Soil pollution surpasses climate change as top threat to underground biodiversity, study finds

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Soil organisms can live anywhere from the surface to much deeper below the soil, from millipeds like Polydesmus to insects and microbes. Credit: The Trustees of the Natural History Museum, London and Harry Taylor

Earthworms, insects and mites are all at risk from soil pollution, and scientists are worried that we know very little about the damage it's

causing.

New research published in the journal *iScience* found that soil pollution was the leading cause of declines among organisms living underground. The finding has surprised scientists, who expected farming intensification and climate change to have much greater impacts.

Dr. Victoria Burton, a co-author of the new research based at the Natural History Museum, says that the findings are "concerning."

"Above ground, land use, climate change and invasive species have the greatest impact on biodiversity, so we assumed that this would be similar below ground," Victoria says. "Our results show, however, that this isn't the case."

"Instead, we found that pesticide and heavy metal pollution caused the most damage to soil biodiversity. This is worrying, as there hasn't been a lot of research into the impacts of soil pollution, so its effects might be more widespread than we know."

"Amid concern over soil degradation, we need to investigate what impacts other sources of pollution, such as microplastics, hydrocarbons and persistent chemicals, are having on the life beneath our feet."

The secret life of soils

Compared to life above ground, what's living in soils is relatively unknown. This is because, in addition to the difficulty in finding the organisms that live down there, soil is actually made up of multiple habitats all sitting on top of each other.

"Soil isn't just a homogenous lump of dirt," Victoria says. "It's a complex environment containing many different structures, nutrients and

minerals. While the majority of life is found within 10 centimeters of the surface, some organisms can live much deeper."

"But with so few specialists who can identify subterranean organisms, we know much less about life below than above ground."

This means that when it comes to finding out how soil communities are faring, there are a lot of open questions. While it's known that habitat destruction and persecution are some of the biggest impacts on aboveground biodiversity, only a few studies have tried to tackle their subterranean equivalents.

To try and account for this in their new research, the team performed what is known as a meta-analysis. This is where scientists take data from many existing studies and re-analyze them to answer new questions that the original research didn't focus on.

For this meta-analysis, Victoria and the rest of her team reused the data of more than 600 studies, including thousands of different datapoints, to see what impact humans were having on the health of soils globally.

Digging into soil research

Based on their results, wildlife above and below ground generally respond very differently to the same issues.

While the loss of a forest above ground might be devastating to the plants and animals that live there, the researchers' predictions that subterranean organisms would also be affected weren't proven. Instead, it seemed that the soil provided a buffer, helping its organisms to be more resilient to certain changes.

"Soils can store moisture and nutrients, which can help life living

underground to withstand changes, at least in the short term," Victoria explains. "For instance, while climate change is affecting more and more species on the surface, its underground impacts appear to be limited for now."

"However, the effect of these impacts in the long-term is less well-known, meaning this buffering effect may only provide temporary relief for soil communities."

While the majority of the changes, like rising temperatures or chemical pollution, were negative for soil biodiversity, there were a few positives. The most important was the use of organic fertilizers and mulch, which introduces more carbon into the soil. This is especially beneficial for earthworms, which feed on the nutrients and cycle them in the soil.

Though this study has provided a deeper insight into the changes affecting soils, it's still barely scratched the surface. The team hope that future research will focus on how the interactions between factors like climate change and pollution, might enhance or limit their joint impacts

They also hope to get more people looking into soils. Victoria is keen to inspire the next generation of researchers while working with students as part of the National Education Nature Park, which is being led by the Natural History Museum.

"I'm excited to include soil biodiversity work within the National Education Nature Park," Victoria says. "It's a good opportunity to get young people excited about the life under their feet, and to get them interested in the life cycles of animals like craneflies and beetles which they might not know about."

"It's not just an opportunity to inspire them, but to do some important science that is currently being overlooked."

More information: Helen R.P. Phillips et al, Global changes and their environmental stressors have a significant impact on soil biodiversity—A meta-analysis, *iScience* (2024). DOI: 10.1016/j.isci.2024.110540

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