MONITORING LAND USE / COVER CHANGE OF SOLAPUR CITY BY USING GEOSPATIAL TECHNIQUES

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Abstract
Rapid urbanization leads to dramatic change in urban landscape dynamics. The knowledge of land use and land cover is important for many planning and management activities and is consider an essential element for modeling and understanding the earth as a system. This paper illustrate the use of remote sensing and Geographical Information System techniques to monitor and measure the land use / land cover and urban growth of Solapur city, Maharashtra, India. IRS Satellite imagery and topographical map of Solapur city with 1:250,000 were compared for the present study over a period of 20 years. Supervised classification methodology has been employed by using Maximum Likelihood Techniques in ERDAS 9.1. Solapur city is located in semi arid region of which is climatically drought prone. The population of Solapur city as per 2011 census was 9, 51,558. It is most popular in manufacturing of textile product. Recently city is expanding because of education hub, emerging medical tourist destination The images of the study area were categorized in to four different classes, viz. water body & Marsh land, vegetation & Agricultural Area, built- up land and open space. The results indicate that the major land use in Solapur City is built -up area. During the period 1990 to 2011, the area under built- up land has increased by 15.63 % due to construction of new buildings on agricultural land, areas under vegetation and open space while Water body & Marsh land increased by 2.58%. As a result, the area under vegetation and open space decreased by 12.90% and 5.22% respectively The paper also highlights the nature, rate and location of change. The importance of digital change detection techniques is proper land use planning for sustainable and uniform growth of Solapur city.

Key Words: *Land Use, Land Cover, GIS, Supervised Classification, Maximum Likelihood Techniques.*

Introduction

The extent of urbanization or the sprawl is one such phenomenon that drives the change in land use patterns. The sprawl normally takes place around the city center or in linear direction along the highways. Usually sprawl takes place on the urban fringe at the edge of an urban area or along the highways. The studies on urban sprawl have been attempted in developed countries and recently in developing countries such as India, Brazil, and China etc. The built-up area is generally considered as parameter for quantifying urban sprawl. The convergence of GIS Remote Sensing & DBMS has helped in quantifying, monitoring, modeling and subsequently predicting this phenomenon. At the landscape level, GIS aids in calculating the fragmentation, patchiness, porosity, patch density, interspersion and juxtaposition, relative richness, diversity, and dominance in order to characterize landscape properties in terms of structure, function & change (Civco et al., 2002). Modeling the spatial and temporal dimensions has been an intense subject of discussion in the disciplines like philosophy, mathematics, geography and cognitive science (Claramunt and Jiang, 2001).

In order to quantify the urban forms such as built-up in term of spatial phenomenon Shannon's entropy and the landscape metrics (patchiness, map density) are computed for understanding the built-up dynamics (Sudhira et al.,2004) Sprawl has been criticized for eliminating agricultural lands, spoiling water quality and causing air pollution. As population increase, so does the need for new housing, schools and transportation networks. In the

urban world today industrial, commercial and residential requirements are markedly different from years past. Decentralization is a trend inductive of urban sprawl and present day industrial commercial and residential areas are no longer necessarily a part of the urban core.

How to measure urban sprawl has been a hot spot of research. Some research organization has put forward their indicators for measuring urban sprawl. Besides many scholars focus on using indicators to measure urban sprawl by establishing multidimensional indicators by GIS analysis or descriptive statistical analysis (Ewing and Don 2002). Remote sensing and GIS, separately or in combination can be used for application in studies of urban sprawl. An attempt has been made in this study to map out the status of Land use/ cover of Solapur city, Maharashtra in view to detect the land consumption rate and the changes that have been taken place during 1990- 2011using GIS and remote sensing technique.

Objectives

To identify land use/ cover of Solapur city using satellite data and geospatial techniques. To analyze land use/cover change by comparing topo sheet map surveyed in 1990 and satellite image of IRS 2011. To examine the spatial dynamics of urban sprawl during 1990 to 2011

Methodology

To work out the land use cover classification supervised classification method with maximum likelihood algorithm was applied in the ERDAS (Earth Resource Data Analysis System) imagine 9.1 Software. Topo sheet with 1:250,000 and IRS satellite data with 30m resolution were used for comparison of land use/ cover assessment. Topo sheet surveying work done in the year 1990 while IRS satellite imagery obtained in year 2011. So 20 years land use/ cover assessment made in this study. Four land use/cover types have been identified and used in this study namely (i) Water body and marsh land (ii) Vegetation and agricultural field (iii) built-up area and (iv) Open space. For performing land use/cover change detection, a post classification detection method was employed. Quantitative areal data of the overall land use/cover changes as well as gains and losses in each category between 1990 and 2011were then compiled.

