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Status Mapping of Landuse/ Land Cover Change of Forest Resources

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Abstract—*Forest resources are vital for the society and wild animals along with biodiversity conservation. With the worldwide highest deforestation rate, India faces competing landuses threats to forest areas causing continuous degradation of the forest and its resources. Major threats are agricultural encroachment, unfettered forest fire, increase in mining activities damaging to vegetation including unmonitored deforestation for timber etc. Landuse/land cover change study of forest resources through remote sensing can give an in-depth insight of the issue. It is the most successful tool for forest-cover monitoring, as it offers a cost-effective option for frequent observations over vast areas. The primary objective of the study is to focus on changes in land covers such as, forest, shrub, and grassland and build up areas etc. under forests. Landsat, SPOT and MODIS, and their associate satellite images have been preferred for forest related studies covering large area. In India, there is comparative study of images from Landsat and IRS LISS III & IV images to evaluate the trend of landuse change. NDVI, FCC, RVI, TSVI, MSVI and PVI etc. vegetation indices have been preferred for the said landuse change studies. There is on an average reduction of 5-10% forest cover area in a 5 year cycle. Due to various aforestation program, there is slight increase in forest area and the pace is very low as compared to unabated deforestation all over the country. More studies will show the severity of the problem which requires immediate and fruitful response to protect the forest resources for the next generation.*

Keyword*: forest, landuse/land cover, remote sensing, Landsat images, deforestation.*

1. INTRODUCTION

Forests represent one of the most important components of the biosphere, regulating the global atmospheric cycles, influencing ecosystems with respect to carbon storage and release, and affecting human well-being through recreational value. According to Phat *et al.,* (2004) the 21st century has brought new challenges for forest management and forest ecosystems. This potentially constitutes an extremely important tool for dealing with climate change, in addition to the ameliorative actions of people (Cai *et al.,* 2011).

According to the International Tropical Timber Organization (ITTO) of the UN, it is estimated that deforestation and forest degradation rise 12.9 million hectares per year and the current area of degraded forest is 850 million hectares. These changes have resulted in coverage to a wide variety of ecological impacts, ranging from local to global scale, including changes in productivity and forests composition, nutrient dynamics, species diversity, and increased atmospheric carbon dioxide (Braswell *et al.*, 2003). Woodcock *et al.,* (2001) advanced a technique for fine resolution observations of the rate, pattern, and extent of forest cover change over large areas. Remote sensing, providing images from airborne and space-borne sensors, has become an effective tool in inventory, planning, and management of forest resources on local, regional, and global scales, respectively. Forests provide support for one billion people that live in extreme poverty around the world, and provide remunerative employment to more than one hundred million. They contain more than 80% of terrestrial biodiversity (FAO, 2012) and provide essential environmental services such as soil conservation, watershed management, protection against floods and landslides, and provide industrial wood (UN).

Proper planning, management and monitoring of the natural resources depend on the availability of accurate land use information. The advancement in the concept of vegetation of the spread and health of the world's forest, grassland and agricultural resources has become an important priority.

2. FOREST LAND USE MONITORING

The satellite remote sensing data helps in quantification of LU/LC patterns and determines their changes with time (Dewan and Yamaguchi 2009; Vanum and Hadgu 2012). Over the past years, data from Earth sensing satellites has become vital in mapping the Earth's features and infrastructures, managing natural resources and studying environmental change.

One way of assessing changes in land use is based on the measurement of changes in vegetal and non-vegetal cover (Bocco, 2001). Forest change mapping and monitoring is feasible when changes in the forest attributes of interest result in Detectable changes in image radiance, emmitance, or microwave backscatter values (Coppin *et al.,* 2004).

Remote sensing has proven to be a valuable tool for land surface monitoring, as it provides a synoptic perspective and periodic view of the Earth's surface. The reflected or emitted electromagnetic energy can be captured through sensors and can then be translated into physical properties of the land surface (Loveland and Defries 2004). The repeated observation of remote sensing makes it possible to investigate changes by comparing the imagery acquired at several points in time.

3. LANDSAT THEMATIC MAPPER DATA

Spaceborne remotely sensed data may be particularly useful in developing countries where recent and reliable spatial information is lacking. Landsat images draped over DEM block diagram; perspective view of the landscape with color coding from Land sat image. Land sat image added to shaded-relief image; enhancement of topography visible in Landsat image.

