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Loss of soil carbon linked to climate change in England and Wales

Soil and plants store around 5% of the world's carbon, but carbon storage in some soils is in decline. Recent research has found that climate change accounted for 9–22% of carbon declines in organic soils in semi-natural habitats throughout England and Wales from 1978–2003. The researchers say monitoring soils rich in carbon should be a priority to ensure that more carbon is not released to reinforce climate change.

Soils accumulate carbon through the decomposition of plant material and from carbon inputs like manure. Soils also release carbon as carbon dioxide and methane through root respiration and the breakdown of organic matter by microbes. The balance between carbon inputs and outputs determines whether the soil acts as a carbon sink or source.

Rising temperatures and altered rainfall patterns caused by climate change are expected to significantly affect soil processes. If warmer temperatures result in more carbon being lost from soils through respiration than is returned by decaying plant litter, a positive feedback cycle would further amplify the effects of climate change.

Two studies in England and Wales reached different conclusions about the impact of climate change on soil carbon concentrations. A 2005 study based on the National Soil Inventory of England and Wales (NSI) found a decline in soil carbon stocks between two survey periods (1978–1983 and 1995–2003). The study found that these losses were unrelated to land-use, which led the authors to suggest there was a link to climate change. However, a separate study in 2007 found no significant change in soil carbon concentrations in the UK between 1978 and 2007.

The present study used soil carbon levels from the first NSI survey to model changes in soil carbon concentrations during the second survey period.

The researchers used the same land-use categories from the original NSI studies, and distinguished between survey sites with organo-mineral/mineral soils and organic soils (which contain >150 g of carbon per kg of soil). They then related estimated changes in average rainfall and temperature, using the UK Meteorological Office's climate data, at each site between survey periods with modelled soil carbon concentrations.

The researchers found that climate change affected the two soils differently. Carbon changes in organo-mineral/mineral soils could be weakly linked to rainfall but not temperature changes, whereas carbon declines in organic soils were strongly related to rising temperatures but insensitive to changes in rainfall.

Only up to 5% of declining carbon concentrations predicted in organo-mineral/mineral soils in agricultural land could be linked to climate change. The researchers concluded that declining carbon concentrations in these soils are more likely the result of reduced carbon inputs due to a reduction in grazing cattle.

In contrast, 9–22% of carbon declines in organic soils in semi-natural habitats, such as bogs, could be attributed to climate change. The researchers found that, when temperatures increased, carbon changes in organic soils followed a similar pattern to bog vegetation changes.

Above an average annual temperature of 7°C, moss cover on temperate bogs with peat soils sharply declines and other plants, such as trees, grow more readily. The researchers suggest that warmer temperatures under climate change may induce plant cover changes, which alter the quality of plant litter, returning less carbon to the soil.

15 October 2015
Issue 431

Source: Barraclough, D., Smith, P., Worrall, F., Black, H.I.J. & Bhogal, A. (2015) Is there an impact of climate change on soil carbon contents in England and Wales? *European Journal of Soil Science*. 66: 451–462. DOI: 10.1111/ejss.12253

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These changes in plant cover could be responsible for the falls in carbon concentrations predicted in this study. For example, soil carbon concentrations in organic soils were stable at approximately 425 g/kg until temperatures reached 7°C, after which carbon levels fell as carbon dioxide would be released into the atmosphere.

The researchers say it is important to identify soils with carbon contents between 250 and 425 g/kg. These soils should be prioritised for surveillance to ensure that the carbon within them is not released, thereby contributing to climate change.

15 October 2015
Issue 431

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