Land Use and Land Cover Change Detection of Periyar Main Canal Command through Remote Sensing Using Multi-Temporal Satellite Data

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Abstract--Land use and land cover is an important component in understanding the interactions of the human activities with the environment and thus it is necessary to be able to simulate changes. Empirical observation revealed a change in land use land cover classification in Periyar main canal (PMC) in Madurai district. In this paper an attempt is made to study the changes in land use and land cover in PMC command area over a period of 38 years period. The study has been done through remote sensing approach using LANDSAT imageries of October 1973 and November 2010. The land use land cover classification was performed based on Satellite imageries. GIS software is used to prepare the thematic maps. The data were analyzed and the objective of the study was derived from the data analysis. The present study reveals the rate of change in urbanization in study area with in the period of 38 years. In period of (1973 to 2001) 28years the destructive deviations in the greenish area (Dense scrub and open scrub) is -12267 ha. At the same time within the period of (2001 to 2010) 10years is -9422ha. In settlement category (Village, town, Commercial and industrial) the changes in 28 years is + 2635 ha. But within 10years +7388ha. These destructive changes in study because of the growth of rapid urbanization.

Keywords: Land use, Land covers, Change analysis, remote sensing, change detection, unsupervised classification

1. INTRODUCTION

The urban is a compound system of human and nature. It is also a high-dense geographical synthesis of population, resources, environment, and social, economic and so on. Land is most important and basic resource concerning the urban development. Population growth, unplanned industrialization, urbanization and its consequences adversely affect the regional environment. Improper land use practice results in an adverse impact on ecosystem. So the two words “Land cover” and “Land use” have important significance in regard to land. Land cover implies the physical or natural state of the Earth’s surface. On the other hand a tract of land is covered by forest or a building or a water body or so but it is quite difficult to say what purpose a building may be used for as it may be used for residential or commercial simultaneously. e.g., a multi-complex building often is being used for cinema hall and at the same time one part of it is being used as commercial area / shopping market. Land use is the manner in which human beings employ the land and its resources. Thus urban development is strictly depends upon Land Use/ Land Cover (LULC) of that area. Several knowledge-based approaches were used by Anderson, 1971, Hutchinson, 1982, Jenssen et.al., 1992 for LULC classification by utilizing additional geographical data beside satellite images. The framework of a national land use and land cover classification system was presented by Anderson, et.al. 1976, for use with remote sensor data. Different workers worked even on municipality level using Geographical Information System (GIS) and Remote Sensing (RS). Recent legal requirements in Colombia require each municipality to develop land use plans for the next decade (Ministerio del Medio Ambiente de Colombia, 1997). For municipal-level general land use planning, Rubiano et al., 1997 makes land use restriction recommendations. To support the specific land use planning, Hyman et.al., 2000 developed spreadsheet programs that run parallel to the GIS to help the municipal agricultural extension service assess agricultural restrictions for different types of land units (Rodriguez et al., 1999). Land use refers to man’s activities and the varied uses which are carried on over land and land cover refers to natural vegetation, water bodies, rock/soil, artificial cover and others noticed on the land (NRSA, 1989). In this work a LULC classification scheme of Periyar main canal area is generated on the basis of United States Geological Survey (USGS) classification system, concerning the existing LULC features of that area i.e. Habitation is sub dived in to Town, Village, Commercial and Industrial. Greenish area Sub dived in to Dense Forest, Dense Scrub,
Open Scrub water bodies and tanks are sub divided in to River and stream and Tanks. Land is sub divided into many other sub Classes.

2. Study Area

Periyar Main canal (PMC) is an important water Infrastructure for agriculture in Madurai district. The area selected for the present study is PMC command Area of Madurai district in the State of Tamil nadu. The study area stretched between the latitudes of 10°5'22.12" to 9° 59'27.32" N and longitudes of 77° 51' 15.03" to 78° 25’ 52.13"E.

PMC is part of Periyar Vaigai System show in fig1. This system is unique in nature, The Periyar-Vaigai system is one of the oldest irrigation systems in India. It is a trans-basin scheme, which came into existence towards the end of the nineteenth century. The system consists of two reservoirs namely, the Periyar reservoir on the Periyar river in the Kerala state, the Vaigai reservoir on the Vaigai river in the state of Tamil Nadu, and the irrigation command areas in the Vaigai basin. The Periyar River, which originates on the western slope of the Western Ghats, flows westwards and discharges into the Arabian Sea. The Vaigai River, which originates on the eastern slope of the Western Ghats, flows east and discharges into the Bay of Bengal.