Landsat imagery that has been geometrically rectified radiometrically normalized and subset into processing areas is ready for input into the change-mapping process (Levien *et al.,* 1999). A concurrent process involves preparing and mosaicking ancillary data layers, including vegetation maps based on CALVEG vegetation categories, fire history perimeters, and timber plantation/harvest information. Dennis *et al.,* (2005) compare the relative effects on land use of government-sponsored transmigration programs, commercial logging concessionaires, and forest fires as contributors to forest degradation in Indonesia. Foster and Rosenzweig (2003) analyze an increase in demand for forest products as a factor that increases forest cover in India, offsetting the expansion of agriculture and rising wages that usually decrease forest cover. The LCMMP uses Landsat-5 TM and Landsat-7 ETM+ satellite imagery within five year monitoring periods. Landsat Multispectral Scanner (MSS), Thematic Mapper (TM) and Enhanced Thematic Mapper Plus (ETM+) data have been broadly employed in studies towards the determination of land cover since 1972, the starting year of Landsat program, mainly in forest and agricultural areas (Campbell, 2007).

3.1 Indian scenario

With the worldwide highest deforestation rate, India faces competing land uses that are causing a major decline in the forests (Selvam, 2012). In addition, increasing need for fuel-wood and charcoal is also contributing towards deforestation (Ademiluyi *et al.,* 2008). Agricultural encroachment and unfettered forest fire can cause many wild species to decline (Alaguraja *et al.,* 2010; Soundranayagam *et al.,* 2011). The reduction and/or degradation of this natural resource can exaggerate the competition specifically to stressed area.

Sudhakar *et al.* (1994) used stratification approach for forest cover type and land use mapping using IRS-IA LISS-II data in Jalpaiguri district of West Bengal, India. Initially, the FCC, NDVI and tasseled cap transformation outputs of the representative areas were generated digitally to differentiate three density classes *viz.* dense/closed forests, open forest and degraded forest within the each vegetation type.

Multispectral, multi-temporal Landsat satellite data of Sukinda valley, Jajpur district, Odisha were acquired for three years namely, 1975, 1992 and 2005. There was a rapid change of quarry and dense forest during the period from 1975 to 2005. Therefore, it can be concluded that increase in mining activities is damaging to vegetation(Table 1; Majumder, 2011).

Santhiya *et al.,* (2010) used Landsat and IRS LISS III satellite data for the years 1976, 1999 and 2007. The maps were compared and changes were attributed; and showed that the drastic changes in landuse profile.

Table 1: Land use land cover mapping of Sukinda valley, Odisha

Land use/Land cover	1975		1992		2005	
	square km	%	square km	%	square km	%
Quarry	0.96	0.26	6.03	1.6	11.8	3.2
Dense forest	204	55.3	181	49.1	172.5	46.8
Water body	1.0	0.27	0.6	0.16	1.37	0.37
Non forest area	162.44	44.17	180.77	49.14	182.73	49.63
Total	368.4		368.4		368.4	

Source: Majumder, 2011.

Vegetation cover decreased from 15.49% to 11.19% during 1999-2007 & 19.49% to 15.77% (1976-1999), respectively. Due to the increased population the settlement and built up areas increased considerably 16.82% (1976), 26.20% (1999) and 31.91% (2007) in Chennai coast. During 1973-2008 Landsat 1973,1990 with 30 mts spatial resolution and IRS-P6 images (2008) with 23.5 mts spatial resolution were concludes that the area under built-up and agriculture has increased while the area extent of forest, has decreased forest (- 2.9%) from17.3 percent to 16.9 %, in the Tamil Nadu State,India (Table 2; Mani and Krishnan, 2013).

Table 2: Land Use / Land Cover 1973-2008 in Tamil Nadu, India (Area %)

Name	1973	1990	2008
Built Up	0.80	1.54	3.43
Agricultural Land	61.52	67.77	69.13
Forest	17.26	16.90	14.39
Grazing Land	1.29	1.18	0.79
Wasteland	8.06	5.61	6.33
Wetland	1.55	0.93	0.65
Water bodies	9.53	6.06	5.29
Total	100	100	100

Source: Mani and Krishnan, 2013.

