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Research Article

REMOTE SENSING AND GIS SPATIAL MAPPING AND MONITORING LAND USE AND LAND COVER CHANGES IN PARTS OF KOVAI AND NILGIRIS DISTRICT, SOUTH INDIA

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ABSTRACT

In this present study, maximum likelihood supervised classification and post-classification change detection techniques were applied to Landsat TM image acquired in 1999 and recent land use/land cover estimates from Resourcesat-2 (2013) image.Respectively, to map land cover changes in parts of Kovai and Nilgiris District, South India. A supervised classification was carried out on the two images individually with the aid of ground truth data. Using ancillary data, visual interpretation and expert knowledge of the area through GIS further refined the classification results. Post-classification change detection technique was used to produce change image through cross-tabulation. Changes among different land cover classes were assessed. However, the result of the work shows a rapid change in the study area forest land between 1999 and 2013 while the periods between 1999 and 2013 witnessed a reduction in this class. It was also observed that all the land use/land cover features are changed by natural hazards (landslide) and manmade impact (rapid growth of population and increasing industries). The main causes of land degradation in the study area are removal of vegetation. This problem needs to be seriously studied, through multi-dimensional fields including socioeconomic, in order to preserve the newly reclaimed land and increase food production.

INTRODUCTION

Land use maps are the basic tools for the planning and show various artificial uses of land. The classification is useful for the present and in future planning. The term land use relates to the human activity associated with a specific piece of land, while land cover relates to the type of features present on the subsurface of the earth. Urban buildings, lakes, residual hills, rocky out crop are all examples of land cover types. Agricultural and mining activities are a few land use categories. For example, vegetation in the form of agricultural crop and forest are classified based on the contextual evidence.

The landuse/land cover pattern of a region is an outcome of natural and socio-economic factors and their utilization by man in time and space. Land is becoming a scarce resource due to immense agricultural and demographic pressure. Hence, information on landuse / land cover and possibilities for their optimal use is essential for the selection, planning and implementation of landuse schemes to meet the increasing demands for basic human needs and welfare. This information also assists in monitoring the dynamics of landuse resulting out of changing demands of increasing population. There has been a worldwide increasing awareness and studies on landuse and land cover changes in the last few decades. And Landuse and land cover change has become a central component in current strategies for managing natural resources and monitoring environmental changes (Okude, 2006). So this makes landuse mapping and change detection will provide relevant inputs in the direction of decision making for implementation of appropriate policy responses (Fasona and Omojola *et al*., 2005). So this paper examined the significance of landuse and land cover changes for different periods in Nilgiris district and their contributions to the emerging patterns in global land use and land cover studies.

Land cover change has been described as the most significant regional anthropogenic disturbance to the environment (Roberts *et al*, 1998). In essence both land use and land cover changes are products of prevailing interacting natural and anthropogenic processes by human activities. Studying land use dynamics is essential in order to examine various ecological and developmental consequences of land use change over a

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period of hiatus. Following are the key points that lead to dedicated study on landuse/land cover change. Landuse and land cover change with land degradation are as a result of motivated by the same set of proximate and underlying factor elements to environmental processes, change and management through their influence on biodiversity, heat and moisture budgets, trace gas emissions, carbon cycling,livelihoods, a wide range of socio-economic and ecological processes (Desanker *et al*., 1997; Verburg *et al*., 2002; Verbug *et al*., 2000; Fasona and Omojola, 2005).

Application of remotely sensed data made possible to study the changes in land cover in less time, at low cost and with better accuracy (Kachhwaha, 1985) in association with Geographical Information System (GIS) that provide suitable platform for data analysis, update and retrieval (Star *et al*. 1997; McCracker *et al*., 1998; Chilar 2000). Spaceborne remotely sensed data may be particularly useful in developing countries where recent and reliable spatial information is lacking (Dong *et al*. 1997). Remote sensing technology and geographic information system (GIS) provide efficient methods for analysis of land use issues and tools for land use planning and modeling. By understanding the driving forces of land use development in the past, managing the current situation with modern GIS tools, and modeling the future, one is able to develop plans for multiple uses of natural resources and nature conservation. The change in any form of land use is largely related either with the external forces and the pressure built up land within the system (Bisht and Kothyari, 2001).

