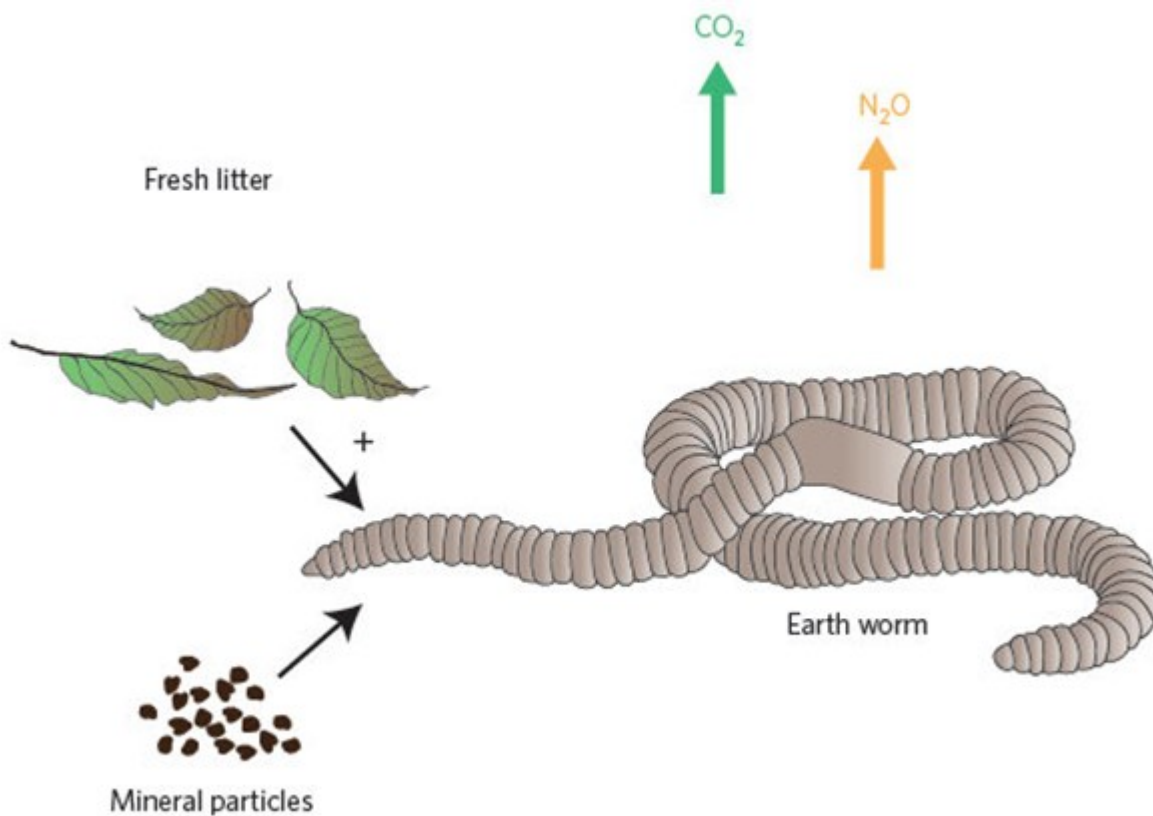


The modest earthworm plays a significant role in greenhouse gas pollution, much more than you would expect. Earthworms don't create a lot of pollution of their own. But the soil on which they live does, and worms play an important role in soil. Soil accounts for about 20% of worldwide carbon dioxide emissions and two-thirds of nitrous oxide emissions. Emissions are created by a variety of natural biological processes affecting plant roots and ground-dwelling microorganisms.

Soil ecosystem engineers are another name for earthworms. This is partly due to the fact that their burrowing changes the physical composition of the soil, making it more porous. Earthworms are also associated with bacteria that are responsible for the majority of CO<sub>2</sub> emissions. The amount of carbon dioxide released in the soil and how much escapes into the atmosphere are affected by the presence of worms. Earthworms increase greenhouse gas production, according to scientists, and their numbers are increasing.

Another potent greenhouse gas is nitrous oxide. Bacteria in the guts of earthworms emit nitrous oxide, which can be three times higher in worm-infested soil than in soil without worms. Isn't it amazing how far we've come in terms of studying the impact of earthworms on climate change?



