Consideration of Geo-Statistical Analysis in Soil Pollution Assessment Caused by Leachate Breakout in the Municipality of Thermi, Greece.

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1. Introduction

The waste load of the landfill is 1.368 tn/day. Recently, more than 6 million tons of urban wastes have been disposed in the area. Landfill leachates are congregated in adjacent lagoon. Lately, a firebreak took place in the landfill and the walls of the lagoon bent. In excess of 1500 m^3 of leachates then were released into a local stream network and contaminate the surrounding area of 800 ha, land owners noticed that leachates remained for roughly 10 months. The contaminated areas are principally used for agricultural activities, irrigated and non-irrigated annual crops, in addition to several settlements are also located in the adjacent areas. The agriculture activities comprise mainly olives cultivation as well as annual crops.

2. Objective

- The current research focuses on issues related to groundwater contamination resulting from soil pollution. The problem that will be addressed is the pollution of soil resources by heavy metals in the area of Tagarades due to the leakage of landfill leachates. The objectives of this study are:

  a) Assess the level of soil resources pollution, and

  b) Determine the risk of metal mobilization and the possibility of groundwater pollution.

3. Materials and Methods

3.1 Study area

- The size of the study area is about 500 ha located in the Prefecture of Thessaloniki, in North Greece and more specifically in the municipality of Thermi between the villages Trilofos, Agia Paraskevi, and Tagarades. The study area is shown by satellite, orthrorectified image

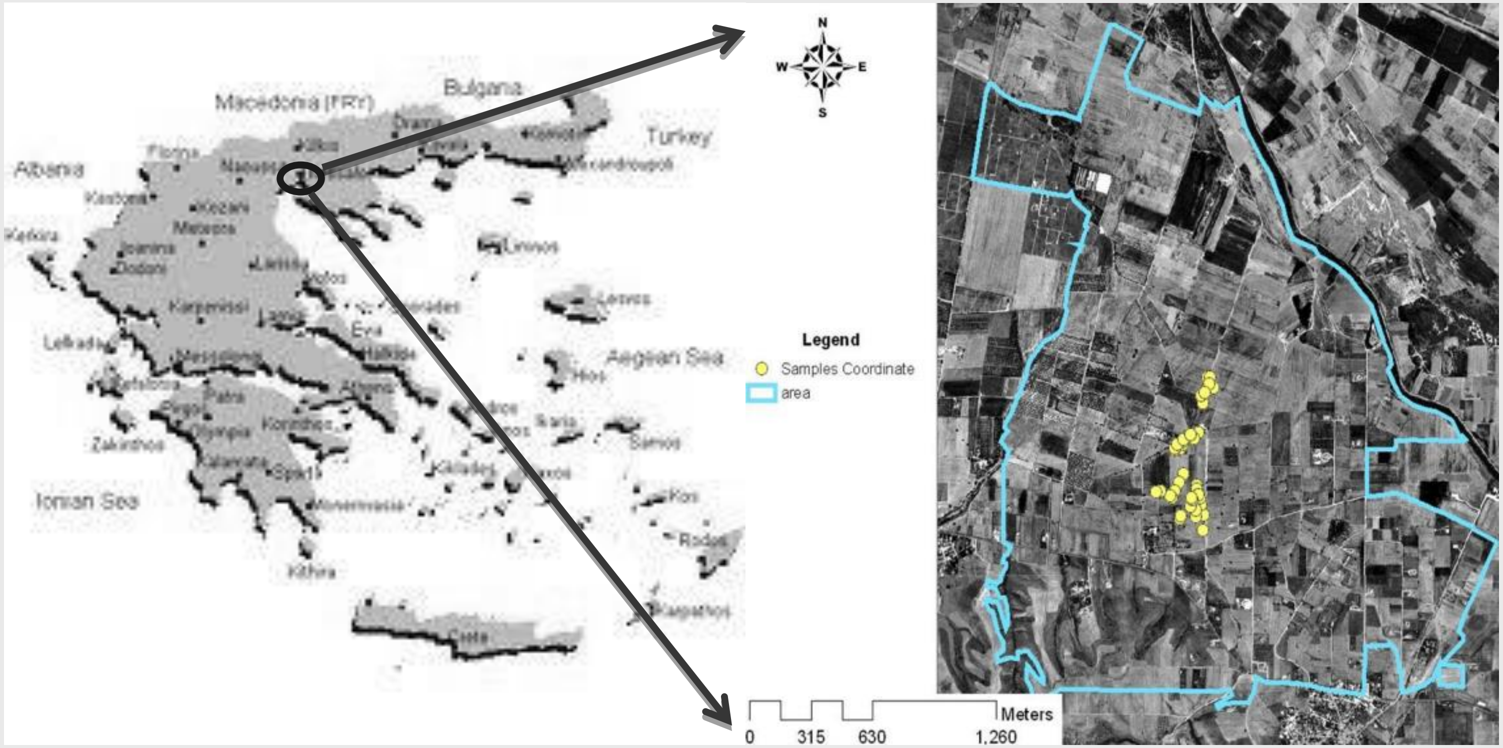


Figure 1, Location study area and soil sampling in Tagarades, Greece


Tagarades
Ταγαράδες
Eparchiaki Odos Neo Rysio-Vasilika
Agia Paraskevi
Αγ. Παρασκευή
Α/Δ Θεσσαλονίκης Ν. Μουδανιών
Kardia
Καρδία
Ano Scholari
Άνω Σχολάρι

3. Materials and Methods

3.2 Study area

- A number of 40 soil samples were taken from the study area representing the affected area by the leachates. The location of the soil samples that were allowed to be taken by land owners.
- Soil samples were taken from light depth (0 – 100 cm) representing the three different soil horizons A, B and C (A = 0 – 30, B = 30 – 70 and C= 70 – 100 cm). Atomic Absorption Spectrophotometer was used to detect total extractable heavy metal concentration of seven different heavy metals in the 40 soil samples.
- Furthermore in each sample the pH, clay content, and organic matter were measured using standard methods of soil analysis as parameters affecting the mobility of heavy metals.

