LAND USE / LAND COVER CLASSIFICATION AND CHANGE DETECTION USING GEOGRAPHICAL INFORMATION SYSTEM: A CASE STUDY

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ABSTRACT

Land use and land cover change has become a central component in current strategies for managing natural resources and monitoring environmental changes. Geographical information system and image processing techniques used for the analysis of land use/land cover and change detection of Sukhana Basin of Aurangabad District, Maharashtra state. The tools used ArcGIS10.1 and ERDAS IMAGINE9.1, landsat images of 1996, 2003 and 2014. From land use / land cover change detection it is found that during 1996-2014, water bodies cover have loss of 4 Sq. Km. Barren land have 146 Sq.Km. loss and forest area with 96 Sq.Km. loss. It is found that urbanization area has gain of 51 Sq.Km. and agricultural land cover also have gain of 195 Sq.Km.

Key words: GIS, Land Use, Land Cover, Supervised Classification, Change Detection.


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1. INTRODUCTION

Land cover refers to the physical characteristics of Earth's surface, captured in the distribution of vegetation, water, soil and other physical features. Land use refers to the way in which land has been used by humans and their habitats. Although land use is generally inferred based on the cover, yet both the terms land use and land cover being closely related are interchangeable.

Land use/cover and its dynamics are important factors that affect ecosystem conditions and functions. In the past 40 years, land use change dynamics has been considerably changing the biogeochemical cycling leading to changes in surface atmospheric energy exchanges, carbon and water cycling, soil quality, biodiversity, ability of biological systems to support human needs and, ultimately the climate at all scales (Amare Sewnet 2016).

Jayakumar S. and D.I. Arockiasamy (2003), attempted to map land use / land cover and change detection analysis in Kolli hill, part of Eastern Ghats of Tamil Nadu, using remote sensing and GIS. About 467 ha increase has been observed in single crop category and about 434 ha decrease has been observed in land with or without scrub category. Majority of the area (13639 ha) is under scrubland. Lesser changes could be noticed in double crop, plantation and barren/rocky categories.

Sathees kumar P and Nisha Radhakrishnan (2010), have studied Remote Sensing And Gis In Land Use Planning. The different land use categories and their spatial and temporal variability in Tiruchirappalli city has been studied over a period of eight years (1998-2006), from the analysis of topographical map, IRS 1D and IRS P6 for the year 1973, 1998, 2002 and 2006 using Arc GIS and ERDAS Imagine 9.1. Based on the results of classified images, the agricultural land coverage area was reduced 7.8% from the year 1998 to 2006, while the area under settlement increased 14.7% from the year 1998 to 2006.

He-Bing Hu, et al. (2012), have analysed Land Use Change Characteristics Based On Remote Sensing and Gis In The Jiuxiang River Watershed. Based on remote sensing and GIS technology, the remote sensing images from 2003 to 2009 were used to the basic data sources, to analyze the characteristics of land-use change in Jiuxiang River watershed. Results showed that watershed land use structure were changed greatly from 2003 to 2009; the proportion of arable land decreased from 34.86% to 19.52%, whereas other types of land use increased. The area of construction land increased most rapidly, from 17.80% to 25.80%.

Jeffry Swingly Frans Sumarauw and Koichiro Ohgushi (2012) have analysed On Curve Number, Land Use and Land Cover Changes in the Jobaru River Basin, Japan. Arc GIS tool to delineate river basin and sub-basin, and HEC-GeoHMS tool for estimating the CN. The result shows that from 1948 to 2005 the CN of the Jobaru River basin decreased from 53.29 to 52.03, which indicates that the land use changes in Jobaru River basin makes the land capability for reducing flood becomes better during this period.

Singh R B and Dilip Kumar (2012) have used Remote sensing and GIS for land use/cover mapping and integrated land management: case from the middle Ganga plain. Alternative land use systems and the integration of livestock enterprises with the agricultural system have been suggested for land resources management.

Kotoky, P. M. et al. (2012), have studied, Changes in Land use and Land cover along the Dhansiri River Channel, Assam by A Remote Sensing and GIS Approach. Information on land use/ land cover change is a critical input for natural resource
management policy decisions. Remote sensing data under GIS domain were utilized to evaluate the changes in land-use/land-cover (LU/LC) spanning a period of thirty three years during 1975 to 2008 along the Dhansiri River channel, Assam, India. Seven different types of LU/LC were categorized and out of them cropland was evident as the most important land use/land cover practices followed by dense mixed jungle in 1975 and the settlement in 2008.

