Collaboration Network on EuroArctic
Environmental Radiation Protection and Research
(CEEPRA) – project

Main results

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Regional Laboratory in Northern Finland
Main objectives:

Establishment of a network between authorities and key research institutes in Euro-Arctic Region and improvement of co-operation in radiation protection, research and emergency preparedness.

Project coordination and management:

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<th>Project Steering Group (Partners, experts, target group members)</th>
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<td>WG Terrestrial</td>
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<td>WG Marine</td>
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<td>MMBI KSC RAS</td>
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<td>Pöyry Finland</td>
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Project duration:
3 years, 16.3.2011-15.3.2014

Partner countries:
Finland, Russia, Norway

Financing:
EU’s Kolarctic ENPI CBC and
Norwegian Kolarctic programmes

Project leader: STUK – Regional Laboratory in Northern Finland
Participating organizations:

- Norwegian Meteorological Institute
- Russian Academy of Sciences, Southern Scientific Centre
Radioactive substances may spread across borders. An existing collaboration network between relevant organisations in the region is vital when dealing with the consequences of radioactive contamination from a nuclear accident, for example. These organisations also need to maintain a comprehensive picture of the current environmental state, conduct regional risk assessments and ensure that the general public, decision-making authorities and other stakeholders, also in the neighbouring countries, are provided with accurate information.

Natural environments have a huge social and economic importance for the populations in the EuroArctic region. Risk assessments have to be carried out taking into consideration the climatic and environmental conditions of the arctic regions as well as the particular lifestyles of the populations. Cross-border cooperation between the relevant national organisations will improve such risk assessments. Cooperation will also offer new ways to share knowledge and inform the public about radiation-related issues.
Objectives

• Establishing a collaboration network in the EuroArctic region.
• Improving the cross-border cooperation between organisations and stakeholders in the project area.
• Increasing public awareness and knowledge with respect to nuclear safety, emergency preparedness and environmental radioactivity.
• Improving cross-border exchange of knowledge and skills.
• Improving the techniques and problem-solving skills related to radiation protection and research.
• Improving emergency preparedness.
• Improving risk assessments of potential nuclear accidents with regard to arctic regions.
• Gaining more information about the radionuclide concentrations, their behaviour and occurrence in the northern environment.
• Increasing the awareness of the general public and stakeholders across the region of radiation protection, emergency preparedness, environmental radioactivity and associated risks and challenges.
WP1 & WP2 Terrestrial and Marine environment:

These work packages are studying the current state of radioactive contamination in terrestrial and marine ecosystems in the EuroArctic region by examining environmental samples collected from the Finnish Lapland, Finnmark and Troms in Norway, the Kola Peninsula and the Barents Sea.

The results provided updated information on the present levels, occurrence and fate of radioactive substances in the Arctic environments and food chains. It was also be possible to estimate where the radioactive substances originate from and the risks they may present in case of a possible accident.
Sources of anthropogenic radioactivity in Euro-Arctic region

- Atmospheric nuclear weapons tests during 1950-60’s
- Nuclear accidents Chernobyl, (Fukushima)
- Releases from Sellafield (UK), La Hague (F) or other installations
- Possible releases from sunken nuclear submarines, dumped nuclear wastes, river runoff...

http://en.wikipedia.org/wiki/Tsar_Bomba
WP1 Terrestrial, achievements

- Verification of sampling and laboratory procedures in Norway, Finland and Russia.
- Terrestrial sampling and measurements done in all countries.
- Good success of all laboratories in the international proficiency test exercise. Analyses done by different laboratories meet proven high standards.
Cs-137 in milk produced in Finnish Lapland
Cs-137 in mushrooms from Northern Norway, Finland and Russia

![Graph showing Cs-137 levels in different types of mushrooms from different regions.](image)

- **Orange birch bolete**
- **Velvet bolete**
- **Brown roll-rim**
- **Red banded webcap**
- **Gipsy mushroom**
- **Rufous milkcap**
- **Woolly milkcap**

**Legend**:
- Blue: Northern Norway
- Red: Northwest Russia
- Green: Northern Finland

**Bq/kg (d.w.)**

- Y-axis: 0, 200, 400, 600, 800, 1000, 1200, 1400, 1600

4.12.2013
WP1 Conclusions

• Global fallout from nuclear weapon testing in the 1950s and 1960s has been the dominate source of anthropogenic radionuclides to the terrestrial environment in the KolArctic region.