3. Materials and Methods

3.3 Geostatistical analyses

- The spatial variability of heavy metal content in soils was determined by means of geostatistical methods
- There are four types of geostatistical analyses, each of which is valid for a certain analysis condition or complex of conditions
- To compare these models statistically, the Root Mean Square Error (RMS) would be implemented.
- The smaller the root mean square, the closer the model comes, on average, to predicting measured values that were removed from the analysis.
- The adopted geostatistical method is Inverse Distance Weighted due its RMS values.

5. Results

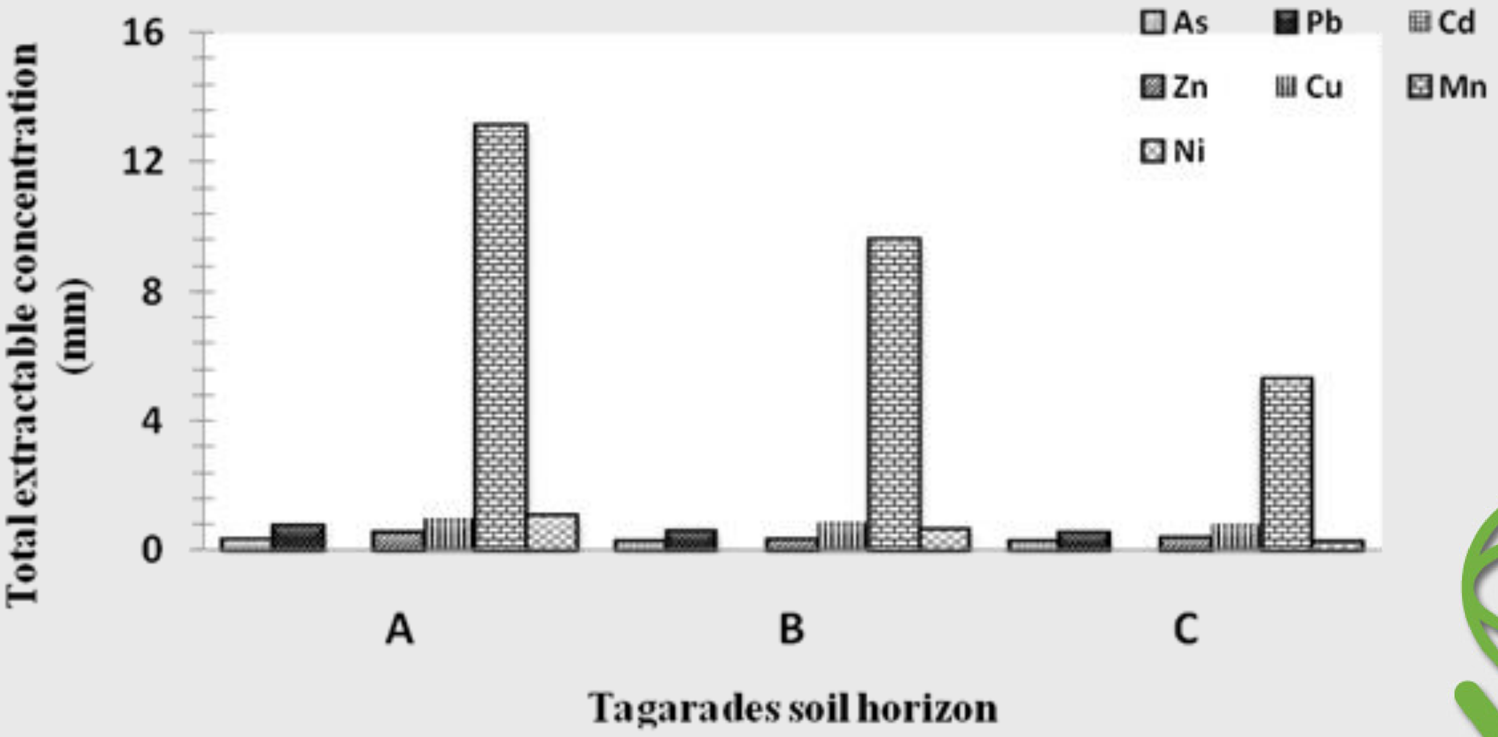


Figure 2, Total extractable concentration of different heavy metals in Tagarades soil horizons

