Performance Analysis of a Citywide Real-time Landslide Early Warning System in Korea

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Rainfall-induced landslide has been one of the major disasters in Korea since the beginning of 21st century when the global climate change started to give rise to the growth of the magnitude and frequency of extreme precipitation events. In order to mitigate the increasing damage to properties and loss of lives and to provide an effective tool for public officials to manage the landslide disasters, a real-time landslide early warning system with an advanced concept has been developed by taking into account for Busan, the second largest metropolitan city in Korea, as an operational test-bed. The system provides with warning information based on a five-level alert scheme (Normal, Attention, Watch, Alert, and Emergency) using the forecasted/observed rainfall data or the data obtained from ground monitoring (volumetric water content and matric suction). The alert levels are determined by applying seven different thresholds in a step-wise manner following a decision tree. In the pursuit of improved reliability of an early warning level assigned to a specific area, the system makes assessments repetitively using the thresholds of different theoretical backgrounds including statistical(empirical), physically-based, and mathematical analyses as well as direct measurement-based approaches. By mapping the distribution of the five early warning levels determined independently for each of tens of millions grids covering the entire mountainous area of Busan, the regional-scale system can also provide with the early warning information for a specific local area. The fact that the highest warning level is determined by using a concept of a numerically-modelled potential debris-flow risk is another distinctive feature of the system. This study tested the system performance by applying it for four previous rainy seasons in order to validate the operational applicability. During the rainy seasons of 2009, 2011, and 2014, the number of landslides recorded throughout Busan's territory reached 156, 64, and 37, respectively. In 2016, only three landslides were recorded even though the city experienced a couple of heavy rainfall events during the rainy season. The system performance test results show good agreement with the observation results for the past rainfall events. It seems that the system can also provide with reliable warning information for the future rainfall events.