Geophysical Research Abstracts
Vol. 12, EGU2010-6439, 2010
EGU General Assembly 2010

Self-Potential Approach to Rainfall-induced Landslide Early Warning

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Rainfall-induced landslides often cause catastrophic disasters. In order to mitigate the disasters, monitoring and forecasting of the landslides are important. There are hydraulic and geotechnical knowledge prior to a landslide based on the indoor and outdoor experiments. They are based on measurements of pore pressure and soil displacement using gaugemeters and CCD video cameras. The obtained facts are as follows; (1) development of the saturated area under the surface, (2) direction of the filtration of water changes from vertical to lateral to the slope, and (3) beginning of the apparent soil displacement about a few tens minutes before the catastrophic slide. On the other hand, the geophysical exploration method is one of powerful tools for subsurface monitoring such as electrical resistivity. The electrical resistivity tomography (ERT) approach shows the slip surface precisely and continuous measurements of resistivity could be helpful to identify the water condition under the ground. Self-potential (SP) method is also applicable to monitor underground fluid motion based on the electro-kinetic effect. Laboratory experiments and geothermal applications show the high capability to detect subsurface water motion. ERT method requires electrical power for operation. On the other hand, SP method is passive measurement and simple in comparison with ERT method. Revil and Hermitte (2002) performed the sandbox experiment and found the good correlation between SP and hydraulic head variations. Revil et al. (2003) also demonstrated the relation between water table and SP based on the pumping well experiments and the volcanic data. Suski et al. (2004) presented the electro-kinetic coupling parameter C' using pumping experiments in the sandbox.
The purpose of this paper is to apply SP approach to develop an early warning system of rain-fall induced landslides. In this aim two kinds of experiments have been performed. One is the indoor rain-fall induced landslide experiment and the other is the sandbox experiment. The same soil is used for both experiments. In the indoor landslide experiment, pore pressure, soil displacement and SP variations have been observed and investigated their relationships. In the sandbox experiment, Suski's method has been applied to obtain the electro-kinetic coupling coefficient C'. The SP variations observed in the indoor landslide experiment have been evaluated with C' quantitatively. This paper presents a capability of SP approach to monitor underground water condition and establish an early warning system of landslides.