Method for measuring the pore air pressure in the mountainous slope for rainfall-runoff processes research

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Many researches have been conducted to clarify the mechanism of rainfall-runoff process in a forested catchment in humid warm-temperate regions. Some results obtained from hydrograph separation using isotopic tracer showed that stream discharge is mainly composed of pre-event old water rather than new water (rainwater). Since the 1980’s, the important issue in rainfall-runoff process studies has been solving how pre-event old water stored in the slope discharge in rapid response during rainstorm event. After 1990’s the role of bedrock groundwater contribution to rainfall-runoff process became to be illustrated. Iwagami et al. (2010) described the contribution of bedrock groundwater during rainfall events in a headwater catchment, however there were some large scale events which were not enough to be explain by the bedrock groundwater contribution. Further possible ideas to explain the rapid outflow of pre-event old water might be effect of pressure wave (Torres et al., 1998) and effect of entrapped air (Marui et al., 1993; Delfs et al., 2013).
Role of pore air effects (e.g., entrapped air and, pressure wave) on rainfall-runoff process are pointed out by previous studies however field evidence of pore air behavior or pore air pressure in the slope scale are still lacking. Also method for pore air pressure observation is not established and not discussed fully. In present study, in order to investigate the behavior of pore air under mountainous slopes, measurements of pore air pressure were conducted at two small headwater catchment in Hitachi Ohta Experimental Watershed and Tsukuba Experimental Watershed, Ibaraki Prefecture, Japan. We measured pore air pressure by detecting the inner pressure of borehole and piezometer. Focusing on the pressure difference between pore air and atmosphere (hereafter we call this as “pressure gap”), it is expected that during a dry period (not during rainfall and ground surface is unsaturated), shallow pore air pressure in the slope is almost at equilibrium state with the atmospheric pressure and the pressure gap might be zero. On the other hand, when the pressure gap was raised remarkably during the rainfall event, pore air is supposed to be entrapped and compressed by infiltrating rainwater (wetting front) and groundwater table (or underlying low permeability layer). During the observation from July 2018 to January 2019, pressure gap rising event have observed in both sites. Also negative pressure gap was observed after the pressure gap rising event. Further observation studies are needed for understanding the effect of entrapped air to rainfall-runoff process which could potentially contribute to the prediction of flash flood or corresponding slope instability.

Keywords: Rainfall-runoff processes, pore air, entrapped air, pressure gap

