LAND USE CHANGE AND LAND DEGRADATION: A CASE STUDY IN NAM CHUN SUBWATERSHED IN THAILAND

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ABSTRACT: Nam Chun subwatershed in Thailand was covered by dense forest some 35 years ago. After Thai government gave concession to companies to cut down the trees as a way to eliminate communist movement in the past, deforestation has led to unselective cutting down of trees. Forest was replaced by maize cultivation, the main crop in the area. Cultivation on steep slope and improper land use practices has led to land degradation. Soil erosion, land sliding and fertility depletion are the main land degradation problems in the area. The heavy rain of 11 August 2001 has caused landslides in highlands, and flooding in lowlands, which resulted in destruction of properties and heavy losses of human lives.

In order to assess land cover change, analysis was made on multi-temporal remote sensing data, in both digital and analogue (air photographs) forms. Study on the impacts of the changes on land was carried out through the study of degradation features, such as gullies and landslides, and by assessing soil erosion, applying model. The study shows that deforestation, which took place in the past two decades, has caused erosion, flooding and various types of mass movement. The degradation was found highest on cropped areas and lowest under forest and grasslands. Gullies are common on steep cultivated areas.

1. INTRODUCTION

Land degradation, a decline in land quality caused by human activities, has become a major global issue since almost a century (Eswaran et al., 2001). In a yearly basis millions of hectares of land is being degraded in all climatic regions. In Thailand too, suitable lands are insufficient to feed the growing population and as a result marginal lands are brought under cultivation and that has caused land degradation (LDD 2001). Deforestation, either for timber or firewood collection or for cultivation has exposed land to rainfall leading to excessive soil erosion on steep slopes. In Chuen watershed it is reported that soil loss amounts to 95 to 125 tons/ha/yr (LDD, 2002). Problem is not confined to cultivation on steep slopes but inappropriate farming practices equally contribute to excessive soil loss. Maize yield is reported to decline by 50% in Huai-Tatfa area due to down slope ploughing (LDD, 1997). Besides the soil erosion, if excessive and prolonged rainfalls, mass movement occurs too which so far has caused lots of damage. This was shown by the excessive rainfall that occurred in the night between 11 and 12 August 2001, which led to the destruction of infrastructure and loss of lives in Petchabun and Prae provinces. The fact that the debris flows and severe flooding took 130 lives, many of whom from the Nam Chun village, and caused damages to roads, bridges, houses, farms, and livestock was repeatedly mentioned by interviewees. In order to avoid risks to people and minimize loss of property in future, effective mitigation measures should be taken in time. For this reason, assessment of land degradation, which helps understand environmental situation, is necessary. The geopedologic study indicates that change of land cover/ use is the major cause, and hence monitoring becomes vital. In the present case study we have used remote sensing techniques including aerial photo interpretation and image classification to monitor land cover/ use change and to study its impact on land degradation.

2. STUDY AREA

The Nam Chun sub-watershed area consists of a narrow valley bordered by sloping and steep hilly and mountainous land, in Petchabun province, Thailand (Fig. 1). It lies between 16^{o} $44^{/}$ and $16^{o}48^{/}$ latitudes and between 101^{o} $02^{/}$ and $101^{o}09^{/}$ longitudes and covers 67 sq.km surface area. Elevation varies from 240 to 1,509 m asl. Climate is characterized by tropical monsoon climate with annual average rainfall of 1,000 mm, most of which fall during rainy season. Rainy season occurs during May to October months. In the hilly and mountainous areas rainfall amount is usually more than in the low lands. Lithologically, sandstone, siltstone and tuffs (of andesitic nature) are distinguished, of which the latter is very complex in texture, structure and bedding. The landforms and their soils well correspond with lithological structure. Cuesta and escarpment occur on the sandstone; different and rather narrow glacis levels (erosional terraces) on the siltstone, and finally low to high hills and small valleys, with narrow depositional terraces occur on the complex tuffs. In the same line, the occurrence of soils in different landforms is studied and it well corresponds with the parent material (lithology) and the geomorphology of the area. Soils comprise of different groups of Inceptisols, Alfisols, Ultisols, and Entisols. Natural vegetation is dominated by *Imperata cylindica.* The steep mountain slopes are mainly forested; although not everywhere of the good quality, and the low lands are traditionally used for growing rice in the wet season. Where irrigation water is available, such crops as mungbeans, soybean and tobacco are grown after the rice is harvested. Most of the sloping and steep lands have been deforested in the last 25 years and are now used for annual crop production, predominantly maize, and locally groundnuts, as a single cash crop, sometimes followed by mungbeans as a second crop. At present land use is mainly grassland, agricultural land and disturbed forest, in patches.