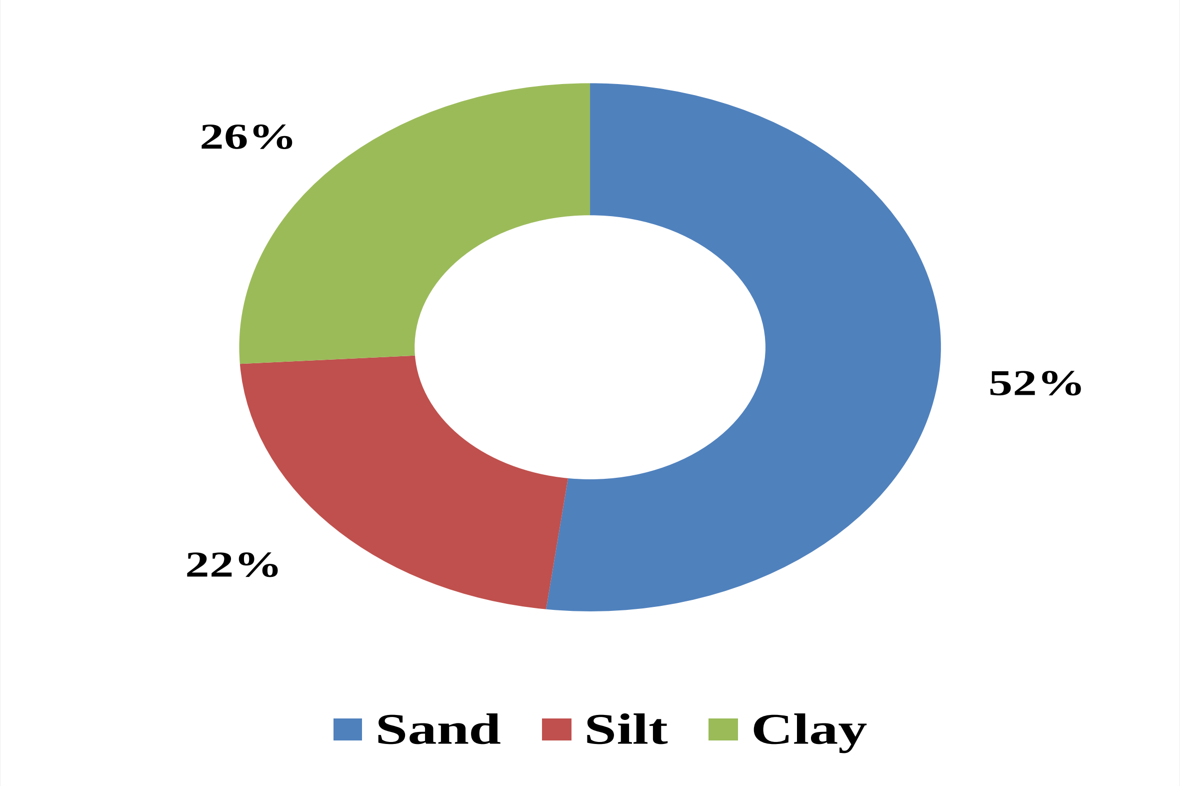


Figure 3. Tagarades soil composition

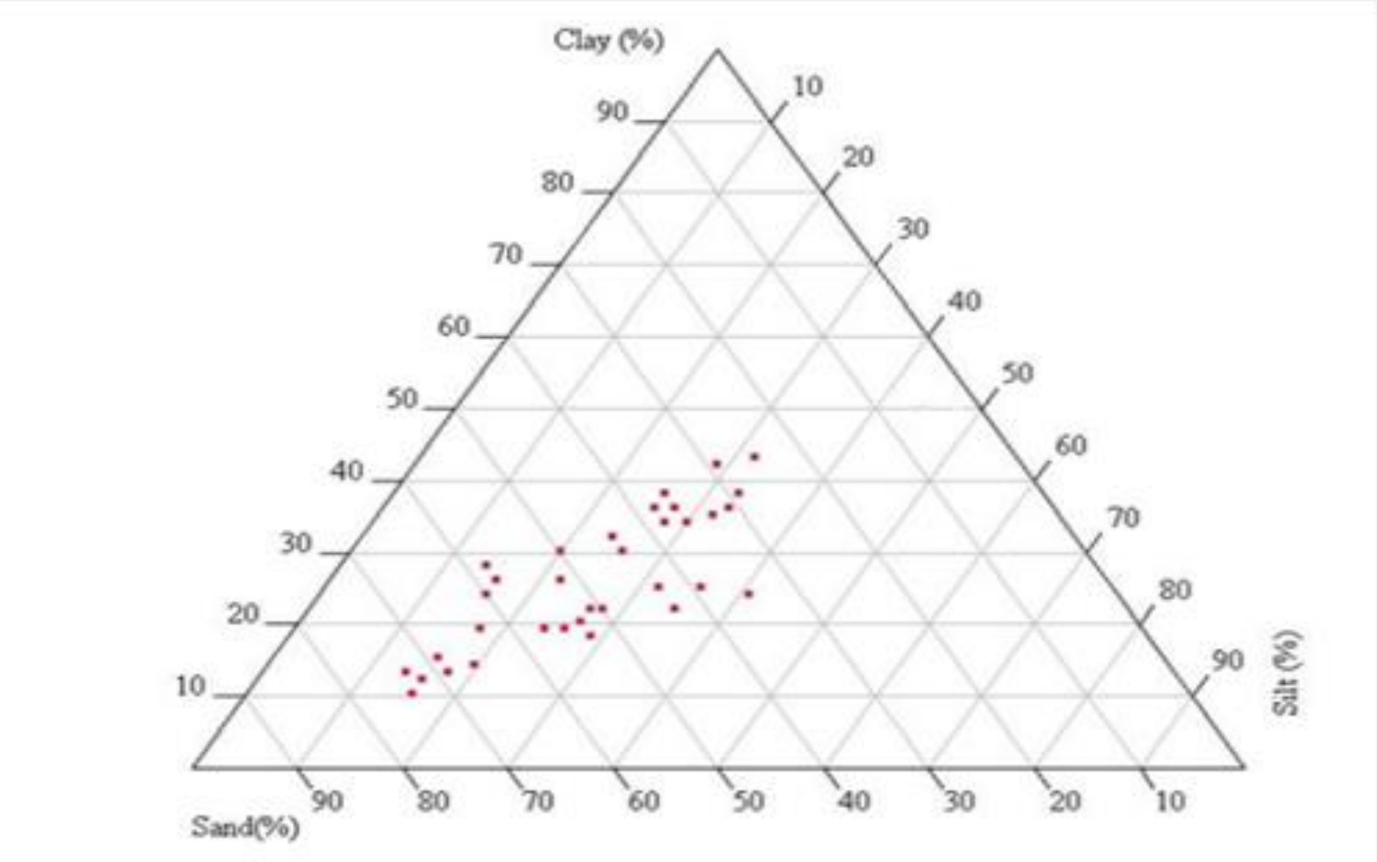


Figure 4, Soil textural classes in Tagarades area