Mani.N. and Rama Krishnan. (2013), have estimated the LU/LC changes in Tamil Nadu State using remote sensed data and Geographic Information System (GIS) with field verification for the objective of the study. Landsat 1973,1990 and IRS-P6 images (2008) were used. The LU/LC of the study area were classified into 7 types as followed respectively built-up, agricultural, forest, grazing land, aste land, wetland and water bodies which adopting NRSC LU/LC classification. The research concludes that the area under built-up and agriculture has increased while the area extent of forest, grazing land, wasteland, wetland and water bodies has decreased in the study area.

Wagner, P. D. S. Kumar, and K. Schneider (2013) have studied an assessment of land use change impacts on the water resources of the Mula and Mutha Rivers catchment upstream of Pune, India. Analyzed past land use changes between 1989 and 2009 and their impacts on the water balance in the Mula and Mutha Rivers catchment upstream of Pune. Land use changes were identified from three Rivers catchment multitemporal land use classifications for the cropping years 1989/1990, 2000/2001, and 2009/2010. The hydrologic model SWAT (Soil and Water Assessment Tool) was used to assess impacts on runoff and evapotranspiration.

Praveen Kumar et al. (2013), have analyzed Land Use/Land Cover Changes Using Remote Sensing Data and GIS at an Urban Area, Tirupati, India Land use/land cover (LU/LC) changes were determined from 1976 to 2003 by using Geographical Information Systems and remote sensing technology. These studies were employed by using the Survey of India topographic map 570/6 and the remote sensing data of LISS III and PAN of IRS ID of 2003. The study area was classified into eight categories on the basis of field study, geographical conditions, and remote sensing data. The comparison of LU/LC in 1976 and 2003 derived from toposheet and satellite imagery interpretation indicates that there is a significant increase in built-up area, open forest, plantation, and other lands. It is also noted that substantial amount of agriculture land, water spread area, and dense forest area vanished during the period of study which may be due to rapid urbanization of the study area.

As maximum villages in the study area are selected for water conservation works under Jalyukt Shiwar Yojana by state government of Maharashtra. To preserve the natural resources and to understand the causes and its effect of over exploitation of soil and water resources the land use and land cover analysis study was carried out.

2. METHODOLOGY

2.1. Study Area

Geographical information system and image processing techniques used for the analysis of land use/land cover and change detection of Sukhana Basin of Aurangabad District, Maharashtra state which is divided into 35 sub watersheds of Aurangabad District, Maharashtra state are evaluated. Study area is located between 75.33°, 75.76° E longitudes, and 19.66°, 19.98° N latitudes. Details of study area is given in table 1.
2.2. Data used

Details of Image information are shown in following table.

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Type</th>
<th>Year</th>
<th>Bands</th>
<th>Path</th>
<th>Row</th>
<th>Resolution (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>LT 5</td>
<td>March-1996</td>
<td>5</td>
<td>146</td>
<td>46</td>
<td>30 x 30</td>
</tr>
<tr>
<td>2.</td>
<td>LT 7</td>
<td>March-2003</td>
<td>7</td>
<td>146</td>
<td>46</td>
<td>30 x 30</td>
</tr>
<tr>
<td>3.</td>
<td>LC 8</td>
<td>March-2014</td>
<td>8</td>
<td>146</td>
<td>46</td>
<td>30 x 30</td>
</tr>
</tbody>
</table>

Survey of India (SOI) Toposheets at 1:50,000 scales were used for the preparation of the base maps and for remote sensing data interpretation.

2.3. Land Use and Land Cover

Different land use/land cover classes like urbanization Barren land, Settlement, Forest land, Water body, Agricultural land. etc. which is shown in table 3. were then identified using visual interpretation keys such as colour, tone, texture, pattern, size and shape. Description of these land cover classes are shown in Table 3. In the supervised classification technique, three images with different years are independently classified. A supervised classification method was carried out using 8 to 10 training sites were made by demarcating a polygon or an area of interest for all the five land use and land cover types. Then for each class average signature was developed. Data is also for accuracy assessment. Maximum Likelihood Algorithm was employed to detect the land cover types in ERDAS Imagine9.1.

