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Implication of Groundwater Resources Utilization in Mountainous Region for Slopeland Disaster Prevention

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In recent years, groundwater resources from mountainous regions have been considered as an alternative water resource in Taiwan. According to previous research outcomes (Hsu, 2011), such a groundwater resource is capable of providing stable and high quality water resources. Additionally, another advantage of using the water resources is attributed to the contribution of slopeland disaster prevention. While pumping groundwater as water resources in hilly areas (e.g., at landslide-prone sites), pore-water pressures can be dropped, which can result in stabilizing landslide-prone slopes. However, the benefit to slope stability by using groundwater resources needs to be quantified. The purpose of this study is to investigate groundwater potential of a deep-seated landslide site first, and then to evaluate variations of slope stability by changing well pumping rate conditions.

In this paper, the Baolong landslide site located at the Jiasian district of Kaohsiung city in Southern Taiwan has been selected as a case study. Hydrogeological investigation for the landslide site was conducted to clarify the complexity of field characteristics and to establish a precise conceptual model for simulation. The investigation content includes surficial geology investigation, borehole drilling (6 drilling boreholes and 350 meters drilling length in total), 45 m pumping well construction, borehole hydrogeological tests (borehole televiewer, caliper, borehole electrical logging, sonic logging, flowmeter measurement, pumping test, and double packer test), and laboratory tests from rock core samples (physical properties test of soil and rocks, triaxial permeability test of soil, porosity determination test using helium, and gas permeability test).

Based on the aforementioned investigation results, a hydrogeological conceptual model for the Baolong landslide site was constructed, and a 2D slope stability model coupled with transient seepage flow model was used for numerical simulation to determine changes of slope stability by means of different well pumping rate conditions. The simulation results show that a positive relationship between the pumping rate and drawdown of well exists. In addition, the positive relationship was found between the pumping rate and the increase of safety factor for both shallow and deep sliding surfaces. If the constant pumping rate reached up to 180 L/min with the decline of groundwater level by 10.6 m, the safety factors of shallow and deep sliding surfaces are raised up to 11.87% and 15.72%, respectively. The amount of pumped water can provide daily water demand for approximately 997 people. This demonstrates the groundwater resource at this area is productive. Meanwhile, the benefit to slope stabilization by pumping groundwater is proved. Therefore, this study can provide the solution for ensuring both the safety of slopeland environment and the supply of water resources in mountainous areas. Such a win-win idea is a good mitigation measure for meeting the aim of territorial and resource sustainability.