The high resolution satellite data such as LISS III (*2009)* data and Landsat ETM *1989,* (path-row: 112-53) are good source to provide information accurately the percentage of open forest and dense forest was decreased 4.28% and 0.10% because of human population growth and conversion of forest into agricultural land during the period of from 1989 to 2009 in Golaghat district, of Assam (Phukan et al., 2013). IRS LISS-III 1998, IRS LISS-III 2010 satellite data revealed that the area under forest cover has decreased from 27.95% in the year 1998 to 18.34% in the year 2010 with a net decrease of 9.61%. The reason for this is because of rapid industrialization and urbanization in Greater Visakhapatnam Municipal Corporation, Andhra Pradesh, (Fig. 1, Anil et al., 2012).

The remote sensing data of LISS III and PAN of IRS ID of 2003 indicates that the dense forest area vanished (−18.10%) during the period (1976 – 2003) of study which may be due to rapid urbanization and small addition of mining activity in 2003 in

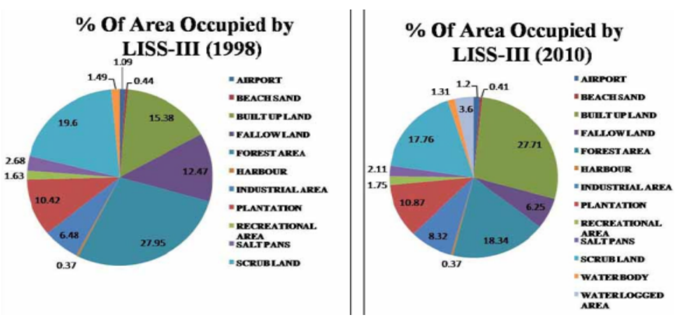
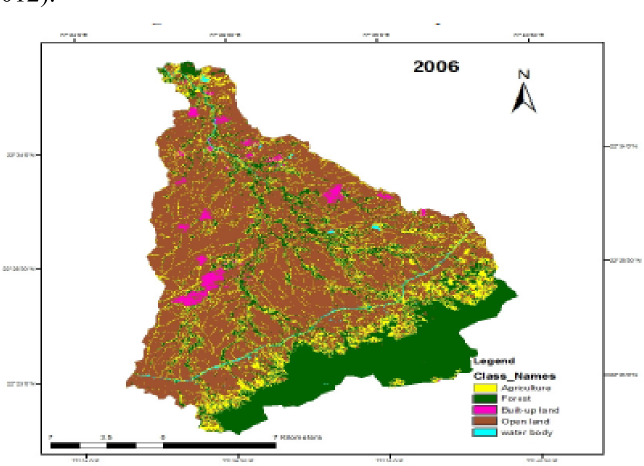


Figure 1: Pictorial representation of areas occupied by LULC during, 1998-2010 in Greater Visakhapatnam Muni. Corporation, Andhra Pradesh, (Anil *et al., 2012).*

Tirupati, India, (Mallupattu and Reddy, 2013). Landsat satellite images were acquired for two year; 1992 and 2006. Found to have experienced rapid changes in land use/ land cover particularly in Farm land it converted to forest land (scrub). Forest land increase by 10.55 % in Indra River watershed, Madhya Pradesh, (Fig. 2, Gajbhiye and Sharma, 2012).



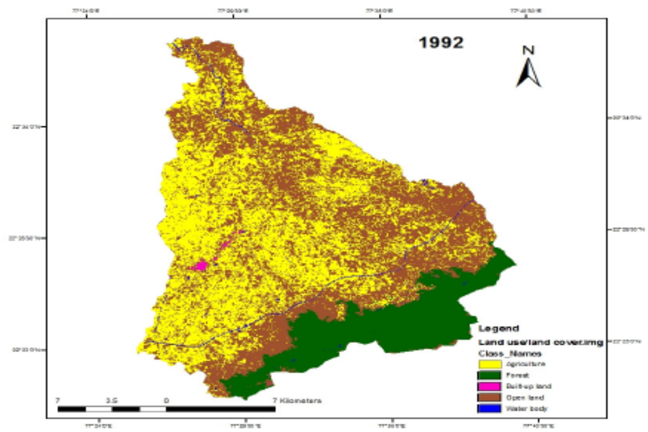


Figure 2: Land use land cover map in 1992 and 2006 in Indra River watershed, M.P., (Gajbhiye and Sharma, 2012).

Through visual interpretation method and digital classification method (supervised classification) have been adopted and prepared the spatial coverage map of 2002 and 2008 by using satellite data sets of Land Sat 5 (Thematic Mapper), Land Sat 7 (Enhancement Thematic Mapper +) in Ausgram Block, Burdwan District, West Bengal, India. Result this forest covered land at year of 2002 (September) reduced to 17% of total study area compared to 1972. This has further been reduced to 14% in 2008 (Prakasam, 2013).