Study Area

Landslide study was an executed in part of Kovai and Nilgirisdistricts of the Western Ghatsregion in Tamilnadu. Study area map prepared from Survey of India (SOI) Toposheets No. 58 A/11 and 15 published by the Survey of India in 1: 50,000 scales. The total area an about 417.17 km^2. The highway is an extension of NH-67 connecting the states Tamil Nadu and Karnataka. The study area lies in between 76°40'29.16" to 76°56'25.10 E longitudes and 11°25'18.256'' to 11°17'32.26" N latitudes. The elevation ranges between 280 m and 2620 m above MSL. (Fig.1)

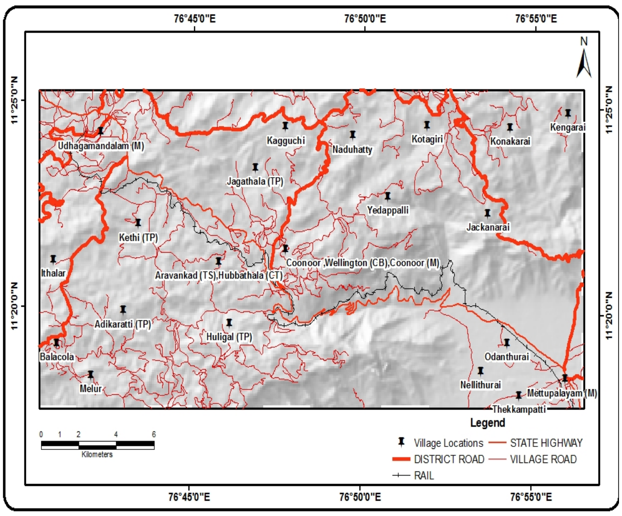

Fig. 1 Study area map

Data Products

The Survey of India Toposheet map Nos. 58 A/11 (1970) & A/15 (1970) and Resourcesat-2 (May, 2013) LISS IV MX path 102 row 065-D and spatial resolution is 5.8m. The spectral resolution is 0.52-0.59 (B2), 0.62-0.68 (B3) and 0.77-0.86 (B4) include geocoded FCC digital data was imported from CD to ERDAS system as an image format.

MATERIALS AND METHODS

The Indian Remote Sensing (IRS) Resourcesat-2 Satellite data of 23 May 2013 were purchased from National Remote Sensing Centre (NRSC). Landsat TM image acquired in 1999 collected from global land cover facility (GLCF) website. The satellite data was registered with reference to Survey of India (SOI) topographical sheets at 1:50,000 scale in the ERDAS Image processing software Data pre analysis is mainly for geometric correction of the satellite images and for some ground truth information. Finally, ground information was collected between 1999 until 2013 for the purpose of supervised classification and classification accuracy assessment.

Image classification

Land use/Land cover classes are typically mapped from digital remotely sensed data through the process of a supervised digital image classification (Campbell, 1987; Thomas, Benning, &Ching, 1987). The overall objective of the image classification procedure is to automatically categorize all pixels in an image into land cover classes or themes (Lillesand& Kiefer, 1994). Supervised classification was done using ground checkpoints and digital topographic maps of the study area. The area was classified into nine classes: Agricultural land, Barren land, Built-up-Land, Crop Land, Evergreen forest, River, Semi evergreen forest, Waste land and Water bodies.

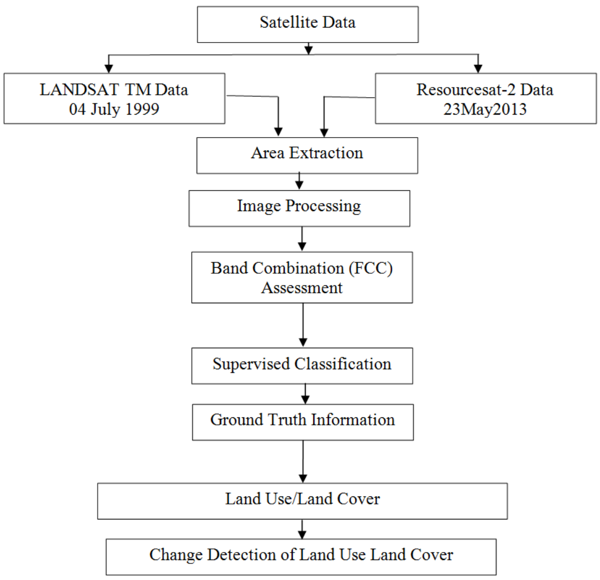

Fig. 2 Flow Chart of Change Detection Studies Methodology

Change Detection Analysis Map Preparation

The procedure adopted in this research work forms the basis for deriving of land use/land cover in different year image interpretation and correlation works were made. The methodology is shown in flowchart Fig. 2. The error matrix also used in this study to assess the accuracy assessment.

