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Application of Remote Sensing Techniques in Forest Cover Mapping

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Abstract: ***Forest cover is an important natural resource which should be conserved on priority basis for sustainable environmental management; however, escalating levels of anthropogenic disturbances have exhorted tremendous pressure on these forests. Depletion of forest has directly affected many ecological, social and economic consequences including extinction of biotic communities leading to loss of biodiversity, soil erosion, global warming and thereby loss of income to forest dwellers. In the present study, forest cover mapping of Western part of Kolhapur district for the year 1989 (TM), 1999(ETM+) and 2012(LISS III) was attempted by digital image processing technique using ERDAS IMAGINE 9.1. The study elucidated three main classes within study region viz. Very dense forest, moderately dense forest and open forest. Result showed that, in 1989 total forest cover was 202675.3 ha, 159376.9 ha in 1999 and 119572.1 ha in 2012. These values of forest cover area indicated decreasing trend in forest cover and thus warrants remedial actions to conserve this vital resource.***

Keywords: Remote sensing, forest cover mapping

1. Introduction

Forest attract attention of many researchers due its potential wealth of biological, mineral, wildlife, medicinal and aesthetic values in addition to the tourism. The term “forest” is defined as “generally, an ecosystem characterised by a more or less dense and extensive tree cover,” and “a plant community predominantly of trees and other woody vegetation, growing more or less closely together,” (Ford-Robertson, 1971). Forest cover change (FCC) was highly relevant to the understanding of the global carbon cycle, changes in the hydrological cycle, an understanding of the causes of changes in biodiversity and in understanding the dependency of rates of degradation and causes of land use change (Band, 1993; Lal, 1995; Houghton, 1998; Pandey, 2002).

Deforestation occurred for many reasons: trees were cut down to be used or sold as fuel (sometimes in the form of charcoal) or timber, while cleared land was used as pasture for livestock, plantations of commodities, and settlements. The removal of trees without sufficient reforestation had resulted in damage to habitat, biodiversity loss and aridity. It had adversely impacted biosequestration of atmospheric carbon dioxide. The above facts tempted us to undertake detailed study using remote sensing application.

2. Study Region

The area selected for the study covers Western part of Kolhapur district and incorporate western part of Chandgad, Ajra, Bhudargad, Radhanagri, Gaganbawada, Panhala and Shahuwadi tahsils. It lies between 15^0 72’ to 17^0 12’ North latitude and 73^0 64’ to 74^0 28’ East longitude covering an area of 1657 sq. kms. This area represents diversified physiography, western part is covered by hills while eastern part is represented by basaltic plateaus. Through the western part of study area Tamraparni, Hiranyakeshi, Vedganga, Dudhaganga, Bhogawati, Tulshi, Kumbhi and Kasari river are flowing. Western part of study area is dominated by red soil where as eastern part is covered by black soil. Seasonal rainfall ranges between 6000 mm in the West to 1150 mm in the East. Average temperature lies around 20^0C in winter and 35^0C summer season. The daily range of temperature fluctuation noticed in this area is large.

