APPLICATION OF REMOTE SENSING AND GIS IN STUDY OF LANDSLIDE IN DANANG CITY FOR THE PURPOSE OF PRODUCING AND RESETTLEMENT

Nguyen Thi Dieu, Truong Phuoc Minh, Nguyen Van Nam[1]
Tran Thi An[1,2]

[1]Faculty of Geography, Danang University, College of Education
41 Le Duan street, Danang city, Vietnam
[2]Graduate School for Creative Cities, Osaka City University
3-3-138, Sugimoto, Sumiyoshi-ku, Osaka, Japan

ABSTRACT

Danang is a small city in the Middle Center Coast of Vietnam, but it is also the center of socio-economic of the Middle of Vietnam. In this small area, there are various kinds of topography from mountain, plain, to the coastal zone. In the condition of seasonal climate of Vietnam, it is very easy for landslide to occur in rainy season in some sensible area. Every year, the landslide hazard happened lead to a lot of damage for the transportation, agriculture, tourism, etc for Danang city.

This study aims to understand the current landslides in Danang city in order to determine the cause of landslides and forecast the landslide situation at some main locations (the mountainous areas, the flow in estuaries, coastal zones), from that proposed solutions to set up the economic activities such as agriculture, tourism, transportation and provide information for planning, relocation and resettlement reasonable.

By using remote sensing and GIS technology, This study focus on some main targets: Studying of landslide situation in Danang city in which we concentrate on some sensible areas such as: Son Tra peninsular, Ngu Hanh Son Marble mountain, Cu De estuary; Building the map of landslide situation and landslide forecasting map of Danang city; understanding the effect of landslide on the produce activities and settlement in Danang city in order to propose the solution for the sustainable development of the city.

I. INTRODUCTION

The natural condition of Danang city is characterized by monsoon tropical climate with the rainy season from August to December and the dry season from January to July. The average temperature is about 25.9^0C, the topography is mainly mountainous in the West and Northeast. Located in the Central Coast of Vietnam, Danang has to suffer from many typhoons every year. With the characteristic that mountain side is slope and reach to the sea, the biggest rivers are short and steep, it is very easy for landslide to occur in rainy season, especially in the mountainous and midlands.

Landslide in Danang city can be divided into some main types: the rock fall in Ngu Hanh Son Marble mountain, landslide in Son Tra peninsular and landslide in some riversides. Landslide in Danang city was caused by many elements of natural conditions such as geology, geomorphology, tectonics, seismology, hydrology, hydrogeology, etc. In addition, the social-economic activities of citizens also contributed to the high speech of landslide such as: building the new roads, tourism activities, deforest, natural resource exploiting, etc.

By using GIS data and remote sensing image, the software of ENVI 4.3 and ARCGIS 9.3, this study try to evaluate and estimate the landslide condition in Danang city, from that building the landslide forecasting map in future.

II. METHODOLOGY

2.1. Data base

In this research, we used some GIS data about the natural condition of Danang city included: administrative, topography, hydrology, land type, land use, etc. In order to determine the landslide points in study area, we used the SPOT image of Danang city in 2009 with the resolution 5m and some field work data.

2.2. Extraction the landslide information from remote sensing data

In this study, the SPOT 5 image was used to get the landslide information for Danang city. This satellite image was acquired on June 2009 with the resolution 2.5m in Panchromatic band and 5m in spectral band. This image was used in observation some objects in study area such as: landslide points, topography, land cover, hydrology, etc. In the Figure 1, image (a) show the landslide point in front of Hai Van tunnel, cross with National street of 14B, in the location of 16°7'57"N and 108°6'12"E ; image (b) is a place located in 16°9'9"N and 108°14'29"E in the transport line in the North of Son Tra peninsular; image (c) shows the landslide point in the Thuy Tu estuary of Cu De river, location of 16°7'22'N and 108°7'26"E; image (d) is the landslide point in Kien slope (Hoa Phu ward, Hoa Vang district), the main road from Quangnam province to Danang city.