RESULT AND DISCUSSION

Land covers classification (1999)

Supervised classification was done with Landsat TM data for the year 1999 (Fig. 3) and the resulting spectral clusters were mostly mixed. Agriculture land has been well separated with most of the other classes, but it was mixed with forest. The agriculture land was the confused class and was mixed with plantation and forest. But the same was well classified in the 1999 satellite data. The settlement was another most confused class and was mixed with all other classes. Forest land was the most dominant class covering an area of 228.82 Km^2 while waste land, water bodies and built-up land covered 1.21 Km^2, 0.98 Km^2 and 11.35 Km^2 of the total study area (Fig. 3).

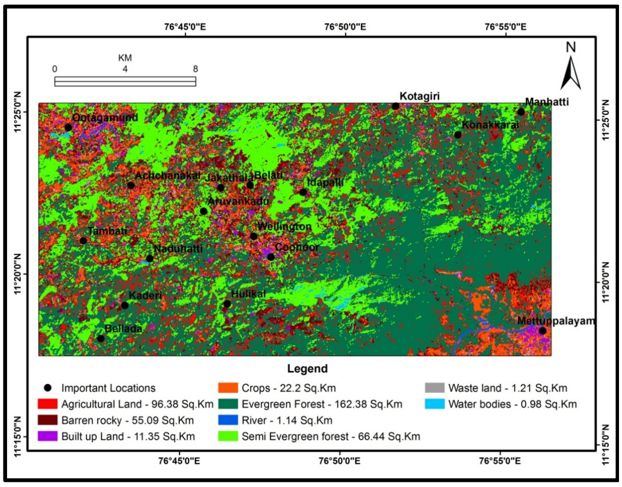

Fig. 3 Land use/land cover map of 1999 – Landsat TM data

km^2, 134.23 Km^2, 3.34 Km^2, 94.96 Km^2, 1.36 Km^2 and 2.93 km^2 of the total study area (Fig. 4).

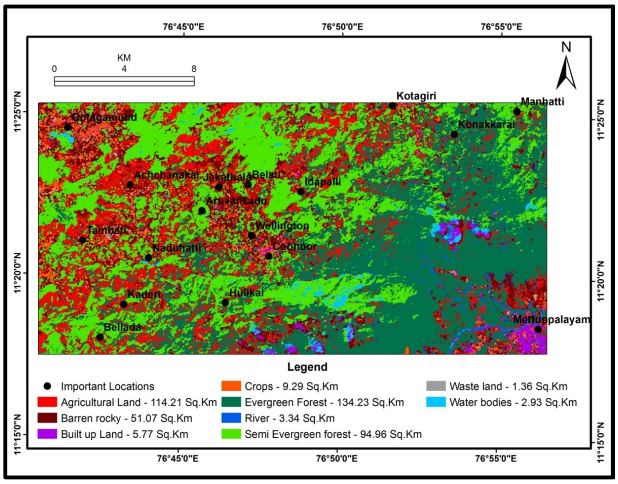

Fig. 4 Land use/land cover map of 2013 – Resourcesat-2 data

Land use/Land covers Change Matrix Analysis (1999 to 2013)

Remote sensing data and GIS provide opportunities for integrated analysis of spatial data. Cross-tabulation performs image cross-tabulation in which the categories of one image are compared with those of a second image and tabulation is kept of the number of cells in each combination.

Post-classification change detection technique was carried out, through cross-tabulation GIS module, for the classification results of 1999 and 2013 images in order to produce change image (Figs. 5a, 5b, 5c, 5d and 5e) and statistical data about the spatial distribution of different land cover changes and non-change areas (Table 1).

