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LAND USE CHANGE DETECTION OF URBAN AREA USING GIS AND RS TECHNIQUES: A STUDY OF AHMEDNAGAR CITY, MAHARASHTRA, INDIA"

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Abstract:

The world population in the period of 2011 to 2050 is expected to increase by 2.3 billion, passing from 7.0 billion to 9.3 billion. The urban areas of the world are expected to absorb all the population growth expected over the next four decades while at the same time the world rural population is projected to start decreasing (United Nations, 2011). Most of the population growth expected in urban areas and will be concentrated in the cities and towns of the less developed regions. Maharashtra is one of the most urbanized states in India.

Land is one of the critical natural resources on which most developmental activities are based. For success of any planning activity, detailed and accurate information regarding the land cover and land use is necessary Jitendra Kumar (2011). It is also necessary to analyze urban encroachment on arable land, so that we can plan and upgrade infrastructures, to update land use and land cover maps, and much more. It is in this context that urban planners require nearly continuous acquisition of data to formulate government policies and programs. This can be well served by the new and upcoming technology, namely, Remote Sensing and GIS M. Anji Reddy (2009). Management and planning of urban space requires spatially accurate and timely information on land use and changing pattern. Remote sensing becomes useful because it provides synoptic view and multi- temporal Land uses / Land cover data that often required R. K. Nigam (2000)

The present research has used Remote Sensing and GIS techniques in detecting land use changes that have been experienced in last fifteen years from 1997 to 2011 in Ahmednagar city areas.

Key Wards: *land use, land cover, urban planning, Remote Sensing, GIS.*

1. Preamble:

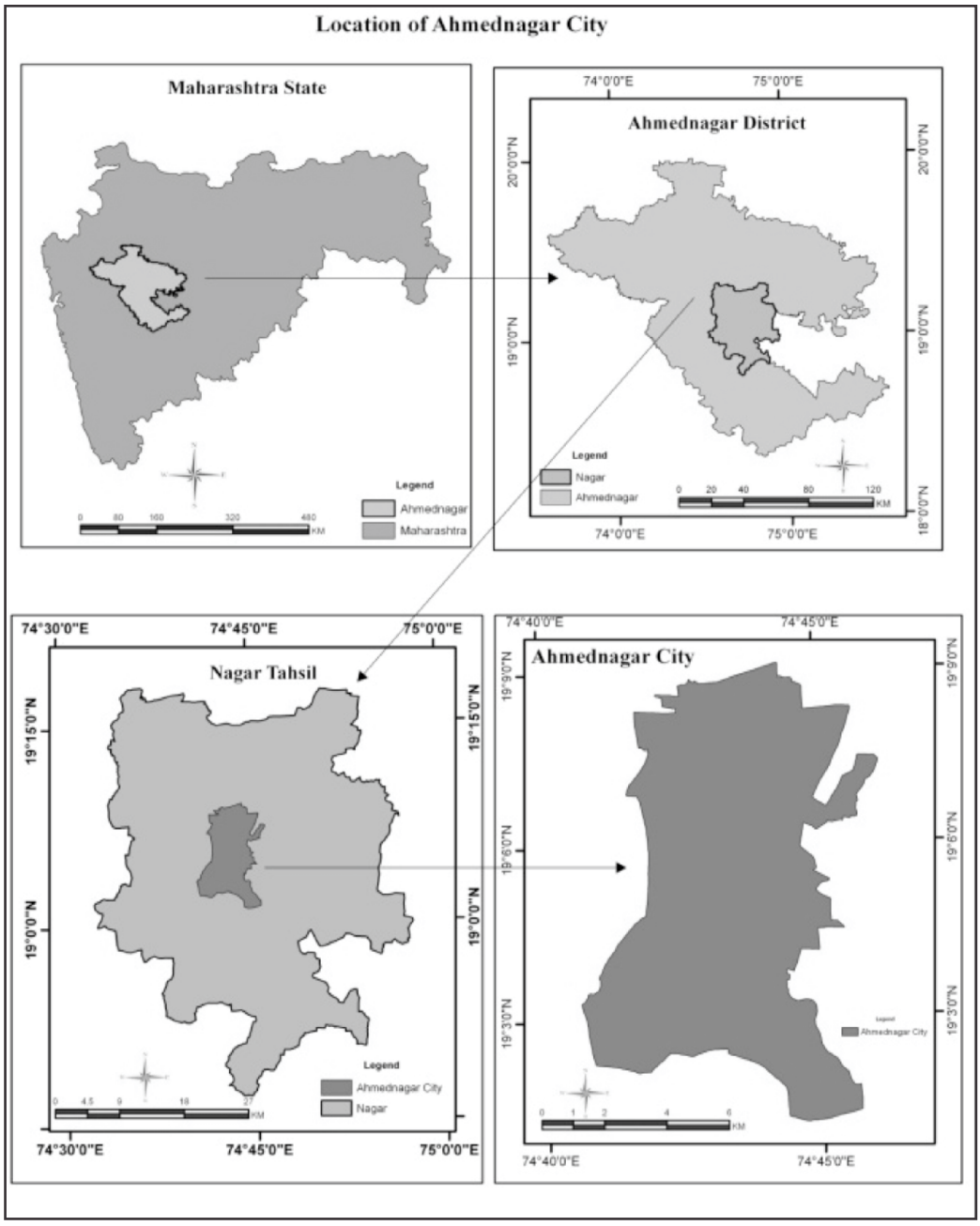
The technology of remote sensing along with geographic information systems (GIS), facilitates spatial data analysis and offers a platform to produce various options for modeling. In the high-resolution satellite data used for urban land use mapping in many studies and in most research. Urban land use is categorized into residential, commercial, industrial and public, etc. (Van der Sande et al. 2003).

