THE PROBLEM

Heavy metal contamination threatens soil health in the Copa Mică area of Romania. The region’s main environmental problems are caused by emissions from the ore processing industry, which include, among other pollutants, cadmium, copper, lead and zinc. Pollutant emissions (with a high concentration of $\text{SO}_2$) from the non-ferrous metallurgical factory have also decreased soil structural stability and soil pH. Natural sheet, rill and gully erosion processes have intensified due to the lithological susceptibility of land to erosion.

PROPOSED SOLUTION

In 2015, we set up an experimental field to study the effects of amendments used for remediating heavy metal-contaminated soils in-situ. Our solution uses amendments (Na-bentonite, dolomite, natural zeolite and manure) to reduce metals transfer from the soil to plants, limiting the input of metals into the food chain. This would have a positive impact on human health in the region.

AIMS, OBJECTIVES AND EXPERIMENT DESIGN

The primary objective of the experiment was to test how effectively different amendments convert heavy metals into less mobile forms in the soil. We judged the effectiveness of each treatment by assessing changes in heavy metal bioavailability and metal accumulation in plants grown on treated soils.

We used a Randomized Complete Blocks Design in the experimental field, which is located in a highly polluted area, 800 m away from the source of contamination. Four amendments were applied: bentonite (90 t ha$^{-1}$), dolomite (50 t ha$^{-1}$), natural zeolite (90 t ha$^{-1}$) and manure (45 t ha$^{-1}$), dry matter.

A mix of perennial grasses and straw cereals – belonging to the family of Gramineae – were sown in all plots. Over two years, soil samples were collected from each experimental plot and analysed in the laboratory.

STAKEHOLDERS INVOLVED

Stakeholders worked together to find solutions that reduce the effects of contamination, improve the soil quality and crop production. The local stakeholder groups included landowners, local authority representatives, land users and farmers. External stakeholders were mostly researchers, representatives of the County office for soil science and agro-chemistry and students interested in contamination issues.
The main results from the experimental field were:

- The highest increase in pH values was for soil treated with Na-bentonite (7.16) compared with the control (5.18).
- In both experimental years, concentrations of available cadmium, lead and zinc decreased significantly with the application of amendments, and they followed the order (highest to lowest): control > natural zeolite > manure > Na-bentonite > dolomite.

- Compared with the control all treatments had statistically significant effects on metals accumulation in biomass but the highest decrease of metal content in the plant was after dolomite application.

Landowners and land users in the contaminated area are primarily concerned with the cost of implementation, effectiveness of applied treatments and long-term effects on soil quality. Of all the soil amendments, the manure was the most favoured by stakeholders as it is cheap and widely available.

The stakeholders were heavily involved in selecting the measures to be tested, and then participated in setting-up the field experiments and other demonstrations activities. The demonstration activities focused on familiarising stakeholders with the application of inorganic and organic amendments to reduce the transfer of metals from contaminated soil to crops. The experimental plot was organised in collaboration with members of the community from the affected area. The land was offered by a key local stakeholder, an agronomist who is an experienced collaborator with the research team. The landowner’s involvement helped strengthen the confidence of other farmers in the study and increased their interest in the selected measures.

Although soil amendments, and especially dolomite and Na-bentonite, significantly reduce the bioavailability of metals this reduction is not sufficient to produce safe food or fodder.

- Reducing the metal toxicity and improving the soil fertility led to the development of a consistent vegetation cover with positive effects on soil erosion and loss of soil biodiversity.
- Further investigations on the long-term impacts are essential to examine the positive but potential transitory implications of these amendments.
- The field experiment and all demonstration activities contributed to knowledge improvement of the local community about the safe use of contaminated land.

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Further information about the case study:
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