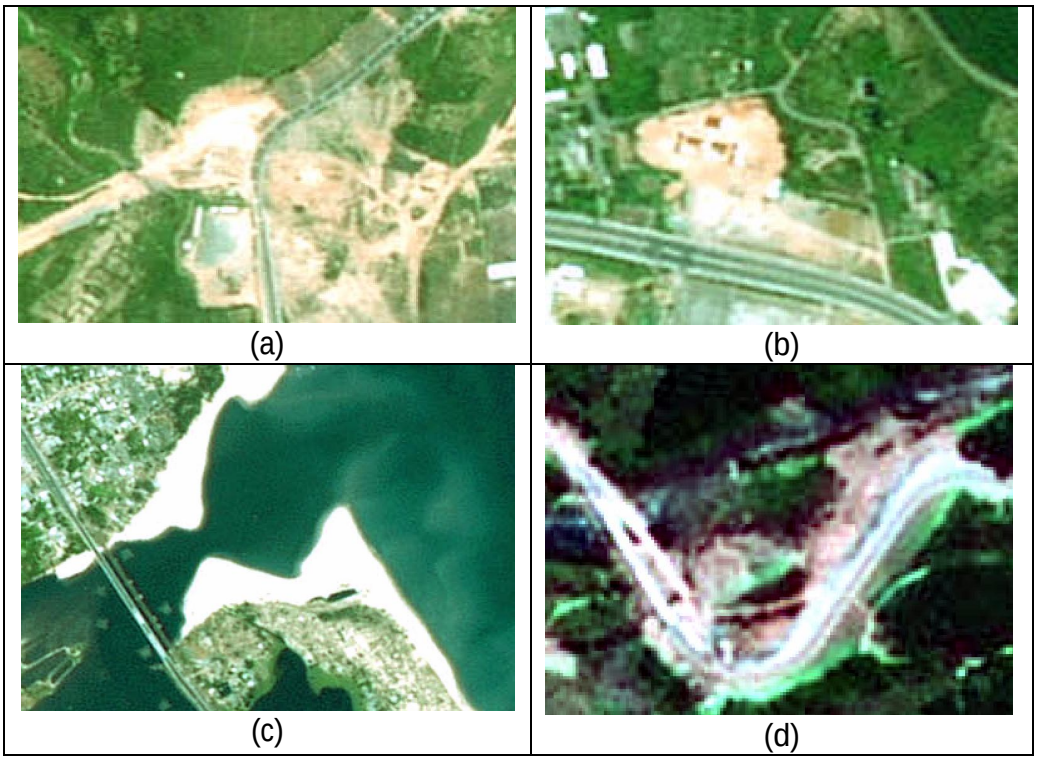


Figure 1: Some landslide points in Danang city
(Extract from SPOT 5 image of Danang city)

2.3. Model Builder Tool for Landslide prediction

Remote sensing data, topographic map, field trip data and other layers were used as the input data for this research. Other information were represented by geology, hydrology, climate, etc. A landslide vulnerability model was built based on Model Builder Tool in ARCGIS 9.3 software by combination all thematic layer maps and the weight of each layer. The result is the landslide vulnerability map for Danang city which can show the risk of landslide hazard for each region in five levels: very high, high, medium, low and very low.

The input layers for this study included: topography, slope, aspect, drainage density, rain fall, land use and land type. Each layer has a weight corresponds with its role in the landslide hazard. Understanding the natural condition of Danang city as well as the forces producing landslide, we concluded that rain fall, drainage density and slope play the most important roles in landslide hazard. The topography of Danang city has more than 50% of mountain, so slope and drainage density will impact strongly on landslide in this region. Furthermore, Danang city locate in climate of monsoon tropical with a heavy rainy season during half of year. Therefore, rainfall is the most important factor that cause to landslide

happening in Danang city. Based on the research of Thach NN (2001), Loi NK (2011) about landslide in Vietnam, we choose the input layers for Model Builder Tool are: slope, aspect, rainfall, drainage density, land use and land type. The weight of each layer can be showed in table 1:

Table 1: The input layers used in Landslide vulnerability model

Layer	Slope	Aspect	Rain fall	Drainage density	Land use	Land type
Weight	7	1	9	8	4	6

In each layer, the value of each polygon was divided into some levels depend on its effect on landslide. The score of each polygon is its value when dividing and multiplied with the weight of the layer it belongs to. A Model Builder Tool was built by union all input layers. The output layer is the landslide vulnerability map for Danang city. In the output layer, the score of each polygon is sum of the point in each layer that can be showed in this formula:

Landslide_Score = [Slope_Score] + [Aspect_Score] + [Rain_Score] + [Drainage_Score] + [Land_Score] + [Soil_Score]