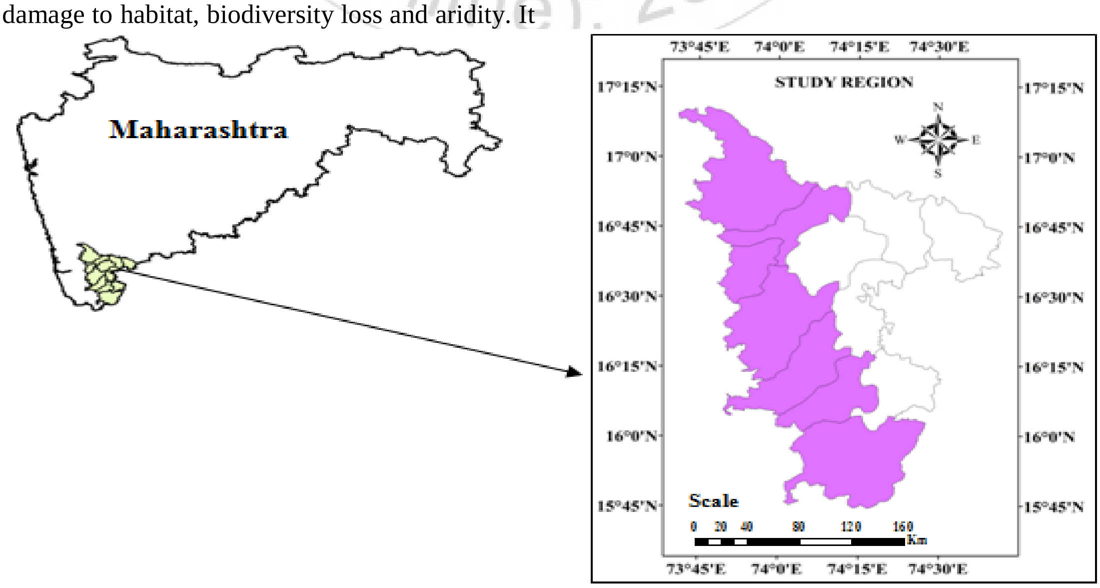

Figure 1: Location Map of Study Region

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3. Data Sources

The base map of the study area was prepared from the Survey of India 1:50,000 scale topographical sheets. To make the forest cover mapping of the study area, three images from the satellite LANDSAT TM and ETM + and IRS R2-LISS III for the years 1989, 1999 and 2012 respectively were used. To cover whole study region data from three different paths and rows data was used for all sensors. The digital satellite images of the year 1989-TM and 1999-ETM+ was obtained from the Earth Science Data Interface (ESDI) at the Global Land Cover Facility (GLCF), a NASA-funded member of the Earth Science Information Partnership at the University of Maryland. IRS-R2 LISS-III, digital satellite image used for the study was procured through National Remote Sensing Centre (NRSC), Hyderabad.

4. Methodology

Methodology deals with field survey, pre-processing (Georefrencing and radiometric correction) of satellite data, supervised classification, extraction of forest types by export data tool from ArcGIS 10.2 and NDVI calculation. Detailed information about methodology, used for deforestation studies, is shown in Figure No. 2

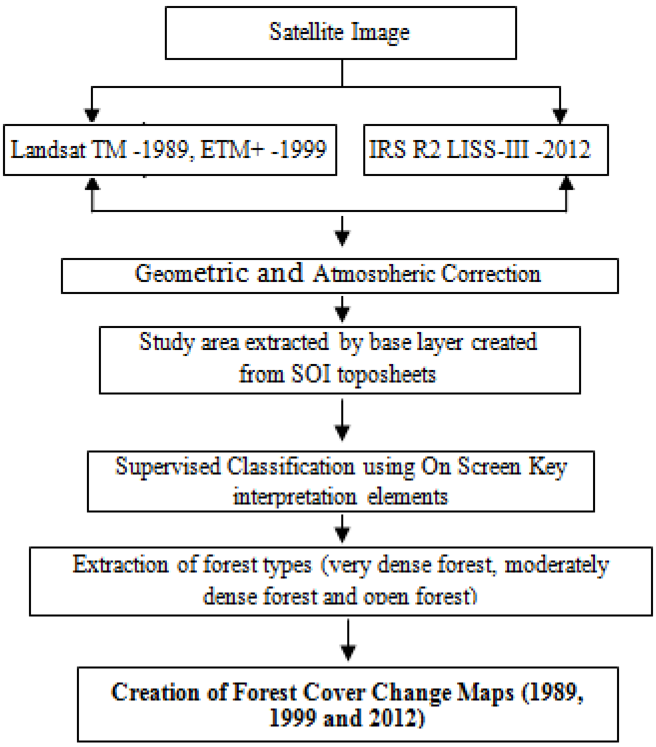

Figure 2: Flow chart of methodology

4.1 Field Survey

Field survey was carried out for deforestation in January 2012 and November to December 2013, using Global Positioning Systems (GPS). 77 villages from Chandgad, Ajra, Bhudargad, Radhanagari, Gaganbavda, Panhala, and Shahuwadi tahsils were selected for field survey by applying 10% random sampling method. Minimum 5 questionnaires were filled in each village by local people as well the person who gave his/her land for government scheme like dam construction. Due care was taken to acquire dependable data through reliable sampling. During the survey some people did not given sufficient information about forest cutting due to the fear of action on them for wood cutting from forest office. In some part of study region deforestation was attempted for rehabilitation of settlements which lost their land in dam construction in the suitable sites.

