Original Research Paper Geography

Monitoring Physical Expansion of Pune City Using GIS and Remote Sensing Techniques

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ABSTRACT

Urbanisation is correlated with population density and built-up density. The haphazardly increasing trend of urbanisation creates problems like increasing cost of land, urban congestion, poor housing structure, low educational status, lack of basic urban services and other related problems. This is mainly due to uncontrolled and unplanned urban expansion. The present research work is an attempt to monitoring physical expansion of Pune City during 1973-2014 with the help of GIS and remote sensing techniques. The city has been expanding in all directions during the last four decades but this is more pronounced to the east of the city than to the west, due to natural barrier like hills and undulating topography. The major problem of the study area has shifting of agricultural areas into non-agricultural uses.

KEYWORDS : GIS, Land Use, Remote Sensing, Urban Services,

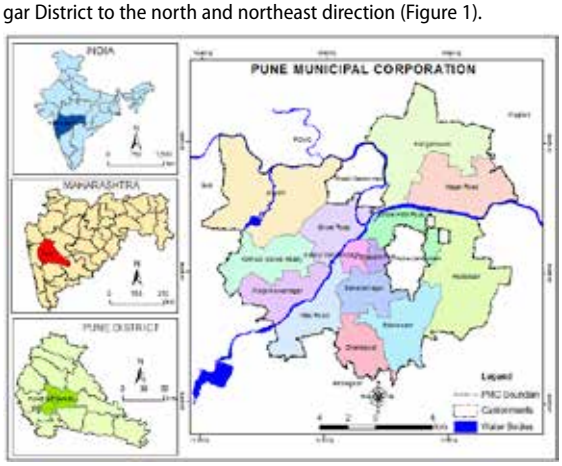
INTRODUCTION

Urban growth has recognized as a symbol of development as well as a burden over natural resources. The process of urbanisation speeded up in the wake of industrial revolution in the western world leading to the expansion of infrastructure such as transport and communication, which propelled increased rural to urban migration (Yeh and Li, 2001). Increasing Urbanisation and urban growth is the biggest challenge of the present century because rapid urbanisation results the haphazard and unplanned growth of cities. Rapid urbanisation raises many issues, which might have both positive and negative impacts on environment (Mundhe and Jaybhaye, 2014). The urban authorities have failed to deal with the rapidly increasing urban areas (Brahabhatt et al., 2000; Bhatta, 2012). Therefore, present research work is an attempt to monitoring physical expansion of Pune City during 1973-2014 with the help of GIS and Remote Sensing techniques.

GIS and remote sensing techniques have been used as powerful and effective tools to monitor land use/land cover changes. Thus, become an important component in current strategies for managing natural resources and monitoring environmental changes for sustainable urban planning.

STUDY AREA

The Pune City has been selected as a study area for the research work because Pune is one of the fast developing urban agglomerations in Asia and ranks eight at national level. Pune is a situated near the western margin of the Deccan Plateau and at an altitude of 560m above the MSL (ESR, 2013-14). Pune City lies between latitudes 18° 25′ N and 18° 37′ N and longitudes between 73° 44′ E and 73° 57′ E and cover geographical area is around 250 sq. km with a population of over 3 million in 2011(Census of India, 2011). The city is bounded by Thane District to the northwest, Raigad District to the west, Satara District to the south, Solapur District to the southeast and Ahmednagar District to the north and northeast direction (Figure 1).



"Figure 1: Location Map of Study Area about here".

OBJECTIVE

The main objective of the present study is to monitoring physical expansion of Pune City during 1973 to 2014 using GIS and Remote Sensing techniques. The study provide some important suggestions for the planners and the decision makers to deal with the haphazard urban expansion and pressure of population in the metropolitan cities.

MATERIAL AND METHODS

In this study, remote sensing data collected from United State of Geological Survey *web site* like Landsat MSS (1973), TM (1992) and ETM+ (2001), Landsat OLI/TIRS (2014). Firstly, standard image processing techniques have been used for the analysis of satellite data such as rectification, enhancement and classification (Congalton and Green, 1999; Desai et al., 2009; Mundhe and Jaybhaye, 2015). The classification of satellite images have been categorized into two major classes such as built-up and non built-up area. After that, pre processing has involved scanning, geo-referencing and digitization of Survey of India (SOI) topographical maps scale 1:50,000 to serve as the base map. Topographical maps and other maps have been digitized in different layers such as roads and railway network, administrative boundaries and built-up area. The built up area of Pune City has been extracted from classified Landsat satellite imageries of the last four decades. This extract was overlaid on the boundary layer. Lastly, fieldwork was conducted to understand the actual changes that took place in the study area for last four decades.