Study area

Solapur city is situated on the south east fringe of Maharashtra state and lies in the Bhima & Seena basins. It lies between 17º34'47" to 17º 44'9" North latitude and 75º 48'49" to 75 º 57' 54" East longitudes and encompasses an area of 18291.90 Hector². According to the 2011 census total population of Solapur city is 951,558.

Solapur is situated in semi arid region of Maharashtra plateau an important place in the history of modern India. The city is known as textile center of the Maharashtra state. Solapur is famous for cotton textile industries and Vidi industry (small scale). Apart from this industry chemical, engineering industry, agricultural goods market, medical and hospitality are also operating prominently in the city. The city is emerging as a educational hub, Medical Tourist Destination, and Pilgrimage Destination. The climate is an tropical nature temperature varies from 20ºC to 43ºC. Rainy season extends from June to September, with the period of maximum rainfall normally occurring during the months July and August.

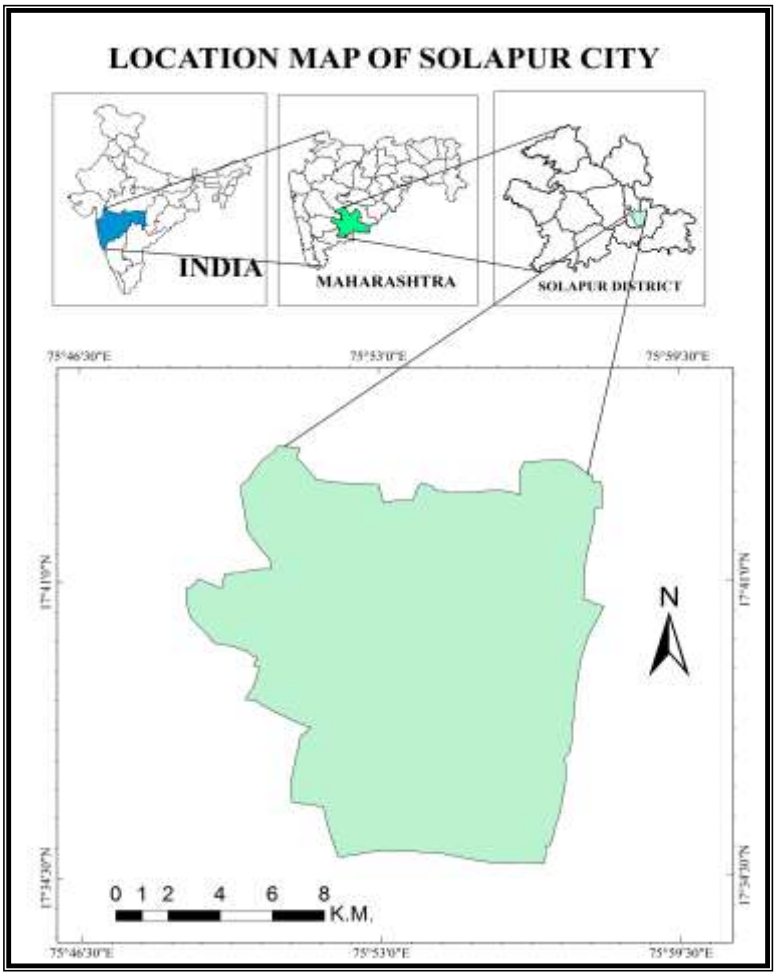

Figure 1. Location Map

Result and discussion

The data obtained through the analysis of satellite imagery is presented in the table 1.1 and results are diagrammatically illustrated in figures. Fig. 2 depicts land use/cover spatial status of two study periods i.e.1990 and 2011. Figure 3 depicts land use cover change from 1990 to 2011 indifferent land use categories e.g. Water body and marsh land, Vegetation and agricultural field, built-up land and, Open space. Figure 4 diagrammatically illustrates magnitude of change in different land categories while figure depicts urban sprawl expansion along major roads. A brief account of these results is discussed as under.

Land Use/ Cover Status

Fig. 1.2 depicts spatial pattern of land use/cover of Solapur city for the year 1990 and year 2011. These data reveal that in 1990 about 3945.01 hector² (21.56%) area was under water body and marsh land, 7654.90 hector² (41.84%) under vegetation and Agricultural land, 1552.73 hector² (8.48%) under built-up area and 5139.26 (28.09%) hector² under open

space. During 2011 the area under these land cover categories was found to be 4115.58 hector² (24.14%) area was under water body and marsh land, 5297.22 hector² (28.95%) under vegetation and Agricultural land, 4395.00 hector² (24.02%) under built-up area and 4184.10 hector² (22.87%) under open space respectively.