4.2 Pre-processing of Satellite data and toposheets

The Satellite digital images (Landsat TM -1989, ETM+-1999 and IRS R2 LISS-III -2012) were already georeferenced with UTM projected coordinate system, datum and spheroid as WGS 1984 and zone 43 North. To cover whole study region, three different path and row satellite data were used that is 146/049, 147/048 and 147/049 for TM and ETM and 095/061, 096/061 and 096/062 for LISS III. All the three paths and rows satellite data were mosaiced using Mosaic pro tool in ERDAS IMAGINE 9.1. Path/Row 147/049 of TM and ETM sensors image having error regarding to the colour, for this error correction the Image dodging option was used which was followed by colour balancing and histogram matching techniques were used on dodged image during mosaic procedure.

The toposheets were georeferenced (which is used to create base layer) by using four corner points of the toposheets were taken as the Ground Control Points as there latitudes and longitudes were already known. Georefrencing procedure was done using ArcGIS 10.2 software environment. All 19 toposheets were georefrenced using Universal Transverse Mercator (UTM) projected coordinate system with same datum and spheroid i.e. WGS 1984 and zone 43 North with Nearest Neighbour resampling techniques. Then all toposheets were mosaiced together using 'Blend' mosaic operator and 'Match' mosaic colormap mode. Study area was digitized along tahsil boundary which was found in Survey of India (SOI) toposheets, then this AOI (Area of Interest) overlapped over mosaiced satellite images of TM, ETM and LISS III images to extract study region satellite images for 1989, 1999 and 2012 respectively.

4.3 Forest Cover Classification

In order to classify the satellite images of TM, ETM+, LISS III, three classes were delineated namely, Open Forest, Moderate Dense Forest and Very Dense Forest. Using the area of interest (AOI) tool and region growing properties with 10 Euclidian distance from ERDAS IMAGINE 9.1 to select the training areas, generated spectral signatures that matched each spectral class from satellite image and assigned class names for the signatures. The success of supervised classification depended upon the training data used to identify different classes. Hence selection of training data had to be done meticulously keeping in mind each training data set had same specific characteristics included number of pixel, size, shape, tone, texture, location, number of training areas, placements, uniformity, idealised sequence for selecting training data, feature selection etc.(Chanda A. M. and Ghosh S. K., 2006). Nearly 90 to 145 training sites (AOI) created for each class to get best results in classified image. Signatures of each class that were significantly

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different in spectral reflectance values were discarded while the signatures that had similar values were merged. Maximum Likelihood Classifier (MLC) algorithm was used to perform final classification based on the probability of a pixel belonging to a specific group. Since conventional per-pixel image classification regularly produced ‘salt and pepper’ effects, a majority filter was frequently used to reduce these effects (Lu and Weng, 2007). A majority statistical 3× 3 filter was applied to the results from the supervised classification from study area.

5. Result

5.1 Field Survey

According to field survey, maximum people used forest wood as local fuel, in addition to prepare Broom, Erley for farmers used during work in rainy season, to store agricultural products like Rice, Nachani, Ground nut, Maize and Cereals etc. In the South-Western part of the study region including Chandgad and Ajra tahsil some zooming cultivation practices were found by removing forest. Some farmers converted their private forest area for commercial tree plantation like Nilgiri, Shisam, Sagvan, Cahewnut, Mango, etc. Government scheme also played vital role in deforestation. Dam construction under various development projects removed forest cover during 1995 to 2010, around the suitable sites and for the rehabilation of the effected villeges (who loss their farmland and village area in dam construction). According to field survey 2 to 3 % forest wood has been used by people for fuel and other domestic use. Private plantation increased during last two decades had important role in deforestation, proved to be dangerous for environment, thus necessitated proper forest management strategy.

