Environmental radioactivity during 50 years

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Investigations of man-made radioactivity in the Danish environment from 1957
Atmospheric nuclear weapons tests

Global pollution from atmospheric nuclear weapons tests: fission products, activation products, fissile material and tritium
Radioecological sensitivity

- Studies covering
  - Air, water, soil
  - Grain, bread
  - Grass
  - Vegetables and fruit
  - Sea plants
  - Milk, meat, fish
  - Total diet
  - Human body, bone

- Radioecological sensitivity is the time integral of quantities of the sample type from a quantity of the radionuclide deposited

- Example for Cs-137 in Danish cow’s milk
  - 2.0 Bq/L d per Bq/m²
Strontium-90 and caesium-137

- Fission products of particular importance due to long half lives and significant uptake in food chains
Aerosols

• Monitoring of radioactivity in air is based on aerosol collectors located in Haderslev, Allinge and Risø.
• Air is sampled at flow rates of 500-2000 m$^3$/h through organic filters retaining particles.
• Filters are changed weekly and analysed for short-lived radionuclides first and later for longer lived radionuclides, particularly $^7$Be, $^{210}$Pb, $^{90}$Sr, $^{137}$Cs.
Radioactivity in Air at Risø

1. E+02
   1. E+01
   1. E+00
   1. E-01
   1. E-02

CONCENTRATION (µBq/m³)

YEAR


Fukushima, 2011
Chernobyl, 1986

Atmospheric nuclear weapon tests 1945-1980

Sr-90
Cs-137

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Precipitation

Precipitation is collected at Risø and 10 other locations in Denmark and analysed for content of Sr-90 and Cs-137.

![Graph of Cs-137 in precipitation at Risø, 1960-2009]
Milk, potatoes, vegetables and total diet

Sampling zones (I-VIII) for milk, potatoes, vegetables and total diet in Denmark.


Cereals: rye, oats, wheat, barley
Stream, lake and ground water
Sea water and plants

Casium-137 in seaweed (Fucusvesiculosus and Fucus serratus) from February 1983 to June 2009 collected at Klint, Zeeland (55°58'N, 11°35'E).

DTU Nutech, Technical University of Denmark
Caesium-137 in fish/cod

![Graph showing Caesium-137 concentration in fish from different regions (Faeroe Islands, Greenland, Nordsøen, Kattegat, Østersøen) over the years. The x-axis represents the years from 1960 to 2010, and the y-axis represents concentration in Bq/kg frisk vægt. Different markers and colors distinguish the regions.]

DTU Nutech, Technical University of Denmark
Humans

- Employees at Risø monitored for radiocaesium and tritium
- Human bone samples received from hospitals (with difficulty)
External exposure

External exposure rates in 4 locations in Denmark, as measured with a NaI(Tl) detector.

Grain sampling locations (State experimental farms in Denmark)
Radioactive contamination in Denmark

- Poster in building 204 shows concentrations of strontium-90 and caesium-137 in air, precipitation, milk and grass at Risø and in Denmark since the 1950’s
- Including input from the Fukushima accident in Japan in 2011
Why monitor environmental radioactivity?

- EURATOM Treaty: Health and safety matters - Obligation of EC Member States to monitor levels of radioactivity in air, soil and water and to ensure compliance with basic standards
- Helsinki Convention: Contracting Parties undertake to prevent and eliminate pollution of the marine environment of the Baltic Sea Area caused by harmful substances from all sources
- Study man-made and naturally occurring radionuclides in the environment to document baseline levels and increase knowledge on behaviour and processes
- Expertise available for emergency purposes in case of accidents/incidents involving release of radioactivity to environment
- Improve radiological assessment models in decision support systems used by authorities in case of accidents
- Useful platform for research and development of existing and new analytical methods and application of these in other areas