Geophysical Research Abstracts
Vol. 19, EGU2017-14519-1, 2017
EGU General Assembly 2017

An integrated, cross-disciplinary study of soil hydrophobicity at atomic, molecular, core and landscape scales

G.Peter Matthews (1), Stefan Doerr (2), Geertje Van Keulen (3), Ed Dudley (3), Lewis Francis (3), Richard Whalley (4), Andrea Gazze (3), Ingrid Hallin (1), Gerry Quinn (3), Kat Sinclair (3), and Rhys Ashton (4)

(1) School of Geography Earth and Environmental Sciences, University of Plymouth, UK (pmatthews@plymouth.ac.uk), (2) Dept of Geography, Swansea University, Swansea, UK, (3) Medical School, Swansea University, Swansea, UK, (4) Rothamsted Research, Harpenden, UK

Soil hydrophobicity can lead to reduced soil fertility and heightened flood risk caused by increased run-off. Soil hydrophobicity is a well-known phenomenon when induced by natural events such as wildfires and anthropogenic causes including adding organic wastes or hydrocarbon contaminants. This presentation concerns a much more subtle effect – the naturally occurring changes between hydrophilic and hydrophobic states caused by periods of wetness and drought. Although subtle, they nevertheless affect vast areas of soil, and so their effects can be very significant, and are predicted to increase under climate change conditions.

To understand the effect, a major interdisciplinary study has been commissioned by the UK's Natural Environment Research Council (NERC) to investigate soil hydrophobicity over length scales ranging from atomic through molecular, core and landscape scale. We present the key findings from the many publications currently in preparation. The programme is predicated on the hypothesis that changes in soil protein abundance and localization, induced by variations in soil moisture and temperature, are crucial driving forces for transitions between hydrophobic and hydrophilic conditions at soil particle surfaces, and that these effects can be meaningfully upscaled from molecular to landscape scale.

Three soils were chosen based on the severity of hydrophobicity that can be achieved in the field: severe to extreme (natural rough pasture, Wales), intermediate to severe (pasture, Wales), and subcritical (managed research grassland, Rothamsted Research, England). The latter is already highly characterised so was also used as a control. Hydrophobic/ hydrophilic transitions were determined from water droplet penetration times.

Scientific advances in the following five areas will be described:
(i) the identification of these soil proteins by proteomic methods, using novel separation methods which reduces interference by humic acids, and allows identification by ESI and MALDI TOF mass spectrometry and database searches,
(ii) the examination of such proteins, which form ordered hydrophobic ridges, and measurement of their elasticity, stickiness and hydrophobicity at nano- to microscale using atomic force microscopy adapted for the rough surfaces of soil particles,
(iii) the novel use of a picoliter goniometer to show hydrophobic effects at a 1 micron diameter droplet level, which avoids the averaging over soil cores and particles evident in microliter goniometry, with which the results are compared,
(iv) measurements at core scale using water retention and wicking experiments, and
(v) the modelling and upscaling of the results from molecular to core scale using the PoreXpert void network model of dynamic wetting and Haines jumps.

An explanation will also be given as to how the results will be further upscaled by incorporation into the JULES hydrological model of the UK Meteorological Office, used to predict flooding for different soil types and usage.