LANDSLIDE HAZARD POTENTIAL AREA IN 3 DIMENSION BY REMOTE SENSING AND GIS TECHNIQUE

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Abstract

As August 11, 2001 the landslide and flood have claimed 130 lives and 207 houses in Petchboon province Thailand. Total damage could be minimized if landslide hazard potential area have been indicated before. Landslide hazard in 3 dimension is beneficial to understand for people that are not familiar with contour line map to see three dimension .

Methodology and results :

1. To classify rectified Landsat TM image in 3 categories -undisturbed forest - disturbed forest or bamboo - grass or agricultural area

2. Scanning contour lines at 20 meters interval from topographic map at scale 1:50000 and generate three dimension model.

3. Slope classes within 5 degree Interval was done.

4. To estimate soil stability in 5 classes by using ratio of soil texture, soil depth, and rock type.

5.To assess landslide hazard by using the 3 factors were land cover, slope gradient, and soil property. The assessment shows that 3%, 45%, 44%, 7% and1% of the area have very high, high, moderate and low potential hazard respectively.

6.Simulate potential hazard area in 3 dimension.

1. Introduction

On the night of August, 11/12, 2001. The intense and continuous rain produced debris flows and severe flooding that claimed 130 lives, most of them lived in Num Ko village. The debris flows and floods extensively damaged roads, bridges, communication systems, houses, farms, and livestock and half of Num Ko village was almost completely destroyed. In the past , floods usually is caused by torrential rain from watershed areas, which run past Num Ko Village. Because it could not flow fast enough into estuaries of Pa Sak river. Topography of study area are rolling to hilly. The dense forests have been cleared for cash crops (maize and ginger).

Although neither storms nor debris flows can be prevented, effective mitigation measures should be taken to reduce risks to people and loss of property. One of measures is to search the landslide potential area in three dimension which is beneficial to understand for people that are not familiar with contour line map to see three dimension .

2. Study Area

Num Ko watershed is the study area located in Petchboon Province, lies between and North latitude and and East longitude. It is about 400 km north of Bangkok. Total area is 128 km^2 .Topography is mountainous with elevation ranging from to meters above mean sea level. Landuse is mainly grass land/agriculture land disturbed forest .

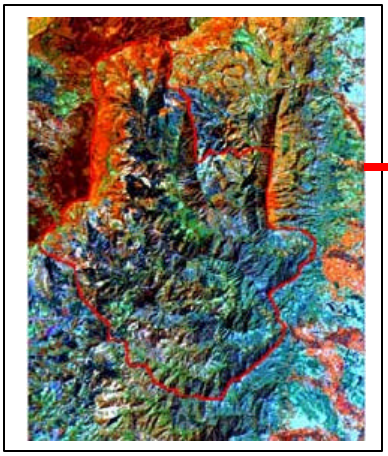
3. Methodology

The methodology consists of four parts.

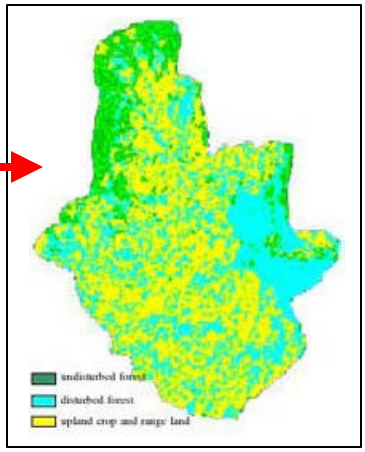
3.1 Remote Sensing : Landcover map was generated from Landsat TM(figure 1). Supervised classification was carried out by using 3 bands (3,4,5) with a maximum likelihood algorithm. The final classification result consisted of three categories were undisturbed forest, disturbed forest and bamboo, upland crop and range land. (figure 2) After classification was done, filtering was applied with a 3x3 median filter . The final raster map was converted to vector file.

