Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)
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AGE04-04 会場:102B 時間:5 月 20 日 15:00-15:15

斜面地下水中の圧力伝播機構に関する研究
Mechanism of water pressure propagation in the hillslope aquifer

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In hillslope hydrology, saturated lateral flow along soil-bedrock interface greatly contributes to the increase in rainfall runoff volume[1)]. van Meerveld and McDonnell (2006) reported interesting phenomena that during rainfall, groundwater level at the upslope wells responded earlier than that sited downslope, and traveling velocity of peak water level between the wells was about ten times as fast as pore water velocity[2)]. Various theories have been proposed to explain rapid water movement in soil and quick runoff response (macropores and soil pipes, translatory or piston flow, groundwater ridge and so on). However, difference between traveling velocity of peak water level and pore water velocity is not clarified sufficiently. The objective of this study is to clarify the mechanism of the peak water level traveling through the slant aquifer by the model experiment and numerical analysis.

We packed toyoura sand homogeneously to form a model slope of 210 cm long, 100 cm high and 5 cm wide, with a reservoir at the upslope boundary, and an outlet at the downslope end. Nine tensiometers were inserted to monitor reservoir water level and groundwater level. Tipping bucket was used to measure flow rate from the outlet. First, we kept reservoir water level constant in order to make steady state water flow in the slope. Then, we added water to the reservoir to simulate groundwater level fluctuation. In the numerical analysis, we tried to reproduce the model experiment using HYDRUS-2D, which simulated two dimensional water movement through soil in the model slope and reservoir. Reservoir water level was controlled by the water flux boundary condition (BC) at the top of the reservoir. Downslope outlet was assigned as seepage face BC, and the other boundary surrounding the model slope was no flux BC. Soil hydraulic function was described by the van Genuchten-Mualem model.

As soon as reservoir water level rose, all the tensiometers and flow rate at downslope outlet responded simultaneously. This result means that fluctuation of groundwater level in part may influence groundwater level of whole aquifer. Groundwater level peak occurred at upslope and transferred to downslope, and maximum discharge was observed just after the groundwater level peak at the vicinity of the downslope outlet was detected. Traveling velocity of peak water level was 5-35 times as fast as pore water velocity. As packed toyoura sand was a homogeneous medium, translatory flow could explain the difference between traveling and pore water velocity. Numerical simulation quantitatively reproduced amplitude of the groundwater level fluctuation, but time required to transfer the fluctuation toward downslope part was overestimated. In conclusion, translatory flow might play an important role in the rapid traveling of peak water level. Quantitative discussion of traveling of peak water level in aquifer is important to understand quick runoff from hillslope at the rainfall event.

References 1) van Meerveld and McDonnell. 2006. *Water Resour. Res.* 42 W02410, 2) van Meerveld and McDonnell. 2006. *Water Resour. Res.* 42 W02411

Keywords: groundwater level, traveling velocity