

SEDIMENTATION AND WITHIN-BASIN VARIATIONS IN THE GULF OF FINLAND AS DETERMINED BY ^{137}Cs TRACER

Henry Vallius^a, Harri Kankaanpää^b, Lauri Niemistö^b
and Olavi Sandman^c

^aGeological Survey of Finland, POB 96, FIN-02151, Espoo, Finland

^bFinnish Institute of Marine Research, POB 33, FIN-00931, Helsinki, Finland

^cMikkeli Water and Environment District, POB 77, FIN-50101 Mikkeli, Finland

Sedimentation rates at 98 stations in several coastal and open sea areas in the Gulf of Finland were determined using ^{137}Cs distribution in sediment profiles. The ^{137}Cs activities of the sediment cores were measured using direct gamma-spectrometric measurements (Kyzyurov et al., 1994) either on board research vessels or at the respective institutes. Relative rates were calculated. The results show that annual surficial sedimentation rate varies between 0.05 and 1.94 cm a⁻¹ (Fig. 1), corresponding to a dry matter flux of 0.01 - 0.30 g cm⁻²a⁻¹ (Fig. 2). The mean sedimentation rate for all studied cores (n = 98) was 0.6 cm a⁻¹ and the mean dry matter accumulation rate (n = 45) was 0.14 g cm⁻²a⁻¹. The accumulation rates were highest at bottoms of recent, muddy sediments. The ^{137}Cs activities in cores from the studied area varied between 0.04 and 2.4 Bq g⁻¹ wet weight (Fig. 3). The highest activities are found in layers corresponding to the year 1986 from areas mostly affected by the fallout cloud of the Chernobyl nuclear power plant accident. The areal distribution of ^{137}Cs in sediments is correlated with that measured on land but the activities and distribution pattern in sea sediments has been modified by drainage from land and secondary transport in the sea (Fig. 4).

Mixing of the sediment strata was found to be considerable in the Gulf of Finland. This is mostly caused by bioturbation, as the oxygen content in near bottom waters was good during the whole study period. This can be seen in the pattern of the ^{137}Cs profiles.

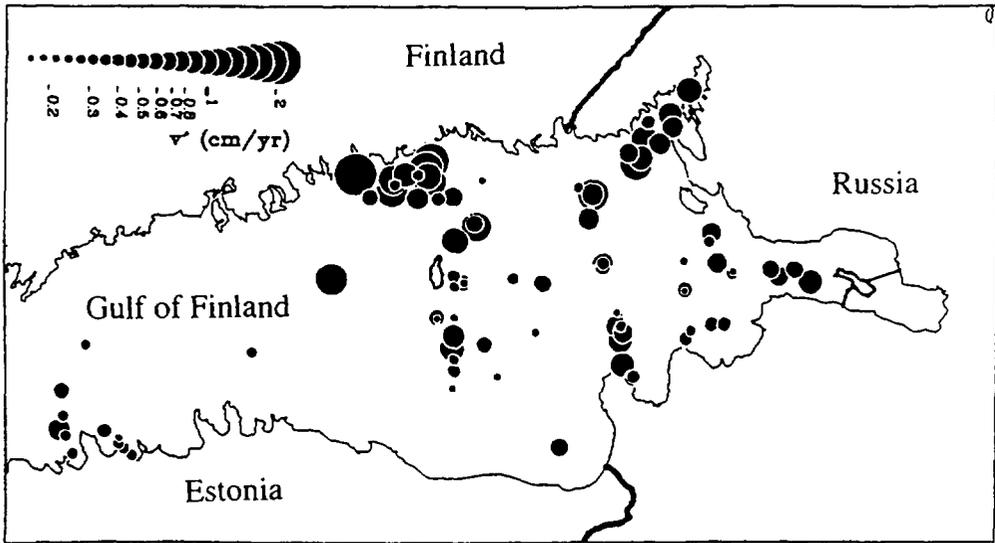


Figure 1. Measured average sedimentation rates in different parts of the Gulf of Finland