Land use/Land cover Change

The data presented in table 1 and figure 3 depict that both positive and negative changes occurred in the land use /cover of Solapur city. During this period the water body and marsh land increased 21.56% in 1990 to 24.14% in 2011 which accounts for 2.57% of total land cover area. The vegetation cover decreased from 41.84% in 1990 to 28.95% in 2011which accounts for 28.95% of total city area. It is due to increasing population of the city which required more land for new settlers.

Table 1. Solapur City: Area and amount of Change in land use/cover categories (1990-2011)

Land use/cover categories	Area 1990		Area 2011		Change in volume 1990-2011	
	Area in Hector²	Area in %	Area in Hector²	Area in %	Area in Hector²	Area in %
Water body and marsh land	3945.01	21.56	4415.58	24.14	470.57	2.57
Vegetation and agricultural field	7654.90	41.84	5297.22	28.95	-2357.68	-12.88
Built-up area	1552.73	8.48	4395.00	24.02	2842.27	15.53
Open space.	5139.26	28.09	4184.10	22.87	-955.16	-5.22
Total Area	18291.90	100%	18291.90	100%	----	----

Computed By: - Author

The built-up area has increased from 8.48% in 1990 to 24.02% in 2011 which accounts for 24.02% of the total city area. The dramatic increase in built-up area is due to rapid growth of population, continuous establishment of small and large scale companies and development of roads etc. (During the study period of Solapur city in the fringe area.) The open space has slightly decreased from 28.09% in 1990 to 22.87% in 2011 which accounts for 22.87 of the total city area. Open space is also shows declining trend as shown in figure 2.

Spatial dynamics of urban sprawl

The Solapur city is known to have undergone extremely fast areal expansion in recent year due to industrialization resulting in an unprecedented population growth over a period of 20 years. Over a period of time, Solapur has developed linearly from eastward and southward along National highway no. 9 and 13. The central business district (CBD. inner city) is located in the central part. It is heavily built up and characterized by mixed commercial and transport related activities. The public, semipublic, residential and other land use activities have been mostly concentrated in the south. On comparing the satellite data sets pertaining to 1990 and 2011 it is found that the built-up area in and around the Solapur city has increased by 284.27 sq hector (15.53%) over the period of 20 years (1990 to 2011).

Fig. 1.4 explains urban expansion processes in the Solapur city during the period of 1990 to 2011 is along the major roads. As per map NH 9, NH 13, Akkalkot SH, Tuljapur SH and Hotagi road buffer is created with the range between 200 to 1000 M. It reveals that NH 13, Akkalkot SH and Hotagi road expanded rapidly and reality estate owners, developers

constructed housing colonies. On NH 13 Maximum expansion was taken place up to 1000 M from both side. In between Akkalkot SH and NH-9, the city was expanded beyond 1000 mts. distance also. On the contrary NH 9 and along Tuljapur SH the process of expansion was very slow it is because of deep black cotton soil. Where agriculture is major source of income, here the expansion from NH 9 was only 200 M. from both sides. The area and density under urban land is decreasing while going the way from major roads. Most urban expansion can be observed within a distance of major roads.