There are three main hydraulic structures in the Periyar-Vaigai system. The most important among them is the Periyar reservoir, which is located in the state of Kerala and satisfies most of the demands of the system. The credit for the Periyar Dam goes to the noted British engineer, Colonel John Penny quick. Releases from the Periyar reservoir are picked up at the Vaigai reservoir, which is a balancing reservoir. After coming out of the Periyar power house, the releases of the Periyar reservoir and the natural flows of the Vaigai basin flow through the Cumbum valley. The Cumbum valley agriculture areas are irrigated through the channels taking off from 15 anicuts constructed across the rivers Vairavanar and Suruliyar. After that the rivers suruliyar, upper vaigai and theniyaru get combined in theni district in the place of vaigai reservoir. Vaigai reservoir was constructed across Vaigai River during 1954-59.

3. Aims and objectives

The objective of this paper to understand the early history of Land use and land cover changes detection using multi temporal satellite data of PMC command area, Madurai District, Tamilnadu. This present study also find out the volume of deterioration of Agriculture and Increasing Volume of urbanization during 1973, 2001 and 2010 in the study area.

4. Materials and Methods

- A Topo sheets of Madurai District (58K1, 58K5, 58F16, 58G13, 58J4, 58J8)
- ArcGIS 9.1 and Erdas 9.2 and Global mapper

For the study, Landsat satellite images were acquired for three year; 1973, 2001 and 2010. Both were obtained from Global Land Cover Facility (GLCF) an Earth Science Data Interface. Topo sheets are purchased from Survey of India (SOI), data source detail as (Table1) in below

<table>
<thead>
<tr>
<th>s.no</th>
<th>Data Type</th>
<th>Date of production</th>
<th>Scale</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Landsat image</td>
<td>21.10.1973</td>
<td>30m ETM</td>
<td>GLCF</td>
</tr>
<tr>
<td>2.</td>
<td>Landsat image</td>
<td>19.10.2000</td>
<td>30m ETM</td>
<td>GLCF</td>
</tr>
</tbody>
</table>
In this work a LULC classification scheme of Periyar main canal area is generated on the basis of United States Geological Survey (USGS) classification system, concerning the existing LULC features of that area i.e. Habitation is sub divided in to Town, Village, Commercial and Industrial. Greenish area Subdivided in to Dense Forest, Dense Scrub, Open Scrub water bodies and tanks are sub divided in to River and stream and Tanks. Land is sub divided into many other sub classes.

To understand the deterioration of Agriculture and urbanization growth, both primary and secondary data relevant to topic have been gathered from a wide range of sources. The urbanization cover of the area has been properly highlighted by deriving data from the Survey of India topographic maps of 1:50000 scale and the satellite imagery of ETM multi-spectral imagery attained during 1973, 2001 and 2010 combined with detailed field verification. The demographic data for the PMC Command area for the period from 1973 to 2010 have been analyzed. The land use maps prepared by using potential of Arc GIS software.

6. RESULT AND DISCUSSION

Land Use / Land Cover Distribution - The static land use land cover distribution for each study year as derived from the maps are presented in the Tables in below

<table>
<thead>
<tr>
<th>Land use/ Land cover categories</th>
<th>1973</th>
<th>2001</th>
<th>Change (1973-2001)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dense Forest</td>
<td>8933.30</td>
<td>7162.33</td>
<td>-1770.97</td>
</tr>
<tr>
<td>Dense Scrub</td>
<td>29585.16</td>
<td>24352.03</td>
<td>-5233.13</td>
</tr>
<tr>
<td>Open Scrub</td>
<td>20220.74</td>
<td>13186.02</td>
<td>-7034.72</td>
</tr>
<tr>
<td>Barren land</td>
<td>6558.47</td>
<td>16641.54</td>
<td>10083.07</td>
</tr>
<tr>
<td>Village</td>
<td>1700.21</td>
<td>2748.00</td>
<td>1047.79</td>
</tr>
<tr>
<td>Town</td>
<td>3352.94</td>
<td>4891.13</td>
<td>1538.19</td>
</tr>
<tr>
<td>Commercial and Industrial</td>
<td>40.00</td>
<td>89.00</td>
<td>49.00</td>
</tr>
<tr>
<td>Tanks</td>
<td>65.52</td>
<td>60.00</td>
<td>-5.52</td>
</tr>
<tr>
<td>Inland water</td>
<td>1032.39</td>
<td>2250.10</td>
<td>1217.71</td>
</tr>
<tr>
<td>River and Streams</td>
<td>739.00</td>
<td>739.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Mining</td>
<td>282.42</td>
<td>391.00</td>
<td>108.58</td>
</tr>
<tr>
<td>Total</td>
<td>72510.15</td>
<td>72510.15</td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Land use / Land cover change of Periyar main canal command area (1973 -2001)

