The Mesh Optimization of the Environmental Investigation Applied to the Diagnosis of the Quality of the Basement (Algerian Experience)

Abderrahim Gheris

1 Introduction

Potentially polluted site is made to be sampled at different stages of its characterization or remediation, to meet various objectives. In all cases, the problem of the sampling strategy in terms of "how to reach a sufficient level of knowledge relative to study objectives, with a minimum data positioned better?" Speaking of sampling strategy means then also take into account financial constraints or deadlines, decide of the sample sizes appropriate to the objectives of study, to program the sampling phases in order to best resolve uncertainties or to integrate all existing data to determine the number and location of additional samples. Currently, sampling strategies most often result of a reflection of practitioners based on their experience, knowledge of the site as well as common sense. The objective of this work is to show what can be the contribution of geostatistics to rationalize sampling of polluted sites. Through the use of database collected during a project of research estimation and evaluation of the risk of spreading the pollution of ground water, emitted by a plant of paintings [2]. The Algerian regulations do not provide specific recommendations on the sampling methodology. The Algerian methodological guide recalls the different approaches of the points location and refers to the recommendations developed by the U.S. EPA in 1991 [5] and by the european standardization [1]. The site in question has a multiple pollution (three pollutants) on an area of about 5 ha of land. It is a plant of paintings located in north eastern Algeria, where various chemicals containing heavy metals were dumped for many years from the 80 s. Between the years 2008 and 2010 a study was carried out on this site to locate and study the special distribution of soil contamination by heavy metals. For this purpose a systematic sampling campaign (soil and water) has been executed, the results of this campaign

A. Gheris (✉)
INFRARES Laboratory, University Mohamed Chérif Messadia, BP1553, 41000 Souk Ahras, Algeria
e-mail: agheris@hotmail.fr

E. Pardo-Igúzquiza et al. (eds.), *Mathematics of Planet Earth*,
Lecture Notes in Earth System Sciences, DOI: 10.1007/978-3-642-32408-6_112,
© Springer-Verlag Berlin Heidelberg 2014

Fig. 1 Location on the site plan of sampling (36°17′19, 89″N; 7°56′20, 71″E)

were mustered in a database [2]. Therefore, over a period of 2 years, successive campaigns have resulted to the realization of surveys using a mechanical auger. From the beginning the sampling strategy was to perform systematic surveys with an advancing from south to north, the boreholes are shown in Fig. 1. Laboratory analysis of 47 soil samples collected during this campaign showed high levels of three substances: lead, cadmium, and chromium [3]. The groundwater level is located at about 10 m depth at the right site. The sands clay aquifer is a very productive aquifer (permeability greater than 10^{-3} m/s). The basement consists of yellowish sandy clay, silty sand with pebbles, yellowish clay and limestone concretion.

1.1 Production of Maps of Contamination

The criterion of rationalization of the selected sample assumed to estimate, from the available data on each pollutant, a 3D map of the probability of exceeding its guideline value. Several geostatistical methods allow estimating a probability of exceedance. Include the estimation by kriging, usually after data transformation (eg., log transformation log, Gaussian) [4]. According to the study [2, 3] and for each of the three pollutants, it has been deduced from the 3D map of probability of exceeding

