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Geostatistics: a decision-support tool for the decontamination and the recovery of radiocontaminated territories. Study at the scale of the T22 trench in the Chernobyl exclusion zone

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The explosion of Chernobyl reactor n°4 released nearly 13.10^{19} Bq of radionuclides in the atmosphere and led to the delineation of a 30 km radius exclusion zone. The following year, about 800 shallow trenches were dug and the low to medium activity nuclear wastes were buried in order to prevent their dispersal. However, those trenches are dug in permeable aeolian sand and do not prevent the migration of radionuclides in the superficial aquifer. As the Ukrainian authorities would like to recover part of the exclusion zone territory, it is necessary to quickly assess the radionuclide stock, which could still possibly contaminate the groundwater, by reliable means. The study of the T22 trench shows the effectiveness and the relevance of geostatistics in this issue.

The stock of cesium-137 available in 1999 in the T22 trench and its uncertainties related to the spatial variability are assessed. To do so, the limits of the trench basement are first interpolated using the results of ground penetrating radar profiles, undertaken to characterize the subsoil, and using the results of the in situ gamma spectrometry carried on boreholes drilled in the trench. Different geostatistical approaches are examined. Then, the raw data characterizing the intensity of gamma radiation in the soil are analyzed according to their localization in the trench to reassess the limits of the trench, the volume of radiocontaminated soil, the stock of cesium-137 in 1999 and the associated uncertainties. The results of the current and previous analysis of the radionuclide stock and its limits are discussed and the different results of the trench limits are compared.

Finally, a hydrogeological model is constructed. The hydraulic parameters are estimated and compared using different methodologies of inverse modeling. Several geostatistical simulations based on the variogram model of the radionuclide stock are introduced in the hydrogeological model in order to evaluate the impact of the radionuclide stock spatial variability on the groundwater pollution plume underneath the T22 trench.

The aim of this work is to integrate geostatistics as a tool that quantifies the uncertainties related to the spatial variability of certain parameters leading to a reasoned approach to land decontamination.