AREA INFORMATICS AND TRIGRS MODEL FOR STUDY SHALLOW LANDSLIDE VULNERABILITY ASSESSMENT. A CATE STUDY IN BAVI AREA, HANOI REGION, VIETNAM

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ABSTRACT

Recently, we obtained a number of modern techniques for studying hazards, but these do not synchronize, slow, and not much effect. One big question is to enhance the capacity of developing communities resilient to shallow landslide disaster. Authors had using the TRIGRS model (Transient Rainfall Infiltration and Grid-based Regional Slope-Stability Model) with erea informatics (GIS technology, RS data, physical geography, geological structure, sociological investigation,…) and GRASS-GIS to estimate where shallow landslide may occur and what areas are involved. With many parametres involved (natural moisture content, natural density, specific gravity, porosity, degree of saturation, void radio, liquid limit, plastic limit, plasticity index, consistency, coefficient o compression, friction angle, cohesion,…) we had a good result in area study.

Somes area where we forecasted was happened shallow landslide in some week ago (on 26-27th July 2010).

This result can support the realization of early warning systems, capable to timely inform agencies and population of risks in order to take appropriate measures and limit the loss of lives and damages

Key words: TRIGRS with Bavi, VN

1. INTRODUCTION

The general target of this study is to enhance the study ability, find an appropriate solution for geohazards, for example shallow landslide), contributing in the sustainable development of the Hanoi City. The western and northwestern areas of Hanoi consist of mountainous regions. Annually, during the rainy season landslide phenomenon usually happens and becomes more and more severe, causing very large consequences in lives and economic life of the locality. Recently, in …, 2010, torrential rains and landslide made … dead persons, damaging tens houses and constructions, with the total damage of up to tens billions VND. For studying this urgent problem, we have been using an association of methods, with the main method as the Area Informatics and the mathematic model TRIGRS. The study results are satisfactory, because they were checked up in some areas that were forecasted by us as possible of high-grade landslide happening, and this hazard happened. We

disseminate our study results on the Internet and present the areas possible of hazard happening. This can support the early warning system, aiming to help people and central as well as local administrations to set forth projects to minimize damages, contributing in the sustainable development of Hanoi City.

2. METHODS AND RESULTS

2.1. Methods

For studying the shallow landslide problem in the study area, the authors have been combining traditional and modern methods, the core of them consists of two groups : area informatics and mathematic model TRIGRS [2]. They can be shortly described as follows:

- Keeping in touch the field (investigation, measurement; filming, taking digital photos; interviewing local authorities and people,…) and carrying office works (references; analysis, classification of materials; study on remote sensing data,…). Collected data as the input for solving problems consist of hydrometeorological, geological, topographical, … data. They form the database for solving the problem**.**
- Applying the model TRIGRS (Transient Rainfall Infiltration and Grid-Based Regional Slope-Stability Analysis). This model can be summarized as follows:

TRIGRS is a Fortran program for computing transient pore-pressure changes, and attendant changes in the factor of safety, due to rainfall infiltration using the method outlined by Iverson (2000). The authors extended Iverson's (2000) method by implementing the solution for complex storms, a solution for additional basal boundary conditions, and a simple runoff-routing scheme.

The program operates on a gridded elevation model of a map area and accepts input from a series of ASCII text files. Infiltration, hydraulic properties, and slope stability input parameters are allowed to vary over the grid area thus making it possible to analyze complex storm sequences over geologically complex terrain.

The optional routing scheme achieves mass balance between rainfall input, infiltration, and runoff over the entire grid by allowing excess water to flow to downslope cells that are receiving less direct precipitation than they are able to absorb.

The program saves output to a series of text files that can be imported to GIS software for display or further analysis. ..

- Embedding the results of model use into GIS softwares [1] .
- Using the expert system in the analysis, assessment, correlation and check up of materials and obtained results for setting forth scientific conclusions and warnings on hazards;
- Development of WPS (Web processing service) capabilities that allows for on-line simulations and result display (IST) on the computer network, aiming to disseminate

informations, serving the fast warning work for minimizing damages, contributing in the sustainable development.

2.2. Results

2.2.1. *Study area*

Bavi is a mountainous suburban district, situated in the northwest of Hanoi City. In the framework of this article, we concentrate the introduction to one of vulnerable areas that is the Tam Đảo Park [Fig. 1]. This area is composed mainly of rocks of the Vien Nam Formation, including *Eruptive facies*: tuffaceous agglomerate, porphyritic trachyte, rhyolite, porphyritic dacite; *Effusive facies*: porphyritic basalt, amygdaloidal basalt, basaltic tuffs, andesitobasalt. Total thickness: 1800 m. Besides, there still are igneous rocks of the Ba Vì Complex: dunite, peridotite, gabbodiabase. Covering these rocks, there is the weathering crust of great thickness (from 1-2 to over hundreds meters).

2.2.2. *Data*

Beside digital materials, we still use remote sensing data as combining materials (Figure 2).