3. METHODOLOGY

Available data for the study included black and white aerial photographs of 1996 and colour aerial photographs of 2003 (scale 1:50,000), Landsat TM data of 1988 and topographic map at scale 1:50,000 (Map sheets 5242III and 5242IV, 1988). Aerial photos were interpreted to delineate land cover/use classes while Landsat TM data was used for image classification and for generating normalized difference vegetation index (NDVI). Aerial photos were interpreted under mirror stereoscope to delineate 5 land cover/ use classes (Undisturbed forest, disturbed forest, rangeland, agricultural land and miscellaneous land). The land cover/land use classes were verified in the field, and transferred onto the prepared orthophoto mosaic, to ensure high geometric accuracy.

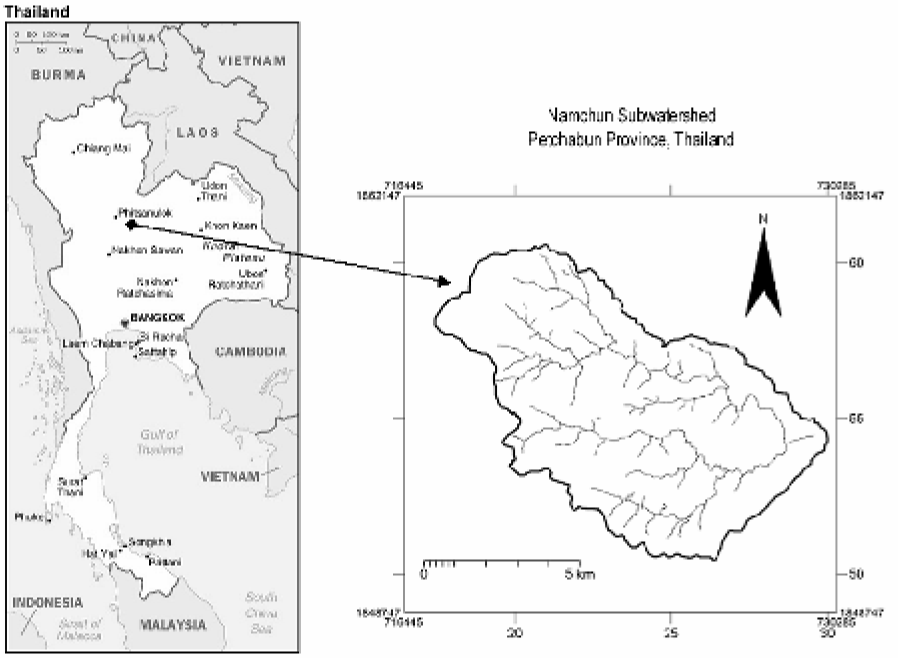

Fig. 1: Study area

The Landsat TM data was subjected to geometric correction using topographic map as the base. Sufficient ground control points were taken to reduce errors. Normalized difference vegetation index was calculated using TM bands 3 and 4 to detect areas of high and low vegetation cover. This was to assess density of forest cover and map forest degradation. Spectral classification, using training samples, was carried out to map land cover/ use classes. Overlay of land cover/ use maps from the years 1988, 1996 and 2004 shows the places where land use changes have taken place within the past 16 years. Land degradation assessment by means of erosion modelling and assessing land degradation features in the field shows the effect of land use changes. An assessment was made on the effect of land cover/land use changes on land degradation.

4. RESULTS AND DISCUSSION

The study of land use change approved the conclusion drawn from the geopedologic survey that the main cause of land degradation is deforestation. On bare surfaces and on maize cultivation fields rill erosion is common (Fig. 2). Besides, the study reveals that landslide takes place on deforested steep mountain slopes (Fig. 3). Soil loss assessment by applying erosion model (Morgan, 2001) shows that soil loss is highest in areas under annual crops (20 - 40 t/ha/yr) followed by orchards (10 – 20 t/ha/yr) and degraded forest and grazing land (<10 t/ha/yr). Soil loss assessment map is shown in Fig. 4.

