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Press Release

The changing climate could increase mobility of toxic metals in soils

University of Tübingen and Helmholtz Centre for Environmental Research (UFZ) team investigates the effects of rising temperatures and carbon dioxide levels on agriculture

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The changes scientists expect in the climate could cause the toxic metals naturally occurring in soils to become more mobile, destabilize ecosystems and increasingly enter the human food chain via agriculture. Such scenarios are particularly likely to occur in slightly acidic soils, which make up around two thirds of all soils. These are the conclusion of an experimental study on agricultural soils tested for the metal cadmium, which can cause cancer. The study was headed by assistant professor Marie Muehe from Plant Biogeochemistry at the University of Tübingen and the Helmholtz Center for Environmental Research (UFZ). The results have been published in the journal *Nature Communications Earth and Environment*.

By 2100, global temperatures are predicted to rise by two to four degrees compared to pre-industrial levels. In that time, the current carbon dioxide content of the atmosphere is expected to double. Here in Germany, the amount of precipitation could decrease slightly. Marie Muehe says the further effects are hard to predict: “Climate change and metals each separately place stress on the microorganisms in the soil, collectively referred to as the soil microbiome. We sought to investigate the previously little-known combined effects of these influences,” she says. There are toxic metals in every soil on our planet, says Muehe, but in bound form they are of little significance for soil organisms and plant cultivation. The situation changes when the metals are mobilized. “In our study, we examined cadmium, the classic example of a toxic metal found in the soil,” she says. Cadmium has a toxic effect on all living organisms because it inhibits physiological processes in the cells.

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Complex interactions

In the experiment, the research team filled columns with agricultural soil provided by various farms. “We ran these soils through a regular growing season in Germany in the laboratory, but under the assumed climate conditions of the year 2100,” explains the study's lead author Sören Drabesch, also from the University of Tübingen and the UFZ. “We investigated the changes in the soil and soil microbiome over time.”

The research team found that the mobility of the cadmium present in the soil will increase on today’s conditions by around 40 percent in slightly acidic soils in the summer temperatures of future climate conditions. “It can then be found in higher concentrations in the pore water of the soil and influences the soil microbiome, or the activity pattern of various microorganisms,” says Drabesch. “Certain microorganisms become more active, utilize more nitrogen and thus further acidify the soil environment.” In some soils, cadmium levels are set to rise to such an extent that the soil microbiome suffers and the ecosystem has to adapt. By contrast, no comparable problems were found in soils that were originally slightly alkaline. Even under changed climatic conditions, the cadmium was not mobilized to any great extent.

The study shows how complex the interactions are between the changing climate, the substances in the soil and the soil microbiome, says Muehe. “Ecosystems, including agricultural ecosystems, could be massively disturbed by increased amounts of mobile cadmium in the future. This could also change the greenhouse gas emissions caused by agriculture and the mobile cadmium could end up in crops which could then be harmful to human health.” These developments must continue to be monitored, the researchers say.

Soils naturally contain small amounts of metals such as cadmium. These could be mobilized to a greater extent in the future by a changing climate, thereby entering the human food chain via crop cultivation. Photos: Sören Drabesch

Publication:

Sören Drabesch, Oliver J. Lechtenfeld, Esmira Bibaj José Miguel Leon Ninin, Juan Lezama Pachecco, Scott Fendorf, Britta Planer-Friedrich, Andreas Kappler, E. Marie Muehe: Climate induced microbiome alterations increase cadmium bioavailability in agricultural soils with pH below 7. *Nature Communications Earth and Environment*, https://doi.org/10.1038/s43247-024-01794-w

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