LAND USE / LAND COVER AND LANDSLIDES IN COONOOR AND KOTHAGIRI TALUKS OF NILGIRI DISTRICT- A GEOSPATIAL ANALYSIS

R. Neelakantan[*] and S.Yuvaraj[†]

ABSTRACT

The Nilgiri hill ranges of South India are prone for landslides due to deforestation which results in direct entry of rainwater into the fractures leading to final increase of pore pressure. The use of land for various purposes without much consideration of the hydrological conditions may have its impact on the occurrence of major landslides. Though the triggering factor is rainfall, a general credence is given to the changes in land use pattern. In this context, the present study attempts to document all the landslides/landslips of the study area using existing data, satellite data and field data. Next, the land use and land cover mapping was done using latest high-resolution data. To understand the causative factors of such landslides, the landslide data and land use data were analysed with GIS environment and the categories of land use patterns have been identified. Based on the number of landslides in each category, the land use pattern was calculated and threshold limits are identified. Then, raster images were developed for landslide vulnerable and invulnerable zones. Finally, based on the land use/land cover pattern categories, the entire area has been classified into high, moderate, and low vulnerable zones of landslide prone areas for the land use/land cover pattern concerned.

Key Words: Landslides, land use, GIS, Nilgris

Introduction

Landslide has become a fast spreading epidemic in mountainous systems of several parts of the world (Davison, 1889; Wentworth, 1943; Varne, 1958; Bartarya and Valdiya, 1989; Kelarestaghi, 2003). This phenomenon is being witnessed more in mountainous systems that witness faster urbanization, tourism and industrial developments. Hence, scientists, technocrats and planners have concluded that the anthropogenic activities in general are the prime contributors to landslides. Ramasamy and Muthukumar (2008) have indicated the various earth system processes and the related land systems *viz-a-viz* lithology, structure and tectonics including neotectonic, Geomorphology, Landuse/land cover dynamics and Hydrological dynamics. They assign different grades of Landslide vulnerability to the terrain systems and Rainfall and other anthropogenic activities. They act only as the triggering parameters for landslides (Ramasamy and Muthukumar 2008). The previous studies by Geological Survey of India (GSI) conclude that the main causes of landslides in the Nilgiri hills are excessive deforestation, obstruction to the normal drainage channels and frequent changes in landuse (Seshagiri *et. al*., 1982). During 1978 and 1979, over 300 landslides, large and small, mostly of debris nature occurred between Uthagamandalam and Coonoor, the major tourist spots in Western Ghats. It is clearly stated that, in the 1978 landslides, deforested slopes had failed, while the adjacent areas with similar topography and geology had withstood slide movement (Seshagiri *et. al*., 1982). The study by GSI also reveals that, about 70% of the original forest land has been

[*]Associate Professor, Department of Industries and Earth Sciences, Tamil University, Thanjavur - 613010 : email: neels2004@gmail.com

[†]Research Scholar, Department of Industries and Earth Sciences, Tamil University, Thanjavur - 613010

deforested, and put into cultivation and used for residential purposes. It is said that, nearly 2,00,000 tea saplings enter Gudalur taluk of Nilgiri district every day, presumably for planting on freshly cleared area (Bijoy *et. al.*, 2002). Also studies (Jha *et. al*., 2000) on deforestation and landuse changes in southern part of the Western Ghats showed a loss of 25.6% in forest cover between 1973 and 1995.

Study area

The study area covers about 525.94 sq. km in the northern and southern parts of the Nilgiri hill Ranges of Coonoor and Kothagiri revenue taluks of Nilgiri District. It is covered by the Survey of India (SOI) topographic sheet Nos. 58 A/11, 58 A/12, 58 A/14, 58 A/15, 58 E/2 and 58 E/3. It is geographically located between 76°40′ 26″ to 77° 00′ 52″ E longitudes and 11° 14′ 36″ to 11° 34′ 43″ N latitudes and shown in Fig. 1. It is bounded by Ootacamund town in the northwest, Coonoor town in the southeast and west and Kothagiri in the northeast and northern portion in the Moyar river. The study area is approachable by metal road and rail from Coimbatore via Mettupalayam.