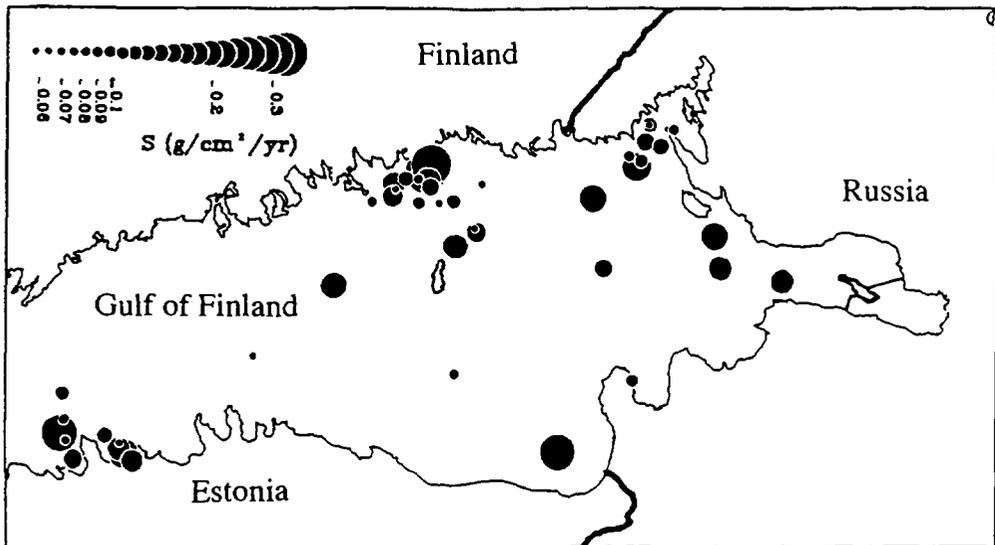


Figure 2. Measured dry matter accumulation rates in the Gulf of Finland.

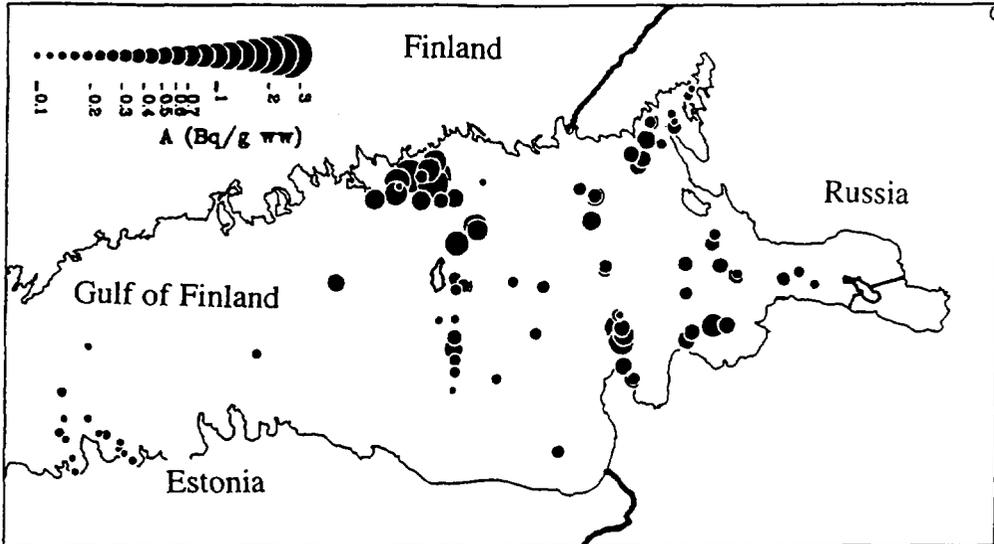


Figure 3. Maximum ^{137}Cs activity in the sediment slices.

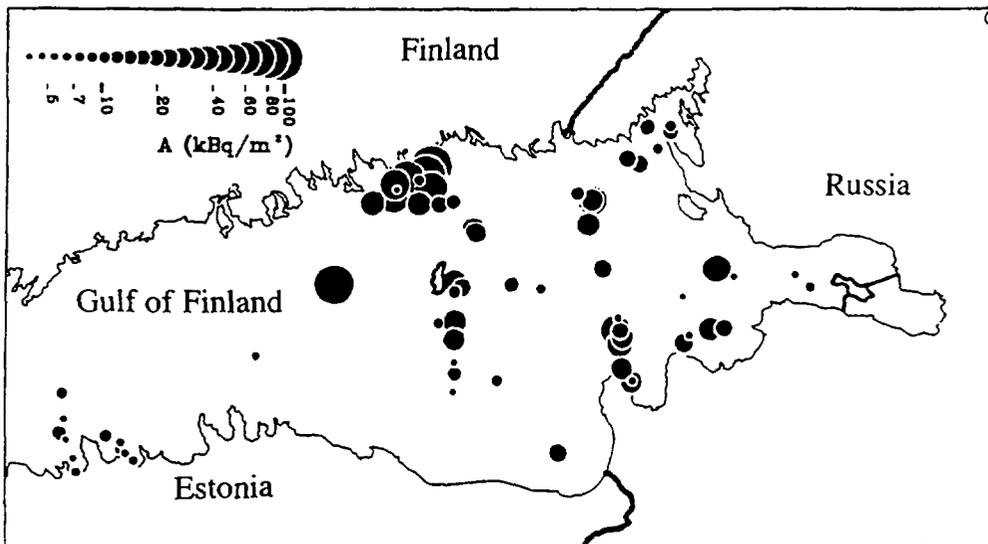


Figure 4. Total ^{137}Cs activity at the sampling stations.

There seemed to be no correlation between maximum ^{137}Cs concentration in cores and bottom depth, suggesting that the main factor affecting the occurrence of ^{137}Cs is the distribution pattern of Cs after the Chernobyl accident. Bottom depth and sedimentation rate did not correlate, but a slight tendency toward increasing rate with decreasing depth especially close to river outlets was observed.