2.2.3. *Results*

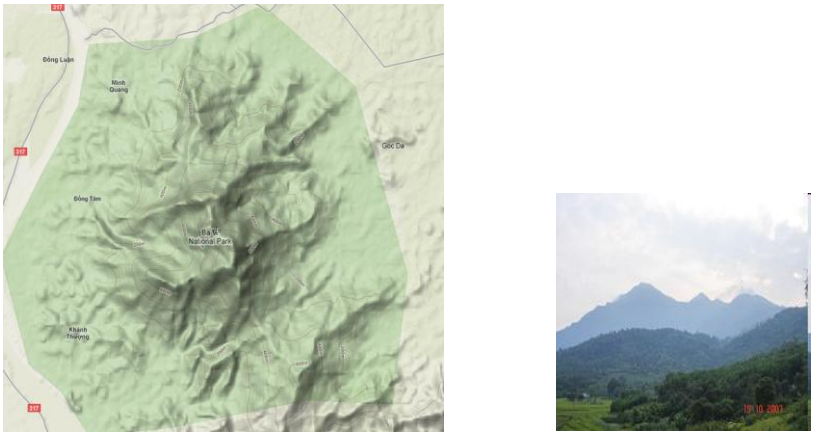

Figure 1. National Park in Bavi area

The results of using model TRIGRS show in the table 1, fugure 2, 3 and 4

Table 1. Variables input and results

Zone ID	Variable name and values								Degree of hazard
	cohesion	*phi*	*uws*	*diffus*	*K-sat*	*Theta-sat*	*Theta-res*	*Alpha*	
1	2600	36.	2.7e+04	8.0e-04	4.0e-06	0.70	0.06	0.17	very hight
2	2800	39.	2.65e+04	7.0e-4	5.0e-06	0.65	0.06	0.5	hight
3	3200	38.	2.6e+04	5.0e-4	7.0e-06	0.55	0.06	0.5	hight

Cohesion : the Soil cohesion, c
Phi : Angle of internal friction, φ
Uws : Unit weight of soil, γ_s
Diffuse : diffusivity
K-sat : Saturated hydraulic conductivity
Theta-sat : Soil saturated volumetric water content, θs
Theta-res : Soil residual volumetric water content, θr
Alpha : A fitting parameter for soil size distribution, α , approximately equal to the inverse of the inverse of the height of capillary rise.

