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
  - $2.0 \text{ Bq/L d per Bq/m}^2$
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

CONCENTRATION (µBq/m³)

Atmospheric nuclear weapons tests 1945-1980

Chernobyl, 1986

Fukushima, 2011

YEAR

Sr-90

Cs-137
Precipitation

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

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Graph: Caesium-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

Caesium-137 in seaweed (Fucus vesiculosus 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 concentration of caesium-137 in fish/cod from 1960 to 2010.](image)

**Axes:**
- **Y-axis:** Concentration (Bq/kg fresh weight)
- **X-axis:** Year (1960-2010)

**Data Points:**
- Færøerne
- Grønland
- Nordsøen
- Kattegat
- Østersøen

**Legend:**
- Blue circles: Færøerne
- Green squares: Grønland
- Red triangles: Nordsøen
- Light blue diamonds: Kattegat
- Dark brown diamonds: Østersøen

**Note:**
- The graph illustrates the concentration of caesium-137 in fish/cod from various regions over time, with a noticeable decrease in concentration post-1980.
Humans

• Employees at Risø monitored for radiocaesium and tritium
• Human bone samples received from hospitals (with difficulty)
External exposure rates in 4 locations in Denmark, as measured with a Na(Tl) detector.
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