After ground truthing , Accuracy assessment was carried out. To determine the accuracy of classification, a sample of pixels is selected on the classified image and
their class identity is compared with the ground reference data. The detailed methodology is illustrated in flowchart in Figure 1

Table 3 Description of land use/land covers units.

<table>
<thead>
<tr>
<th>S.No</th>
<th>Land cover class</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Urbanization</td>
<td>Urban/Rural Settlement</td>
</tr>
<tr>
<td>2</td>
<td>Agricultural Land</td>
<td>Crop Land, Fallow/Harvested Land, Plantation</td>
</tr>
<tr>
<td>3</td>
<td>Forest</td>
<td>Dense Forest, Degraded / Open forest, Forest plantation</td>
</tr>
<tr>
<td>4</td>
<td>Water bodies</td>
<td>River / Stream, Lake / Reservoir /Tank / canal Tank with scrub / Plantation</td>
</tr>
<tr>
<td>5</td>
<td>Barren land</td>
<td>Salt affected Land, Gullied / Ravinous, Land with / without scrub, Sandy Area, Barren Rocky / Stony waste / Sheet Rock</td>
</tr>
</tbody>
</table>

Flowchart adopted for analysis of land use/ Land cover in Basin.

Figure 1 Methodology Flowchart

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3. RESULTS AND DISCUSSION

Output after processing in shown figure 2, the water bodies extent and its proportion for the year 1996, 2003 & 2004 in basin was 6 Sq.Km. which is 0.9% of the total area in 1996. Its cover was decreased to 0.40% in year 2003 and 0.30% for the year 2014. Land under forest cover in the year 1996, 2003 and 2014 in basin was 206 Sq.Km. amounting 30.80% of the total area in 1996. It was found decreased to 29.00% and 16.40% in the year 2003 and 2014 respectively.

Urbanization extent and its proportion for the year 1996 was 13 Sq.Km. accounting 1.9% of total area. Its cover was increased by 4.2% and 9.6% in the year 2003 and 2014 respectively. Urbanization found in increasing trend in the basin.

Agricultural land in basin was 68.00 Sq.Km. which is 10.20% of the total area in 1996. Agriculture land cover extent and its proportion decreased to 8.1% in 2003, whereas it is increased 39.30% in 2014, it shows five times increased than which is in 1996.

Barren land in the basin was 376 Sq.Km. which is approximately half the total area of the basin. In 2003 it decreased to 58.30% and 34.40% in 2014. This shows that area Barren land area decreases from 1996 to 2014 decrease in barren land have compensated by increase in urbanization and Agricultural land. Details are presented in table 4 and also in graph.

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Area (sq.km)</td>
<td>%</td>
<td>Area (sqkm)</td>
<td>%</td>
</tr>
<tr>
<td>Water body</td>
<td>6</td>
<td>0.9</td>
<td>3</td>
<td>0.4</td>
</tr>
<tr>
<td>Urbanization</td>
<td>13</td>
<td>1.9</td>
<td>28</td>
<td>4.2</td>
</tr>
<tr>
<td>Barren</td>
<td>376</td>
<td>56.2</td>
<td>390</td>
<td>58.3</td>
</tr>
<tr>
<td>Agricultural</td>
<td>68</td>
<td>10.2</td>
<td>54</td>
<td>8.1</td>
</tr>
<tr>
<td>Forest</td>
<td>206</td>
<td>30.8</td>
<td>194</td>
<td>29</td>
</tr>
<tr>
<td>Total</td>
<td>669</td>
<td>100</td>
<td>669</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 4 Land use/cover of Sukhana Basin from 1996-2014.
Figure 2 Land use/land cover maps of Sukhana Basin in 1996, 2003 and 2014. 

The assessment of the accuracy of classification found by ratio of the mapped area that has been correctly classified in comparison to reference data such as toposheet, reconnaissance survey ground truth to the total area mapped. The accuracy found to be 85%.

4. CONCLUSION

From study of land use / land cover change detection, it is found that during 1996-2014, water bodies cover have loss of 4 Sq. Km. Barren land have 146 Sq.Km. loss and forest area with 96 Sq.Km. loss. It is found that urbanization area has gain of 51 Sq.Km. and agricultural land cover also have gain of 195 Sq.Km. Land use / land cover must be improved with reference to resource management and application of conservation treatment in the basin.

REFERENCES


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