• The impacts of the Chernobyl accident in 1986 had a variable but minor impact on the KolArctic region.

• Levels of anthropogenic radionuclides in all compartments of the terrestrial environment in the KolArctic region have shown decreasing trends.

• Levels of anthropogenic radionuclides in all compartments of the terrestrial environment in the KolArctic region are low and will have no environmental impacts.

• Levels of anthropogenic radionuclides in all terrestrial food items in the KolArctic region are low and present no human health issues.
WP2 Marine, achievements

- Joint expedition (Russia, Finland, Norway) in 2012.
- First results published.
- Measurements show that the current levels of artificial radionuclides in the Barentsian marine environment and biota are very low and the concentrations of radioactivity have been stable in recent years.
WP3 Atmosphere:

Work package focus on atmospheric modelling and the assessment of radionuclide distribution in case of accidents in EuroArctic region with the release of radioactive substances to the environment.

Two nuclear accident scenarios will be considered for dispersion modeling:

a) an accident at the new Nuclear Power Plant at Pyhäjoki
b) an accident at a Floating Nuclear Power Plant in the Arctic Ocean, to the north from the Kola Peninsula

From the data, concentration and deposition levels, dose rates and inhalation doses to humans was evaluated.
Computer model of a hypothetical accident at Hanhikivi

Total deposition of Cs-137 and Cs-134, kBq/m², valid: 08.07.2010 00UTC

- Cs-137:
  - 1000.0: 735
  - 300.0: 245
  - 100.0: 73.5
  - 30.0: 24.5
  - 10.0: 7.35
  - 3.0: 2.45
  - 1.0: 0.735
  - 0.3: 0.245
  - 0.1: 0.0

- Cs-137+:
  - 1000.0: 735
  - 300.0: 245
  - 100.0: 73.5
  - 30.0: 24.5
  - 10.0: 7.35
  - 3.0: 2.45
  - 1.0: 0.735
  - 0.3: 0.245
  - 0.1: 0.0
Recommendations

Protective measures in early and intermediate phases of a nuclear emergency
• Protective actions concerning population in early phase
  ➢ Sheltering indoors, iodine prophylaxis, evacuation
• Protection of workers
  ➢ Protective actions shall be planned and performed in the way that the radiation dose to workers is as low as reasonably possible and the dose limits are not exceeded.
• Restriction of entrance to potentially hazardous area
• Measures concerning food production and other production
  ➢ In contaminated areas, it is recommended that the use of food obtained is limited and restricted until the concentrations of the foodstuff are determined via measurements.
• Actions to reduce exposure from the environment
  ➢ Decontamination and other actions to decrease dose
  ➢ Restrictions of use of areas
  ➢ Industry and trade in contaminated area
• Actions concerning foodstuffs, drinking water and animal feed
• Radioactive wastes
Dose estimation from a nuclear power plant accident

• Estimations of mean annual radiation dose (internal and external) after the first year, twenty and fifty years from the accident.

• Internal dose estimations are based on the Finnish data of dietary intake of $^{137}\text{Cs}$ after the Chernobyl accident.

• Ingestion dose depends on the contamination level of an area, consumption rates of different types of foodstuffs and proportion of local foodstuffs in the diet.

• Highest internal doses are caused to people who consume lot of foodstuffs of wild products (reindeer, game, fresh water fish, forest berries, mushrooms).

• After fifty year, the dietary intake of radioactive cesium is caused mainly from natural products.

