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GEOCHEMICAL MAPPING OF SOIL Pb IN THE MINING VILLAGE OF STRATONI, GREECE: VARIATIONS BETWEEN DIFFERENT INTERPOLATION METHODS

Sofia Nicolaou *[1] and Ariadne Argyraki [1]

[1] Department of Economic Geology and Geochemistry, University of Athens, Panepistimiopolis Zographou, Athens, Greece, email: samba@hotmail.com

ABSTRACT

Geochemical mapping is an important tool for environmental assessment, enabling recognition of spatial associations between contamination hot spots and potential sources of pollution. It is also very useful for communicating research results to stakeholders outside the scientific community through visualisation of relationships between geochemical parameters and various spatial features over an area. Various interpolation methods [1] can be used for producing a continuous surface of a geochemical parameter from point sample data. However, the choice of the interpolation method can affect significantly the map output.

INTRODUCTION

Geochemical maps provide valuable information for hazard assessment and for decision support. The study area of this research is the mining village of Stratoni, an industrial area of mining and processing of sulphide ore in North Greece. The total sampled area of 1.5 km^2 was covered by a 200 x 200 m grid and 36 surface soil samples.

The spatial distribution of potentially toxic elements, in soil was studied by using two different interpolation methods: the deterministic method Inverse distance Weighted (IDW) and the geostatistical method of ordinary kriging.

Tables 1,2 present the differences between interpolation methods in terms of estimated min and max Pb concentrations and % area with Pb exceeding the 3rd quartile of concentration values.

MAPPING METHODOLOGY

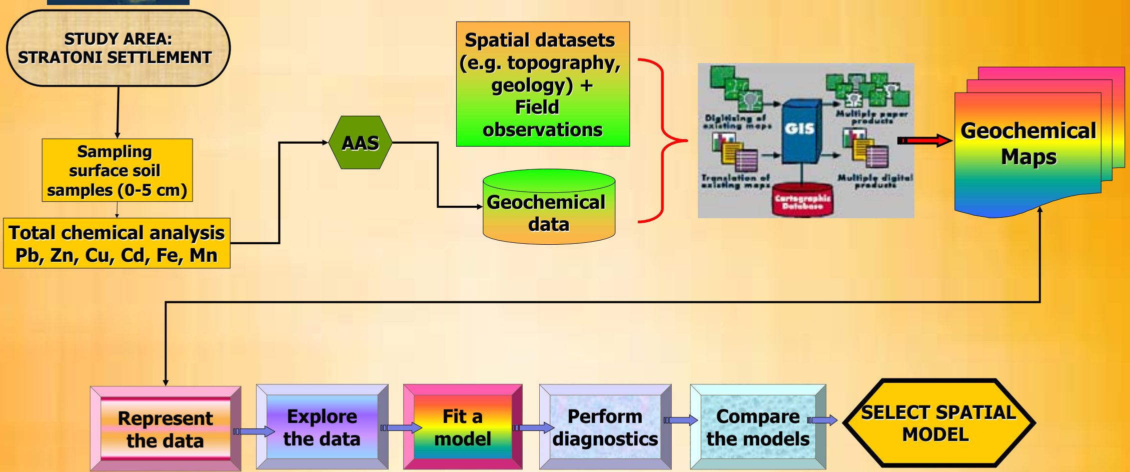


Table 1: *Comparison between maximum and minimum Pb concentrations in soil (µg g^{-1}), as calculated from measured data and the interpolation methods used.*

	MEASURED DATA	INTERPOLATION METHOD	
		IDW	ORDINARY KRIGING
Pb (N=36)			
Min	178	278	161
Max	3497	3123	2983

Table 2: *Comparison of settlement % area with soil Pb exceeding the highest quartile of concentration, as calculated by the two interpolation methods*

