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Impact of the Chernobyl accident on Norway: Lessons learnt

Norway was one of the European countries most seriously affected by the Chernobyl-accident. According to a nationwide survey in 1986 the total deposition of 137Cs in the country was estimated at 2300 ± 200 TBq and about 10 % of the territory received more than 20 kBq m-2 of this radionuclide. This has resulted in significant exposure of wildlife as well as domestic animals grazing in forest and mountain areas and corresponding contamination of meat and milk intended for human consumption. Reindeer were particularly vulnerable due to its lichen feed during large parts of the year, but also sheep (and goats) frequently showed 137Cs activity levels far above the upper limits defined for human consumption. Prognoses based upon on-going monitoring programmes indicate that there will still be problems with high concentrations of 137Cs in animals on rough grazing in Norway for 10-20 years to come.

During the first few years after the accident radioecological research had favourable conditions and biologists, chemists, physicists, veterinarians and agricultural researchers were working together to learn about the behaviour of 137Cs in terrestrial and aquatic foodchains. Emphasis was placed on its behaviour in natural soils, uptake in forage, and transfer to animals. Transfer of Cs from soil was studied for a great number of naturally growing plants and fungi, and some mushroom species were found to be extreme Cs accumulators leading to problems in years with abundant mushroom growth. To avoid discarding meat and milk, considerable efforts were done to develop countermeasures reducing Cs activity levels in domestic animals, the most successful being: (1) Use of Prussian blue (Gieze salt) to reduce the uptake of 137Cs, (2) providing clean feed a few weeks before slaughter in connection with live monitoring of animals, and solely for reindeer (3) changing slaughter time from February to September, reducing the influence of lichen feeding, which is most important during winter.

Prior to the Chernobyl accident food chain transfer was most frequently discussed in terms of transfer factors based just on measurements of activity concentrations in the media in question. The research in Norway and elsewhere after Chernobyl has emphasized the importance of chemical speciation of the radionuclides for their behaviour e,g, in soil, water, and sediments. The mobility of Cs ions in the boreal soils of Scandinavia with high organic matter content has shown to be much greater than in the previously studied agricultural soils with high content of mineral matter including clay minerals fixing Cs ions strongly. Thus the uptake of Cs in plants from these soils is much greater than previously experienced, and strongly dependent on the chemistry of the soil solution. Particularly high mobility of 137Cs is observed in southernmost Norway where the soils are more acidified than elsewhere.
Results from repeated nationwide surveys of natural surface soils showed that the decline of 137Cs was greater in coastal regions than in areas farther inland, probably attributable to much greater deposition of Mg2+ and Na+ in the former areas, replacing Cs ions adsorbed to soil particle surfaces. This effect appeared to be particularly strong near the southern coast where deposition of NH4+ from transboundary pollution is evident in addition to the marine cations. The effect of precipitation chemistry on the 137Cs mobility however is found to decline with time, indicating that the 137Cs cations are gradually moving to sites where they are more strongly bound. Experiments where identical soil columns, containing 137Cs from Chernobyl and freshly added 134Cs, are exposed to precipitation of different quality in amounts corresponding to ten years of deposition, largely confirm the conclusions from the repeated soil surveys.

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