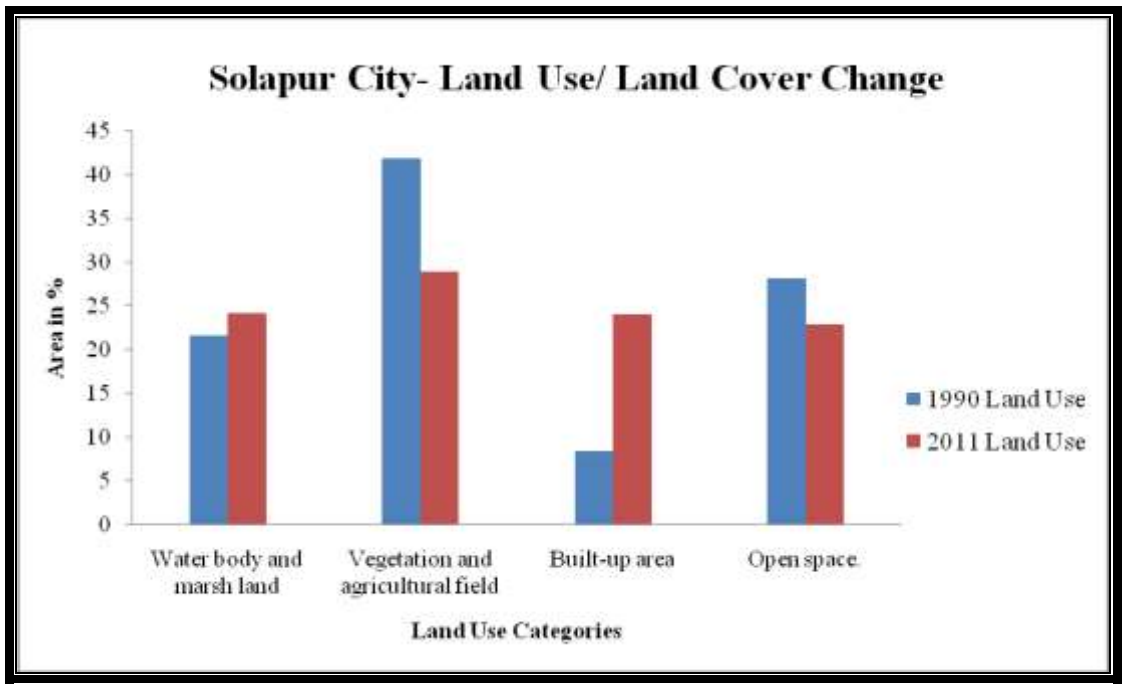

Figure 2. Solapur City Land Use/ Land Cover change.

Conclusions

The present study reveals that remote sensing and GIS are important technologies for temporal analysis and quantification of spatial phenomena. Change detection is made possible by these technologies in less time, at low cost and with better accuracy. The study conducted in one of the largest growing cities of Maharashtra state reveals that multi temporal spatial data ar e very useful to detect the changes in land use quickly and accurately. The study reveals that the major land use in Solapur city is built-up area. During the period 1990- 2011 the area under built-up land has increased by 2842.27 hectors (15.53%). The increase in built-up area is due to construction of new buildings on area under agriculture, vegetation and open space. Water body and marsh land is also increased by 2.57% due to the unplanned discharge of sewage water on agricultural land and open space. As a result the area under vegetation, agricultural land and open space was declined by 12.88% and 5.28% respectively. The urban expansion along the major roads (i.e. NH13, Hotagi road, and Akkalkot S.H. road) reveals that occupancy of area and built-up density are decreasing while going away from the major roads. The approach adopted in this study

clearly demonstrated the potential of GIS and remote sensing technique in measuring the change pattern of land use/ cover in city area. The study not only provides scientific way to understand the future urban growth but also provide methodology for assessing urban land use in cost effective and less time period. The present study is useful for decision making process and helpful for planners to formulate suitable plan for sustained urban development in the region.

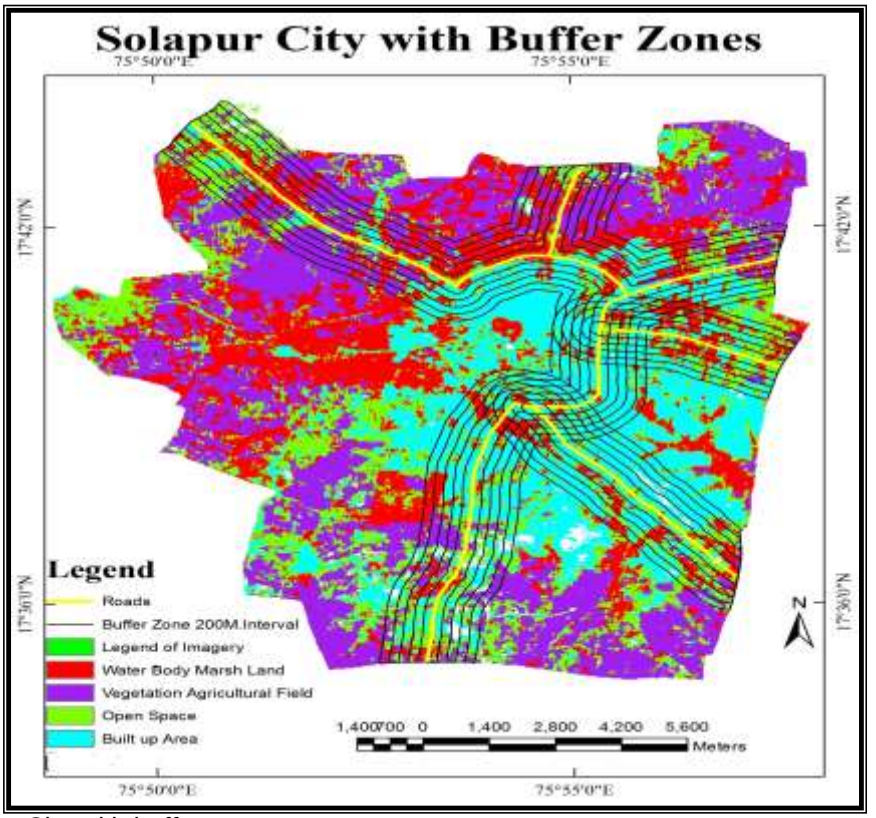

Figure 3. Solapur City with buffer zones.

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