Table 1 Land Cover Change Matrix Analysis for 1999 - 2013

1999	Barren Rocky	Agriculture Land	River	Water Body	Build up Land	Crop Land	Waste Land	Evergreen Forest	Semi Evergreen Forest	1999 Total
Barren Rocky	20.34	14.92	0.67	0.27	0.59	1.60	0.16	5.82	10.72	55.09
Agriculture Land	9.19	48.36	0.76	0.22	0.46	1.47	0.21	27.10	8.62	96.39
River	0.17	0.09	0.41	0.05	0.13	0.23	0.001	0.06	0.01	1.15
Water Body	0.012	0.004	0.008	0.70	0.003	0.002	Nill	0.007	0.25	0.98
Build up Land	3.41	2.13	0.04	0.03	2.36	2.40	0.18	0.37	0.44	11.36
Crop Land	7.48	8.63	0.32	0.02	1.08	2.96	0.59	0.98	0.13	22.19
Waste Land	0.44	0.27	0.002	0.001	0.14	0.17	0.17	0.01	0.004	1.207
Evergreen Forest	6.94	36.95	0.96	0.61	0.81	0.41	0.05	93.47	22.18	162.38
Semi Evergreen Forest	3.09	2.86	0.15	1.04	0.22	0.05	0.003	6.42	52.61	66.44
2013 Total	51.072	114.21	3.32	2.94	5.79	9.29	1.36	134.23	94.96	417.19

Supervised classification was done with Resourcesat-2 data for the year 2013, and the resulting spectral clusters were mostly mixed. Fig. 4 reveals that crop land has been well separated with most of the other classes, but it was mixed with plantation and fallow land. The waste land was the confused class and was mixed with fallow land, plantation and wasteland. But the same was well classified in the 2013 satellite data. The settlement was another most confused class and was mixed with all other classes. Forest land was the most dominant class covering an area of 229.19 Km^2 while barren land, built-up land, crop land, evergreen forest, river, semi evergreen forest, waste land, water bodies covered 51.07 Km^2, 5.77 km^2, 9.29

The land cover change matrix of the study area from 1999 to 2013 is shown in Figs. 5a, 5b, 5c, 5d and 5e and Table 1. From this table, it could be found that there was a considerable change (46.93% of the total land area) in the land use in the study area during the period. Due to 'Landslide Hazards" barren rocky was altered to agricultural land of 14.92 $km^2$and Evergreen forest of 5.82 km^2in the study area.

Agricultural land(Fig.5a) transformed tobarren land an area of 9.19 $km^2$and Evergreen forest and Semi Evergreen forest of 27.10 $km^2$and 8.62 $Km^2$where Konakkarai, Mettupalayam, Coonoor and Hulikal are the major changing locations.