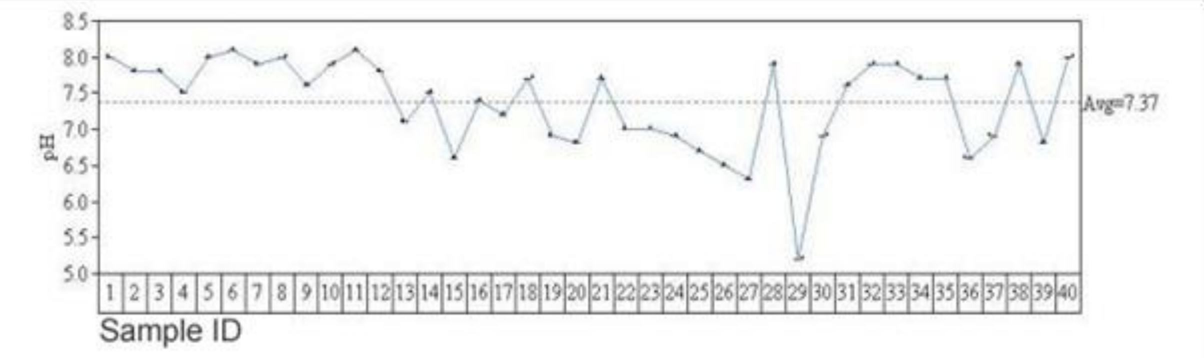


Figure 5, Tagarades soil pH

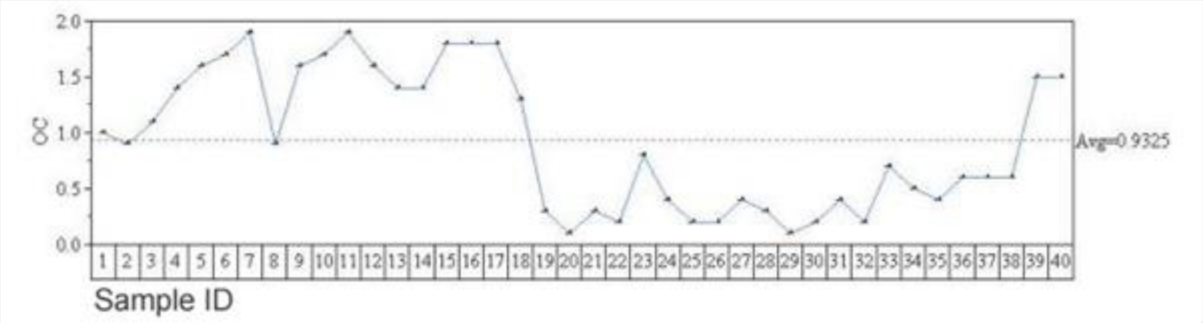
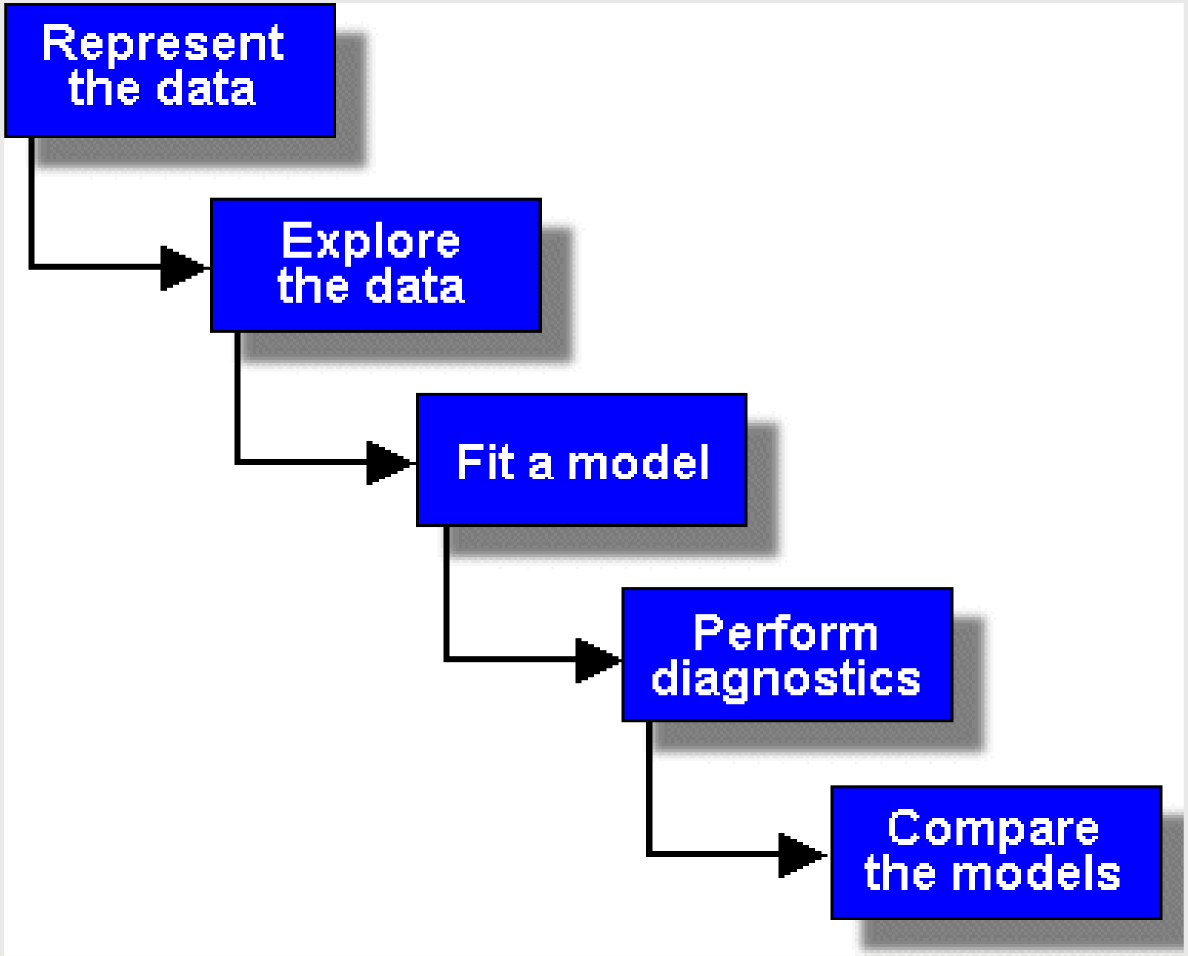
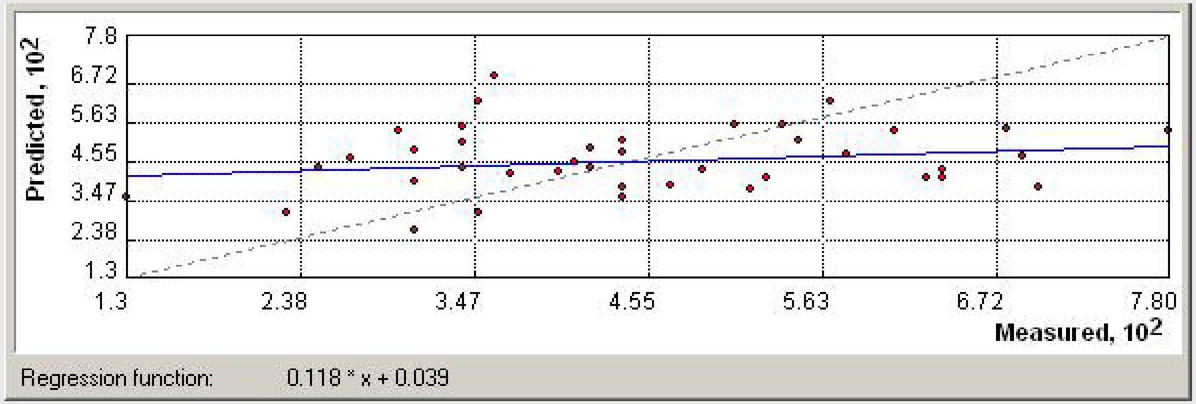