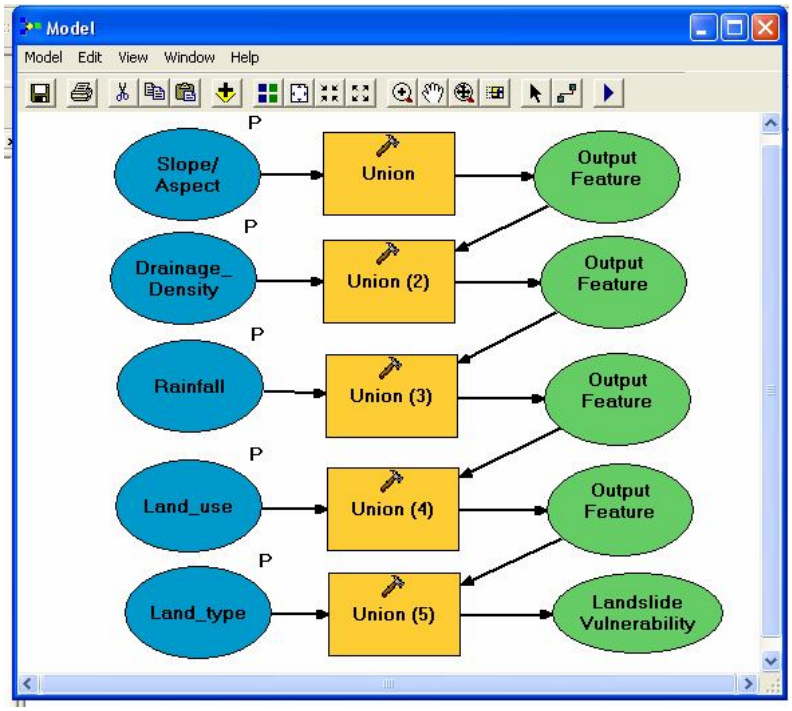


Figure 2: Model Builder Tool in ARCGIS 9.3 used for landslide vulnerability map

3. RESULT AND DISCUSSION

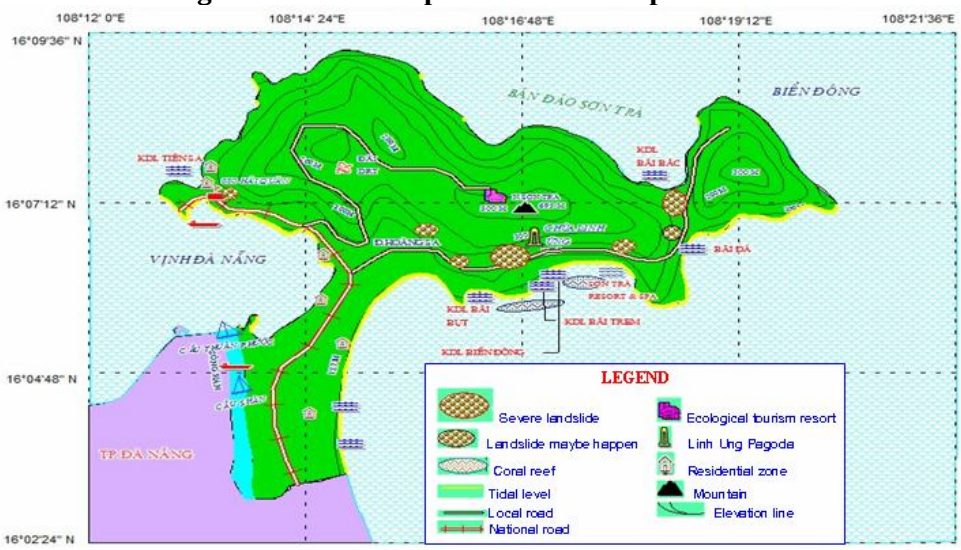
3.1. Landslide situation in Danang city

3.1.1. Landslide in Son Tra peninsular

From the survey in Sontra peninsular, we found out two main points of landslide, one near Linh Ung pagoda and another in Nghe cape. In Figure 3, we can see these main points of landslide. In Linh Ung pagoda, the surface of landslide had area up to 15000m^2, the slope up to 70-75^o. The weathering crust is too thick and easy breakable. There are also many rock blocks with the huge size. Although there are many methods to repair the landslide hazard such as: building stone jetty, grass growing, drainage ditches making…but this point still be

destroyed by landslide in rainy season. The landslide point in Nghe cape has a smaller size than Linh Ung pagoda but has a high risk with landslide. The topography is too steep (> 70^0), land cover is so poor, the weathered processing is almost come to end. The surface has many furrow – drains and ditches. All of them force the evaporation in dry season and break down structure of soil in rainy season.

Figure 3: Landslide points in Son Tra peninsular



3.1.2. Rock fall in Ngu Hanh Son Marble mountain

Ngu Hanh Son Marble mountain is a system of karst mountain with five main tops of mountain. This is the famous tourist place as well as an important handicraft village of Danang city. This karst region is characterized with the height from 50 to 100m, the slope in 15 - 20^0, sometimes reach to 35^0, the land cover is very poor, the rock structure with many cross fractures which are very easy to be broken in rainy season. In addition, the handicraft activity in this village took away too much material from the marble mountains. Recently, the rock fall phenomenon happened more regularly in this region. In September 2011, there are three severe cases of rock fall in Moc Son mountain, one of five mountains in Ngu Hanh Son Marble mountain.