Fig.2: Rill erosion is common on bare surfaces

Fig. 3: Landslides are common on deforested steep mountain slopes

As a result, the agricultural land decreased from 1,733 ha in 1988 to 765 ha in 2004 (15% decrease), and rangeland increased from 552 ha in 1988 to 2250 ha in 2004 mainly because agricultural lands were converted into rangeland (25% increase) (Table 1, Fig. 5). Land cover in rangeland is mainly bushes and grasses, which have protecting effect on bare surfaces against the impact of rainfall. However, there is sill continuous decline of primary forest, in 1988 dense

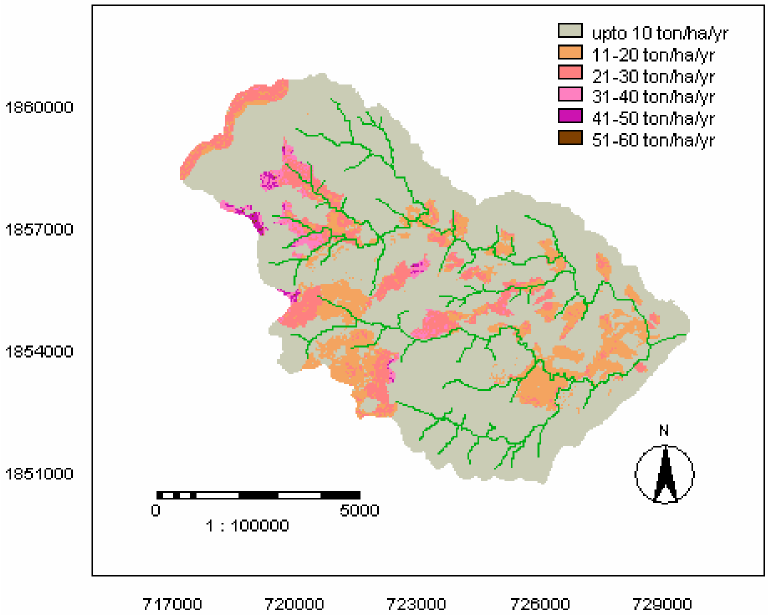

Fig. 4: Soil erosion map of Namchun subwatershed (Saengthongpinit, 2004)

forest cover was more than 50%, which decreased to 41% in 2004. Recently forest department started plantation of trees on rangeland. It is anticipated that mass movements will still continue to occur in case of excessive rainfall events but the damage will certainly be seen more on the cultivated areas on steep slopes.

Table 1: Land cover/ use types in 1988. 1996 and 2004

Land Cover/land use types	**Land cover/land use in 1988**		**Land cover/land use in 1996**		**Land cover/land use in 2004**	
	Hectares	**%**	**Hectares**	**%**	**Hectares**	**%**
Agriculture	1,733	25.15	1,254	18.20	765	11.10
Range land	552	8.02	1,708	24.79	2,250	32.66
Disturbed forest	624	9.06	-	-	836	12.14
Undisturbed forest	3,912	56.78	3,765	54.66	2,844	41.28
Miscellaneous			94	1.36	126	1.84
Road	43	0.63	44	0.63	44	0.63
Stream	25	0.36	25	0.36	25	0.36
Total	6,889	100	6,889	100.00	6,889	100.00

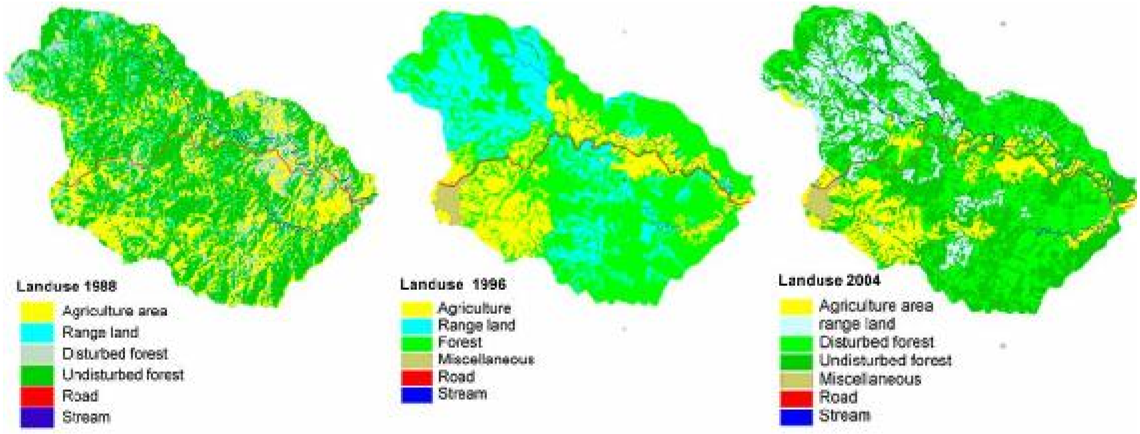

Fig. 5: Land cover/ land use in 1988, 1996 and 2004

5. CONCLUSION

The study shows the effect of deforestation on steep mountain slopes on land degradation. It also shows how monitoring of land cover/ use helps understand the dynamic of land degradation process in an area, as related to the geopedologic setting.

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