

# I bet you didn't know

## *Soil fungi could reduce global warming*



Fig 1. Soil is essential for growing food.



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The impact of increasing carbon dioxide (CO<sub>2</sub>) in the atmosphere, mostly through burning fossil fuels, has and will continue to have a significant impact on all aspects of our lives.

**T**he Earth is warming at much higher rates than at any time in the past, leading to climate change. Could soil and the fungi that live within it be key players in reducing this impact? A team of research scientists, Luiz A. Domeignoz-Horta and co-workers, has recently shown that fungi play an important role in how much carbon (from CO<sub>2</sub> in the atmosphere) is stored in and released from the soil.

### Why is soil so important?

Many of us rarely think about the soil that is all around us, do we? What is it made of? What lives in it? Why is it important? What do we use it for (Figure 1), and how does it impact on our lives? However, this body of soil, known as the pedosphere, alongside the organisms that create it and live within it, could be an important factor in reducing climate change.

Soil is extremely complex. It is composed of eroded particles of rock, organic matter, minerals, gases, liquids, and a diversity of organisms. The organic matter is formed from the faeces (poo) of animals and decomposed plant matter. There are many different soil types based on the size of the soil particles, including peat, clay, chalky, loam, sandy, and silty soils. Different soils have different properties; for example, peat is made up of very old, decayed plants and is dark, crumbly and rich in nutrients.



Questions for children to consider:

**Which soils have you heard of?**

**What type of soil can you find near you?**

**Why do you think soil is important?**

Soil is vital in supporting life. It stores water, interacts with and modifies the Earth's atmosphere (see 'carbon cycle' below) and provides a variety of habitats for animals and plants.

Over recent years, the significance and importance of soil with respect to global warming has grown considerably. This is because soil stores carbon, holding three times as much carbon as the Earth's atmosphere. Soil is also responsible for removing 25% of the Earth's fossil fuel emissions each year. It can separate and store carbon for decades or much longer. By storing more carbon in the ground, the amount of  $\text{CO}_2$  in the atmosphere can be reduced. Atmospheric  $\text{CO}_2$  is important – it acts like a blanket around the Earth and stops heat from the sun escaping (Figure 2) - but the amount needs to be limited to prevent temperatures rising too much. With less  $\text{CO}_2$  in the atmosphere, the Earth warms at a slower rate.

## How does soil store carbon? The 'carbon cycle'

The carbon cycle is the process through which carbon-based substances are changed in the environment (Figure 3). Plants absorb  $\text{CO}_2$  (gas) from the atmosphere and use water and sunlight to turn the

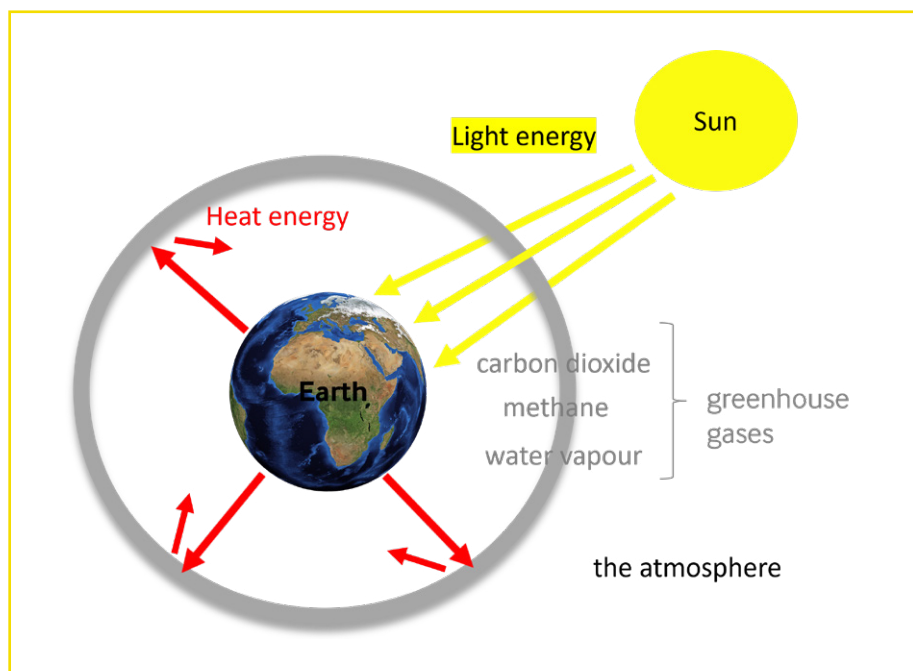


Figure 2. The Earth is getting warmer because gases in the atmosphere act like a blanket and stop heat escaping