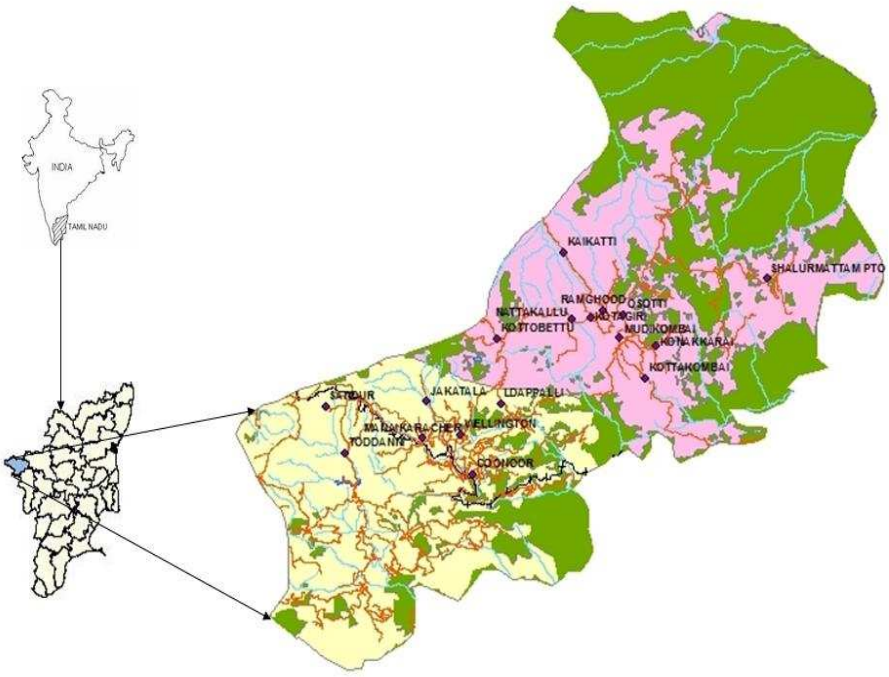

Fig. 1 Study Area

Methodology

The landslide/landslip map was prepared using existing landslide incidence data, satellite data and field data. The landslide/landslip distribution pattern has been generated in GIS data bases. Then, the land use/land cover (henceforth LU/LC) patterns were interpreted from IRS P6 satellite data. Raster images were created. Next, the GIS data of LU/LC was overlaid with landslide/landslip incidence data. Then they were analyzed independently for their maximum, minimum, mean, median and mode by drawing histograms. The thresholds were established and GIS images were generated displaying landslide vulnerable and invulnerable zones. This was prepared on the basis of incidence of number of landslide/landslip in each zone with the input of LU/LC pattern. The landslide maxima were correlated with land use data and the control of land use pattern was evaluated. Based on the frequency of landslide/landslip, the LU/LC category was buffered out and final landslide zonation was done which compressing most, moderate and least vulnerable zone with special reference to LU/LC pattern concerned.

Inventory of Landslide

For inventory of the landslides/landslip, at first, the study area IRS P6 LISS 4 high resolution digitally enhanced satellite data has been processed and buffered out of the study area. From the same, based on the tonal variation, slope variation, fresh and old vegetation data has been critically analyzed and the landslide locations were identified.

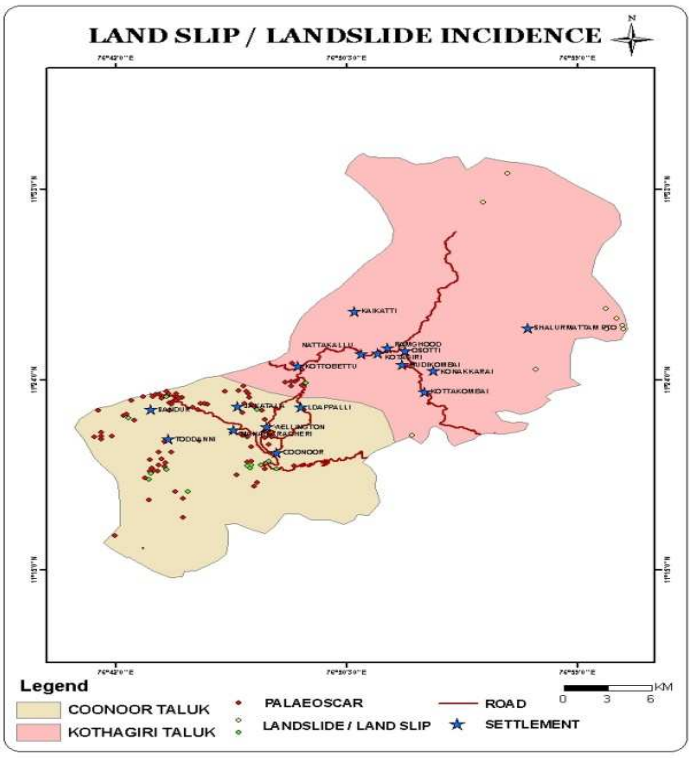

Fig. 2 Landslide/slip incidences

Then, ground truth verification was made through the field survey to confirm the landslide/landslip incidences. Secondly, the existing landslide incidence data was collected and database was created. During the field survey, it was observed that most of the landslide/landslip incidences occurred in and around the ghat road alignments, either along road side or adjacent the areas. After duly analyzing the satellite and existing data on landslides and field survey the final landslide/landslip incidences map were prepared and the same were converted into digital format in Arc GIS environment is shown in Fig. 2. In the study area, 107 landslides/landslip incidences were identified and mapped.