The land use planning is a part of larger process of city planning. It is basically concerned with location, intensity, and amount of land development required from housing, recreation, education, and cultural activities of the people. The study of urban land use and its planning is of considerable significance in the overall planning of urban places. According to R. K. Nigam (2000) remote sensing becomes useful because it provides synoptic view and multi- temporal Land uses / Land cover, which are often required to accurately describe land use changes for planning and sustainable management.

In this research authors have used Remote Sensing and GIS techniques in detecting land use changes that have been experienced in last fifteen years from 1997 to 2011 in Ahmednagar city areas.

2. Study Area:

The Ahmednagar city is located between 190 01' 11" North to 190 09' 4.7" North latitudes 74040' 37.52" East to 740 46' 8.28" East longitudes. City is located at the height between 630 m to 695 m. from mean sea level. Ahmednagar city is located in the central part of the Deccan plateau, in the upper 'Sina river' basin.


Location of Ahmednagar City
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Ahmednagar City
Nagar
Ahmednagar City
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74°45'0"E
19°9'0"N
19°6'0"N
19°3'0"N
Legend
Ahmednagar City

Map: 1: Location of Study Area

1. Aims and objectives:

The major aim and objectives of the present paper are outlined in the following lines.

i) To study existing urban land use (developed / undeveloped) pattern with the help Town planning data and Remote Sensing techniques.

ii) To compare town planning and satellite land use / land cover data.

iii) To study spatial variation in urban land use pattern of Ahmednagar city.

iv) To assess the temporal land use/ land cover of Ahmednagar city.

v) To detect change in urban land use/land cover of Ahmednagar city from 1997 to 2011.

2. Methodology:

This research is based on secondary sources of data. Land use data of Developed and undeveloped land use class are obtained from second revised D.P. (development plan) report of Ahmednagar Municipal Corporation.

Satellite images of the period February 1997, January 2007 and January 2011 are analyzed with software's (Erdas imagine 9.3). First satellite image brought for the year 1997 which is acquired by IRS-1C LISS-III satellite and it has spatial resolution a 23.5 m. Second image brought form NRSC-Hydrabad for the year 2007 has acquired by IRS-1C/ 1D-LISS III having 23.5 meter resolution. Third image is downloaded from Bhuvan software for the year 2011 which is acquired by IRS 1C/1D LISS-III. From both type of classification (supervised and unsupervised classification) supervised classification is use for this research.

3. Developed and Un-developed urban area

The concept of 'land use' is related to the use of land which is used for certain activity for a given period of time. Land use is the purposes for which and the way in which human beings employ the land and its resources: for example, farming, mining, or lumbering.

The term 'Land cover' originally referred to the kind and state of vegetation (such as forest or grass cover), or land cover describes the physical state of the land surface: as cropland, mountains, or forests.

Department of town planning AMC prepares existing land use data with the help of actual field survey. This data has been used for preparation of second revised Development Plan report of Ahmednagar town. The Ahmednagar municipal council has given corporation status on 30 June 2003. Area of Ahmednagar city is 80.21 sq. km. Existing land use survey has conducted for extended area and it is sanctioned by government of Maharashtra in 2008. In the present work, total 80.21 Sq. Km. area of Ahmednagar city is taken in to consideration, with its classification as developed and undeveloped area for comparison.