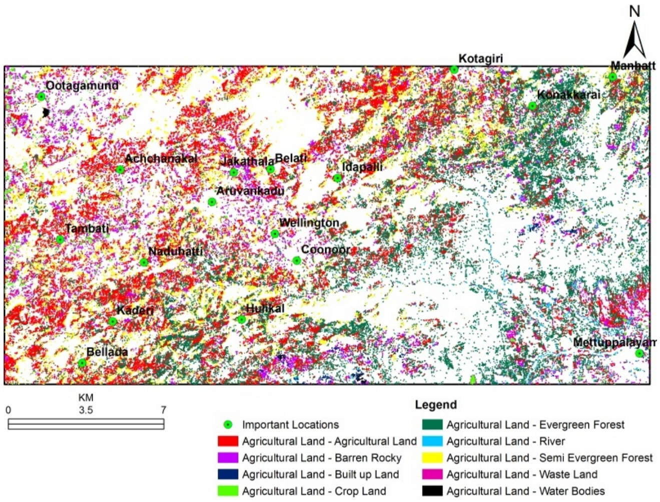

Fig. 5a Land use/land cover change – Agricultural land 1999 to 2013

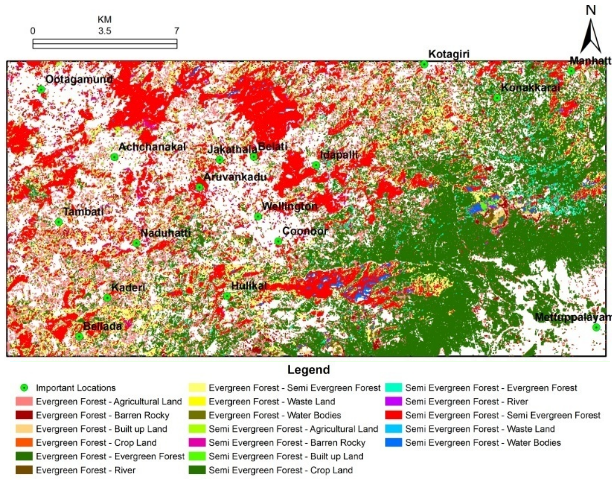

Fig. 5b Land use/land cover change – Forest land 1999 to 2013

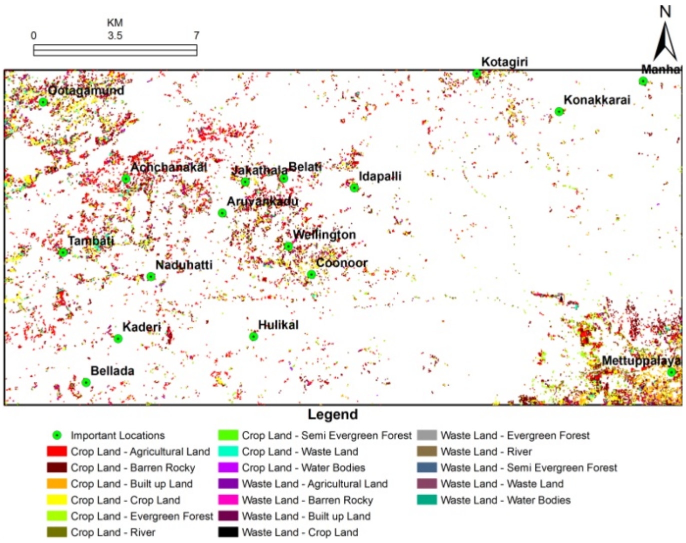

Fig. 5c Land use/land cover change – Crop and waste land 1999 to 2013

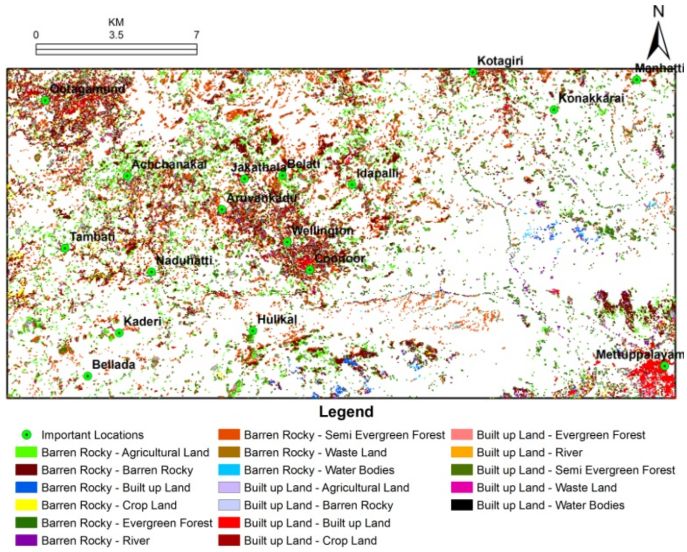

Fig. 5d Land use/land cover change – Barren and Built up land 1999 to 2013

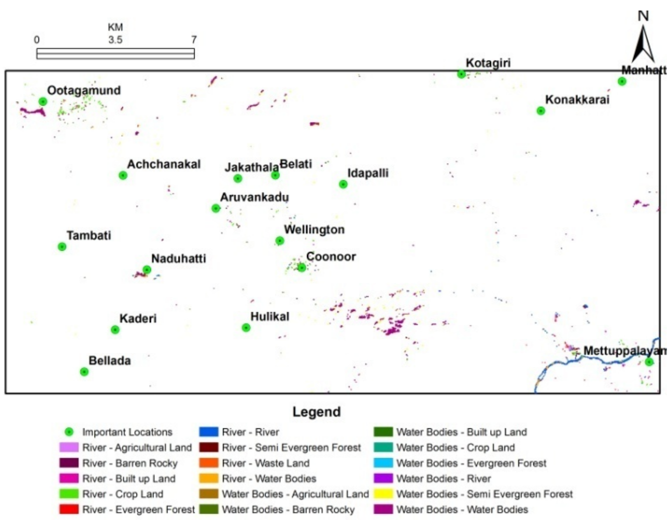

Fig. 5e Land use/land cover change – River and Water bodies 1999 to 2013

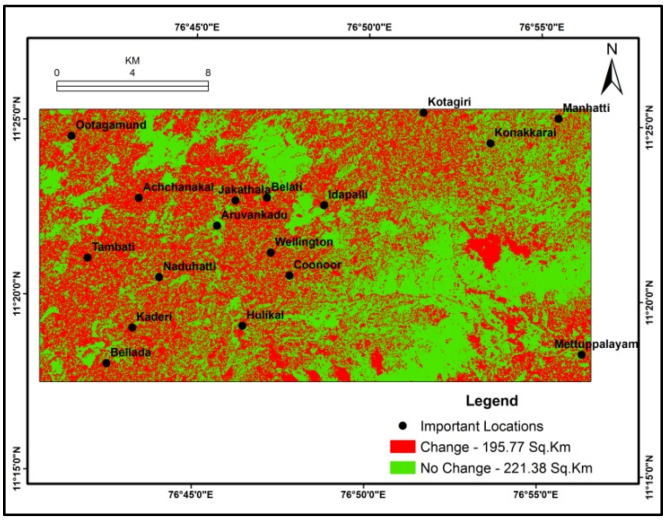

Fig. 6 Integration Map of Land use/Land covers 1999 and 2013 - Change No Change

River and water bodies (Fig. 5e) are small changes of during the study period due to landslide soils. Many places are occurs in debris or landslides, damage of the settlements (Fig.5d) during study period. After landslide that places are reproduced the other landforms like plantation, barren land, crop land and waste lands.

The crop land (Fig. 5c) was converted into build up land of 1.08 km^2 due to real estate promotion and industrial development activities followed by forest (0.98 km^2) in the area of study area. Evergreen and semi evergreen forestland (Fig. 5b) was also changed to agricultural land (36.95 Km^2 and 2.86 Km^2 as well as built-up land category of (0.81 Km^2 and 0.22 km^2 due to increasing of population.

The above said features are belongs to agriculture land categories. That is, increasing population density was the main reason for the reduction of agricultural land. The rate of agricultural land changed into unused land was noticeable during this period.

Comparison of Land covers Classification (1999 and 2013)

The results of land use/land cover assessment based on digital image interpretation for the Landsat TM satellite data (1999) and Resourcesat-2 satellite data (2013). These two years land use/land cover maps were compared polygon by polygon. A post-classification comparison method was used for comparisons of images acquired on different dates to produce "from - to" change maps (Jensen, 1996; Kumaravel *et al*. 2013 and Vijayakumar *et al*. 2015). Apart from change and no change information, the classification comparison also resulted in a change matrix that provided "from - to" change information. The post-classification change detection can reveal not only the nature of change (e.g., from to changes) but also every possible type of change, even though the detected changes are subject to the accuracy at which each cover is mapped in the respective land cover maps (Gao, 2009 and Gurugnanam *et al*. 2012).

