Soil water repellency could change soil’s ability to sequester carbon

Extreme events, such as droughts and prolonged dry spells, under climate change could increase the water repellency of soils, according to a recent study. In the long-term, this could reduce the capacity of soils to sequester carbon.

Soil can act as a carbon sink to offset climate change by removing carbon dioxide from the atmosphere. However, soil temperature and soil water content are strongly affected by climatic conditions. For example, under predicted future extreme events, such as extended dry spells, drought conditions and heat waves, higher soil temperatures and low soil water content could cause long lasting changes to water repellency of soils. Even when wetter climate conditions return, water repellent soils may not recover their earlier capacity to store water.

The study, conducted under the EU CARBOExtreme project¹, explored evidence into the effects of extreme climate events on soil repellency, and the implications for carbon sequestration. For water repellent soils, water cannot completely coat soil particles. Instead, the water forms beads on the surface of the soil particles, which changes the availability and distribution of water in the soil. This affects the behaviour of microbes that decompose organic matter in the soil, which is made of waxes and oils from fungi, microbes and decomposed plant material.

Soils in general are ‘wettable’ (non-water repellent) when they are moist. However, as soil dries out, there is a critical level of soil water content below which the soil becomes more water repellent. Further drying of the soil increases the water repellency to a maximum value. Dry soils will not be wettable again until the critical soil water content point is reached by adequate levels of water.

Higher temperatures are known to increase repellency, possibly through changes in the arrangement of organic matter in soil during the drying process, or through waxes from organic matter coating soil particle surfaces.

In drought conditions, more likely under climate change, repellency can potentially affect carbon stores in the soil. For example, a thin water-repellent layer can develop on the surface of the soil. This can cause rainwater to run off the soil surface and eventually find alternative places or means of infiltrating the soil.

On the one hand, lower levels of soil moisture associated with water repellent soils suggest microbial activity will be reduced and rates of carbon released from decomposition of soil organic matter will fall. This impact could be worsened by long lasting changes to water repellent properties, caused by drought, of some soils.

On the other hand, lower soil moisture levels would reduce the amount of water available to plants that draw down carbon dioxide from the atmosphere as they grow, thereby reducing plant productivity. In addition, changes to water flow in the soil caused by increased repellancy could encourage more drought tolerant species to grow. These types of plants generally contain more oils and waxes, and together with a shift towards a more drought-tolerant fungal soil community (from one dominated by microbes), could further increases repellancy.

It is thought that shorter term benefits of reduced microbial activity that enhance carbon sequestration could be outweighed in the longer term by reduced plant productivity that effects the potential of soils to act as a carbon sink.

1. CARBOExtreme is supported by the European Commission’s Seventh Framework Programme: www.carbo-extreme.eu


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Theme(s): Climate change and energy, Soil