Geophysical Research Abstracts
Vol. 17, EGU2015-8271, 2015
EGU General Assembly 2015

Preferential and biomat flow mechanisms identified from staining experiments in forested hillslopes: from pore to plot-scale

Kirill Gerke (1), Roy Sidle (2), and Dirk Mallants (1)

(1) CSIRO Land and Water, Adelaide, Australia (cheshik@yahoo.com), (2) University of the Sunshine Coast, Sustainability Research Centre, Australia

Field staining experiments in five different plots at two sites in Japan (Okaya in Nagano Prefecture and Konohara in Mie Prefecture) were undertaken to improve understanding of subsurface stormflow runoff within organic layers of natural forested hillslopes. This type of shallow lateral subsurface flow, specifically referred to as biomat flow, was observed only at the Okaya site based on staining experiments conducted under controlled water application rates. When the same irrigation rate was applied to the Konohara site, overland flow without a significant shallow subsurface component was the dominant flow mechanism. Even in gently sloping (15-20°) forest soils at the Okaya site, biomat flow was responsible for lateral dye transport over much longer distances than sub-surface flow in the matrix of mineral soil layers. Based on analysis of staining pattern images observed in the Okaya site we conclude that: (i) the organic biomat layer could be divided into two sub-layers of different structure; (ii) biomat flow transported the dye tracer longer distances than subsurface flow in the matrix; and (iii) the biomat layer topography affected biomat flow by generating preferential flowpaths and subsequent percolation into the deeper soil. Based on field experimental results and pore-scale consideration of water infiltration into pores of soils with varying wettability properties, we hypothesized and developed a conceptual model for two key biomat flow mechanisms. The first mechanism considers lateral subsurface flow due to a permeability contrast between the much more porous and hence permeable biomat layer and the underlying mineral soil. The second mechanism involves a hydrophobic soil layer between the biomat and the underlying mineral soil. Flow across the hydrophobic layer is believed to occur when a threshold pore pressure is exceeded, i.e. as a result of a perched water table within the biomat layer. Lower pore pressures are needed to initiate flow when preferential flow paths exist that are less hydrophobic than the surrounding organic layers. Numerical models of catchment hydrology should include lateral biomat flow when such layers are present in hillslope soils, in addition to typical subsurface flow within the soil matrix.

This work was partially supported by RSF grant 14-17-00658 (pore-scale modelling) and RFBR grants 13-04-00409-a and 13-05-01176-a.