However, the relationship between earthworms and climate change is very complex. Scientists have sometimes battled with a major problem of whether earthworms help increase or decrease the maximum carbon emissions produced by the soil, especially since research shows that worms increase soil emissions and help the soil store carbon for as long as possible efficiently. This major problem is what scientists call the Earthworm Dilemma.

However, more profound research revealed that earthworms in the soil increase the emissions of nitrous oxide by 42 percent and that of carbon by 33 percent. But their ability to increase emissions of one type of greenhouse gas while at the same time decreasing another helps to balance the greenhouse gas of soils all over the world. On the whole, worms only enhanced soil's global warming potential by 16 percent, according to the research. While earthworms are primarily beneficial to soil fertility, they inevitably increase greenhouse gas emissions.

According to recent research, the most common earthworms living in the top layer of soil are *Dendrobaena octaedra*. They consume leaves, crop waste, and other plant materials. Their droppings provide a feast for soil bacteria that produce nitrous oxide as they expel the remnants. The plant matter is then mixed with dirt by their digging and churning, where it decays and creates carbon dioxide. The more earthworms there are, the more plant debris is broken down faster, and the more carbon gets extricated into the atmosphere.

Organic fertilizers contribute to greenhouse gas emissions as well. This is because earthworms eat organic fertilizers, which impacts earthworm populations. As the use of organic fertilizers rises, so will the number of earthworms, which could be harmful to the world's atmosphere.

Joann K. Whalen, a professor in the department of natural resource sciences at Montreal's McGill University who studied earthworms for 20 years, said; "Earthworms can both be allies and enemies." In North America, forests are being attacked by invasive earthworms who eat up litter layers faster than the woods can regrow. As a result, some tree species may be unable to withstand a sudden loss of litter. These earthworms, in a sense, decide which trees will develop there in the future.

"We are losing the litter on the surface of the soil which has effects on future forest composition but a lot of that may be moving deeper into the soil and holding the carbon there," said Neher (Deborah Neher), a professor at the University of Vermont, in Burlington. Scientists claim that there are two types of earthworms. Some species potentially speed up climate change by feeding on leaves, then pooping out a mix that's fodder to tiny microbes and fungi that spew carbon into the atmosphere. On the other hand, other worms help lock

carbon in the soil by using their poop to bind it more tightly and make it harder for microbes to break down.

Apart from being responsible for nitrous oxide and carbon emissions, earthworms significantly impact soil structure, water flow, nutrient dynamics, and plant growth. According to Charles Darwin, Earthworms may transport vast volumes of soil from the lower strata to the top and organic matter down into deeper soil layers. Earthworms transfer a considerable amount of soil through their intestines, and in ten to twenty years, they can flip over the top six inches of soil.

Some worm species dig permanent holes deep into the earth, which can last long after the worm has died and serves as a key conduit for soil drainage, especially during severe rains. The holes also help to prevent surface water erosion. Other species burrow horizontally in the top several inches of soil, increasing overall porosity and drainage. Earthworms can also help with water retention. Earthworms can dramatically boost the water-holding capacity of soils by fragmenting organic materials and enhancing soil porosity and aggregation.

Earthworms are not the only ones causing greenhouse gas emissions. Human activities such as burning fossil fuels and deforestation are responsible for the great bulk of carbon dioxide in the atmosphere, which accounts for 60% of global warming from greenhouse gases. Many ideas have been offered by scientists to minimize greenhouse gas emissions. Many of these proposals call for carbon to be trapped in the soil, yet these little creatures have gotten ahead of us. According to new research, millipedes and oribatid mites' feces also convert carbon into a more decay-resistant form.

The impact that earthworms have on plants is not to be overlooked. According to Van Groenigen, if more plants grow due to earthworm fertilization, they consume carbon dioxide in their normal photosynthesis cycle, reducing greenhouse gas emissions. While worms contribute more to greenhouse gas emissions than previously assumed, they are unlikely to cause a global warming disaster. However, scientists are still conducting series of research to fully understand earthworms species and how they could contribute to climate change in the future.