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Volcanic flood simulation of magma effusion using FLO-2D for drainage of a caldera lake at the Mt. Baekdusan

Khil-Ha Lee (1), Sung-Wook Kim (2), and Sang-Hyun Kim (3)

(1) Daegu University, Gyeongsan, Korea, Republic Of (khil_ha@yahoo.com), (2) GI CO. Ltd., Busan, Korea, Republic Of (suwokim@chol.com), (3) Busan National University, Busan, Korea, Republic Of (kimsangh@pusan.ac.kr)

Many volcanic craters and calderas are filled with large amounts of water that can pose significant flood hazards to downstream communities due to their high elevation and the potential for catastrophic releases of water. Recent reports pointed out the Baekdusan volcano that is located between the border of China and North Korea as a potential active volcano. Since Millennium Eruption around 1000 AD, smaller eruptions have occurred at roughly 100-year intervals, with the last one in 1903. Sudden release of huge volume of water stored in temporarily elevated caldera lakes are a recurrent feature of volcanic environments, due to the case with which outlet channels are blocked by and re-cut through, unwelded pyroclastic deposits. The volcano is showing signs of waking from a century-long slumber recently. Volcanic floods, including breakouts from volcanic lakes, can affect communities beyond the areas immediately affected by a volcanic eruption and cause significant hydrological hazards because floods from lake-filled calderas may be particularly large and high. Although a number of case studies have been presented in the literature, investigation of the underlying physical processes is required as well as a method for interpreting the process of the rapid release of water stored in a caldera lake. The development of various forecasting techniques to prevent and minimize economic and social damage is in urgent need. This study focuses on constructing a flood hazard map triggered by the magma effusion in the Baekdusan volcano. A physically-based uplift model was developed to compute the amount of water and time to peak flow. The ordinary differential equation was numerically solved using the finite difference method and Newton-Raphson iteration method was used to solve nonlinear equation. The magma effusion rate into the caldera lake is followed by examples at other volcanic activities. As a result, the hydrograph serves as an upper boundary condition when hydrodynamic model, called FLO-2D runs to simulate channel routing downstream to give the maximum water level. Once probable inundation areas are identified by the huge volume of water in the caldera lake, the unique geography, and the limited control capability, a potential hazard assessment can be represented. The study will contribute to build a geohazard map for the decision-makers and practitioners.

Keywords: Volcanic flood, Caldera lake, Hazard assessment, Magma effusion

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