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Forest cover and land use mapping using remote sensing and GIS technology

Shruti Kanga
Centre for Climate Change and Water Management, Suresh Gyan Vihar University, Jagatpura, Jaipur
*Corresponding author: shruti.mgi@gmail.com

ABSTRACT
The satellite application's for effective forest management on a more scientific basis commensuration with the priorities set at state, District and Micro levels studies. The shift in priority of forest management towards ecologically sustainable forest resources management with other land resources call for reliable spatial database with a provision to update and retrieve for management decisions at various levels. The application of satellite data for various priorities & objectives leading to resources assessment have been discussed. The utilization of GIS for data base creation and requirement of forest resources information system involving effective inventory data analysis packages supporting volume yield and cull factor analysis has been discussed in detail. The area was classified into 8 class's i.e. agricultural land, fallow land, built up, deciduous forest-dense, deciduous forest-open, scrub forest and waterbodies. The result showed that about 63.32% area was under agricultural land, 6.73% under fallow land, 4.64% under built up, 69.67 sq. km under water body, and around 22% under forest area in which 222. 94 sq km was under deciduous forest-dense,163.04 sq. km was under deciduous forest-open, 99.16 sq km under scrub forest and 56.74 sq. km under open scrub. The area statistics for land use/land cover clearly specifies that the major area is used for agricultural purposes followed by forest area. The demand of information on land cover, land use and their changes is increasing at the global, regional and national levels to support policy decisions and regulate management processes.

Keywords: Forest; Remote sensing; GIS; Agriculture

INTRODUCTION
Land cover refers to the physical and biological cover over the surface of land, including water, vegetation, bare soil, and/or artificial structures. Land use denotes how humans use the biophysical or ecological properties of land. Land use is characterized by the arrangements, activities and inputs people undertake in a certain land cover type to produce, change or maintain it. Definition of land use in this way establishes a direct link between land cover and the actions of people in their environment. Information on land use and land cover is required in many aspects of sustainable management of land resources and policy development, as a prerequisite for monitoring and modelling land use and environmental change, and as a basis for land-use statistics at all levels (Jansen and Di Gregorio, 2004).

Land cover-land use analysis provides knowledge about landscape patterns and their changes which over time gives very important insights into the ongoing natural and human processes in the ecosystem. Human activities are a major factor contributing to global change, and they are overriding natural changes to ecosystems brought on by climate variations. Land-cover communicates to the different features on Earth's surface (Lillesand *et al*., 2007) with the composition and characteristics of Earth surface elements (Karwariya and Goyal, 2011) including natural and anthropogenic features, and thus describes the Earth's physical state in terms of the natural environment and the man-made structures (Karwariya and Tripathi, 2012) which can be mapped using satellite imagery with spectral signatures. Satellite data is a significant and useful tool for monitoring and management of resources.

Remotely sensed data are extensively and efficiently used in land-use/land-cover (LULC) classification (Brahabhatt *et. al*., 2000; Hyman *et. al*., 2000; Alaguraja *et. al*., 2010; Karwariya and Goyal, 2011; Gupta and Roy, 2012; Karwariya and Tripathi, 2012; Selvam, 2012; Sinha *et. al*., 2013) due to its repetitive data acquisition capabilities, digital format suitability for computer processing and lower cost than those associated with traditional methods (Karwariya and Goyal, 2011; Sinha *et. al*., 2103). Remote sensing change detection studies can be used to recognize areas of changes needs to managed (Rogan *et. al*., 2002; Coppin et. al., 2004; Kennedy et. al., 2009). Repetitive satellite images, aerial photographs are useful for both visual assessment of natural resources changing aspects occurring at a particular time and space as well as quantitative evaluation of land cover changes (Tekle and Hedlund, 2000).

Various studies on deforestation and degradation have been conducted in tropical forests using coarse and high-resolution remote sensing data (Kanga *et al*., 2011). The temporal assessment of forest changes based on satellite imagery of various time series is becoming an important technique for assessing the degree of threat to ecosystem (Yadav *et al*., 2015; Kanga *et al*., 2013). GIS on the other hand provides environment to analyze digital data useful for change detection, database development, and modeling of its future change and data dissemination for effective management planning. Remote-sensing methods are considered to be appropriate for most developing countries to assess historical and future deforestation rates, i.e., forest area change (Kanga *et al*., 2015; Kanga *et al*., 2014). Study of land cover changing characteristics includes developing a multi temporal land cover database using satellite images of different time periods. The landcover mapping have to be useful for applications at different scales. Therefore it is important to plan a scheme which follows a constant method and permits accumulation of detail of diverse stages. It will not only help in the generation of land cover maps that are well-matched with each other but also can be used reliably for studies related to LU/LC and forest cover changes too. Such a database is essential for evaluating significant drivers for land cover and land use change and further in various decision-making policies related to LU/LC management.