The satellite imageries Landsat and IRS LISS-III geocoded data were used as input for change detection. The imageries were used for identification of changes between different times for the identified classes viz, Forest Land. The area under forest faced net decrease of 12.3% which can be attributed to the declining trend of forest in the North-West region of the district of Y.S.R. Kadapa, Andhra Pradesh (Prathap and Reddy, 2015). Multidate geocoded FCC of IRS-1D LISS-III on 1:50,000 scale for March 2002, September 2002, and May 2003 with pixel size of 23.5 m (spatial resolution) were obtained and interpreted visually to prepare land use/land cover maps for the year 1984 and 2003. The total forest area did not change much (27.66% in 1984 to 27.51% in 2003) over the period of 20 years, however some area of degraded and moderately dense forest has been transformed to dense forest as a result of improvement in vegetation cover through afforestation under Integrated Watershed Development Programs, In addition, some area of degraded forest was transformed to dense (976.5 ha) or moderately dense (755.5 ha) forest in Balachaur watershed in Punjab, India (Bazgeer *et al.,* 2008).

The satellite images (Landsat-5,7,8) of 1991, 2001 and 2014 indicate negative change is noticed in vegetation that is -2.3 per cent for the period of 1991-2001 noted a further decrease of -3.48 per cent in 2001-2014. Ultimately, for the general period, the figure has reduced to -5.86 per cent where rapid changes have been taken recently by the construction of

Bangalore–Mysore Industrial Corridor,India, (Table 3, Boloor and Nusrath, 2015).

Table 3: Temporal Land use and Land Cover – Area and Rate of Change (%)

S.No	Classes	Area (%)			Changes (%)		
		1991	2001	2014	1991 - 2001	2001-2014	1991-2014
1	Built Up	1.81	4.43	9.59	59.15	53.80	81.13
2	Vegetation	86.93	84.97	82.11	-2.30	-3.48	-5.86
3	Waste Land	6.76	6.45	4.44	-4.78	-45.23	-52.18
4	Water Bodies	4.50	4.15	3.86	-8.50	-7.56	-16.71

Source: LULC Analysis in Bangalore–Mysore Corridor, India, (Boloor and Nusrath, 2015).

Ashok *et al.,* (2015) found that forest cover spread over 0.51% in year 2005- 2006 which has increased to 2.04% in the year 2011-2012 in the area. The reason for increase area under forest is forest plantation carried by government on wastelands particularly hilly undulating scrub lands.

3.3 International scenario

Spatial patterns of land cover changes in the Omo-Shasha-Oluwa Forest Reserves were conducted on Landsat TM and ETM+ imageries of 1986 and 2002 using remote sensing . The results showed that the forest decreased by about 12%. Extent of tree plantation (*Gmelina arborea*) grew from about 145 sq. km in 1986 to about 322 sq. km in 2002 (122% increase). The natural forest declined from about 2569 sq. km in 1986 to about 2253 sq. km by 2002, while the non-forest areas increased by some 5% from 341 km2 in 1986 to about 490 km2 by 2002 because natural and anthropogenic processes such as illegal logging, demand for soft wood for industries and expansion of settlements, (Fig. 3, Adedeji, 2014).

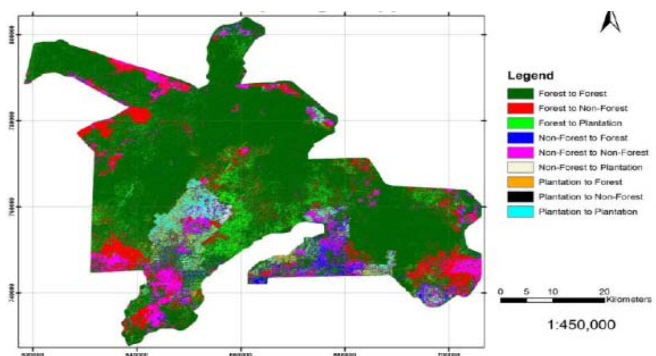


Figure 3: Land cover change map (1986-2002) of Omo-Shasha-Oluwa Forest Reserve (Adedeji, 2014)