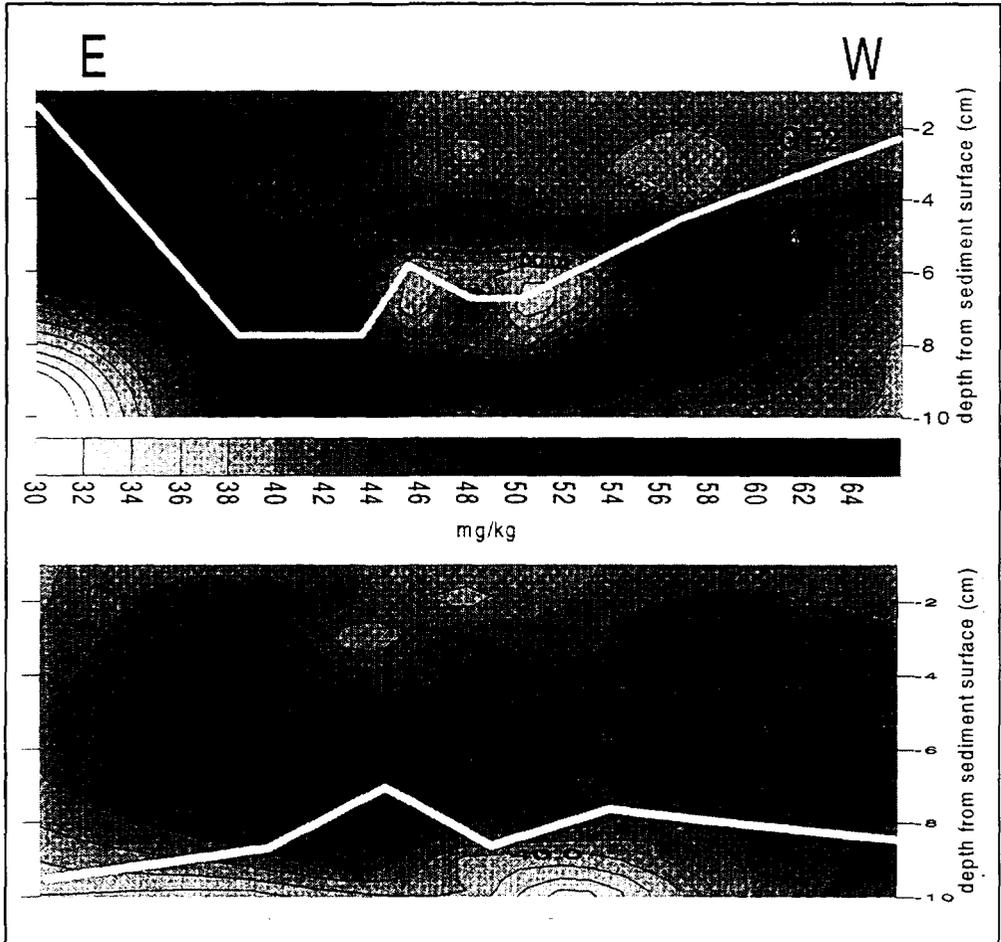


Figure 5. Depth of the sediment containing the Chernobyl peak of ^{137}Cs (white line) at two stations in the Gulf of Finland (GF2 = mid Gulf of Finland, horizontal scale 2.30 kms, F41 = eastern Gulf of Finland, horizontal scale 1.85 kms) and content of partially leachable copper.

Within-basin variation of sedimentation was studied in two basins, one at Lavansaari, eastern Gulf of Finland and the other in mid Gulf of Finland, off Käsnu peninsula in Estonia. Transects of approximately 1 nautical miles length and with 7 - 9 sampling sites were taken. The sedimentation since 1986 could be counted from the Chernobyl peak. At Lavansaari sedimentation had been uniform in the whole basin through that time interval while at the station in mid Gulf of Finland sedimentation had varied a lot (range 1.5 - 8 cm in 9 years). There sedimentation had been fastest in the middle of the basin (6.5 - 7.5 mm a⁻¹) and slowest at the borders (1.5 - 2.5 mm a⁻¹), (Fig. 5). When comparing the ¹³⁷Cs dating curve of the basins to chemically analysed metal data a clear correlation can be seen. The basin study and the variations in within-basin sedimentation show the necessity of thorough investigations of the sedimentary environments in any studies comprising recent sediments in the Gulf of Finland.

The direct ¹³⁷Cs measurement technique can be successfully used in the Gulf of Finland, southern Gulf of Bothnia and in parts of the main Baltic Sea because of high radiocaesium activities and relatively high accumulation rates. The method is also a good tool for evaluation of stations suitable for sediment studies and monitoring.

References

- Kankaanpää, H., Vallius, H., Sandman, O. and Niemistö, L., 1997. Determination of recent sedimentation in the Gulf of Finland using Cs-137. *Oceanol. Acta*, 20; 6: 823-836.
- Kyzyurov, V., Mikheev, J., Niemistö, L., Winterhalter, B., Häsänen, E. and Ilus, E., 1994. A simple method for the determination of deposition rates of recent sediments based on cesium-137 activity following the Chernobyl accident. *Baltica*, 8: 64-67.