Journal of Mining and Earth Sciences

Website: http://jmes.humg.edu.vn

3D slopes stability modeling for landslide early warning design at Halong city area

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ARTICLE INFO

Article history:
Received 6th Sept. 2019
Accepted 16th Oct. 2019
Available online 30th Dec. 2019

Keywords:
Cao Thang,
Column analysis,
Landslide,
Limit equilibrium method,
Scoops3D.

ABSTRACT

Landslides are a very common form of natural disasters in Vietnam with diverse scales, complex triggers, and mechanisms. The greatest objective of the landslide studies is zoning and predicting, and therefore, a combination of appropriate, modern study methods are needed. This study presents the results of time-variant slope stability analysis by combining the limit equilibrium method with geospatial data. The slope stability analysis was conducted at six times, with the variation of pore water pressure ratio, ru corresponding to the change of rainfall in the study area. The results of the study have helped restore the landslide scenario in Cao Thang, Ha Long, and evaluated the landslide trigger. This model can also be used for slope stability analysis and landslide prediction for early warning, management, and urban planning.

1. Introduction

Landslides are a natural disaster that occurs due to the geodynamic processes, causing instability of the slope, moving material on the slope, destroying everything involved on the way of them (Cruden & Varnes, 1996). Urban landslides are a new trend of natural disasters, growing in scale and complex in the mechanism. Therefore, it is necessary to have identification methods, zoning landslide risks to have early warning solutions and reasonable urban planning. The methods of landslide prediction can be divided into three categories: empirical, statistical, and physical methods (An, Kim, Lee, & Tran, 2016).

For shallow landslide prediction, many studies have built and developed physics-based mathematical models, describing physical processes through mathematical equations. This method integrates the analysis of space-time stability, so it overcomes the disadvantages of empirical and statistical methods. There are some models of shallow landslide prediction such as the Distributed, Physically Based Slope Stability Model (dSLAM), (Wu & Sidle, 1995); the Shallow Landsliding Stability Model (SHALSTAB), (Montgomery & Dietrich, 1994); Stability INdex MAPping (SINMAP), (Pack, Tarboton, & Goodwin,

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