Landuse/Land cover Mapping

Land use refers to human activities and various uses which were carried on the land. Land cover refers to natural vegetation, water bodies, rock, soil, artificial cover and other factors due to land transformation. The vegetation cover improve the stability of slope when compare to base soil. For LU/LC mapping, the visual interpretation was done using IRS P6 satellite data and was classified as below (Fig. 3).

Forest plantation

Plantation in the forest area includes eucalyptus, wattle, and pine. Each variety is seen in separate plots. Where two or more of them are found mixed in a single plot they are included in the mixed plantation. The same has been interpreted and classified as forest plantation and it occupies an area of 143.938 sq. km.

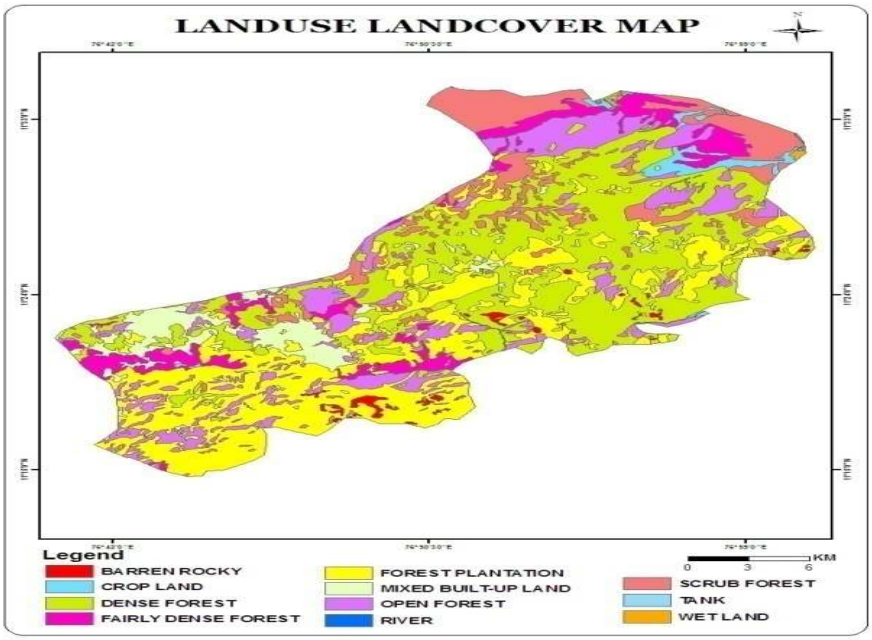

Fig. 3 Land Use / Land Cover

Built-up land

An area of human habitations developed due to non agricultural use and that which has a cover of buildings, transport, communication, which in association with water vegetation vacant land. There are varieties of land use in the area under study. But for the sake of convenience, they have been grouped into built-up land category. The difference in tonal and textural variations in the imagery was recognized. It occupies an area of 103.88 sq. km.

Reserved forest

The remaining areas of forest land, outside the areas of eucalyptus, wattle and other plantation are mapped under reserved forests categories. It occupies an area of 264.18 sq. km.

Dense forest

It is a high land and associated with hilly land forms. It is observed as dark red to bright red colour, large size, fine texture and distinct pattern in the imagery. The same has been compared with topographical data and buffered out as dense forest categories. It occupies an area of 165.7 sq. km.

Fairly dense forest

Almost similar pattern as above has been observed as dense forest and in the colour and texture has a slightly variation. Such areas are mapped as fairly dense forest areas and it occupies 37.32 sq. km.

Scrub forest

Within the forest area, the areas with flat land to upland and also hill slopes with light brown colour, irregular size, medium to rough texture and irregular pattern are the scrub forest. It occupies an area of 61.2 sq. km.

Crop land

Land use for agriculture having pattern of fields with dark grey tone, varying size, irregular shape, relatively fine texture are the crop lands in the study area. It occupies an area of 8.23 sq. km.

Barren rock

Inside the forest and open high land with linear pattern, fine texture, and regular shape white grey tone the Barren rocks were observed. In the study area the barren rocky areas occupy 4.91 sq. km.

Wet land

The low lying flat lands, with distinct pattern, fine texture, irregular shape all size varies and bluish to red colour are mapped as wet lands and it occupies 0.81 sq.km.

