Geophysical Research Abstracts
Vol. 17, EGU2015-9528, 2015
EGU General Assembly 2015

Evolution of hydrological pathways in engineered hillslopes due to soil and vegetation development

Willemijn M. Appels (1), Andrew M. Ireson (1), Jeffrey J. McDonnell (1), and S. Lee Barbour (2)

(1) University of Saskatchewan, Global Institute for Water Security, Saskatoon, Canada, (2) University of Saskatchewan, College of Engineering, Saskatoon, Canada

The structure and hydraulic properties of soils and bedrock within a hillslope combined with the timing and rates of water availability control the partitioning of precipitation into vertical and lateral flowpaths. In natural hillslope sites, heterogeneity in both soil texture and structure are the result of long-term landscape evolution processes and consequently can be assumed to be static relative to the timescale of rainfall-runoff processes. However; engineered hillslopes, constructed commonly as reclamation covers overlying mine waste, have been observed to undergo rapid changes in hydraulic properties over relatively short timescales (i.e. 3-5 years) as a result of weathering (e.g. freeze-thaw and wet-dry cycles) and vegetation growth (e.g. increasing rooting depth and density). Rainfall-runoff responses on such hillslopes would therefore not only be expected to reflect seasonal dynamics, but also the evolution of the system from a relatively homogeneous initial condition to a system with increasing heterogeneity of soil texture and structure.

We present results of a combined field and modeling study of three prototype soil covers on a saline-sodic shale overburden dump at the Syncrude Canada Ltd. Mildred Lake mine, north of Fort McMurray, Canada. Since their construction in 1999, soil properties, hydrological response to atmospheric and vegetative demands, and vegetation properties have been extensively monitored. The three covers have undergone substantial evolution due to freeze-thaw processes and aggrading vegetation.

In this work, we quantify hydrological processes in the reclamation covers, focusing on inter- and intra-annual patterns. To this purpose we analyzed the long-term hydrometric data with field sampling of the distribution of salts and the stable isotopes of water within soil water and subsurface flow in the base of the cover. We use a 2D Hydrus model to explore the co-evolution of soil and vegetation and quantify its effect on flow partitioning and salt movement from the overburden into the soil.