to man and biota) of contamination in Arctic areas due to nuclear weapons testing, the Chernobyl accident and different accident scenarios.

Another important objectives is development of a method of quantifying vulnerability (i.e. defining a 'vulnerability index') so that different areas and ecosystems may be compared and identification of vulnerable areas. This will require an assessment of many factors including the transfer of radionuclides through foodchains in northern areas and the dietary habits of indigenous peoples.

The focus will be on the terrestrial and fresh water ecosystems, but the marine environment will be included within the development of the vulnerability index concept, and for comparative purposes.

ARMARA - Radioecological assessment of the consequences of contamination of Arctic waters: modelling the key processes controlling radionuclide behaviour under extreme conditions.

This project is finished, and the final report has been submitted to the EU. Large amount of data on marine radioactivity has been collected in this project, and will be implemented in the AMAP Data Centre.

Project JNRI - Mayak 2

Assessment of consequences from possible accidents at Mayak PA nuclear installations and the subsequent contamination of the Ob river system and the Arctic Seas and Assessment of the population doses in the riverside area of Techa.

The programme period is July 1996 to July 2001.

Objectives

- to evaluate the risk of accidental scenarios at Mayak PA which may lead to severe contamination of the river system and hence the Arctic seas

- to assess long term consequences for the Arctic population as a consequence of each scenario

- to assess the present radiation dose to inhabitants at Muslyumovo and Brodokalmak

Vulnerable areas

The project is developing a method for quantification of the vulnerability of different areas to radioactive fallout. The method will be applied in mapping of vulnerable areas of Norway. The project is financed by the Norwegian Research Council, and is ending in December-99.

The vulnerability of an area depends on several factors, and can be studied using different approaches. Fluxes of radionuclides in different food production is one of them. Therefore information on land use and agricultural production will be collated. Another aspect is the identification of the food products that will most easily exceed the intervention levels in the different areas. This is important for planning of monitoring programs and implementation of countermeasures.

Information and results will be integrated in a geographical information systems (GIS), and maps of vulnerable areas of Norway will be produced. The vulnerability of different food chains will also be compared. This is crucial for the implementation of cost-effective countermeasures for the reduction of the exposure of the population, and for maintained confidence to Norwegian food products.

ATOMFLOT - Monitoring of the radioactive contamination of the sea environment in the area of discharge, of waste waters from the liguid radioactive waste treatment plant at "Atomflot"

Objectives

- Development of a physico-mathematical model for dispersion of discharged radioactive materials in the sea environment.

- Obtaining parameters required for model verification and model verification proper.

- Measurement of existing levels of radioactive contamination of the sea environment in the area of "Atomflot".

- Model calculation of radionuclides dispersion in the water of the Kola Bay and coastal hypothetical large-scale accidental discharge of radionuclide in the sea environment.

- Calculation of dynamics of the contamination of water, sediments and sea biota at different distances from the source of radionuclide release.

- Estimation of doses for those who contact with contaminated sea ecosystem.

- Development of an optimal scheme of radioactive monitoring of the waters of Kola Bay and adjacent water of the Barents Sea using results of field studies and computer model for radionuclides transport in the areas.

Long-term consequences of potential radioactive contamination in the Northern areas.

Objectives

- To study the long-term radiological consequences of different potential accident scenarios (accidents at reprocessing/nuclear power plants, releases from nuclear submarines etc.)

- Develop a spatially variable model to calculate the dose to man from 134Cs, 137Cs and 90Sr.

- Identify vulnerable areas.

Whole body measurements in Northern Norway

Since 1965 NRPA has performed whole body measurements among reindeer herders in Kautokeino, Finnmark. The project has been carried out in order to assess the radiation dose to a population group assumed to receive the highest doses of radiocaesium (^{137}Cs) from the nuclear weapons tests in the 1950's and 1960's. Since 1987 NRPA has also performed whole body measurements among reindeer herders in Nordland, Trøndelag and Hedmark, in areas that were among the most contaminated in Norway after the Chernobyl accident.

Measurements were last performed in spring 1999.

EU's fifth framework programme

Several projects relevant for the AMAP area has been applied for in the fifth framework programme. These have not yet been contracted.