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Soil wettability, moisture status and CO_2 flux in a long term drought and warming simulation experiment

Emilia Urbanek (1), Janina Bösken (2), Albert Titema (2), David Nunez Pastrana (3), and Bridget Emmett (3)

(1) Swansea University, Geography, Swansea, United Kingdom (e.urbanek@swansea.ac.uk), (2) Centre for Geo-ecological Research (ICG), Institute for Biodiversity and Ecosystem Dynamics (IBED), University of Amsterdam, Amsterdam, The Netherlands, (3) Centre for Ecology and Hydrology, Environment Centre Wales, Bangor, UK,

Current climatic predictions include altered rainfall patterns and increased temperatures which in consequence can enhance the development of soil water repellency (SWR; i.e. hydrophobicity). Soils may become more severely water-repellent or SWR may spread into the environments where it has not been observed before. As the soil moisture dynamics, including restricted infiltration and uneven distribution of water is severely altered in water-repellent soils, so might be the decomposition of organic matter and overall exchange of gases like CO_2 between the soil and the atmosphere.
Long-term climatic simulation study has been conducted for over a decade at upland heathland sites in Oldebroek (Netherlands) and in Clocaenog (UK) [1]. At each site nine 20 m2-large plots were selected and each three were subjected to: a drought effect created by a rainfall exclusion using an automatic self retracting waterproof curtains; a warming effect using a self retracting curtains reflecting infrared radiation overnight, and control plots. The soil at the sites was a peaty podzol and sandy podzol both highly prone to soil water repellency development. The sites were constantly monitored since the start of the experiment and the range of meteorological and environmental measurements included for example: soil moisture, temperature, vegetation and root zone changes, soil CO_2 flux. The observations of soil moisture content have shown that the soil moisture did not recover to the original values in the drought system even after the rainfall exclusion has been stopped for winter time, suggesting the development of soil water repellency [2]. The severe changes in moisture dynamics have also significantly affected the soil CO_2 flux.
The aim of the study was to investigate whether the long-term drought and warming treatments have any effect on the severity and persistence of SWR and how far the moisture changes and the SWR altered the CO_2 flux from these soils.
The measurements of the SWR, moisture and CO_2 have been conducted periodically over a summer season on both sites. Additional similar measurement have been conducted under constant laboratory conditions on samples collected from all plots.
The results available to date provide a strong indication that climatic conditions do affect the development of SWR and in consequence alter the soil carbon dynamics.

1. Beier, C., et al., Novel approaches to study climate change effects on terrestrial ecosystems in the field: drought and passive nighttime warming. Ecosystems, 2004. 7(6): p. 583-597.
2. Sowerby, A., et al., Contrasting effects of repeated summer drought on soil carbon efflux in hydric and mesic heathland soils. Global Change Biology, 2008. 14(10): p. 2388-2404.