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Development and application of Automated Debris-flow Monitor System in Taiwan

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This paper introduces the ten automated debris-flow monitor stations in Taiwan established by Soil and Water Conservation Bureau (SWCB). The purpose of setting up these stations is to collect local field data of debris flows. These real-time data may help us to understand the physical mechanism of debris flows and to improve the accuracy of the current debris-flow warning model based on rainfall thresholds. Besides, these data can be utilized as references for designing debris flow disaster prevention constructions and for academic research.

Each debris-flow monitor station consists of the monitor equipments, the front data-receiving center, the medium transmission system, the back data-processing system and the web-based real-time display system. The monitor instruments include rain gauges, CCD cameras, wire sensors, geophones and ultrasonic airborne level meters. The operation of the system is in “normal mode” with lower sampling rate in usual times. When the rainfall exceeds specific threshold in field, the whole system will automatically switch to “event mode” with a higher sampling rate. In event mode, all the collected data will be transmitted to SWCB Debris Flow Emergency Response Center promptly as information for decision-making. Besides, specialists who are on duty in SWCB can change the operation mode and operate some on-the-spot instruments through remote control module. The system is a “half-opened” one designed to expand for the further necessities in the future in order to integrate the precious resources.

During the Mindulle typhoon period in July 2004, the first debris flow event was monitored since the automated debris flow monitor system has been established from

2001 in Taiwan. The observation data shows that the discharge of the river decreased abruptly just before the debris flow surge appeared. Big boulders gathered at the front surges of debris flows and formed the wavy shape on the surface. The velocity of debris-flow front was about 10—13 m/s. The depth of the front surge was estimated from 5.5 to 6 meters and the maximum diameter of the boulders in debris was from 4 to 5 meters. The average depth of the debris-flow surge was about 2 meters and the moving process of debris flows lasted for about 5 minutes. The Fast Fourier Transform (FFT) was adopted to analyze the ground vibration signals detected by geophones. The frequency range of ground vibration generated by debris flows was between 2 to 150 Hz and mainly between 5 to 50 Hz. The superior frequency appeared at 20 Hz and belongs to the lower frequency range relatively. Different locations of geophones would strongly affect the amplitude of ground vibration caused by debris flows.