Estimation of Groundwater Flow using Self-potential Measurements in Hillslopes

Yutaka Abe[1], Tada-nori Goto[2], Kazuya Kondo[3], Maki Tsujimura[4]

[1] Geo-Environmentai Sci., Life and Environmental Sci., Univ. of Tsukuba, [2] JAMSTEC, [3] Dept. Environ. Earth Sci., Aichi Univ. Educ., [4] Inst. of Geosci., Univ. of Tsukuba

This study aims to investigate the relationship between the self-potentials on the soil surface and the subsurface flow process quantitatively in the hillslope. We performed measurement of the self-potentials on the soil surface and hydrometric observation and laboratory experiments using column to evaluate the gradient of self-potentials and soil water flux.

Self-potentials have a clear correlation with the soil storage, the depth of the groundwater table and the groundwater flux. A clear positive correlation between self-potential and hydraulic gradient of groundwater was observed in the fields and laboratory experiment. This suggests that it is possible to estimate quantitatively the groundwater flow using self-potential measurement in the hillslopes.

It has been proposed recently subsurface flow process through soil layer and bedrock is the key to investigate rainfall-runoff process in mountainous watershed.

In the field of geophysics, several information about underground have been taken by measuring self-potentials or resistivities on the ground surface. It has been recognized that self-potential measured for observation of volcanic movement and earthquake seemed to include some noises of groundwater flow (Sasaki et al., 1997). This suggests that it is possible to get the information of subsurface flow process by measuring self-potential. Therefore, this would be a new method for hillslope hydrology.

This study aims to investigate the relationship between the self-potentials on the soil surface and the subsurface flow process quantitatively in the hillslope, and to discuss the possibility that the method of measuring the self-potentials could be applied to rainfall-runoff process studies in the headwater catchments. Measurement of the self-potentials on the soil surface and hydrometric observation were performed on slopes in Kawakami Experimental Basin, Nagano prefecture. Also, laboratory experiment was performed using column to evaluate the gradient of self-potentials and soil water flux.

The self-potential showed a considerable decrease near the divide, then increased gradually down to the foot of the hillslopes. This profile was also observed on the other basins. Therefore, this would be common for the self-potentials profile on the slope from the top of the mountain.

Self-potentials have a clear correlation with the soil storage near the divide of the mountain, whereas there is less correlation in the down-slope. Also the self-potential shows a positive correlation with the depth of the groundwater table.

Higher self-potential values were observed in the region where groundwater flowed upward, whereas lower self-potential values were observed in the region with downward groundwater flux.

A clear positive correlation between self-potential and hydraulic gradient of groundwater was observed in the fields and laboratory experiment. This suggests that it is possible to estimate quantitatively the groundwater flow using self-potential measurement in the hillslopes.