Cesium-137 in riverine sediments in two regions in southernmost Sweden

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Prior to commissioning of new nuclear or radiation-related facilities, extensive preoperational studies of the existing levels of radionuclides in the environment and their variability are required [1, 2]. This includes repeated external dose rate measurements in situ as well as analysis of radionuclide concentrations in various types of environmental samples in the surroundings of the new facility. Reference sites, which in the future will not be affected by the new facility, also need to be covered. Aquatic bottom sediments are of particular importance, as anthropogenic radionuclides released and discharged into the environment may accumulate in the sediments. Apart from acting as a sink or reservoir, bottom sediments may also become a source from which radionuclides re-suspend into the water and become part of the food chain for various organisms. The data generated can be used for predicting activity concentrations in food products and biota, and to understand site-specific dispersion and radioecology.

Here we report results of the activity concentrations in sediments, that have emerged during preoperational studies around the neutron facility the European Spallation Source (ESS), that is under commissioning in the outskirts of the city of Lund in the county of Skåne in southern Sweden (Figure 1). Grab samples of sediments were collected in 2022 using a Lamotte bottom sampling dredge (Heraco AB) in rivers of the two main catchment areas for ESS: Kävlinge river and Höje river (Figure 1). A pond within the ESS area was also sampled as well as the relevant waste-water treatment plant in Lund (Källby). The largest river of Skåne, Helge river, located in eastern Skåne, and originating from the county of Småland north of Skåne, was tested as reference site (Figure 1). Before entering the Baltic Sea, the river splits in two branches. The smaller branch winds north-east towards the exit at the harbour of the village Åhus. The smaller branch splits in two at the islet of Mölleholmen (Figure 1). Nowadays, the branch south of Mölleholmen is partly overgrown by an alder swamp forest, severely limiting the water flow.

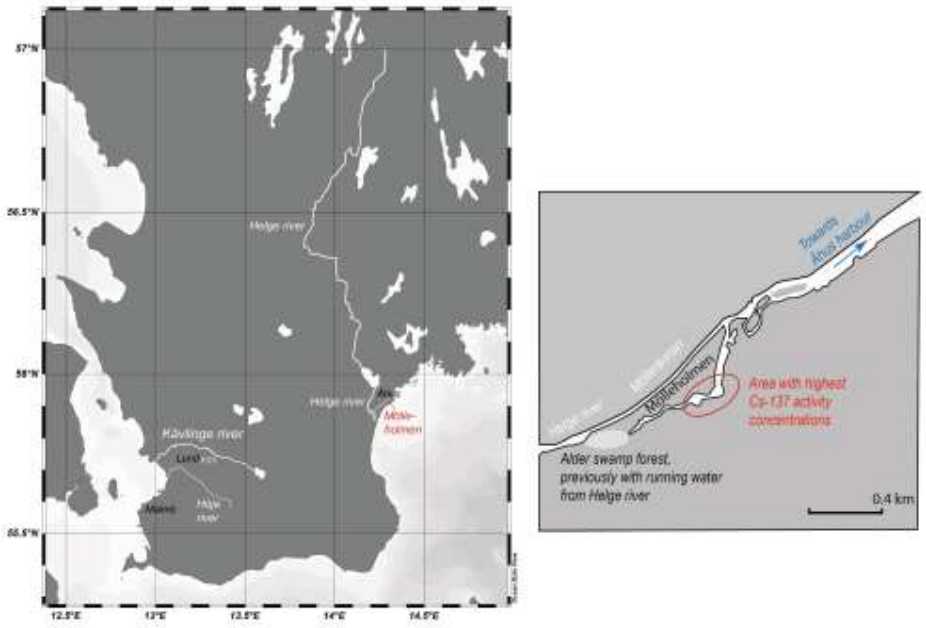

Figure 1. Study areas in western and eastern Skåne. Map: Schlitzer, Reiner, Ocean Data View, https://odv.awi.de, 2021.

Sediment samples were sieved down to a size of 2.0 mm prior to freeze-drying. Three groups of sampling sites were identified based on the ^{137}Cs activity concentrations and the geographical location: western Skåne, eastern Skåne (excluding Mölleholmen), and Mölleholmen (Figure 1). For ^{137}Cs, the mean activity concentrations of sediment samples were statistically different for all three groups (at 0.05 level in t-tests, Figure 2). The group from eastern Skåne (excluding Mölleholmen) had a significantly higher average ^{137}Cs activity concentration (N = 10, average 38 Bq kg^{-1}, standard deviation (*SD*) 17 Bq kg^{-1}, standard error of mean (*SEM*) 5 Bq kg^{-1}) than the group from western Skåne (N = 12, average 8.4 Bq kg^{-1}, *SD* 5.5 Bq kg^{-1}, *SEM* 1.6 Bq kg^{-1}). This may be an effect of different regional fallout from past nuclear weapon's testing in the 1950s and 60s, and from the Chernobyl accident [3]. However, western Skåne was generally more affected by bomb testing fallout as well as Chernobyl fallout than eastern Skåne [3]. Instead, it can be speculated that ^{137}Cs is fixed by entrapment in the lattice structure of clay minerals which are more frequently occurring in the soil of western than of eastern Skåne and also in the catchment area for Helge river in Småland. Moreover, the higher degree of flooding of arable land around Helge river than in western Skåne may be responsible for transporting more ^{137}Cs from land to river in eastern than in western Skåne.

The increased ^{137}Cs level observed in three samples in the Mölleholmen group (N = 3, average 144 Bq kg^{-1}, *SD* 23 Bq kg^{-1}) may be a result of that this part of Helge river has previously been used for the disposal of latrine waste, which may lead to an increased concentration of ^{137}Cs from past nuclear weapon's testing in the 1950s and 60s**.** No statistically significant difference between the mean average activity concentrations of ^{40}K in sediments exists between the three groups (at 0.05 level, one-way ANOVA).

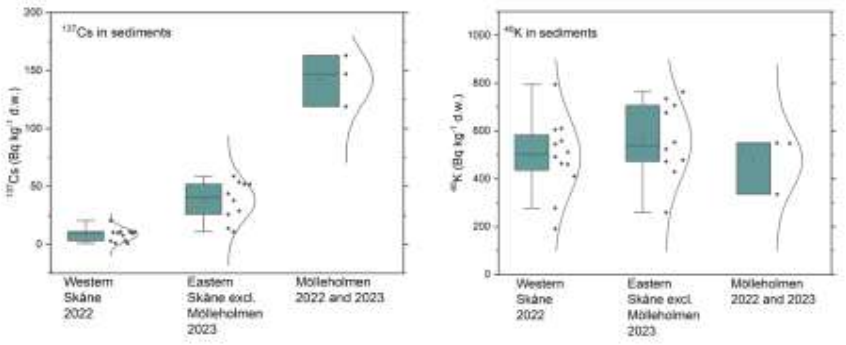

Figure 2. Activity concentrations of ^{137}Cs and ^{40}K in sediment samples.

References

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3. Isaksson, M., Erlandsson, B., Linderson, M.-L. 2000. Calculations of the deposition of ^{137}Cs from nuclear bomb tests and from the Chernobyl accident over the province of Skåne in the southern part of Sweden based on precipitation. Journal of Environmental Radioactivity, 49(1): 97-112.