STUDY AREA

The total geographical area of Nawada district is 2494 sq. km. and the total forest area of the Nawada Forest Division is 583.65 sq. km., which is 23.40% of the total geographical area of the district. The forests in Nawada Forest Division correspond to the 'Tropical Dry Deciduous Forests' as per Champion and Seth's classification of forests. Within this type, local variations are met with, due to variations in nature of soil and topography. Better stocked patches occur in cooler and protected areas on the south-west corner of the district adjoining the forests of Jamui Forest Division of Bihar and Giridih Forest Division of Jharkhand State. There are four Ranges in the Division- Nawada, Hisua, Rajauli and Kauwakol. Major cropping areas are paddy, wheat, pulses and vegetables. The topography of the Nawada district comprises of two distinct landscapes i.e. Plain land of North and the hilly area of the south as 45% comes under the plain land which is used for agricultural purposes.

MATERIALS AND METHODS

Data used for this study was collected from field survey, literature review, satellite images and topographical maps. The field survey was conducted to give an overview of the physical condition of the study area, including topography, vegetation and land use type. GPS points of land cover types were taken, detailed information on previous forest cover types and general management practice. Information on forest livelihoods and conservation measures happening was gathered using a number of research tools such as formal interviews, focus group discussions and field observations. Landsat Thematic Mapper at a resolution of 30 m of 1988 and 2006 were used for forest cover classification. The satellite data covering study area were obtained from global land cover facility (GLCF) (http://glcfapp.glcf.umd.edu:8080/esdi/) and earth explorer site (http://earthexplorer.usgs.gov/). These data sets were imported in ERDAS Imagine version 9.3 (Leica Geosystems, Atlanta, U.S.A.), satellite image processing software to create a false colour composite (FCC). The layer stack option in image interpreter tool box was used to generate FCCs for the study areas. The primary data used in this study were topographical maps and satellite images. With the help of the topographical maps and satellite images base maps were prepared. Field surveys were conducted through Global Positioning System (GPS) receiver. Digital photos were taken for different types of land use and land cover, along with many of GPS point readings. The data collected during the field surveys were used for three major purposes as to regulate the major types of land use and land cover in the study area, which helped design a land-use and land-cover classification scheme and to associate the ground 'truth' of a specific type of land use and land cover with its imaging characteristics, which helped classify images and produce land-use and land-cover maps. Therefore, fieldwork has been an essential component for data acquisition and collection.

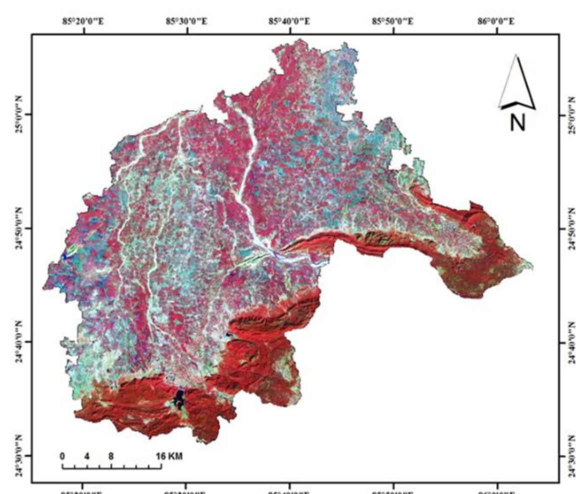
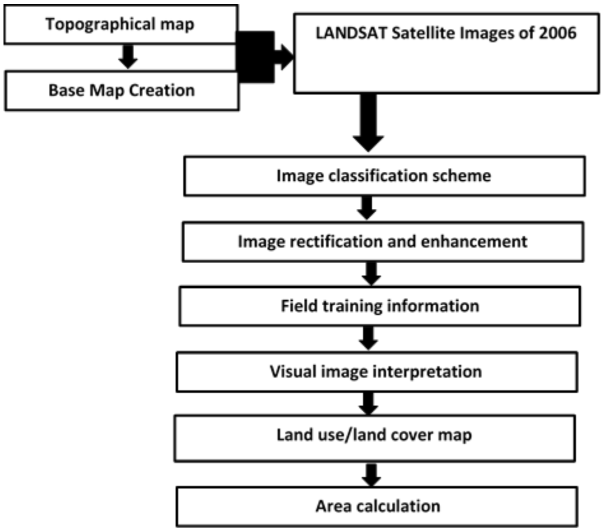