• Majority of the total dose due to external radiation.
Estimated internal and external doses ($^{134}\text{Cs}, \; ^{137}\text{Cs}$) in 2011, 2030 and 2060

<table>
<thead>
<tr>
<th>Cs-134,137 deposition area kBqm$^{-2}$ in 2010</th>
<th>Internal and external dose, mSva$^{-1}$ in 2011</th>
<th>Internal and external dose, mSva$^{-1}$ in 2030</th>
<th>Internal and external dose, mSva$^{-1}$ in 2060</th>
</tr>
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<tbody>
<tr>
<td>2450</td>
<td>135</td>
<td>13</td>
<td>6.7</td>
</tr>
<tr>
<td>735</td>
<td>41</td>
<td>4.0</td>
<td>2.1</td>
</tr>
<tr>
<td>25</td>
<td>1.4</td>
<td>0.13</td>
<td>0.067</td>
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<tr>
<td>7</td>
<td>0.41</td>
<td>0.040</td>
<td>0.020</td>
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<tr>
<td>2</td>
<td>0.14</td>
<td>0.013</td>
<td>0.0067</td>
</tr>
<tr>
<td>0.2</td>
<td>0.014</td>
<td>0.0013</td>
<td>0.00067</td>
</tr>
</tbody>
</table>

Some examples of radiation doses:

- 6000 mSv The dose which may lead to death when received all at once
- 1000 mSv The dose which may cause symptoms of a radiation sickness
- 100 mSv The highest permitted dose for a radiation worker over a period of five years
  - 4 mSv The average annual radiation dose for Finns caused by indoor radon, X-ray examinations, etc
- 0,1 mSv The radiation dose received by a patient having his/her lungs X-rayed
- 0,01 mSv The radiation dose received by a patient having his/her teeth X-rayed
Health hazards of radiation

• An unprotected person at the site of the accident or in close neighbourhood may in a short time receive such a high radiation dose that it has an immediate effect on the person's health. A high radiation dose destroys a lot of cells. It may cause a radiation sickness. In a severe nuclear power plant accident, there would be symptoms within some twenty-kilometre radius of the nuclear power plant, at the most.

• Several years after a severe accident, an increase in cancer cases and possibly in hereditary disorders can be discovered. Even in the severest accidents, health hazards can be avoided if appropriate measures against radiation are taken.
Modelling of an accident at a floating nuclear power plant (FNPP)

- Site Shtokman gas field
- Icebreaker reactor
- Two hour release
- Release height 0-20 m

- Inventory (NKS-139)
  Kr-85 \(1\times10^{12} \text{ Bq}\), Kr-85m \(1.5\times10^{13} \text{ Bq}\), Kr-87 \(9.5\times10^{12} \text{ Bq}\), Xe-133
  9e+13 Bq, Xe-135 1e+14 Bq, I-131 9e+12 Bq, I-132 1e+13 Bq, I-133 4e+13
  Bq, I-134 9e+12 Bq, I-135 3e+13 Bq, Ba-140 2e+12 Bq, Ce-141 2.4e+11 Bq,
  Cs-134 7e+12 Bq, Cs-136 1e+13 Bq, Cs-137 2e+12 Bq, La-140 7e+11 Bq,
  Rb-88 1e+12 Bq, Sr-89 1e+12 Bq, Sr-90 3e+11 Bq, Te-127 2e+11 Bq, Te-
  129 4e+11 Bq, Te-129m 2e+11 Bq, Te-132 6e+12 Bq, Te-133m 2e+12 Bq,
  Zr-95 2e+11 Bq

- Release fraction 1\% for \(^{137}\text{Cs}\) and \(^{131}\text{I}\), 0,1\% for \(^{90}\text{Sr}\) and \(^{241}\text{Pu}\)

Results from SILAM dispersion model
Dose calculations from Valma
Weathes model ECMWF
Results—$^{131}$I and $^{137}$Cs

- $^{131}$I activity concentrations in the air
  - Max 483 Bq/m³

- $^{137}$Cs activity concentrations on the ground (or on the sea), surface activity of $^{137}$Cs
  - Max 8610 Bq/m²

Nuclear tests 4000 Bq/m²
Chernobyl $<1E05$ Bq/m²
Results – Effective dose

- Botn inhalation and external exposure (ground and air) max. 0.0151mSv
Conclusions, FNPP case

• First of all
  – Wind direction is very rarely from gas field to the mainland

• Second
  – Shtokman gas field is a far away from human settlement

• That is why
  – Probability to release to mainland is small
  – If the worst case will happen --> countermeasurements were not needed in mainland

But countermeasurements will be needed for workers at the gas field
WP4 Social Impacts:

WP3 and WP4 are interrelated. WP4 focused on the assessment of social effects and effects on tourism based on the results of two accident scenarios considered in the WP3.