RESULTS AND DISCUSSION

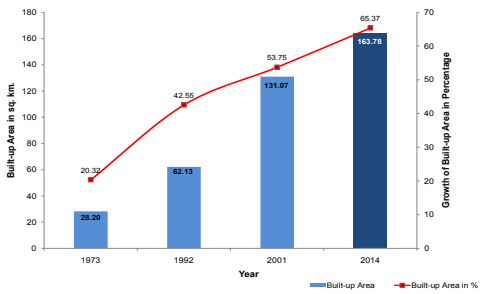
The built-up is generally considered as the parameter of monitoring urban growth (Torrens et al., 2000). The proportion of the total population in a region to the total built-up area of the region is a measure of quantifying growth. It can be quantified by considering the impervious or the built-up as the key feature of development, which is delineated using topographical maps and satellite data, gives a better knowledge for understanding the behaviour of such physical expansion (Epstein et al., 2002).

Urban expansion over a period of time will help in understating the nature and growth of this phenomenon and visualizing the future development (Cheng and Masser, 2003). The study is mainly concentrated on the built-up area, since that, was considered as prime indicator of urban expansion. The built-up area of Pune City has increased from 28.20 sq. km to 163.78 sq. km during the period of 1973 to 2014. The total geographical areas during 1973 were 138.76 sq. km with a population of around 0.85 millions, out of which the share of the built-up areas was 28.20 sq. km and the rest, 110.56 sq. km, was marked as non-built-up area. The total geographical area including the non built-up land in 2014 shows 250.56 sq. km with a population of around 3.1 millions, out of them the built-up area was 163.78 sq. km (Table 1). It is mainly due to expansion of industrial areas, IT industries and educational institutions in study area.

"Table 1: Physical Expansion of Pune City (1973-2014) .

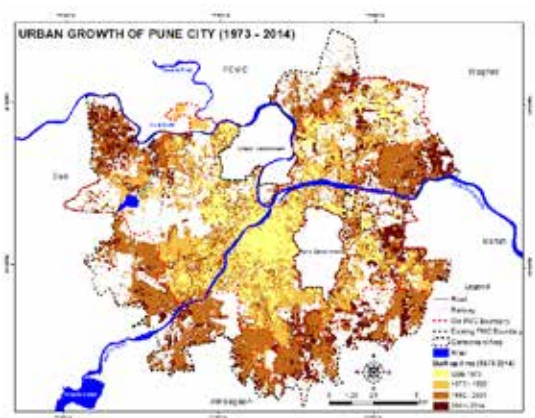
Category	1973	1992	2001	2014
Built-up Area (sq. km)	28.20	62.13	131.07	163.78
Non Built-up Area (sq. km)	110.56	83.87	112.77	86.78
Total Area (sq. km)	138.76	146.00	243.84	250.56
Total Population (Lakhs)	8.6	16.9	25.4	31.2

The boom in built-up area has happened during 1992 to 2001, in which it has expanded from 62.13 sq. km to 131.07 sq. km, whereas, during 2001 to 2014 the expansion from 131.07 sq. km to 163.78 sq. km. It clearly shows that, during the period from 1992 to 2001, the expansion was 68.94 sq. km and in the next 13 years expansion has decreased about 32 sq. km (Figure 2).



"Figure 2: Urban growth of Pune City (1973 – 2014) ".

The analysis reveals that, the rate of physical expansion of Pune City was not constant but it was fluctuating in last four decades. The physical expansion is highest during 1973 to 1992, it was 120.32 % followed by 110.96 % during 1992 to 2001 and 24.96 % in 2001to 2014 (Figure 3). Pune City is expanding towards east and northwest direction, encroaching adjacent small towns and engulfing rich agriculture land. Most of the vacant lands close to the road networks have converted for residential or commercial purpose.



"Figure 3: Urban Expansion of Pune City (1973 - 2014)".

CONCLUSIONS

The city experienced the positive and negative growth rate of area as well as population. The area of city increased from 28.20 sq. km to 163.78 sq. km during the period of 1973 to 2014. In addition, to areas under non built-up land categories have decreased. The analysis shows that a phenomenal rise in the built-up area that has grown by 45.05% signifying a spree in construction activities during last four decades. Expansions of Pune City has haphazard and unplanned development, increased number of problems like encroachment of hill slope and riverbank, unauthorized slum development, overcrowding, environmental degradation and loss of agricultural land etc. These problems require immediate suggestion of the planners and municipal administrator.

The planners need the detailed information regarding city like future direction of development and estimation of civic services. GIS and remote sensing techniques are proving for estimating the direction of the physical expansion and its effect on existing land use/land cover.

SUGGESTIONS

Pune City experienced a rapid horizontal urban expansion, which resulted in loss of valuable land for agriculture, decline in cultivated area and uncoordinated outward sprawl. A certain remedies have been suggested for sustainable planning and management of Pune City.

To check the deviations in the land uses with the respect to what has been allotted in the development plan.

Fertile land around the city to be protected.

To identify illegal encroachments along the hill slopes and riverbanks in order to stop the unregulated and unplanned development and maintain the green cover area.

Land use/land cover pattern of the Pune City would be of immense help in formulation of policies and development planning.

There needs to be a stricter implementation of agricultural land conversion laws and greater encouragement for farmers to remain in farming activities.

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