Alqurashi and Kumar, (2014) using Landsat (TM4, 5 and OLI-TIRS) images, path 169 and row 45) images showed Urban area increased by approximately 17574 ha (174%) in Makkah and by approximately 7391 ha (113%) in Al-Taif. The vegetation cover also increased in both Makkah and Al-Taif by approximately 3145 ha (291%) and 5017 ha (262%) respectively, due to increasing afforestation in the urban areas of Saudi Arabia during 1986 to 2013.Work on land cover change study of the Oil Sands Mining Development in Athabasca, Alta, Canada was carried out by Natural Resources Canada (2005). The primary impact was assessed using an information extraction method applied to two Landsat scenes. The study was done using two Landsat images of 1990 and 2001. Land cover maps shows a decrease of natural vegetation in the study area for 2001 approximately 64% relative to that of 1992. Earthquake 2005 played a major role in land-use change. The vegetative land decreased by 1.053%, bare land by 1.394%, settlement, forest and water area increased by 9.29%, 2.82%, and 0.33%, respectively. Major portion of vegetative land and bare land was converted into settlement (Raza *et al.,* 2012).

Carranza *et al.,* (2014) examined the multitemporal fragmentation of the Arid Chaco forest in central Argentina during the period 1979-2010 using forest maps derived from Landsat images MSS and TM with the indices were % of forest cover, edge density (ED; m/ha), mean patch size (MPS; ha) and patch density (PD; number of patches/ha) and formulas of the LPIs revealed that the forest cover consistently declined from roughly 31% of the 1979 landscape to - 4% in 2010.In the first two decades (1979-1999) forest cover decreased from -31% to - 23%, while in the last ten years (1999-2010), a much larger forest loss (from -23% to -Landsat MSS and Landsat ETM+ (path 185, row 31) were used from 1976 to 2000, agricultural areas, urban areas and bare soil increased 137030 ha (36.2%), 1859 (117.0%) and 2494 (174.9%) respectively. On the other hand deciduous, pasture, and coniferous decreased 7.029 ha (8.3%), 5.568 ha (72.8%) and 5.115 ha (50.2%) respectively in size, North-East Turkey, (Fig. 4, Reis, 2008).

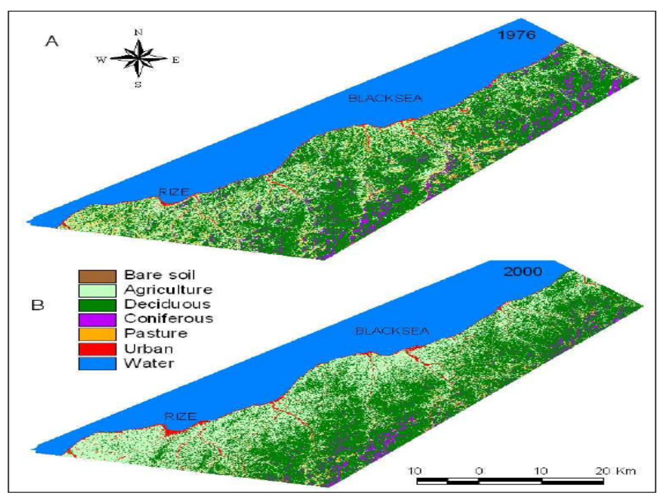


Figure 4: The classification images of land use\land cover in Rize (Reis, 2008).

Remotely sensed imagery has witnessed increased interest for the following reasons, such as i. Increased data availability, quality, and decreased data costs across large study extents, ii. Development of large-area forest mapping/monitoring projects using a wide variety of spectral data captured by different platforms, featuring disparate spatial and spectroradiometric characteristic capabilities iii. Demand for more precise estimates of disturbance impacts with Landsat like data iv. Growing need for automated mapping and map updating in complex landscapes using expertsystems/knowledge-based classification, v. Demonstrated potential of data integration/fusion for predictive forest change mapping

4. CONCLUSION

Remote sensing satellite data has the unique capability to detect the changes in landuse quickly and accurately. The advancement in the concept of vegetation mapping has greatly increased research on landuse/land cover change thus providing an accurate evaluation of the spread and health of the world's forest land agricultural resources has become an important priority with the RS data. From the analysis it has been found that the satellite data is very useful and effective for getting the results of temporal changes, with this effective data it has been found that the forest and cropland is decreasing at the cost of haphazard growth of plantation and settlements. This will help in maintaining the ecological balance and improving microenvironment of the region. The conservation and management of forests are very important for the development of human life.

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