5.2 Forest Cover Change

Three classes were created as open forest, moderately dense forest and very dense forest through supervised classification technique.

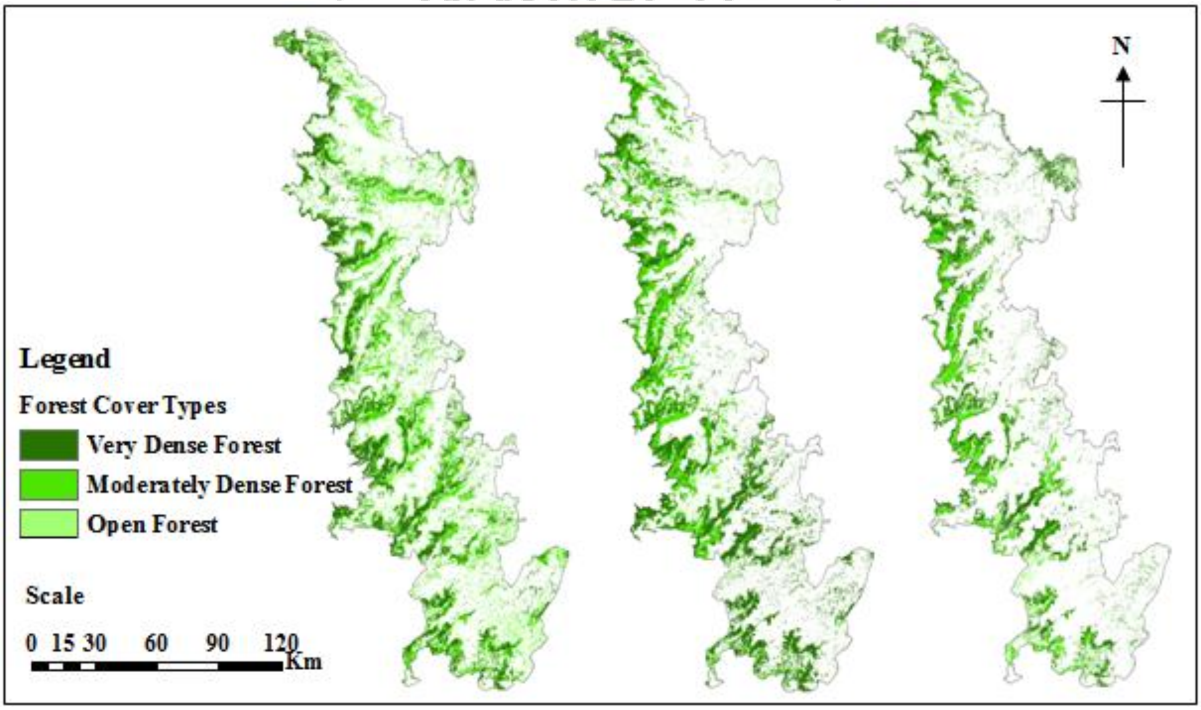

Figure 3: Forest cover mapping from 1989 to 2012

Selective data of forest cover for the year 1989, 1999 and 2012 are tabulated in Table No. 1

Table 1: Forest Cover area in Hectares

Year → / Class Name ↓	1989	1999	2012
	Area in hectares	Area in hectares	Area in hectares
Open Forest	75485.6	16774.3	12895.4
Moderate Dense Forest	47078.8	48729.2	37598.3
Very Dense Forest	80110.9	93873.4	69078.4
Total	**202675.3**	**159376.9**	**119572.1**

In 1989 total forest cover is 202675.3 ha, 159376.9 ha in 1999 and 119572.1 ha in 2012. These values of forest cover area indicated decreasing trend in forest cover. The drastic change in open forest in 1999 and 2012 is noteworthy. The moderately dense forest showed albeit positive change in 1989 to 1999 but it showed decreasing trend in 2012 in area that is 47078.8 ha in 1989 and 48729.2 ha in 1999, but it decreases by 11 ha in 2012 i.e. 37598.3 ha. Very dense forest shows increasing trend in 1999 which sharply declines in 2012.

