There's a climate bomb under your feet

By **Bloomberg News**
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In Photo: Forest-management project in Peru

Long before most people ever heard of climate change, scientists divided a patch of Harvard University-owned forest in Central Massachusetts into 18 identical 6-meter by 6-meter squares. A canopy of red maple and black oak trees hangs there, looming above the same stony soil tilled by colonial farmers. Rich in organic material, it was exactly what the researchers were looking for.

They broke the land up into six blocks of three squares each. In every block, one square was left alone, one was threaded with heating cables that elevated its temperature 9 degrees Fahrenheit (5 degrees Celsius) above the surrounding area. The third square was threaded with cables but never turned on, as a control.

That was 26 years ago. The purpose was to measure how carbon dioxide (CO_2) may escape from the Earth as the atmosphere warms. What they found, published on October 5 in the journal *Science,*may mean the accelerating catastrophe of global warming has been fueled in part by warm dirt.

As the Earth heats up, microbes in the soil accelerate the breakdown of organic materials and move on to others that may have once been ignored, each time releasing CO_2 into the atmosphere.

Extrapolating from their forest study, the researchers estimate that over this century the warming induced from global soil loss, at the rate they monitored, will be "equivalent to the past two decades of carbon emissions from fossil-fuel burning and is comparable in magnitude to the cumulative carbon losses to the atmosphere due to human-driven land use change during the past two centuries."

The good news, however, is that the research community is now fully on the case. Over the past week, at least four high-profile papers largely funded by the United States government have contributed new evidence, observations and insight into the role of soil and forests in the global carbon cycle—the flow of material in and out of land, air, life and sea that's currently broken and getting worse.

From a technical perspective, what they're talking about here is plain old dirt. Ground. Loam. Land. Trees and leaves.

From a practical perspective, it's something different entirely. Soil is also cotton, corn, soybean, wheat, oranges, cattle and the rest of humanity's food and fiber.

When it's healthy, it grows most everything we need. It absorbs and retains moisture that might otherwise flood valleys where people live. It also absorbs and retains carbon that might otherwise be heating up the atmosphere.

The atmosphere gets all the attention in climate change, mostly because that's where the warming happens.

Even the oceans draw more concern than soil, especially when their warming temperatures help fuel massive storms and floods that kill humans and destroy communities. The seas hold 60 times more carbon than the atmosphere and absorb more than 90 percent of the heat that industrial pollution generates.

The soil, meanwhile, has been mostly ignored until lately. It's both hugely influential on global warming and something humanity has a good deal of control over.

The top 3 meters or so of the Earth store more carbon than the entire atmosphere and all plants combined. Taking care of the planet's soil is "critical for stabilizing atmospheric CO_2 concentrations," according to a synthesis by Stanford University's Robert Jackson and five colleagues, published recently in *Annual Review of Ecology, Evolution and Systematics*.

Scientists aren't going to resolve the global carbon cycle down to the last atom soon. What the *Annual Review* authors do point out, though, is that land use and agricultural practices can simultaneously trap carbon in soil—helping the fight against warming—and improving yields for all the things humanity's swelling population will need in coming decades.

Reducing tillage and fallow time, managing grazing better, planting more legumes and other practices all help keep more carbon in the ground.

Back when the soil researchers were setting up their Harvard forest plots in 1991, Earth-system science and soil-health science were completely different fields. That's been changing in ways that should be encouraged, according to another report, in *Global Change Biology*, also published on October 5.

Binding scientists, policy-makers and landowners together in conversation could have a significant effect on reducing global CO_2, perhaps, offsetting projected emissions from thawing permafrost in the rapidly melting, high-latitude Northern Hemisphere.

The authors tout as a hopeful example the International Soil Carbon Network, a scientific initiative designed to pool data and identify gaps in monitoring and knowledge. "Soils have entered an 'anthropogenic state,' with most of the global

surface area either directly managed by humans or indirectly influenced by human activities," they write.

Warming soil may set off a chain reaction of carbon emissions that "could be very difficult, if not impossible, to halt."

The hopeful calls for collaboration laid out in the *Annual Review* and *Global Change Biology* must nevertheless be tempered by the steady drumbeat of off-putting news from other parts of the Earth science research community.

Late last month scientists from Woods Hole Research Center and Boston University published in *Science* an analysis of satellite data showing one of the most dramatic turnabouts in recent memory.

Long thought of as sponges that suck in CO_2 from the atmosphere, tropical forests may actually be a source of emissions. Deforestation is obviously an enemy of forests; what the authors found was that forest degradation—losing healthy patches here or there to human or natural causes—is more damaging to carbon-soaking capacity than previously believed.

The Harvard forest study leaves readers on a similarly thought-provoking note. The research itself found that soil loses its carbon in pulses of microbial activity.

Microbes feast away on organic matter in elevated temperatures, chewing it down to CO_2 and emitting it. Then the soil settles down to emission rates seen in unheated areas, the microbes having exhausted their food source. After a time, new microbes move into the heated patches and eat up harder-to-digest material, such as lignin, the stuff that makes wood hard. Then they, too, get sated and die off or move on, reducing emission rates with them.

Scientists have long been concerned that once humans kicked off warming of the atmosphere and seas, other parts of nature will take what we've begun and run

with it. Some things are in our control—land use, pollution from fossil-fuel combustion.

A global pulse in microbial carbon-munching, however, they write, "could be very difficult, if not impossible, to halt."

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