Figure 4: Rock fall in Ngu Hanh Son Marble mountain in Sept. 2011

3.1.3. Landslide situation map of Danang city

Based on some lines and points of observation, we built the landslide situation map for Danang city by using GIS. This map was built by Mapinfo 9.0 software by combination some thematic layers included: landslide points, topography, hydrology, administrative…The landslide points layer was built based on the result of survey in field trip, statistic data about landslide in Danang city and extraction from SPOT image. In this map, the main points of landslide include: Kien slope in Phu Tuc village, Hoa Phu commune, the road around Son Tra peninsular, Ngu Hanh Son Marble mountain and Thuy Tu estuary- Cu De river.

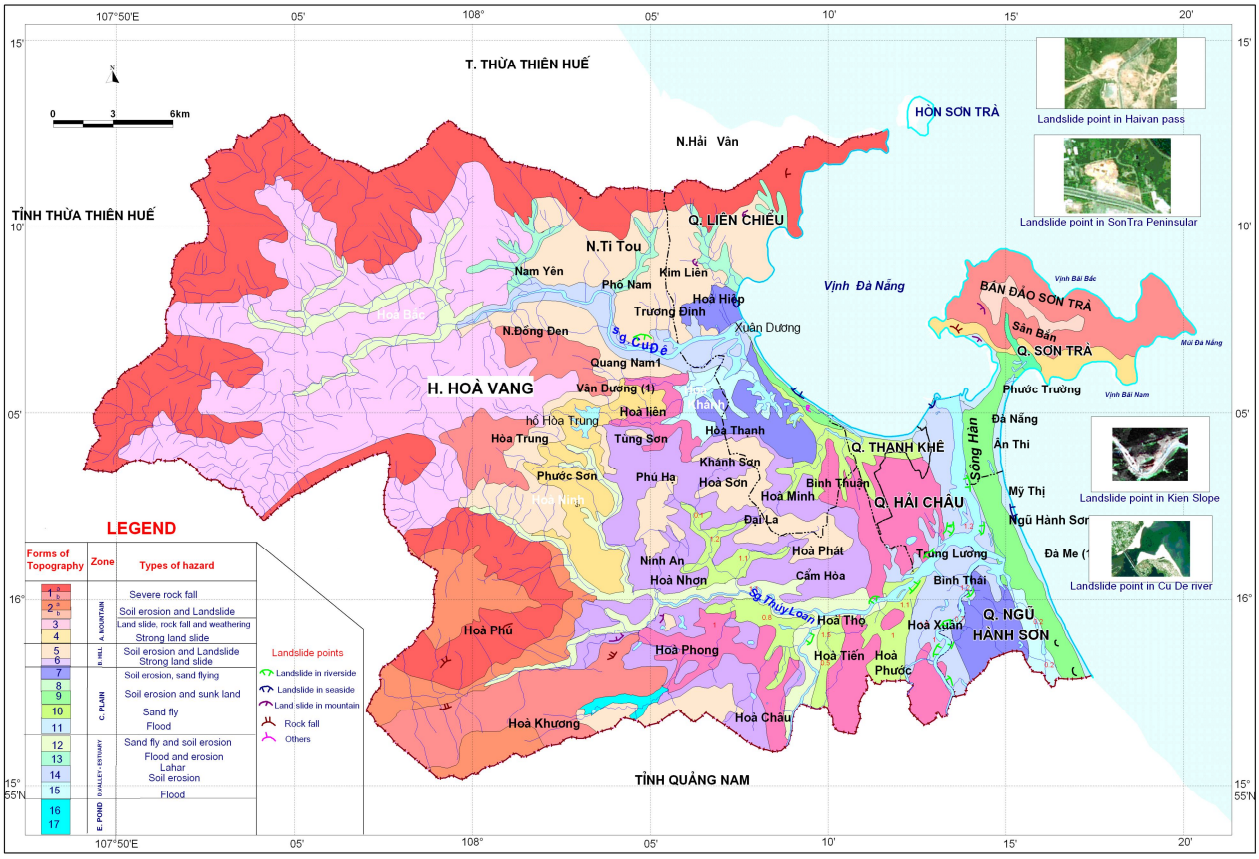


Figure 5: Landslide situation map of Danang city

Legend: *Forms of Topography***:** 1a and 1b - Average mountain (>750m) and low mountain (250-750m) with slope $>40^0$; 2a and 2b - Average and low mountain with wavy top; 3 - Average and low mountain (500-800m) with slope $>30^0$; 4 - Low mountain with wavy top and slope $>30^0$; 5 - High and average hill; 6 - Low hill; 7 - Plain formed on the sea alluvium; 8 - Plain formed on the river alluvium with the height of 8 - 15m; 9 - Plain form on natural sandy dyke with the height of 8-20m; 10 - flat plain in the height of 3-6m; 11 - Modern plain near seaside; 12 - Valley of erosion and accumulation; 13 - Narrow and steep valley; 14 - Estuaries; 15 - Sunken region near estuaries; 15 and 16: Pond