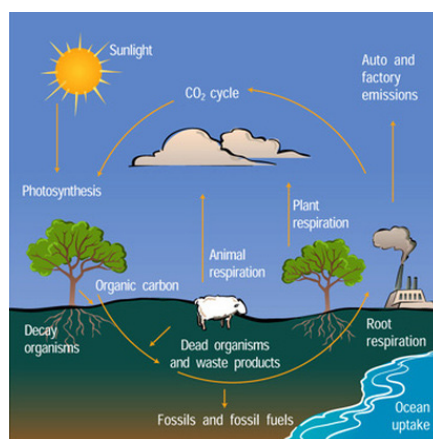


Figure 3. The carbon cycle

carbon into living tissue (leaves, stems, seeds and roots). This process is called photosynthesis and is effectively storing carbon in the plant. Animals eat plants to obtain energy to live. When plants and animals die, the carbon-based organic matter is consumed by decomposers in the soil (such as worms, bacteria and fungi). Some of this carbon is converted into materials in the soil. Over very long periods of time, these materials may become fossil fuels. When burned, the stored carbon is released back into the

atmosphere as  $\text{CO}_2$ . At each stage of the carbon cycle, living animals and plants respire, releasing  $\text{CO}_2$  to the atmosphere.

Plants also release carbon as a sugary substance through their roots to the soil. Microbes (bacteria, fungi, protozoa and nematodes) feed off the sugary substance produced, breaking it down into other carbon-based materials. Certain fungi, known as mycorrhizal fungi, produce special sticky compounds that help soil clump together. This is essential for the formation of humus, which protects the carbon within it for long term storage. The more fungi in the soil, the more clumping occurs, and the more carbon can be stored.

Human activity is disrupting the fragile balance of the carbon cycle. Burning fossil fuels releases more  $\text{CO}_2$  into the atmosphere and there are no longer enough trees or plants on Earth to remove the extra amount of  $\text{CO}_2$  being produced. Another means to remove the excess  $\text{CO}_2$  is necessary.



## What happens when soil is warmed up?

Due to increases in CO<sub>2</sub>, the Earth's temperature is predicted to rise by more than 1.5°C within the next 20 years. This will lead to increasing soil temperatures. Scientists predict that this will lead to an increase in bacteria that feed on the soil and respire, and the release of yet more CO<sub>2</sub> into the atmosphere.

Creating soils that can store more carbon could therefore be one answer to reducing CO<sub>2</sub> in the atmosphere. Luiz Domeignoz-Horta and his colleagues have shown that soil produced by specific groups of fungi and bacteria working together result in better carbon storage at higher soil temperatures. The scientists created their own soil to test. They separated bacteria and fungi from forest soil and grew them in petri dishes for 4 months. The microbes were fed on a simple diet of sugar and allowed to churn out soil. Finally, soil was heated to see how much CO<sub>2</sub> it produced. Bacteria-rich soils made more CO<sub>2</sub>; those with more fungi created less CO<sub>2</sub>.

This new study shows that fungi-rich soils grown in the lab release less CO<sub>2</sub> when heated than others. This suggests that fungi are particularly important in making soil that store more carbon.

The diverse communities of organisms that live in soil are also very important in the process of carbon storage. By understanding soil and the organisms that live within this most precious organic commodity, scientists hope that they will be able to create soils that store more carbon, and keep it there for centuries or even millennia, reducing CO<sub>2</sub> in the atmosphere and the rate of global warming.

The **Teacher Guide** that accompanies this article suggests how children could investigate different types of soils and find out more about organisms that live in soil.

### **The paper that inspired this work was:**

*Direct evidence for the role of microbial community composition in the formation of soil organic matter composition and persistence*

By Luiz A. Domeignoz-Horta<sup>1,2</sup>, Melissa Shinfuku<sup>1</sup>, Pilar Junier<sup>3</sup>, Simon Poirier<sup>4</sup>, Eric Verrecchia<sup>5</sup>, David Sebag<sup>4,5</sup> and Kristen M. DeAngelis<sup>1</sup>

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## Glossary

**carbon** – a simple chemical substance that exists in all plants and animals and is an important part of coal and oil

**carbon cycle** – the process by which carbon is continually transferred from the atmosphere to the earth and back again

**carbon dioxide** – a gas formed from carbon and oxygen

**climate change** – a long-term change in the average weather patterns on Earth

**decomposer** – an organism that breaks down dead organisms (and their waste) into the substances that plants need for growth; examples include fungi, earthworms, beetles and bacteria

**fossil fuel** – fuels containing carbon that have been created by natural processes, such as decomposing plants and animals, over millions of years; examples include coal, crude oil, natural gas and petrol

**global warming** – the long-term heating of Earth's surface observed since the pre-industrial period (between 1850 and 1900) due to human activities

**humus** – the dark, organic material in soil, formed when a plant or animal decays

**microbe/microorganism** – microscopic organisms (life forms) that can exist as a single cell or colony of cells; examples include bacteria and fungi

**minerals** – substances required by plants and animals in tiny amounts for various functions, for example calcium and copper

**mycorrhizal fungi** – fungi that form beneficial associations with plant roots in soil

**nutrient** – a substance that plants and animals need to survive, for example carbohydrates and proteins

**organism** – a living thing capable of a separate existence

**organic matter** – any material produced by a living plant or animal, such as leaves or dead animals

**pedosphere** – the uppermost layer of the Earth's surface, composed of soil and subject to change due to erosion by water and wind

**photosynthesis** – the process where plants use energy from the sun, with water and carbon dioxide, to create their own carbohydrate or food store