Geophysical Research Abstracts
Vol. 17, EGU2015-8507, 2015
EGU General Assembly 2015

Smart plants, smart models? On adaptive responses in vegetation-soil systems

Martine van der Ploeg (1), Ryan Teuling (2), Nicole van Dam (3,4), and Gerrit de Rooij (5)

(1) Wageningen University, Environmental Sciences, Soil Physics and Land Management, Wageningen, Netherlands (martine.vanderploeg@wur.nl), (2) Wageningen University, Environmental Sciences, Hydrology and Quantitative Water Management, Wageningen, Netherlands, (3) German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, Germany, (4) Radboud University, Faculty of Science, Molecular Interaction Ecology, Netherlands, (5) Centre for Environmental Research GmbH - UFZ , Halle, Germany

Hydrological models that will be able to cope with future precipitation and evapotranspiration regimes need a solid base describing the essence of the processes involved [1]. The essence of emerging patterns at large scales often originates from micro-behaviour in the soil-vegetation-atmosphere system. A complicating factor in capturing this behaviour is the constant interaction between vegetation and geology in which water plays a key role. The resilience of the coupled vegetation-soil system critically depends on its sensitivity to environmental changes.
To assess root water uptake by plants in a changing soil environment, a direct indication of the amount of energy required by plants to take up water can be obtained by measuring the soil water potential in the vicinity of roots with polymer tensiometers [2]. In a lysimeter experiment with various levels of imposed water stress the polymer tensiometer data suggest maize roots regulate their root water uptake on the derivative of the soil water retention curve, rather than the amount of moisture alone.
As a result of environmental changes vegetation may wither and die, or these changes may instead trigger gene adaptation. Constant exposure to environmental stresses, biotic or abiotic, influences plant physiology, gene adaptations, and flexibility in gene adaptation [3-7].
To investigate a possible relation between plant genotype, the plant stress hormone abscisic acid (ABA) and the soil water potential, a proof of principle experiment was set up with Solanum Dulcamare plants. The results showed a significant difference in ABA response between genotypes from a dry and a wet environment, and this response was also reflected in the root water uptake.
Adaptive responses may have consequences for the way species are currently being treated in models (single plant to global scale). In particular, model parameters that control root water uptake and plant transpiration are generally assumed to be a property of the plant functional type. Assigning plant functional types does not allow for local plant adaptation to be reflected in the model parameters, nor does it allow for correlations that might exist between root parameters and soil type.

[1] Seibert, J. 2000. Multi-criteria calibration of a conceptual runoff model using a genetic algorithm. Hydrology and Earth System Sciences 4(2): 215-224.
[2] Van der Ploeg, M.J., H.P.A. Gooren, G. Bakker, C.W. Hoogendam, C. Huiskes, L.K. Koopal, H. Kruidhof and G.H. de Rooij. 2010. Polymer tensiometers with ceramic cones: performance in drying soils and comparison with water-filled tensiometers and time domain reflectometry. Hydrol. Earth Syst. Sci. 14: 1787-1799, doi: 10.5194/hess-14-1787-2010.
[3] McClintock B. The significance of responses of the genome to challenge. Science 1984; 226: 792-801
[4] Ries G, Heller W, Puchta H, Sandermann H, Seldlitz HK, Hohn B. Elevated UV-B radiation reduces genome stability in plants. Nature 2000; 406: 98-101
[5] Lucht JM, Mauch-Mani B, Steiner H-Y, Metraux J-P, Ryals, J, Hohn B. Pathogen stress increases somatic recombination frequency in Arabidopsis. Nature Genet. 2002; 30: 311-314
[6] Kovalchuk I, Kovalchuk O, Kalck V., Boyko V, Filkowski J, Heinlein M, Hohn B. Pathogen-induced systemic plant signal triggers DNA rearrangements. Nature 2003; 423: 760-762
[7] Cullis C A. Mechanisms and control of rapid genomic changes in flax. Ann. Bot. (Lond.) 2005; 95: 201-206