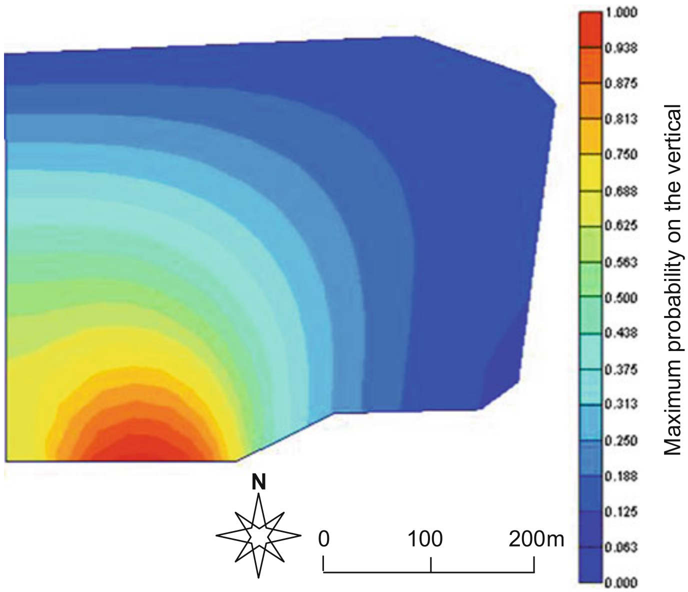

Fig. 2 Probability map derived from existing data

a 2D map synthetic for the highest probabilities calculated on the vertical (from 0 to 6.0 m depth). For example, Fig. 2 shows the resulting map for lead. As expected, the first polls in the region of higher probability showed high soil that impregnated. As and progresses to the northward the impregnations were less important. The area of highest probability corresponds to an area incineration of packaging waste for raw materials; she occupies about 8 % of the total surface. Therefore the map of probabilities reflects the spatial representation of the spread of pollution.

2 Probabilistic Simulation and Results

Now using the database of test results in the laboratory [2], we performed a series of simulation under various scenarios, to test the performance of different types of sampling strategies used to detect circular source occupying 8 % of the total site area (area highlighted by the previous study). The first simulation scenario is to consider only a certain number of polls (between 15 and 40) disposed according to a layout random, the second scenario, activation of the same points, but according to a layout stratified random, and finally a transverse and longitudinal profile which forms a fish bone. The results of the performance of these themes are shown in the graph in Fig. 3.

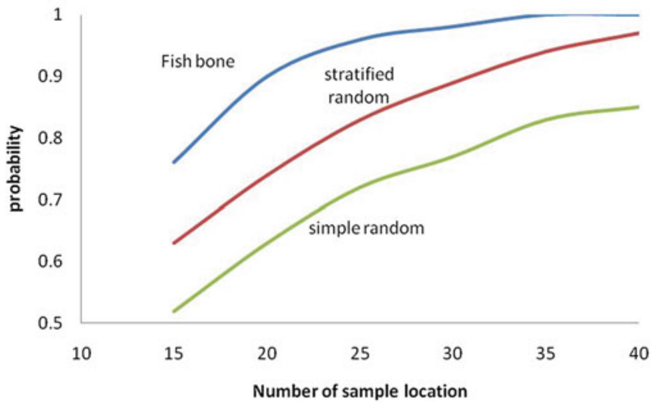

Fig. 3 Performance of the different strategies

3 Conclusion

We can say that the least costly strategy in financial term is the diagnostic by profiling. Then comes the geostatistical analysis exploratory, which allows developing through the integration of all the information collected a risk mapping. Additional sampling is recommended to minimize the uncertainty about the levels of pollutants in the uncertain zones, for example using methods of linear or non-linear kriging.

References

1. AFNOR. Norme NF ISO 10381–1 (X 31–008-1). (2003). Qualité du sol - Échantillonnage-Partie 1: Lignes directrices pour l'établissement des programmes d'échantillonnage.
2. Gheris, A. (2011). Les sols contaminés, modélisation et prédiction du transfert des particules dans un aquifère (cas de la ville de Souk Ahras). Geotechnical PhD Thesis, University of Guelma, Algeria.
3. Gheris, A., & Mekssaouine, M. (2010). 3D numerical simulation of the impact of the activity of a production unit of paintings on the groundwater of the city of Souk Ahras. First international water conference, CIEAU 2010, University of Annaba, Algeria.
4. Pellet, M. & Laville-Timsit, L. (1993). Échantillonnage des Sols par Caractérisation d'une Pollution: Guide Méthodologique. Édition du BRGM, rapport n° 37865 ENV 4S 93. 80 p.
5. US Environmental Protection Agency. (1991). Superfund program-respresentative sampling guidance-volume 1: soil. OSWER Directive 9360.4–10, EPA 540/R-95/141.