

Geostatistical mapping of a contaminated riverbank in Norway

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Measured activity concentrations of plutonium isotopes in sediments at a former discharge site for liquid low level radioactive waste in the Nitelva river, Norway, were found to exceed legal exemption limits for radioactive waste. The measured activity concentrations were generally very low, and it was not obvious from an environmental or radiological point of view if any action to reduce the contamination would be advantageous, necessary, or even disadvantageous. The riverbank sediments are normally submerged under water during the year, but can potentially be exposed to air when the water level is very low. Furthermore, the site is in vicinity of the municipality of Lillestrøm and is close to an outdoors area commonly used for recreational activities. The uncertainties of the environmental consequences of the contamination, and the location of the site close to a settlement, called for a careful assessment of the sediments. A series of measuring campaigns were performed at the site, with aim to map the activity concentrations and the spatial extension of the contaminated sediments. The mapping would primarily form a basis for a radiological assessment of the situation, but could also be used to plan a potential excavation.

There were three campaigns performed at the riverbank (1-3) and one campaign along the river bottom (4).

Campaign 1 contains 46 samples collected at 15 locations at depths ranging from 0-40 cm in 10 cm layers. All the samples were analyzed for ¹³⁷Cs and ²⁴¹Am by γ -spectroscopy, and for ^{239,240}Pu by radiochemical separation and α -spectroscopy.

Campaign 2 contains 38 samples collected at 13 locations at depths ranging from 0-30 cm in 10 cm layers. All the samples were analyzed for ¹³⁷Cs and ²⁴¹Am, and 12 points where the ¹³⁷Cs and ²⁴¹Am values were above the detection limit were additionally analyzed for ^{239,240}Pu.

Campaign 3 contains 43 samples collected at 15 locations at depths ranging from 0-30 cm in 10 cm layers. 14 samples were analyzed for ¹³⁷Cs and ²⁴¹Am based on their location in a poorly mapped portion of the site.

Campaign 4 contains 16 samples collected with a clamshell grab, capable of collecting a single sample covering a sediment layer of 15 cm. 13 samples were analyzed for ¹³⁷Cs and ²⁴¹Am, and 7 samples were further analyzed for ^{239,240}Pu.

The analyzed results of the measurement campaigns were used as input for a geostatistical analysis with the software Kartotrak. A large part of the analysis is dedicated to the comparison of the different campaigns, spatially and statistically, to ensure the consistency of the complete database. Basemaps, profiles, histograms and scatter plots are intensively used for this exploratory data analysis. Then, the variogram tool enables the analysis and modelling of the spatial correlation to produce 3D estimates of the activity levels.

Ultimately, the spatial extension and activity levels of the contaminated sediments were successfully constrained and determined, and the results were used as basis for a radiological assessment of the situation. Our presentation will focus on the radiological mapping of the site, and demonstrate the capabilities and usefulness of geostatistical tools.