3.2. Risk of landslide in Danang city

In order to zone for the landslide vulnerability map of Danang city, we based on the output layer of Model Builder Tool. In this layer, the score of each polygon is sum of scores in all input layer, so it can be considered as the risk of landslide hazard. We divided them into five levels as follows:

Table 2: Levels of Landslide vulnerability in Model Builder Tool

Level	Very low	Low	Average	High	Very high
Score	0 – 35	35 - 50	50-75	75-100	>100

The landslide vulnerability map for Danang city based on Model Builder Tool of ARCGIS software is as follows:

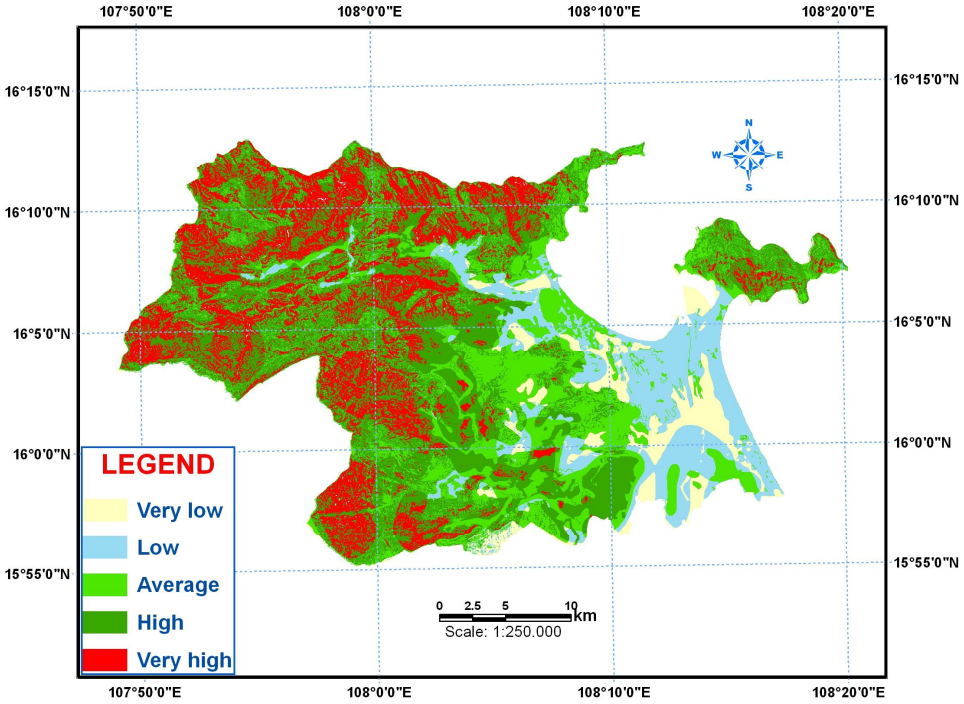


Figure 6: Landslide vulnerability map of Danang city

3.3. Conclusion:

- Study of landslide hazard based on GIS and remote sensing data for Danang city can determine the risk of landslide in Danang city in five levels that can be described in Landslide vulnerability map. In this map, the very high level area of landslide up to 36% area of Danang city, in which some sensible areas such as Son Tra peninsular, Kien slope, Hai Van pass and other mountainous regions in the West also included.

- From this study, it can conclude that growing forest in Haivan pass, Sontra peninsular and Cu De riverside is very important for prevention from landslide hazard. Also, we should relocation the residential zones far from sensible areas in Ngu Hanh Son Marble mountain and Cu De estuary.

- For the high risk areas of landslide in Son Tra peninsular and Cu De estuary, we propose some useful methods such as: growing and recovering forest, especially in the zone with slope over 40^0, concentrate on some technical methods such as: Building the stone embankments, retaining walls, building the jetty along with the direction of tidal waves…Besides, the warning system such as setting of dangerous signs, localize the prohibit areas, zoning for residential lands, etc are also very important.

4. REFERENCES

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