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Article

Multi-Scale Application of Advanced ANN-MLP Model for Increasing the Large-Scale Improvement of Digital Data Visualisation Due to Anomalous Lithogenic and Anthropogenic Elements Distribution

Robert Šajn [1,*], Trajče Stafilov [2], Biljana Balabanova [3] and Jasminka Alijagić [4]

[1] Geological Survey of Slovenia, 1000 Ljubljana, Slovenia
[2] Institute of Chemistry, Faculty of Science, Ss. Cyril and Methodius University, 1000 Skopje, North Macedonia; trajcest@pmf.ukim.mk
[3] Faculty of Agriculture, University "Goce Delčev", 2000 Štip, North Macedonia; biljana.balabanova@ugd.edu.mk
[4] Independent Researcher, 1000 Ljubljana, Slovenia; jasminka.alijagic@gmail.com
* Correspondence: robert.sajn@geo-zs.si; Tel.: +386-1-2809-769

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Abstract: The main objective of this paper is to compare and improve spatial distributions models for Pb and Cu in air and soil using the universal kriging and ANN-MLP at the macro regional scale. For this purpose, both models have been applied for visualization of a spatial distribution of lead (Pb) and copper (Cu) in a morphologically and geologically complex area. Two river basins in the eastern part of North Macedonia, have been selected as the main research region due to the extensive anthropogenic impact of long-lasting mining activities, with emphasis on the specific geochemistry of the area. Two environmental media (soil and moss) have been selected as they are much more available as space from biospheres submitted for destruction processes globally. Surface soil and moss as bio-indicator element measurements were submitted in correlation with geospatial data obtained from DEM, land cover data, and remote sensing, and are incorporated into spatial distribution mapping using an advanced prediction modeling technique, ANN-MPL. Both methods have been further compared and evaluated. The comparative data outputs have led to the general conclusion that ANN-MPL gives more realistic, reliable, and comprehensive results than the universal kriging method for the reconstruction of main distribution pathways. The more the factors influencing the process of distribution of the elements increase, the more the use of ANN-MPL improves.

Keywords: trace elements; soil; moss; spatial distribution; artificial neural network–multi-layer perceptron; universal kriging

1. Introduction

Long-term lithogenic degradation effectively disrupts a number of natural conditions in the environment. In addition, the amount of atmospheric emissions is increasing rapidly worldwide. Emissions from mines, mine activation, smelters, metal processing plants, fertilization, and combustion contribute to the anthropogenic inputs of heavy metals in the environment [1–4]. Surface lithological degradation has been significantly enhanced by long-term mining activities and processing. Mining and flotation waste continue to be a threatening source of degradation, even long after mining activities have stopped. The atmo-lithosphere area is a critical space of the biosphere, which directly affects the well-being of the human population. Well-developed countries implement continuous monitoring programs in order to identify and anticipate anomalous areas and occurrences that negatively affect the health of the population and contribute to ecosystem destruction.

In the late 1960s, Scandinavian countries introduced suitable monitoring models for atmospheric deposition of heavy metals and other trace elements [4]. Since then, many