Geophysical Research Abstracts
Vol. 17, EGU2015-5024, 2015
EGU General Assembly 2015

Revealing the mechanisms and significance of frozen soil infiltration

Manfred Stähli (1) and Masaki Hayashi (2)

(1) Swiss Federal Research Institute WSL, Mountain Hydrology and Mass Movements, Birmensdorf, Switzerland (manfred.staehli@wsl.ch), (2) Department of Geoscience, University of Calgary, Calgary, Alberta, Canada (hayashi@ucalgary.ca)

Frozen soil is one of the most characteristic features of Nordic hydrology. Depending on climate, snow cover and soil properties it can slow down or even inhibit the water's journey from the soil surface to the stream, or it can speed up the journey by generating overland flow. When Harald Grip's and Allan Rhode's book came out in the mid-eighties, state-of-the-art knowledge on frozen soil hydrology was based on numerous cold-chamber experiments and only few field measurements, especially from Alaska. It was already then recognized that frozen soil is not impermeable per se, but its permeability depends on the amount and connectivity of air-filled pores, which in turn depends on ice content. How has our understanding of frozen soil hydrology further developed since then? One important innovation was the application of dye tracers to frozen field plots and soil columns uncovering the flow paths of infiltrating water. A second crucial advance was the development of numerical models to calculate water transfer from the snow cover into soil profiles. These models made researchers aware of the high sensitivity of frozen soil infiltration to boundary conditions (e.g. depth to groundwater) and winter history (e.g. evolution of snow cover, number of mid-winter melt events). A further important insight was that local effects of frozen ground on water flow may vanish at the scale of catchments due to the highly variable topography, vegetation and soil of a landscape. Nevertheless, studies showing the impact of frozen soil on large scale ground-water recharge or stream runoff are still scarce. A recent analysis of long-term runoff data from Switzerland sheds new light on the response of small catchments to frozen ground. Finally, it can be concluded that the Nordic lessons on frozen soil hydrology have been noted by the worldwide research community and are receiving increased attention in the context of climate change and its impacts on seasonally and permanently frozen soil.