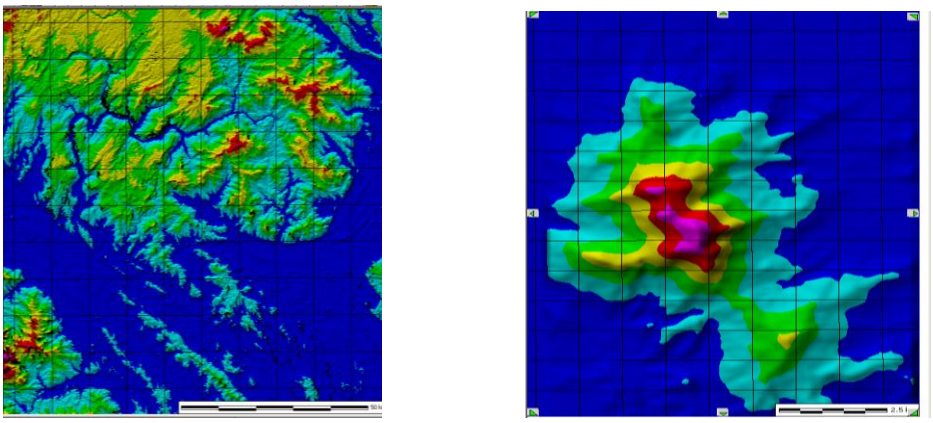

Figure 2. SRTM 90m DEM Digital Elevat

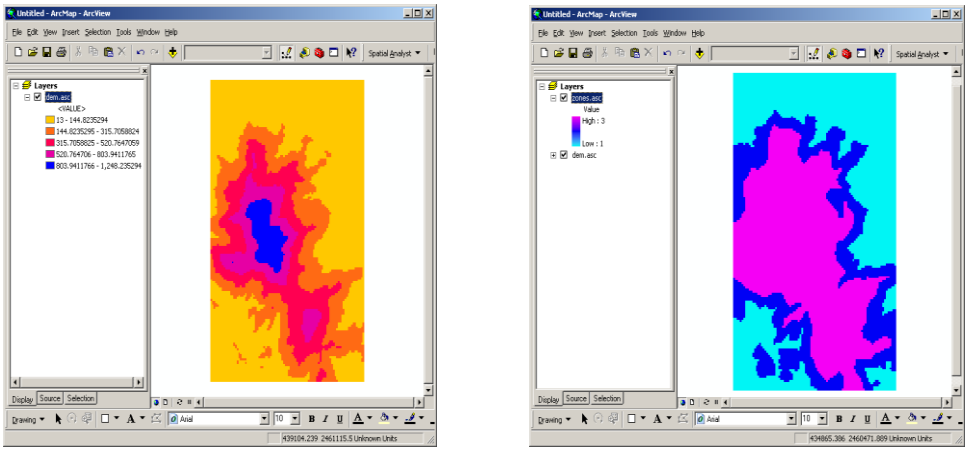

Figure 3. Dem.asc file

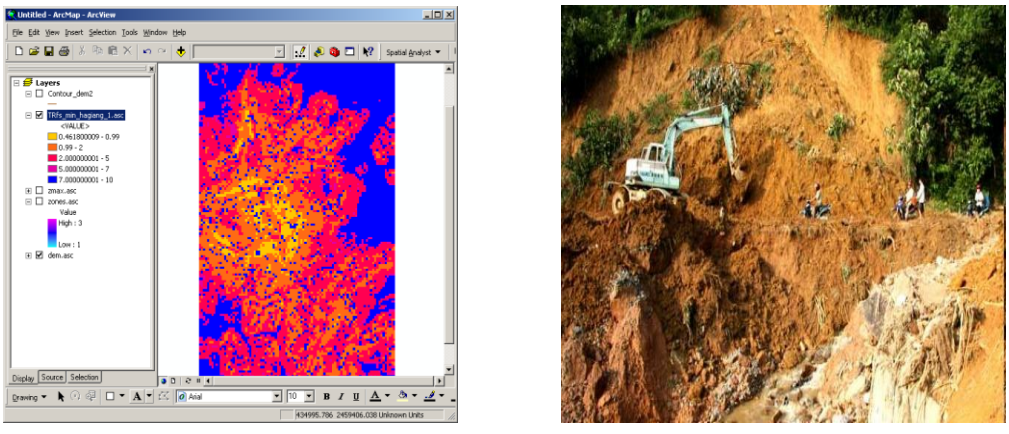

Figure 4. TRfs_min_bavi_1.asc

Some images of Shallow Lanslide in BaVi Region show in figure 5.

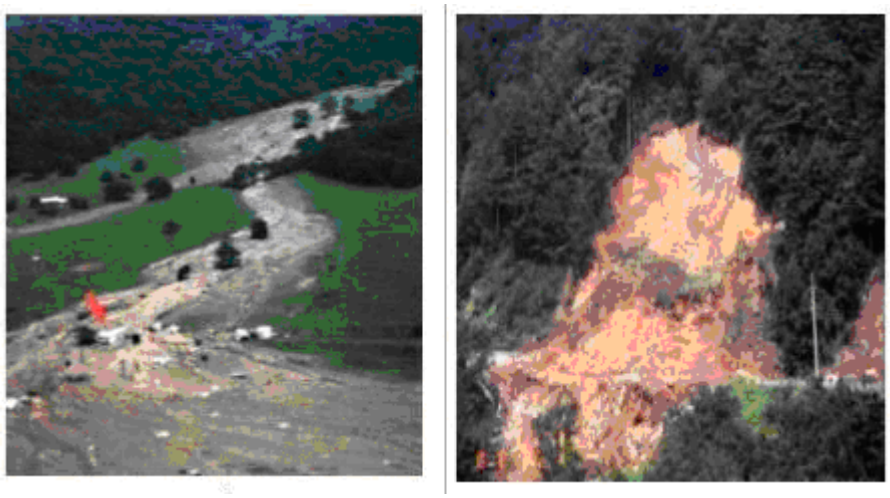

Figure 5. Images of Shallow landslide in region study

3. DISCUSSION AND CONCLUTION

3.1. Discussion

Although this may be considered a freak event due to exceptionally heavy rainfall, it does draw attention to the possibility of other such slope failures occurring in other parts of Vietnam, where similar conditions pertain. Each event whether it is landslide, bogburst or rockfall, is unique event due to a particular set of circumstances. However, such geohazards need to be documented to build up a database of past events, so that risk assessment can be undertaken. This could then lead to steps to mitigate against potential risks. It is the intention of the HUMG as the national earth science agency to create this database of geohazard events and examine the feasibility of carrying out geological hazard vulnerability mapping.

In Vietnam, up to now we are the first carrying out this research direction. Many parameters necessary for the study are rather deficient and lacking the systematical character. However, in our opinions the initial results are rather good. In the coming time, we hope that we will have the cooperation with domestic and foreign scientists in the research and widen the study in other areas of Vietnam. This is also a good research direction for young scientists, especially for domestic and foreign doctorate candidates in Vietnam.

3.2. Conclusions

The shallow landslide phenomenon happens due to an association of elements, but the most basic of them consist of the 4 following (ranked in accordance to their influence level): rainfall from the medium level upwards (with the time usually from 3 hours upwards), thickness of the weathering beds (over 1 m), downgrade of the mountain slopes (sometimes, hilly areas) and vegetation cover.

The minimization of damages caused by landslide is a long-term work, but in the time to come, in our opinions, it is necessary to create the vegetation cover in the upper course of streams, to lower the slope and form the good drainage in localities having the high danger of

landslide, to perform the special Web page on contemporary geohazards (landslide, flood, soil subsidence, …).

REFERENCES

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