Figure 1: Satellite Image of the study area



RESULTS AND DISCUSSION

Forest is a minimum area of land of 0.05-1.0 ha with tree crown cover (or equivalent stocking level) of more than 10-30% with trees with the potential to reach a minimum height of 2-5 m at maturity in situ. A forest may consist either of closed forest formations where trees of various stories and undergrowth cover a high proportion of the ground or open forest (UNFCCC, 2001). India has been divided into broadly sixteen forest types by Champion and Seth (1968) based on rainfall and altitude. Though, with varying climate and man's influence on environment mainly in forests, modification the arrangement of tree species ensuing spatial instabilities on the incidence of forest types. In this context the study of spatial distribution of forest types would help greatly in forest management for accounting the changes that have resulted in the changing quality and composition of forests. With the increased pressure on forest all over the world as well as in India the growing concern of forest management has shown shift in its priority from production forestry to conservation Forestry. The satellite image of year 2006 was classified into 8 classes (Figure.2 1) namely agricultural land, fallow land, built up, deciduous forest-dense, deciduous forest-open, scrub forest and waterbodies. The result showed that in Nawada district, Bihar about 63.32% (1530.37sq km) area was under agricultural land, 6.73% (162.75 sq. km) under fallow land, 4.64% (112.21 sq. km) under built up, 9.22% (222. 94 sq km) under deciduous forest-dense, 6.75% (163.04 sq. km) under deciduous forest-open, 4.10% (99.16 sq km) under scrub forest, 2.35% (56.74 sq. km) under open scrub and 2.88% (69.67 sq. km) under water body (figure.3, Table 1). The area statistics computed for land use/land cover clearly indicates that the major area is used for agricultural purposes.

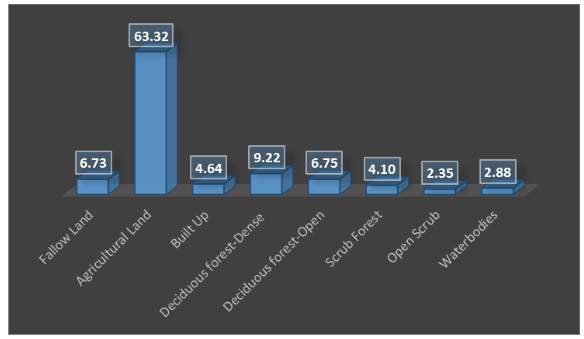


Figure 4: Graph of Forest cover with Landuse/Land cover in the study area (in Percentage).

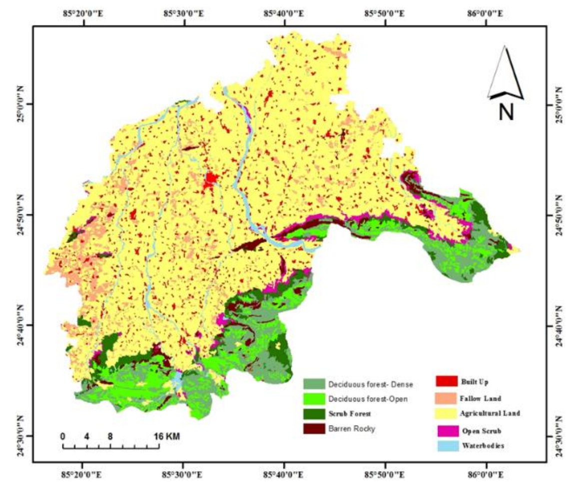


Figure 3: Map showing Forest cover with Landuse/Land cover in the study area.

Class name	Area (in sq km)	Area (%age)
Fallow Land	162.75	6.73
Agricultural Land	1530.37	63.32
Built Up	112.21	4.64
Deciduous forest-Dense	222.94	9.22
Deciduous forest-Open	163.04	6.75
Scrub Forest	99.16	4.10
Open Scrub	56.74	2.35
Waterbodies	69.67	2.88

Table 1: Area of various Landuse/Land cover with Forest cover in the study area.

CONCLUSIONS

The influences of growing human financial actions and the attention of human population into forest zones are being felt throughout the world in both developing and developed countries similar. Evidence about varying designs of land use and land cover over time in forest areas is thus important, not only for the organization and development of these areas, but also for a improved understanding of the association among landscape dynamics and forest ecology responses. Satellite remote sensing permits a surveying, synoptic viewing of huge areas, thus providing the potential for a geographically and temporally detailed assessment of land-use and land-cover mapping in forest areas. In this study has established the helpfulness of satellite remote sensing, visual interpretation and GIS techniques for land-use and land-cover mapping. The study has revealed that a considerable growth in built-up occurred with increase in population and housing growth. The decrease pattern of the spatial distribution of forest was found to be proportional to the growth in built-up. The deterioration of forest was evidently the consequence of the increase of human economic activities in combination with fast built-up development. Therefore the administration should control the unplanned urban sprawl by introducing new technologies for agriculture activities.

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