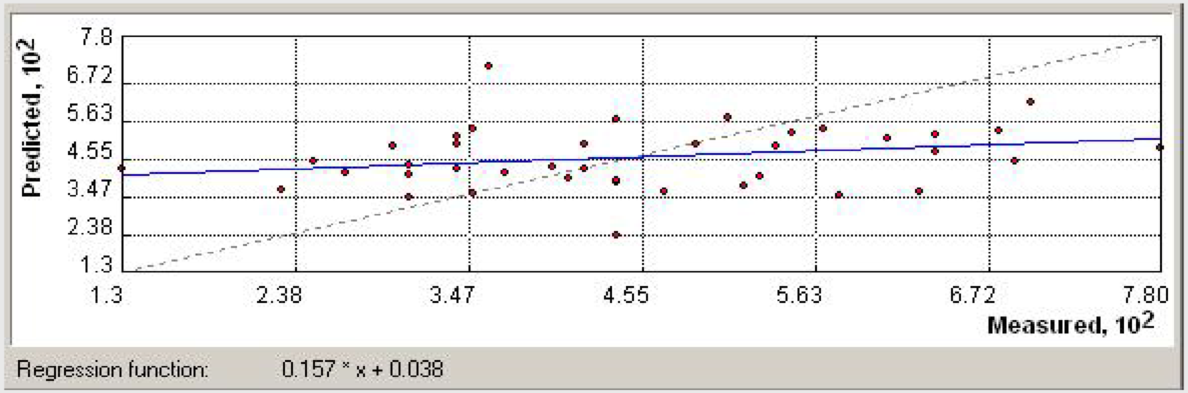
Figure 6, Tagarades soil organic carbon (%)