6. Discussion

During the study period (1989 to 2012) forest land was decreased by about 8 hectares out of total forest area indicating trend towards deforestation of forest to sparse vegetation, especially along the western margin where most of the reserve forest suffered severe damage. Results indicated that the dense forest present during 1989 along the

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western margin had been completely changed to sparse vegetation by 1999 and also by 2012 due to increasing agricultural practices, grazing, wood cutting for fuel and fodder consumption by local villagers along with natural causes like landslide, creeps and faster weathering along active zone. According to field survey, another noteworthy reason responsible for deforestation was wild and accidental fires during summer season, with no rain for months together and increased temperature above 34^{0}C resulted in hundreds of hectares of burn land. Due to continued deforestation the area faced the negative impact of soil erosion, high temperature and dust storms (Ellis et al., 1994). These negative impacts would further lead to climate change and this ripple effect would help in an increase of global warming in the future (Siddiqui, 1991). Thus to safeguard environmental degradation adaptation of conservation practices are warranted. The conservation and management authorities of the reserve forest had been trying hard to overcome this damage and at the same time have started a gradual regeneration programme of planting and replacing native trees in the selective areas.

7. Conclusion

Remote sensing techniques allowed analyzing spatial condition of forest. This could be used for automated and objective based forest monitoring through performing all necessary corrections. In addition to the severe loss in forested area, deforestation in the study area had also diagnosed a highly fragmented pattern with a multitude of small patches. The patches were shaped by the expansion of permanent cultivation and grazing by smallholders. Small patch sizes, lack of connectivity, and permanent agricultural activities had seriously undermined the resilience/regeneration potential of the forest. In the long run, plantations might ease the energy, feed, and construction needs of the people, but would not contribute to any significant recovery of biodiversity. Loss of natural forest had already caused substantial damage to biodiversity. To revive some of these services, it is important to conserve remnant patches before they get worsened. The fragmentation was also linked to the socio-economic and cultural practices, and to a large extent to the economic and infrastructural development in the region. Thus development appears to act in conflict with conservation. The demand for resources to uplift the economic status of the local population and building of roads for better connectivity, dam construction invariably led to forest fragmentation and resulted in deforestation. The areas that were losing the natural cover and associated species due to various socio economic and anthropological influences were basically losing a host of numerous medicinal and economically important plants apart from the endemic species. So a need for proper management of forest resources is warranted.

References

[1] Band, L. E. 1993. Effect of Land Surface Representation on Forest Water and Carbon Budgets. Journal of Hydrology, 150 (2-4), pp.749-772.
[2] Ellis, S., Taylor, D. M., and Masood, K. R. 1994. Soil Formation and Erosion in the Muree Hills, northeast of Pakisthan. Catena, 22, pp. 69-78.
[3] Ford-Robertson, F. C., ed. 1971. Terminology of Forest Science: Terminology Practice and Products. Society of American Foresters, Washington, DC, U.S.A., 349 p.
[4] Houghton, R. A. 1998. Historic Role of Forests in the Global Carbon Cycle. In: G. H. Kohlmaier, M. Weber, and R. A. Houghton, eds. Carbon dioxide mitigation in forestry and wood industry.Berlin: Springer, pp.1-24.
[5] Lal, R. 1995. Sustainable Management of Soil Resources in the Humid Tropics. New York: UnitedNations University Press, 146 p.\
[6] Lu, D. and Weng, Q. 2007. A Survey of Image Classification Methods and Techniques for Improving Classification Performance. International Journal of Remote Sensing, 28 (5), pp. 823–870.
[7] Pandey, D. N. 2002. Sustainability Science for Tropical Forests. Conservation Ecology 6(1), 13 p.
[8] Siddiqui, K. M. (1991). The Forest And Climate Change In Pakistan. Pakisthani Journal of Forest, 41, pp. 6-13.

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