Land cover type	area hectare	percent	Hazard rating
Undisturbed forest	2,810	22.05	1
Disturbed forest	4,703	36.90	2
Upland crop and range land	5,232	41.05	4
Total	12,745	100	

Table1 Land cover types and hazard rating



Fiqure1 Multi-spectral of Landsat TM image

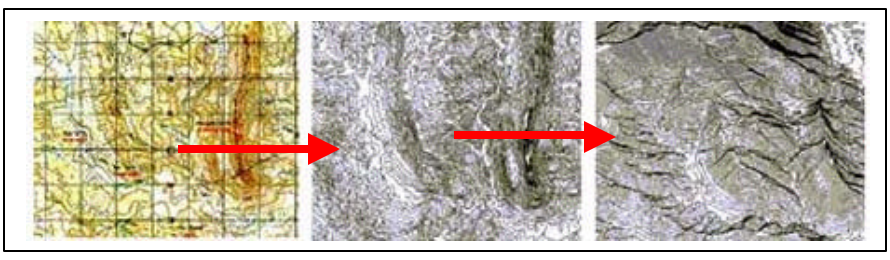


Fiqure2 Classified map

3.2 DEM : Topography is an important factor for landslide in the mountainous area. Since slope gradient is an important role in landslide as well, DEM was done by scanning contour line at 20 meter interval from a topographic base map at scale 1:50000. To vectorize raster map of contour lines and height value of each lines was edited as attribute. Interpolation procedure was followed to generate DEM. DEM was reclassified to generate slope group. (figure 3)

Slope groups	Slope gradient %	area		Hazard rating
		hectare	percentage	
Group1	0-10	1,743	13.68	1
Group2	11-20	258	2.03	2
Group3	21-40	3,180	24.95	3
Group4	41-60	6,180	48.48	4
Group5	>60	1,384	10.86	5
total		12,745	100	

Table2 Slope groups and hazard rating



Fiqure3 Scanning topography map to generate DEM

3.3 Soil : Soil survey was conducted for updating the soil map in the subwatershed of Num Ko and Num Chun after incident 1 week by using auger hole descriptions. The soil in study area are mainly colluvium. Texture and soil depth depend on rock base are main factor for landslide. Coarse and shallow soil are higher susceptibility than fine and deep soil.

Texture and Depth	Susceptibility
Fine and deep	Very low
Medium and deep	Low
Fine and shallow	Moderate
Medium and moderately deep	High
Coarse and shallow	Very high

Table3 Relation between soil and landslide potential

Meaning of texture and depth

Fine texture = Clay , Sandy clay
Medium texture = Clay loam, Loam , Silty loam
Coarse texture = Sand, Loamy sand
Shallow = < 50 cm.
Moderately deep = 50 -100 cm. .
Deep = >100 cm.

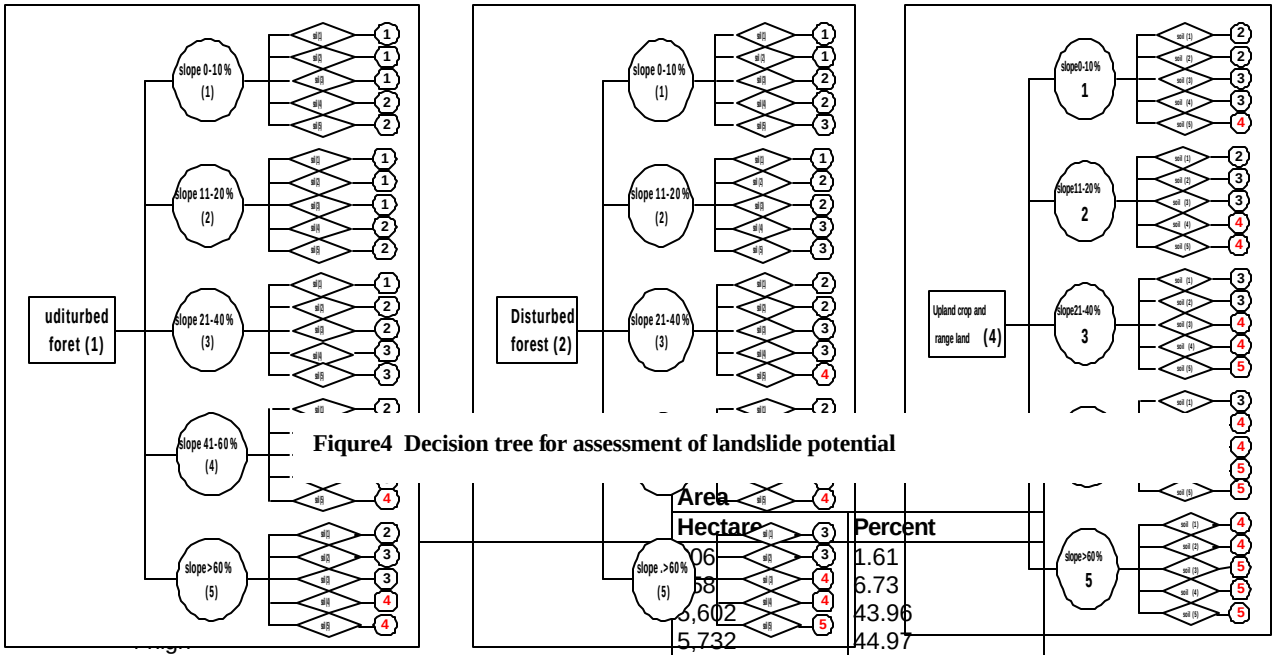
susceptibility / Soil property	Very low	low	moderate	high	Very high
Depth	> 150 cm.	100 - 150 cm.	50 - 100 cm.	25 - 50 cm.	< 25 cm.
Texture	clay	loam	Gravel clay	Gravel loam and sand	Gravel sand

