

## クロアチアザグレブ市後背丘陵地における三次元斜面崩壊予測システムの開発

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### 1. Introduction

The hilly slopes of Mt. Medvednica are located in the northwestern part of Zagreb City, Croatia. It is the pilot area of Japanese-Croatian scientific joint-research project ‘Risk Identification and Land-Use Planning for Disaster Mitigation of Landslides and Floods in Croatia’. In this area, landslides, e.g. Kostanjek landslide and Črešnjevci landslide, have brought damage to many houses, roads, farmlands, grassland, and so on. Therefore, it is necessary to predict the potential landslides and to enhance landslide inventory for hazard mitigation and security management of local community in this area. This study aims to develop a 3D slope stability assessment system combining 3D deterministic model and probabilistic method to assess potential landslides including their locations, size and sliding surfaces. Fig.1 shows the Veliki potok catchment in which covers 10km<sup>2</sup> as the study area.

### 2. Landslide hazard assessment in Veliki potok catchment of Zagreb City

When we evaluate landslide susceptibility at a regional scale, it is arduous works to process large amounts of spatial data and geological data, and to identify the potential landslides. However, ArcGIS provided by ESRI has become a powerful tool for effective analysis and prediction associated with the study of geological hazards for recent years. That is not only because GIS has excellent data structures and spatial data-processing abilities, but also because the collection, manipulation and analysis of the spatial data on landslide hazard can be accomplished much more efficiently and cost effectively.

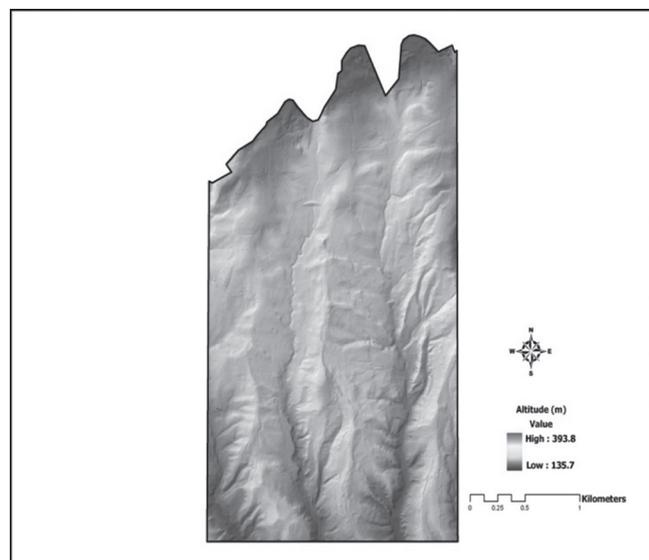


Fig.1 Veliki potok catchment

In this study, we combined deterministic method and probabilistic method to assess potential landslides. Firstly, this study area is divided into several slope units that have similar topographic and geological characteristics using the hydrology analysis tool in ArcGIS. Modelbuilder tool can be used to extract slope units automatically in ArcGIS Version 10. Then, a GIS-based modified three-

dimensional Hovland' s method for slope stability analysis system is developed to identify the sliding surface and corresponding three-dimensional safety factor for each slope unit. Each sliding surface is assumed to be the lower part of each ellipsoid. The direction of inclination of the ellipsoid is considered to be the same as the main dip direction of the slope unit. The center point of the ellipsoid is randomly set to the center point of a grid cell in the slope unit. The minimum three-dimensional safety factor and corresponding critical sliding surface are also obtained for each slope unit. Finally, since a single value of safety factor is insufficient to evaluate the slope stability of a slope unit, the ratio of the number of calculation cases in which the three-dimensional safety factor values less than 1.0 to the total number of trial calculation is defined as the failure probability of the slope unit. If the failure probability is more than 70%, the slope unit is distinguished as 'unstable' from other slope units and the landslide hazard can be mapped for the whole study area. Fig.2 shows the distribution of slope units and the failure probabilities in the study area.

### 3. Results and discussions

Slope unit can be as study objective for landslide hazard assessment in large-scale area. Slope unit can be extracted easily and automatically using Hydrology tools and spatial analyst tools. However, the size of slope unit depends on the defined watershed. GIS-based 3D slope stability method combining with probability method is an effective tool for the landslide hazard assessment in regional scale area because data preparing and processing are simplified. The methods will be used to other pilot area in Dubracina catchment located near Rijeka City, Croatia.

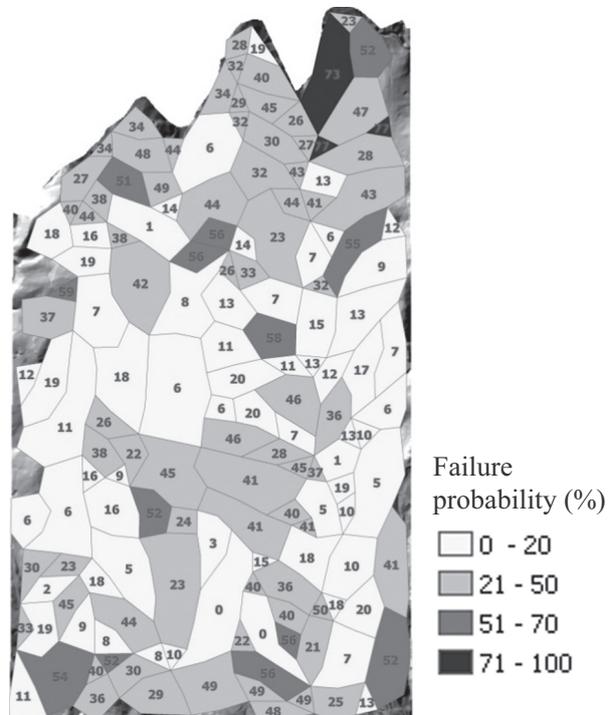


Fig.2 Failure Probability of slope units in Veliki potok catchment

### References

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- 2) Mowen Xie, Tetsuro Esaki, Cheng Qiu, Chunxiang Wang. (2006) Geographical informational system-based computational implementation and application of spatial three-dimensional slope stability analysis. *Computers and Geotechnics*, 33, 260-274.