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Long-term immobilization of heavy metals on a former sewage field by burnt lime, stone dust, leonardite and iron hydroxide

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Abstract (max. 400 words)

Former Berlin sewage field soils are heavily contaminated with heavy metals due to decades of wastewater irrigation. Since irrigation was discontinued, the humus content and soil pH have declined. This causes an increased risk of heavy metal leaching into groundwater and reduced plant biodiversity in the fields.

In order to study long-term heavy metal immobilization and the establishment of diverse plant populations, a field trial in a randomized block design with five-fold repetition was set up in September 2020 on a former sewage fields in Wansdorf (north east of Berlin) using iron (hydr)oxide, rock dust, basic leonardite and burnt lime as amendments. In order to predict the sustainability and to identify the underlying mechanisms of heavy metal immobilization and to obtain basic data on acid neutralisation capacity (ANC) as well as acid buffer rates and heavy metal release associated with acid buffering, pH-stat titration experiments were performed. Therefore, samples of the sewage field soil were air-dried and sieved to < 2mm. Subsequently, the ground amendments were added to the soil samples according to the concentrations used in the field trial (5 wt.%, 0.3 wt.% for lime) and re-wetted. The samples were incubated at room temperature for a few days and again air-dried. For titration, 500 ml ultrapure water was added to each 50 g sample and stirred in advance for 30 min using a magnetic stirrer. The samples were then kept constant at the initial pH of 5.2 and at pH of 3 in a second batch, for a total of 24 h by continuous addition of acid (0.2 M HCl) using an automatic titrator. During the experiment, 18 ml of sample was taken after 30, 60, 180, 360, and 1440 min, respectively. These samples were ultracentrifuged and the supernatant was analyzed for Cd, Zn, Ni, Cu by ICP-OES.

All amendments increased the ANC and decreased metal release upon acid addition. The most promising amendment for long term metal immobilisation was iron (hydr)oxide which reduced the release of heavy metals by one order of magnitude, and according to our predictions, should stabilize pH in the sewage field soil above 5.2 for 37 to 64 years. Further investigations on the binding forms of heavy metals have already been started (sequential extraction of heavy metals according to Zeien & Brümmer 1989). The evaluation of these data is currently in progress.