

The impact of land use on the heavy metal budget in the mining-affected floodplain of the Innerste north of the Harz Mountains

Introduction

The floodplain deposits of the Innerste are strongly contaminated with heavy metals, due to former ore mining in the northern Harz Mountains. Heavy metals are released from decommissioned mine dumps and transported during flood events. The result is an enrichment of heavy metals in floodplain sediments located downriver. Contaminated floodplain deposits are strongly affected by remobilization, transfer and deposition downriver during following flood events. Elements indicating mining activities are in particular lead, zinc, cadmium and copper.

River Innerste springs near Clausthal-Zellerfeld in the north-western part of the Harz Mountains. Following the general inclination the Innerste flows north-west towards its confluence with the river Leine. The investigated river section between the northern margin of the Harz Mountains and its mouth into the Leine is approximately 67 km long (Fig.1) and drains an area of about 1167 km².

The major goal of the PhD project was to investigate the effect of different land use on the heavy metal budget of soils in the floodplain of the Innerste. Captured kinds of land use include agricultural areas, residential areas and nature reserves.

Methods

Eleven transects across the river were defined at locations characterized by different land use. Soil samples were taken along these transects with a 2-5 m distance to the riverbank and half the expansion of the floodplain. The samples were collected divided by soil horizons. Applied methods include the analysis of basic pedologically parameters, total content and soluble fractions of heavy metals. Analyzed elements are cadmium (Cd), chrome (Cr), copper (Cu), nickel (Ni), lead (Pb) and zinc (Zn). Correlation analysis (by Spearman) and nonparametric tests (Kruskal-Wallis-Test) were carried out to evaluate the results.

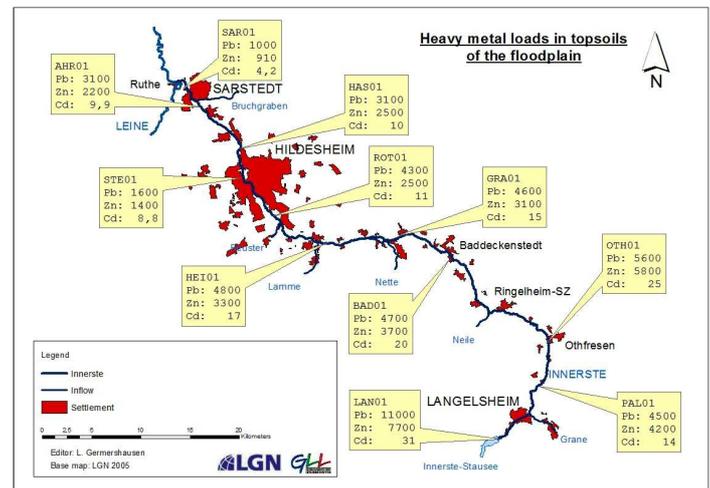


Fig.1) Heavy metal loads [mg/kg] in topsoils of the floodplain on the right side of the Innerste in short distance (2-5 m) to the riverbank. Legal limits are 70 mg/kg (Pb), 150 mg/kg (Zn) and 1 mg/kg (Cd) (BBodSchV 1999).

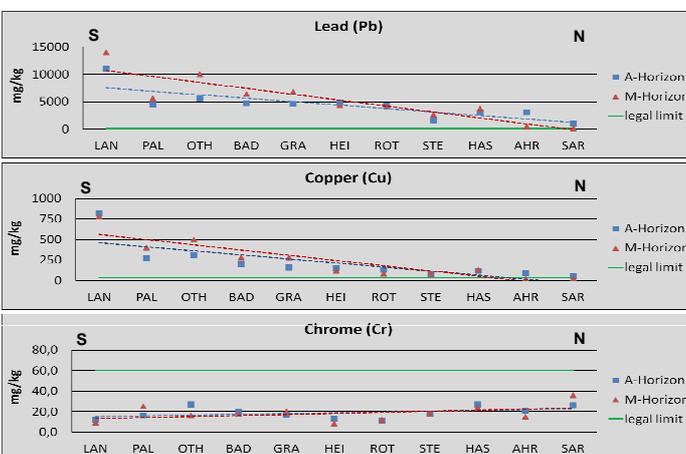


Fig.2) Distribution of total contents in the upper horizons of the floodplain soils in short distance to the river. The graphs show the longitudinal profile of the Innerste from the margin of the Harz Mountains in the south to the mouth into the Leine in the north. Legal limits taken from the BBodSchV (1999).

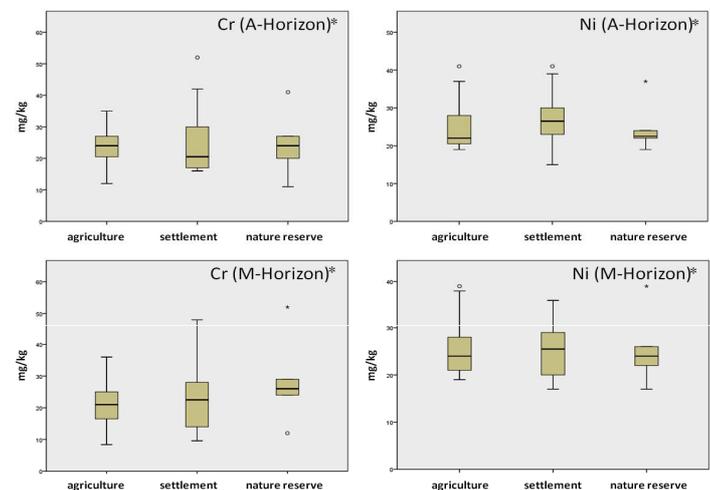


Fig.3) Heavy metal concentrations in upper soil horizons of the floodplain divided according to land use types. (* German classification)

Results

Predominating soil types in the study area are Fluvisols and Gleysols. For better comparability just the two upper soil horizons were considered. The results show that most Cd, Cu, Pb and Zn total contents are significant above average in the floodplain deposits. Concentrations of these elements in general decrease from the margin of the Harz Mountains towards the mouth of the Innerste (Fig.1 and Fig.2). Cr and Ni total contents are distributed more discontinuously (Fig.2).

Results of correlation analysis show a strong relationship between Cd, Cu, Pb and Zn and effects of the former mining industry. Due to the very high contents there is no possibility to discover land use effects on the element budget of these heavy metals in the floodplain deposits. Further results show, that Cr and Ni concentrations within the soils of the study area are not influenced by mining activities. Therefore these elements are useful to investigate effects of land use. The results of nonparametric tests do not yield significant impacts of different kinds of land use. But the results suggest trends of Cr enrichment in soils of nature reserves and increased Ni concentrations in soils of settlement areas (Fig.3).

Conclusion

The investigations have shown that there is no recognizable effect of land use on heavy metal concentrations influenced by mining activities in the floodplain of the Innerste. In contrast, the total contents of Cr and Ni reveal trends of impacts, but still there is no evidence to substantiate these trends. Studies in smaller spatial units are suggested to get more certainty.

Literature:

BUNDESBODENSCHUTZ- UND ALLLASTENVERORDNUNG (BBodSchV) (1999) BBodSchV Anhang 2 – Vorsorgewerte für Böden nach § 8 Abs. 2 Nr. 1 des Bundes-Bodenschutzgesetzes.
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