Geoelectrical monitoring of changes in water content in an embankment using a large-scale rainfall simulator

*Shinichi Takakura[1], Mayumi Yoshioka[1], Naoki Sakai[2], Tomohiro Ishizawa[2], Toru Danjo[2]

1. National Institute of Advanced Industrial Science and Technology, 2. National Research Institute for Earth Science and Disaster Resilience

Measuring the temporal variation of water content in a slope is important for preventing slope disasters. We conducted repeated monthly geoelectrical surveys since February 2011 on one slope of an embankment in the large-scale rainfall simulator of the National Research Institute for Earth Science and Disaster Resilience (NIED). A survey line, which is 18m in length, was set up across the slope. Thirty-seven electrodes were arranged permanently at 0.5-m intervals along the line. Measurements of near-surface soil water content and temperature have been conducted at five places along the line. The embankment is usually outdoors and observations in natural weather have been performed. The results of the repeated geoelectrical surveys show that short-term changes in resistivity correspond to changes in water content caused by rainfall.
In order to confirm the changes in resistivity and water content by rainfall in detail, we conducted the artificial rain experiments, controlling the total amount and intensity of rainfall using the mobile simulator. Eleven experiments were conducted in 2012, 2013, 2014. It was difficult to obtain the rapid change of resistivity structure due to the heavy artificial rain with ordinary geoelectrical equipment, because the analysis of resistivity structure requires measurement by much electrode array combination. In these experiments, therefore, we performed only a continuous measurement using a Wenner array with “a” spacing of 0.5 m and 1 m. The apparent resistivities changed significantly with a rapid change in water content, indicating that geoelectrical monitoring is effective in assessing the condition of a slope during rainfall.
In three experiments in 2015, we used a high-speed resistivity profiling system which can provide 576 (24x24) data in about 10 seconds for the resistivity monitoring. The pole-pole resistivity data were collected at intervals of 1 or 2 minutes and a series of resistivity sections were obtained along the slope of the embankment. The result shows that the high-speed geoelectrical monitoring is effective for observing soil moisture changes caused by heavy rain in real time.

Keywords: Geoelectrical monitoring, resistivity, water content, large-scale rainfall simulator, slope disaster