Tasks was divided by:

a) assessment of social effects on local level (everyday routines or for example reindeer farming)

b) assessment of impacts on tourism (e.g. imago issues)
WP4 Social Impacts

This was the first time that the impacts of radioactive fallout were studied from a social point of view.

The social impacts of radioactive fallout would be multiple and vary from one area to another. Impacts on tourism would include restrictions on the utilisation of natural resources, shrinking revenues in the tourism sector, loss of perceived safety among tourists and a negative development of the image and reputation of the area. These factors would also influence tourists’ decisions and choices.

In the most severely contaminated areas, the social character of an area and its perceived environment could change significantly: the attractiveness of the area as a living environment would suffer, the area would no longer be considered safe and healthy and also the utilisation of important natural resources could suffer. These impacts could be mitigated by disseminating correct information about the effects of radioactive fallout. Such an information campaign should be started early enough.
WP5 Public Awareness:

The purpose of the work package is to enhance public awareness and raise knowledge on general risks and protection issues related to radioactivity, provide information on the status of environmental radioactivity in EuroArctic region and give recommendations on how to minimize risks.
Activities

• The main activities of WP5 include

  – Public seminars
  – Presentations and posters on conferences
  – Presentations and lectures for students and other target groups
  – Presenting the project in media
  – Information brochures about radiation-related issues and about the CEEPRA project
  – Project web site
Public seminars

• Before the Oulu symposium, two open seminars have been held:


*The CEEPRA project members and seminar audience in Murmansk.*
Public seminars


Astrid Liland (NRPA) giving her speech about the Fukushima accident.

Several leaflets on the subjects of the seminar were distributed to the general public.
International conferences

- CEEPRA project and its outcomes have been presented both as oral presentations and as posters in several international conferences, for example:

  - International Polar Year (IPY) 2012 Conference, April 2012, Montreal, Canada
  - 13th International Congress of the International Radiation Protection Association, May 2012, Glasgow, Scotland
  - XXIX International Conference of Biological Resources of the White Sea and Inland Waters of the European North, March 2013, Murmansk, Russia
  - General Assembly of European Geosciences Union, April 2013, Vienna, Austria
  - Russian-Nordic Symposium for Radiochemistry, October 2013, Moscow, Russia
Other conferences and seminars

• CEEPRA project members have given speeches also in several national conferences and seminars as

  – Scientific and Technical Conference for MSTU Students, April 2012, Apatity, Russia
  – XXXth and XXXIth Conferences for Young Scientists for the Murmansk Marine Biological Institute, May 2012 and May 2013, Murmansk, Russia
  – The Seminar Devoted to the Day of Russian Science, February 2013, Murmansk, Russia
  – Ecological Safety of Water Resources in the Arctic region of Russia and the European Union, May 2013, Murmansk, Russia
Lectures and presentations

• CEEPRA project and/or radiation-related issues have been presented for students, pupils and other target groups in several occasions in 2011-2013, for example

  – Presentations to high school students in Rovaniemi, Finland
  – Lectures to Bachelor grade students at the University of Tromsø, Norway
  – Lectures to Bachelor grade students at Murmansk State Humanities University, Murmansk, Russia
  – A lecture to tourists at Pallastunturi, Finland
Project web site and media

• Project web site [www.ceepra.eu](http://www.ceepra.eu) was launched in autumn 2012
  
  – Information and news about project activities and events
  – Available in English, Finnish, Russian, Norwegian and Sami

• Several articles concerning CEEPRA has been published in newspapers, magazines and internet during 2011-2013 in each participating country

• Several scientific articles about the project results has been published

• TV report on the seminar in Tromsø

• Radio reportages in Finnish, in Norwegian and in Swedish
Information brochures

• A general brochure (in English) about the project objectives and planned implementation published in summer 2012

• A leaflet (in Finnish and in English) concerning the realized activities and achieved results was produced for the public seminar in Oulu in November 2013

• A leaflet covering the whole project period and giving more detailed results is planned to be published in spring/summer 2014
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