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Models of facilitated transport of soil moisture through root systems

Andrew Mair[1], Lionel Dupuy[2,3], and Mariya Ptashnyk[1]
[1]Heriot-Watt University, Edinburgh, United Kingdom
[2]Department of Conservation of Natural Resources, Neiker, Bilbao, Spain
[3]IKERBASQUE, Basque Foundation for Science, Bilbao, Spain

Background - Plants grow complex root architectures to explore the soil volume and acquire water and nutrients. The growth of root systems affects the hydraulic properties of soil, and experimental investigations suggest that the hydraulic conductivity is significantly increased in vegetated soil with in comparison to a fallow soil. The mechanisms through which this occurs are not well characterised.

Material and Methods - In this work we propose a novel model for moisture transport through vegetated soil. The model reflects the hypothesis that water flow is a function of the direction of an incumbent root structure, and we use data from constant-head infiltration assays [1] to test hypotheses on the nature of water transport in the soil adjacent to plant roots.

Results - Results suggest that differences in hydraulic conductivity between vegetated and fallow soil may be due to preferential flow of moisture in the direction of plant roots.

Conclusion – The research therefore, confirms that root architectural parameters may play a determinant role in predicting water infiltration of vegetated soil. This could open new avenues of research to improve prediction and management of irrigation and flood defence.

[1] Leung, A. K., Boldrin, D., Liang, T., Wu, Z. Y., Kamchoom, V., & Bengough, A. G. (2018). Plant age effects on soil infiltration rate during early plant establishment. Géotechnique, 68(7), 646-652.

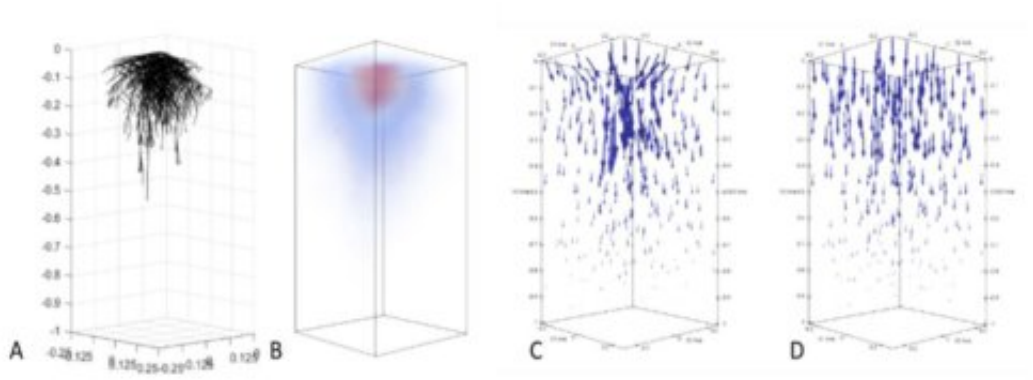

Figure 1 Simulation of water infiltration in vegetated and non-vegetated soil. (A) Simulated root system. (B) Construction of oriented root volumetric density used for computation of facilitated transport. (C) Water fluxes within the root system. (D) Water fluxes in fallow soil.