

Geostatistical Analyses of Heavy Metals in Soil of the Zaida Mine (Hight Moulouya, Morocco)

Meriem Laghlimi¹, Bouamar Baghdad¹, Nouhad Elouadihi¹, Ahmed Douiek², Hassan El Hadi³ et Rachid Moussadek²

¹Agronomic and Veterinary Institute, Madinat El Irfane, Rabat, Morocco; ²National Institute for Agronomic Research, INRA, Rabat, Morocco; ³Department of Geology - Faculty of Sciences, Ibn Tofail University, Kenitra, Morocco

INTRODUCTION

Soil contamination by heavy metal due to the disposal of industrial and urban wastes is one of the most pressing environmental issues. Mining and associated activities are the main sources of heavy metals and can be responsible for significant negative impacts on the surrounding environments. The mining activity in Zaida was abandoned several decades ago. However, those tailing ponds with high levels of heavy metals still remain in the area, which may create environmental risks of geochemical pollution, negatively affecting all components of the environment. As most of these ponds are not covered by vegetation or any other material, wind erodes their surface and high amount of material is transported for long distances, especially fine particles. The aim of this study is to assess the spatial distribution of lead and Zinc in the soils surroundings the abandoned tailings piles.

METHODOLOGY

A total of 51 soil samples were collected around the mine tailings, from a depth of about 0-20 cm (Figure 1). The soils were sampled using a plastic shovel and placed in clean plastic bags and stored at room temperature. Analysis of physico-chemical parameters (pH, electrical conductivity, total calcium, phosphorus, potassium and organic matter) were conducted at the National Institute for Agricultural Research in Rabat. Total heavy metal concentration (Pb, Zn, Cu and Cd) was determined by ICP-AES (Inductive Coupled Plasma - Atomic Emission Spectroscopy). Samples were analysed at the National Centre for scientific and technical studies of nuclear energy (CNESTEN). The determination of heavy metals spatial distribution was carried out using ordinary Kriging interpolation.

MAIN RESULTS

1. Physico-chemical parameters

Table 1 presents some physico-chemical properties of studied soil samples. The pH value ranged between 7 and 8.6. This alkalinity can be attributed to the presence of carbonates. The electrical conductivity values ranged from 0.10 to 1.43 $\mu\text{S}/\text{cm}$. All the soil samples presented a low organic matter content ranging from 0.3 to 2.66%. The obtained results showed that soils in the mining area of Zaida are calcareous, with values ranging from 0.55 to 77.95%. These calcium concentrations are attributed to the formation lithology of the studied area.

2. Heavy metal contents in soil

Levels of heavy metals in soil are shown in table 2. The mean concentrations were 0.99 (mg / kg) for Cd, 14.93 (mg / kg) for Cu, 47.60 (mg /

kg) for Zn and 89.81 (mg / kg) for Pb. These contents are relatively high compared to uncontaminated soil standards carried by other authors Baize (1997), Kabata-Pendias and Pendias (1999), World Health Organisation (WHO) cited by Parizanganeh et al. (2012).

3. Spatial distribution of heavy metals

- The heavy metal distribution is influenced by two factors: the distance from the tailings dam and the wind dispersion of sand particles;
- The kriged maps showed that the heavy metal contents decrease with increasing distance between the sampled points and tailings residue;
- High levels of heavy metals were founded in the North East, north West and South West direction, which correspond to the prevailing wind directions.

	pH	EC $\mu\text{S}/\text{cm}$	CaCO ₃ total%	OM %	P mg/kg	K mg/kg
Min	7.00	0.10	0.55	0.30	2.14	146.00
Mean	8.16	0.31	39.04	1.26	19.37	299.62
Max	8.60	1.43	77.95	2.66	197.10	732.04

Table 1: Physico-chemical characteristics of soils in the Zaida mine

Variable	Mean	Min	Max	Median	SD	Reference values		
						1	2	3
Cd	0.99	0.03	3.00	0.4	1.01	0.05-0.45	-	0.3
Cu	14.93	0.11	77.2	8.98	20.04	2-20	14	4
Zn	47.60	0.13	206.00	49.97	45.76	10-100	62	50
Pb	89.81	0.36	830.95	17.82	162.87	9-50	25	0.2 - 2

- [1] Ordinary soils (Baize, 1997)
- [2] Kabata-Pendias and Pendias, 1999
- [3] OMS (cited by Parizanganeh et al., 2012)

Table 2: Average, minimum and maximum contents (mg / kg) of heavy metals in soil samples

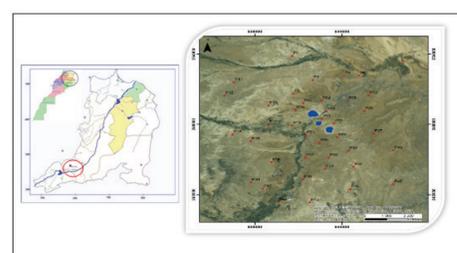
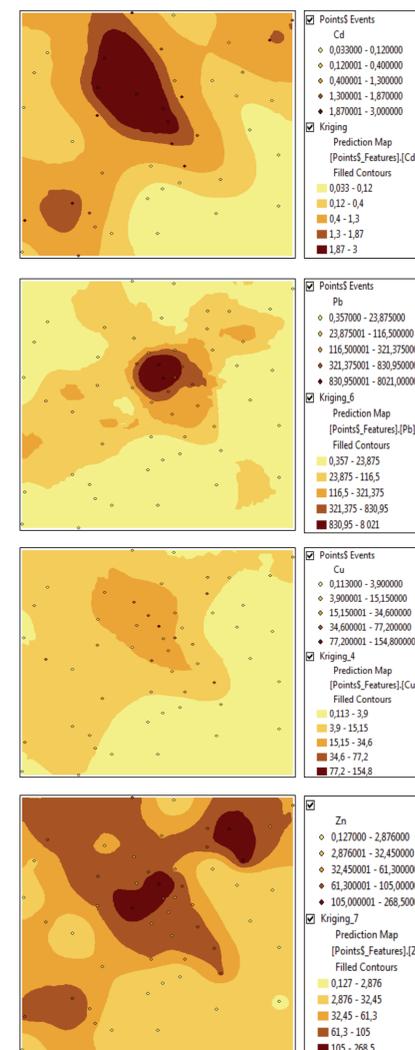


Fig. 1: Location of the Zaida mine and distribution of soil samples



CONCLUSION

The tailings of the Zaida Mine, which was abandoned without any rehabilitation plan, constitute a major source of soil contamination by ETM. The assessment of soil contamination by heavy metals (Cu, Zn, Cd and Pb) shown that soils are affected by poly-metallic pollution. Indeed, the soils located near the tailings dam and those in the two main prevailing wind directions in the studied area have relatively high levels compared to the values of uncontaminated soil from the literature. This enrichment by heavy metals can be mainly attributed to the action of the wind on the sand particles.

GLOBAL SYMPOSIUM
ON SOIL
POLLUTION

2 - 4 MAY 2018 | FAO - ROME, ITALY