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Sampling optimization for radiological characterization: a spatial inventory

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Dismantling and decommissioning of nuclear facilities or remediation of contaminated sites are industrial projects with huge challenges. Precise knowledge of the contamination state is required. Radiological evaluations have multiple objectives to be considered: determination of average activity levels, to allow the categorization of surfaces or volumes (sorted into different radioactive waste categories); location of hot spots (small areas with significant activity levels); and estimation of the source term (total activity) contained in soils or building structures. In addition, there are radiation protection and other logistics considerations.

The characterization phase should be efficient, and the sampling strategy has to be rational. However, investigations also represent capital expenditure; the cost of radiation protection constraints and laboratory analysis can represent a large amount of money, depending on the radionuclide. Therefore the entire sampling strategy should be optimized to reduce useless samples and unnecessary measures

Within the geostatistics framework, the spatial structure of radioactive contamination makes the optimization of sampling (number and position of data points) particularly relevant. Geostatistics methodology can help determine the initial mesh size one the one hand and reduce both global and local estimation uncertainties on the other hand (using meta-heuristic algorithms). Combining the three levels of information, namely historical context, radiation maps and destructive sampling, is also an issue. Then multivariate geostatistics can provide useful recommendations about the total investigation effort.

This paper deals with feedback experience over the past decade in the use of geostatistics and sampling optimization for the radiological characterization of various media (soils, concrete structures, process equipment, groundwater…), various activity levels (clearance, low and intermediate, high), and various sizes from very small areas (a few m2 or a few m3) to very large sites (at a country scale in post-accidental context).