Landuse /Landcover Pattern and Landslides

To evaluate the LU/LC pattern over landslides first GIS based spatial analysis was carried out. For which the landslide/landslip incidence was superimposed with LU/LC data, using GIS overlay function and the landuse verses landslide pattern was generated. It was observed that, the distribution of landslide/land slip incidences were found in forest plantation, mixed built-up land, dense forest, fairly dense forest, open forest and scrub forest in descending order. But for the barren rock, crop land and wet land

categories the landslide/land slip incidences were not found. The same has been tabulated (Table 1).

Table 1 Distribution of Landslide / Land slip incidence in Landuse / Land cover pattern

Land Use / Land Cover	Number of Landslide Locations
Forest Plantation	31
Mixed Built-Up Land	30
Dense Forest	21
Fairly Dense Forest	11
Open Forest	9
Scrub Forest	5
Barren Rocky, Crop Land, River, Tank and Wetland	Nil

Results and Discussion

The study reveals that the forest plantation areas have most number of landslide/landslip incidences. Next in the order are built-up land, the dense forest and fairly dense forest areas. In order to prepare hazard zonation mapping, the area having more than 25 landslide incidences which fall in the categories built-up land and forest plantation areas were buffered out as highly vulnerable zones. Next, the areas having more than 10 landslide/land slip incidences of LU/LC categories were buffered out as moderately vulnerable zones and less than 10 numbers of landslides incidences of LU/LC categories areas were buffered out as low vulnerable areas. Finally the study area was categorized based on the landslide/landslip incidence versus concerned LU/LC pattern into 3 classes such as highly vulnerable, moderately vulnerable and low vulnerable areas and shown in Fig. 4. The GIS based spatial analysis shows that LU/LC categories have greater control over the landslides/landslips. Already a major portion of the original forest land have been deforested and put into cultivation of vegetable, crops, and tea and eucalyptus plantations. About 10% of areas are found used residential purposes. These indicate deforestation is the major cause for landslides. For example, the landslide/landslip in vegetables/crop areas are also triggered by slopes. The LU/LC *vis a vis* landslides reveals the land use for vegetable crops, forest plantation and residential purposes has certainly promoted the incidence of landslides. The undisturbed natural trees and short vegetations have really prevented the possible landslides in these areas. It is thus established that deforestation and conversion of land for agriculture, plantation is one of main causes for such landslides. However, many landslides are noticed in the forest plantation areas too. This study was attempted on preliminary basis, but warrants detailed studies.

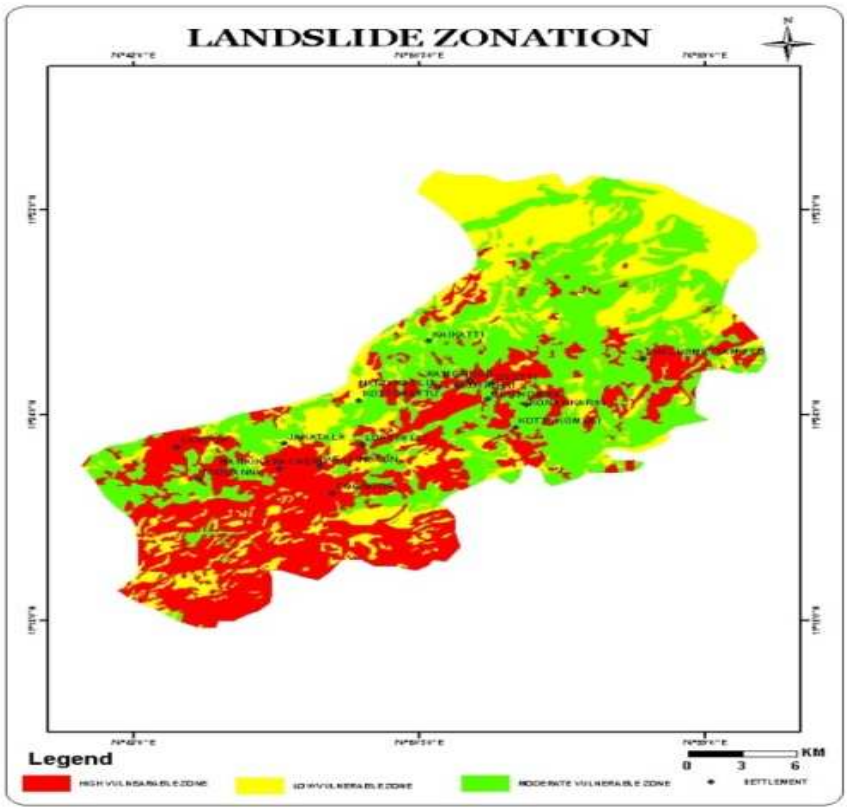

Fig. 4 Landslide Zonation

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