Study on Spatial Variability of Soil Zinc Using Geostatistics in GIS Environment (Case Study: Malekan Region)

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INTRODUCTION

Soils play an important role for human subsistence and development, and food production can be the most important and vital function of soils that is offered to societies. Therefore, the need for studies that provide possibilities to protect and sustain soils is inevitable. Geostatistics have recently been used as a tool for soil investigation and mapping. Geostatistical procedures are helpful to study spatial variability in soil-management practices. Geographic information systems (GIS), as new technology, and geostatistical sciences deal with spatial data. Thus, this common characteristic allows integrating both. The main objectives of this study were to i) analyse spatial dependency of Zn, and i) map the spatial distribution of Zn in the study region.

METHODS

Study Area

Malekan, our study area, is located in the South of the East Azarbaijan province, in the Northwest of Iran. Malekan covers 840 km^2 and is known as agricultural area. The most important soil problem in Malekan is soil alkalinization that restricts the uptake of microelements in the field.

Soil Sampling

Using a random sampling design, 179 samples were collected at different agricultural locations in Malekan. The sample positions were registered with a Global Positioning System (GPS) receiver in a Universal Transverse Mercator (UTM) coordinate system. All soil samples were taken at a depth of 25 cm and mixed. The soil samples were analysed, and the results were recorded in ESRI ArcGIS for further processing.

Geostatistical Techniques

The main application of geostatistics to soil science has been the estimation and mapping of soil characteristics in un-sampled areas (Goovaerts 1999). At first, a semi-variogram was developed for Zn to examine spatial continuity and dependency. The distribution of data should be normal for the parameter estimation, and the K-S test was used to examine the distribution of the data. The information generated with the Zn-variogram was used to calculate sample weighing factors for spatial interpolation by ordinary kriging procedures. The exponential model was selected from standard models that are available to fit experimental semi-variograms, including spherical, exponential, Gaussian, linear and power models. A filled contour map (prediction map) and a relevant prediction standard error map were created for Zn using the ArcGIS Geostatistics tool.

RESULTS AND DISCUSSION

Descriptive Statistics and Geostatistical Analyses

Table 1 shows the summary statistics for Zn. Skewness and kurtosis values are low, and there is no need for data transformation. Table 2 presents the semi-variogram parameters for soil-Zn. Zinc has a strong spatial dependence. Thus, geostatistics can be applied to map and evaluate Zn in the study area.

Usually, a strong spatial dependence of soil properties can be attributed to intrinsic factors, and a weak spatial dependence can be attributed to extrinsic factors (Cambardella et al. 1994). Figure 1 and 2 demonstrate the generated prediction and error maps for Zn.

Table 1. Summary statistics for Zn.

Element	Mean	Median	Min	Max	Std	Skew	Kurt	CV %
Zn	0.42726	0.42	0.18	0.8	0.1326	0.62296	2.7878	31.035

Table 2. Zinc semi-variogram parameters.

Element	Nugget	Sill	Range(m)
Zn	0	0.1246	2380.7

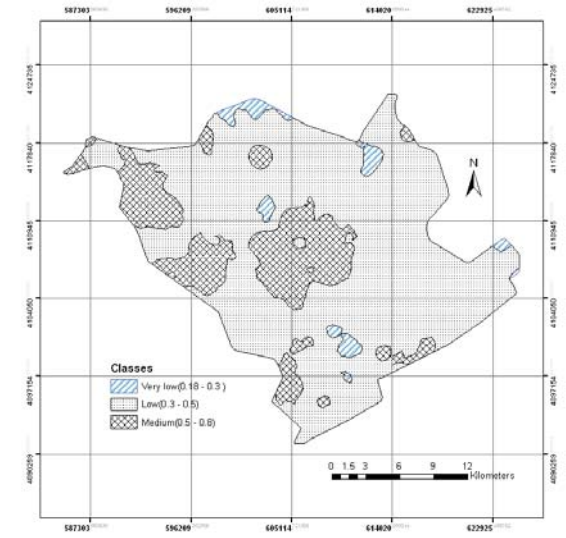

Fig. 1. Prediction map for soil-Zn.

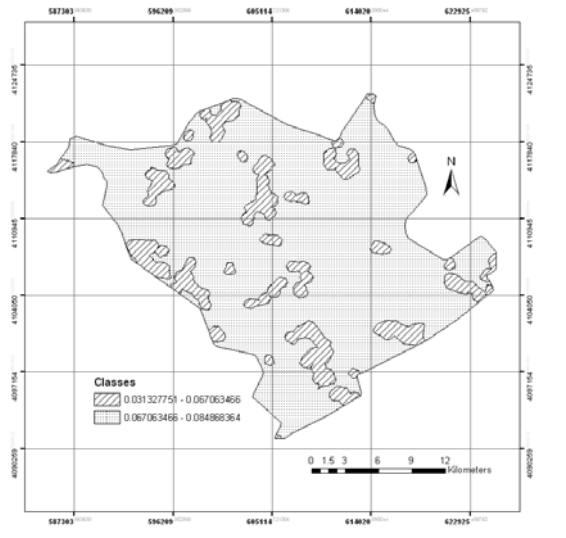

Fig. 2. Prediction standard error map for soil-Zn.

CONCLUSIONS

It was concluded that geostatistical techniques are applicable to investigate the spatial variability of Zn in the study area. Based on prediction and error maps, it was realized that Zn has no toxic status and that the application of Zn fertilizer will improve crop yields in the study area.

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REFERENCES

Goovaerts, P. (1999) Geostatistics in soil science: state-of-the-art and perspectives. Geoderma 89: 1-45.

Cambardella, C.A., Moorman, T.B., Novak, J.M., Parkin, T.B., Turco, R.F. and Konopka, A.E. (1994) Field-scale variability of soil properties in central Iowa soils. Soil Sci. Soc. Am. J. 58: 1501-1511.