The indicated that both land use/land cover conversion and land use/land cover modifications were significant between 1999 and 2013. The accuracy of a change map is equivalent to the product of the classification accuracies of the thematic maps used to create the change map (Klemas, 2001; Mas, 1999). Yuan *et al*., (2005) and Arunkumar, 2015 suggested a more rigorous approach for determining the accuracy of change maps is randomly sample area classified as change and no change and use reference data to determine whether the change was correctly classified. Fig. 6 results that 195.77 Km^2 area fell in no changes during the study period of 1999 to 2013. Most of the study area changes into other feature from the native features due to the natural hazards.

CONCLUSION

The objectives of this study were to provide a recent perspective for land cover types and land cover changes that have taken place in the last fourteen years, to interpretation of supervised classification using ERDAS image processing and to examine the capabilities of integrating remote sensing and GIS in studying the spatial distribution of different land cover changes. In this study, Landsat TM (1999) and Resourcesat-2 image (2013) were used for identification of land use/land cover details. It is observed that the area under study has considerably changed between a time periods of 1999 - 2013. Integrating GIS and remote sensing provided valuable information on the nature of land cover changes especially the area and spatial distribution of different land cover changes.

However, the result of the work shows rapid changes in the study area forest land between 1999 and 2013 while the periods between 1999 and 2013 witnessed a reduction in this class. It was also observed that all the land use/land cover features are changed by natural hazards (landslide) and manmade impact (rapid growth of population and increasing industries).The main causes of land degradation in the study area are removal of vegetation. This problem needs to be seriously studied, through multi-dimensional fields including socioeconomic, in order to preserve the newly reclaimed land and increase food production.

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