Table4 Soil property for erosion susceptibility

Erosion susceptibility	**area**		**Hazard rating**
	hectare	**percent**	
Very low	558	4.38	1
low	2,469	19.37	2
medium	4,720	37.03	3
high	3,408	26.74	4
Very high	1,590	12.48	5
total	12,745	100	

Table 5 Soil susceptibility rating for erosion of study area

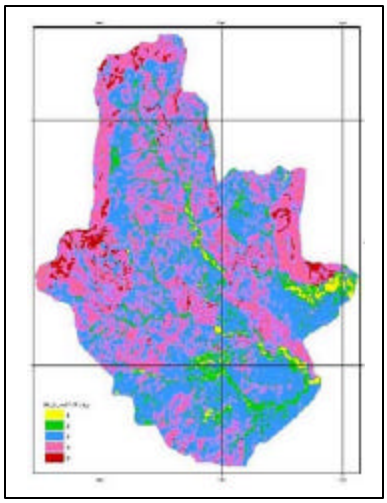
3.4 GIS analysis: Landslide potential was carried out by using map overlay procedures . Although slope gradient is very important for landslide process, other factors such as soil , and land cover/use were also included in GIS analysis to forecast the landslide hazard potential area. Analysis process can be shown into a decision tree. (figure 4 -5)



Fiqure4 Decision tree for assessment of landslide potential

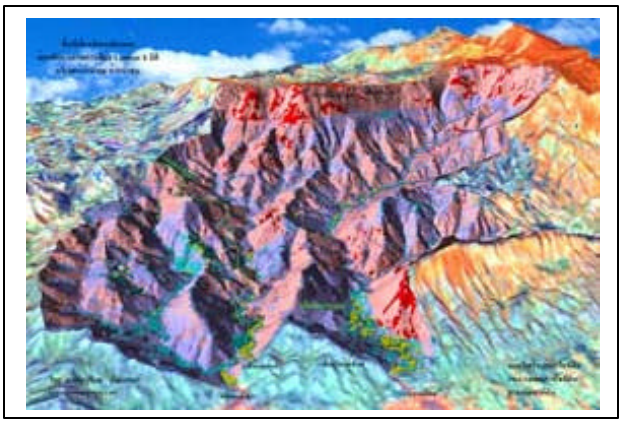
	Area	
	Hectare	**Percent**
	06	1.61
	58	6.73
	5,602	43.96
	5,732	44.97
5 very high	347	2.72
Total	**12,745**	**100.00**

Table 6 Result of landslide hazard potential area analysis



Fiqure5 Landslide hazard potential area map

3.5 3D of Landslide hazard potential area : A multi-spectral Landsat TM image and landslide hazard potential map draped on a three-dimensional view generated from a digital elevation model respectively .
(figure 6)



Fiqure6 Landslide hazard potential drape on 3D of Landsat image

Conclusions

The influence of slope gradient, land cover type and continuously heavy rainfall are very important in mountainous area of northern Thailand. The study shows that landslide occur on steep slope under upland crop and range land. The result of ground truth also shows that landslide occur on steep slope along the stream.

In the past and under normal condition, landslide is very rare to happen in Thailand. At present, Because of climate change and deteriorated natural resources, Trent of landslide incidence will happen to be more frequently.

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