Steps of the analysis procedure

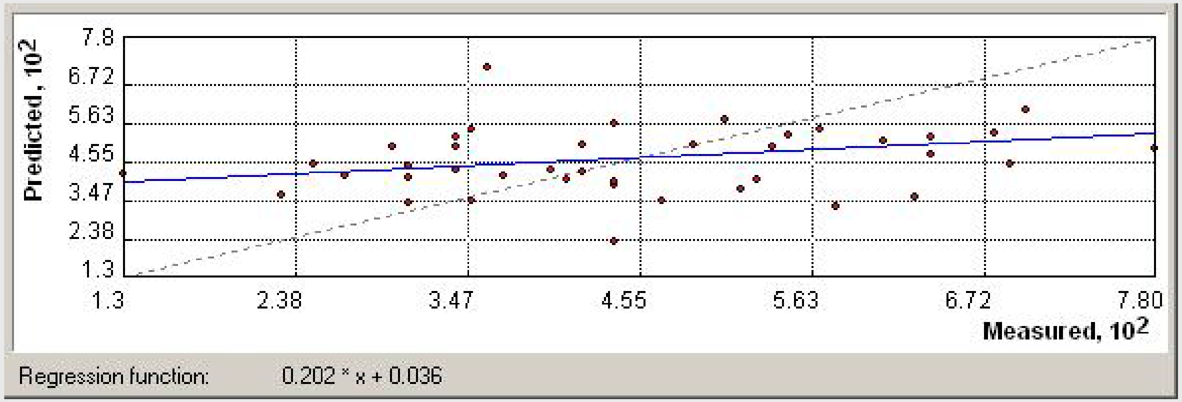




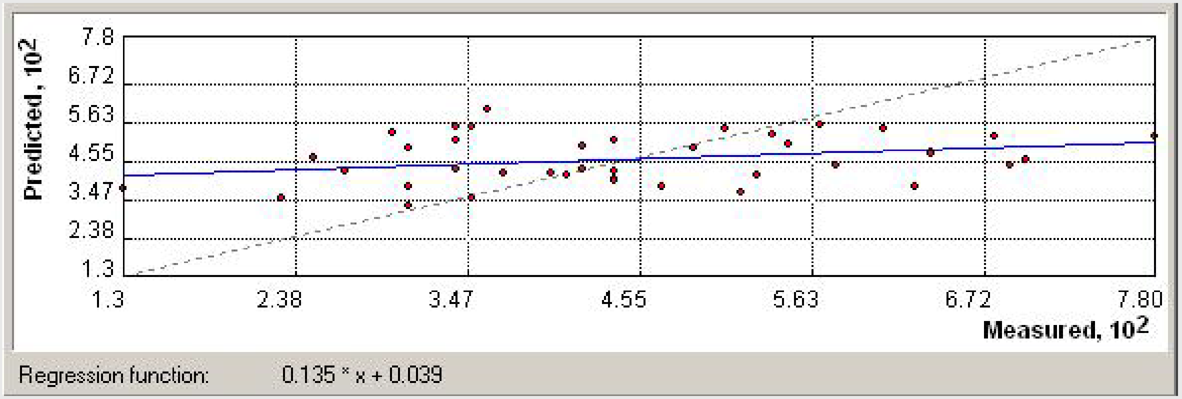
Inverse Distance weighting regression model.



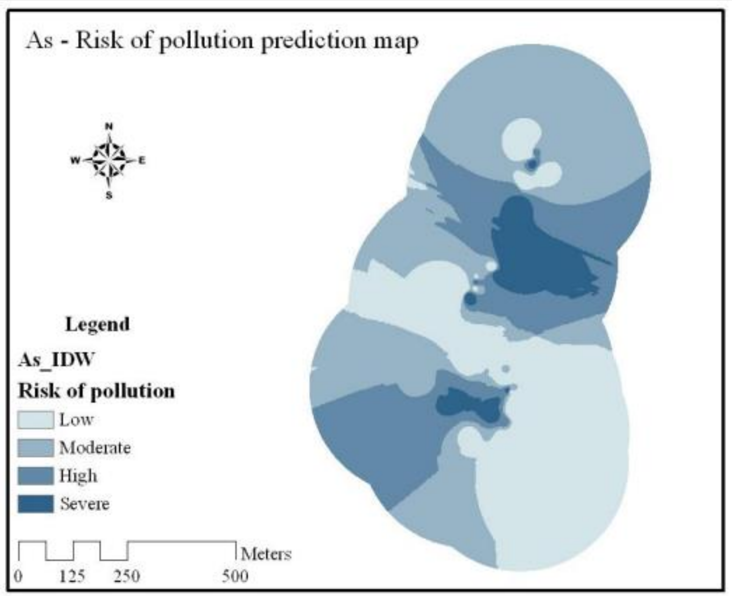
Global Polynomial regression model.

