Geophysical Research Abstracts
Vol. 15, EGU2013-2906, 2013
EGU General Assembly 2013

Analysis of heterogeneous hydrological properties of a mountainous hillslope using intensive water flow measurements

Naoya Masaoka (1), Ken'ichirou Kosugi (1), Yosuke Yamakawa (1), Takahisa Mizuyama (1), and Daizo Tsutsumi (2)

(1) Lab. of Erosion Control, Graduate school of Agriculture, Kyoto Univ., Kyoto, Japan (hatiemon@kais.kyoto-u.ac.jp), (2) Hodaka Sedimentation Observatory, Disaster Prevention Research Institute, Kyoto Univ., Gifu, Japan (tsutsumi.daizo.8m@kyoto-u.ac.jp)

Heterogeneous hydrological properties in a foot slope area of mountainous hillslopes should be assessed to understand hydrological phenomena and their effects on discharge and sediment transport. In this study, we analyzed the high-resolution and three-dimensional water movement data to clarify the hydrological process, including heterogeneous phenomena, in detail. We continuously monitored the soil matric pressure head, psi, using 111 tensiometers installed at grid intervals of approximately 1 meter within the soil mantle at the study hillslope. Under a no-rainfall condition, the existence of perennial groundwater seepage flow was detected by exfiltration flux and temporal psi waveforms, which showed delayed responses, only to heavy storm events, and gradual recession limbs. The seepage water spread in the downslope direction and supplied water constantly to the lower section of the slope. At some points in the center of the slope, a perched saturated area was detected in the middle of soil layer, while psi exhibited negative values above the bedrock surface. These phenomena could be inferred partly from the bedrock topography and the distribution of soil hydraulic conductivity assumed from the result of penetration test. At the peak of a rainfall event, on the other hand, continuous high pressure zones (i.e. psi > 50 cmH_2O) were generated in the right and left sections of the slope. Both of these high pressure zones converged at the lower region, showing a sharp psi spike up to 100 cmH_2O. Along the high pressure zones, flux vectors showed large values and water exfiltration, indicating the occurrence of preferential flow. Moreover, the preferential flow occurred within the area beneath the perched water, indicating the existence of a weathered bedrock layer. This layer had low permeability, which prevented the vertical infiltration of water in the upper part of the layer, but had high permeability as a result of the fractures distributed heterogeneously inside the layer. These fractures acted as a preferential flow channel and flushed the water derived from lateral flow accumulated from the upslope area during the rainfall event. These phenomena occurring at the peak of rainfall event could not be inferred from the parameters derived from the penetration test.