	IDW	ORDINARY KRIGING
Pb	22.87%	20.88%

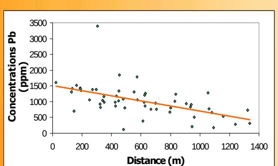


Figure 1: *Graph of Pb concentrations plotted against distance from the ore mill located at the NE corner of Stratoni.*

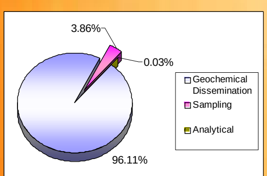


Figure 2: *Pie chart showing analytical, sampling and geochemical variability of Pb in soil as percentages of total variance. Calculations are based on 9 duplicate samples collected 5 m apart, each analysed in duplicate.*

RESULTS

Lead concentrations in soil samples ranged from 124 µg g^{-1} to 2042 µg g^{-1}. The total area characterised by Pb concentrations over 500 µg g^{-1} was estimated to be 80% of the total by both interpolation methods and a spatial pattern showing decreasing Pb concentration with increasing distance from the ore mill plant located on the NNE end of the village was observed (Figure 1).

Sampling and analytical uncertainty of measurements were assessed via a special quality control program (ANOVA)[2,3] that included the collection and analysis of duplicate samples and were found within acceptable limits (Figure 2). The dimensions of interpolation cells where subsequently set as 5 m x 5 m based on the distance separating the sampling duplicates.

The spatial trend is more apparent when the geostatistical method of kriging is used (based on the semivariogram presented in Figure 3), producing a smooth interpolated surface over the total study area (Figure 4).

The deterministic method of IDW produces closed concentration curves around the sampling sites, highlighting the geochemical heterogeneity of surface soil in respect with Pb (Figure 5).

Areas characterized by the highest elemental concentrations were also delineated, providing a criterion for prioritizing the remediation of contaminated land within the village (Figure 6).

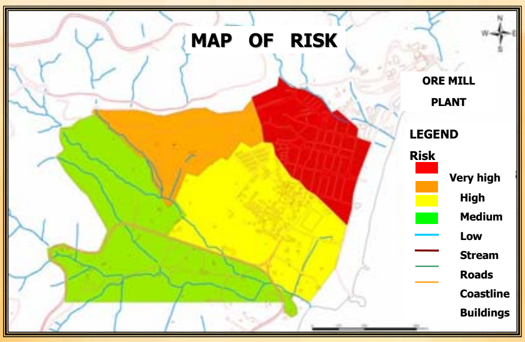


Figure 6: *Stratoni map showing areas of the highest soil Pb, providing a criterion for prioritizing the remediation of contaminated land within the village.*

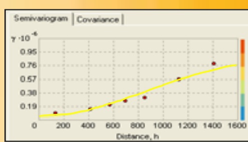


Figure 3: *Semivariogram of soil Pb concentration at Stratoni. Log transformed data are used.*

Figure 4 STRATONI SETTLEMENT GEOCHEMICAL MAP OF Pb ORDINARY KRIGING METHOD (N=36)

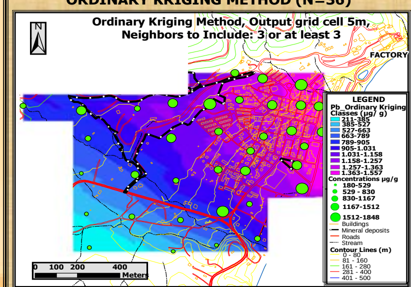
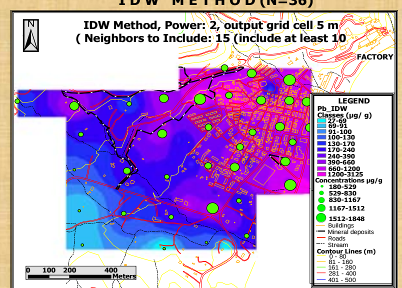


Figure 5 STRATONI SETTLEMENT GEOCHEMICAL MAP OF Pb IDW METHOD (N=36)



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