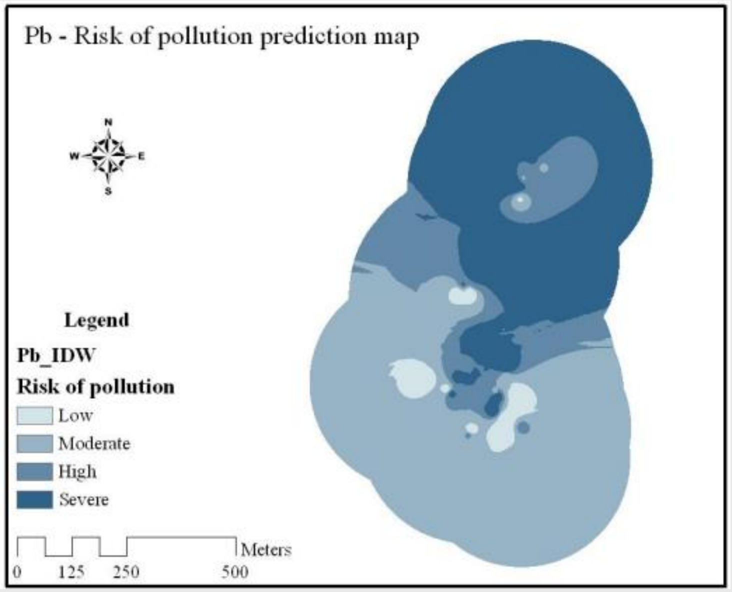


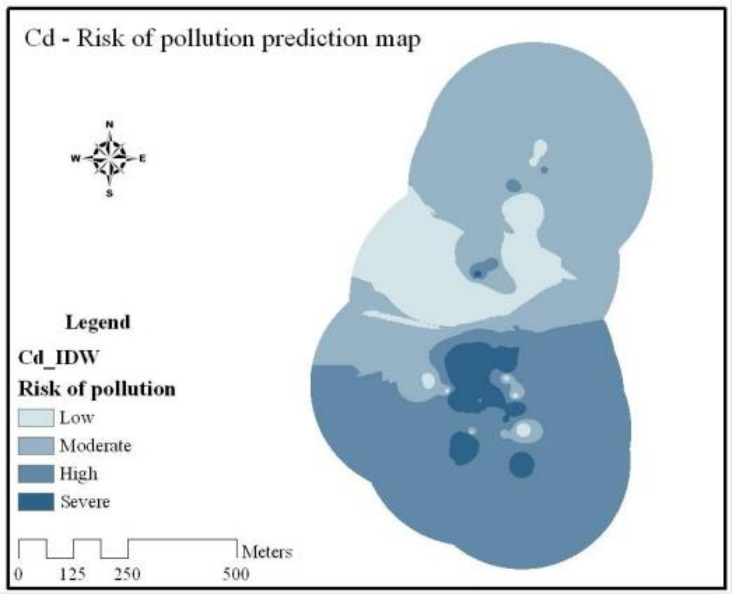
Local Polynomial regression model.

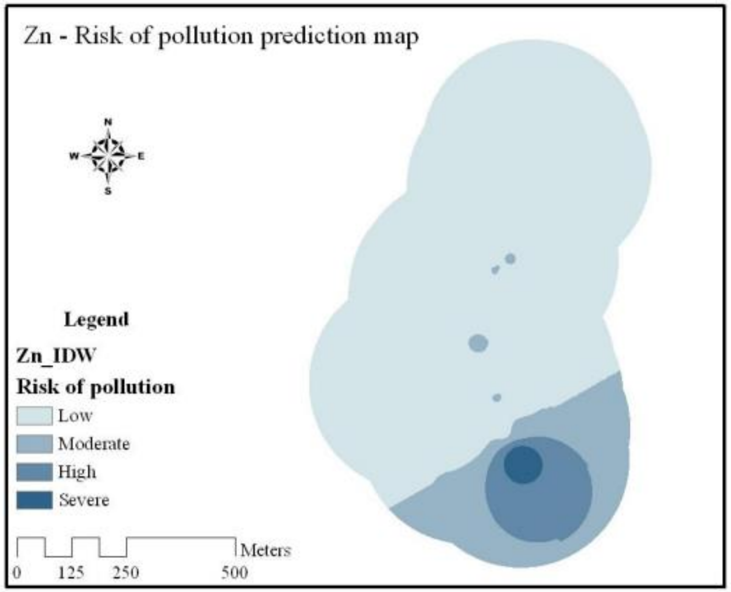


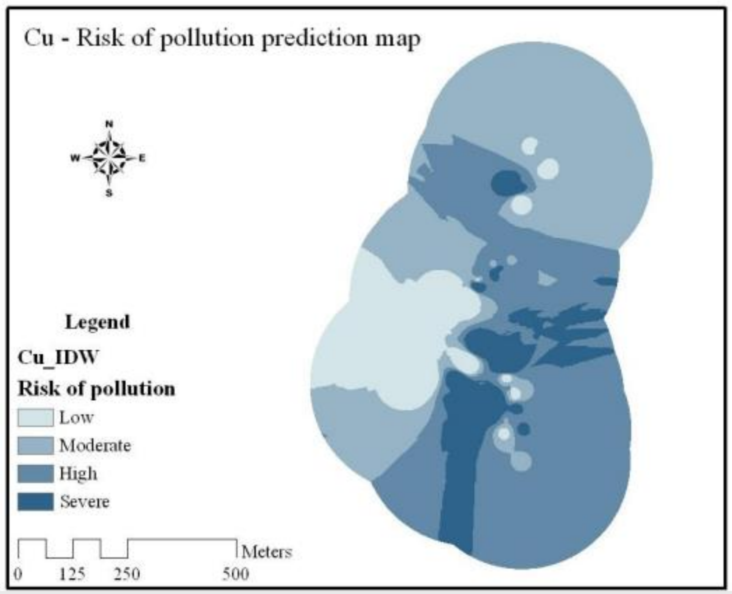
Kriging regression model

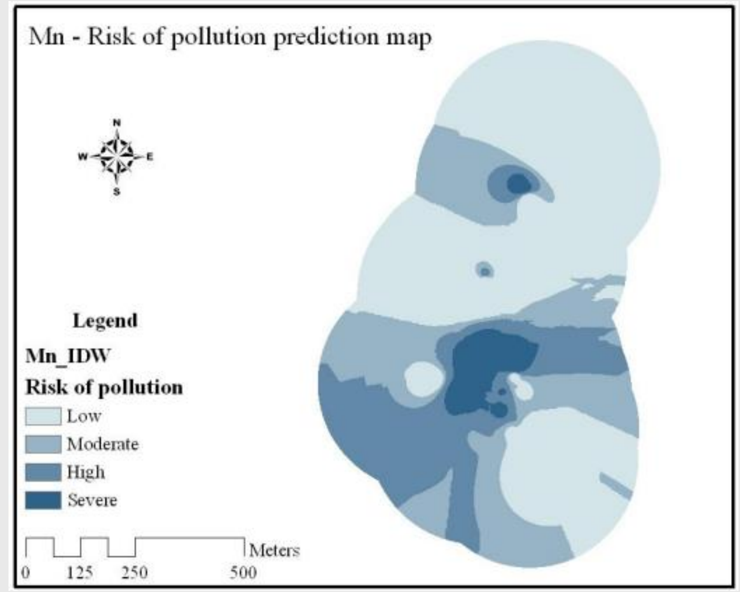

As - Risk of pollution prediction map
N
W
E
S
Legend
As_IDW
Risk of pollution
Low
Moderate
High
Severe
Meters
0 125 250 500