Land use / Land Cover in 1973

As per the land use map prepared by the Survey of India toposheet 1:50000 scale, there are 11 major land use categories. They are dense forest, dense scrub, open scrub, barren land, village, and town, commercial and industrial.
tanks, inland water, River & stream and mining. In overall 72510.15ha command area dense forest is cover 8933.3ha (12.32 %) in Agriculture area, Dense Scrub covers 40.80% , open scrub covers 27.89 totally the Agriculture area as 68.96 % Barren Land covers 9.04% the settlements are classified in to Village, Town, Commercial & Industrial. In that Village covers 2.34%, Town covers 4.62% and industrial and commercial areas covers 0.06 % Water Bodies are Classified in to three categories as Tanks, Inland Water and Rivers and streams,. Tanks areas covers 0.09% inland water covers 0.06% Rivers and streams 1.02% and 0.39% Mining area Covers in total Command area. Land use and land cover map in 1973 as shown in fig2.

Land use / Land Cover in 2001

As per the land use map prepared by the Survey of India toposheet 1:50000 scale, there are 11 major land use categories. They are dense forest, dense scrub, open scrub, barren land, village, town, commercial and industrial, tanks, inland water, River & stream and mining. In overall 72510.15ha command area dense forest is cover 5738.00ha (7.91%) in Agriculture area, Dense Scrub covers 23.64% , open scrub covers 15.13% totally the Agriculture area as 38.77 % Barren Land covers 28.86% the settlements are classified in to Village, Town, Commercial & Industrial. In that Village covers 9.33%, Town covers 11.23% and industrial and commercial areas covers 0.29 % Water Bodies are Classified in to three categories as Tanks, Inland Water and Rivers and streams,. Tanks areas covers 0.08% inland water covers 1.36% Rivers and streams 1.02% and 1.14% Mining area Covers in total Command area.

Land use / Land Cover in 2010

As per the land use map prepared by the Survey of India toposheet 1:50000 scale, there are 11 major land use categories. They are dense forest, dense scrub, open scrub, barren land, village, town, commercial and industrial, tanks, inland water, River & stream and mining. In overall 72510.15ha command area dense forest is cover 7162.33ha (9.88%) in Agriculture area, Dense Scrub covers 33.58% , open scrub covers 18.19% totally the Agriculture area as 51.77 % Barren Land covers 22.95% the settlements are classified in to Village, Town, Commercial & Industrial. In that Village covers 3.79%, Town covers 6.75% and industrial and commercial areas covers 0.12 % Water Bodies are Classified in to three categories as Tanks, Inland Water and Rivers and streams,. Tanks areas covers 0.08% inland water covers 1.36% Rivers and streams 1.02% and 0.54% Mining area Covers in total Command area.
Agriculture fields are converted as plots and residential buildings, and the surface tanks are converted into plots and storage place of stone guvaries. Due to this issues Environmental pollution and Ecosystem issues was occurred in the PMC Command area.

7. CONCLUSION

The objective of this study were to provide recent perspective for land use type and land cover changes that has been taken place in the last thirty eight years, using remote sensing and GIS capabilities in studying the spatial distribution of land cover changes PMC Command area was found to have experienced rapid changes in land use/land cover Particularly in open scrub land. Open scrub land has decreased by 20220.74 ha. In 1973 to 13186.02 ha in 2001. Here open scrub land converted to build up land. Due to these changes we lost our natural ecosystem and biodiversity also. The increase in the area under built up lands may lead to a lot of environmental and ecological problems. Hence government should come forward to take effective measures to protect the land under agriculture in Periyar main canal command area. Here proper land use planning is needed otherwise we lost our natural resources

8. REFERENCES

1. Adel Shalaby and Ryutaro Tateishi. (2007), Remote sensing and GIS for mapping and Monitoring land cover and land-use changes in the North-western coastal zone of Egypt, Applied Geography 27, 28–41.