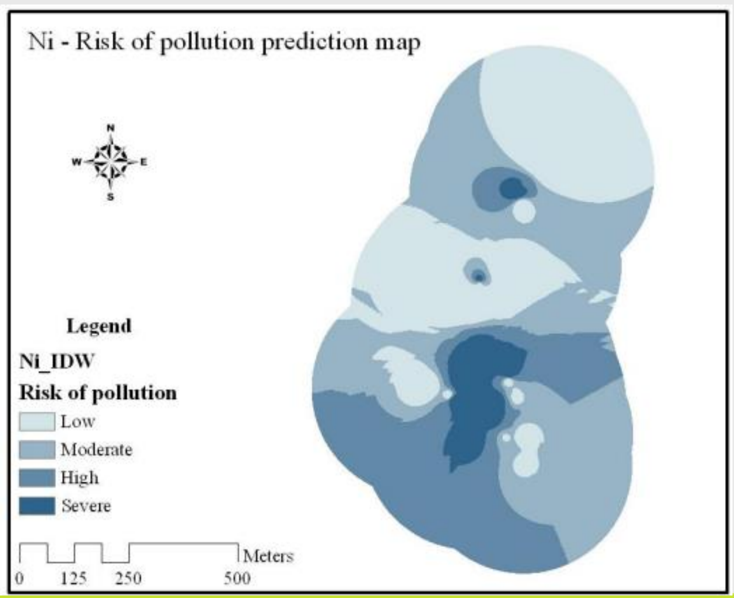

Pb - Risk of pollution prediction map
N
W
E
S
Legend
Pb_IDW
Risk of pollution
Low
Moderate
High
Severe
Meters
0 125 250 500

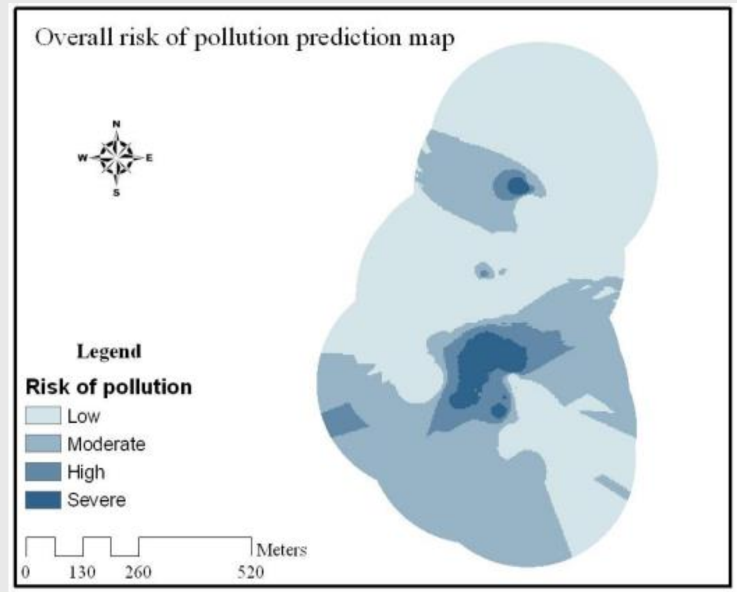

Cd - Risk of pollution prediction map
N
W
E
S
Legend
Cd_IDW
Risk of pollution
Low
Moderate
High
Severe
Meters
0 125 250 500


Zn - Risk of pollution prediction map
N
W
E
S
Legend
Zn_IDW
Risk of pollution
Low
Moderate
High
Severe
Meters
0 125 250 500


Cu - Risk of pollution prediction map
N
W
E
S
Legend
Cu_IDW
Risk of pollution
Low
Moderate
High
Severe
Meters
0
125
250
500


Mn - Risk of pollution prediction map
N
W
E
S
Legend
Mn_IDW
Risk of pollution
Low
Moderate
High
Severe
Meters
0
125
250
500


Ni - Risk of pollution prediction map
N
W
E
S
Legend
Ni_IDW
Risk of pollution
Low
Moderate
High
Severe
Meters
0
125
250
500


Overall risk of pollution prediction map
N
W
E
S
Legend
Risk of pollution
Low
Moderate
High
Severe
Meters
0
130
260
520

5. Conclusion

- Heavy metals were detected in Tagarades soil at depth of 100 cm.
- The corrosion products leach through Tagarades soil profile with a great risk of contaminating Tagarades underground water.
- Heavy metals bonded in soils of Tagarades because of the alkalinity and the higher organic content

- Underground water flow will accelerate the metal horizontal transportation, which will non source of contamination extents further from the original polluting point.
- Establishment of a remedial program to improve soil quality is necessary.
- Agriculture practices should be halted according to the overall risk map at the severely polluted sites.

Recommendations

- More soil sampling all over the study area.
- Landfill specification and construction design.
- Geological and hydrological database‘s and maps.
- Full risk assessment following CLEA model.
- Groundwater sampling for heavy metal pollution

Thanks for your attention