5.1 Developed urban area:

"A Guide to Preliminary Planning Surveys of Urban Areas including Land Use Classification" was published in March, 1977. Developed urban land use of town or city include following groups. a. Residential land use

b. Commercial land use

c. Industrial land use

d. Transport and Communications

e. Public and Semi Public

f. Recreational land use

Table.1: Developed urban area.

Sr. No.	Land Use	Area (In ha.)	Area (% to total developed area)	Area (% to total city area)
1	Residential	634	37.56	7.91
2	Industrial	156	9.21	1.94
3	Commercial	89	5.27	1.11
4	Public and semi pub. Govt.	233	13.78	2.90
5	Public Utility	54	3.20	0.67
6	Trans. and Comm.	455	26.92	5.67
7	Garden, Open space, ground	69	4.06	0.86
Total developed area		1689	100.00	100.00
Total City Area		8021	21.05	21.05

Source: Development plan report AMC, 2005.

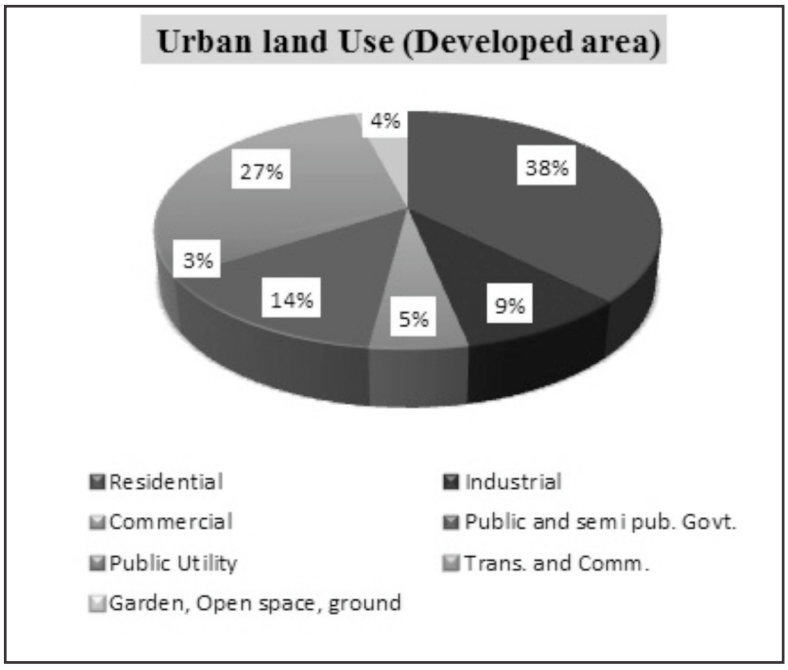


Fig.1: Urban land use in developed area.

As per the Development Plan report city has occupied 8021 ha urban land. Out of total area of Ahmednagar1689 ha i.e. 21.05 percent urban land is developed urban area. Land under residential, industrial, commercial land use, (i.e. Built up area) public and semi-public land use, public utility, transportation and communication and gardens-open space and ground etc. is treated as developed

urban area. 1/5 of city area is developed area and remaining 4/5 area is undeveloped area. If developed area is treated as 100% area, out of total developed area largest area i.e. 37.56% is under residential land use.

MIDC industrial unit is located to the north of Ahmednagar city beyond its existing boundary. Only few small scale industrial estates located near railway station and occupy 9.21% of total developed area. Land under commercial land use is 5.27% only. Public, semi-public and Government offices and acquisition occupy 13.78% of developed urban area. Land under public utility is 3.20% of the total developed area.

Land under transportation and communication include land under road and rail network. In Ahmednagar city this land use occupies second largest after residential land use which is 26.92% of total developed area. Gardens, open space and ground are essential for recreation purpose and occupy 4.06% of total developed area. In developed area of Ahmednagar city Residential Land use and land under Transportation and communication are significant and occupies 64.48% of the total developed area.

5.2 Undeveloped urban area:

As per guidelines in Preliminary Planning Surveys (March, 1977), un-developed urban land use of town or city include following groups. a. Agriculture and Water Bodies:

b. vacant land:

c. Water bodies

d. Defense Department Land

Table.2: undeveloped urban area.

Sr. No.	Land Use	Area (In Ha.)	Area (% to total developed area)	Area (% to total city area)
1	Agriculture	4360	68.85	54.36
2	Vacant Land	1635	25.81	20.38
3	Water bodies	286	4.52	3.57
4	Defense Department Land	51	0.81	0.64
Total Un -developed Area		6332	100.00	100.00
Total City Area		8021	78.95	78.95

Source: Development plan report AMC, 2005.

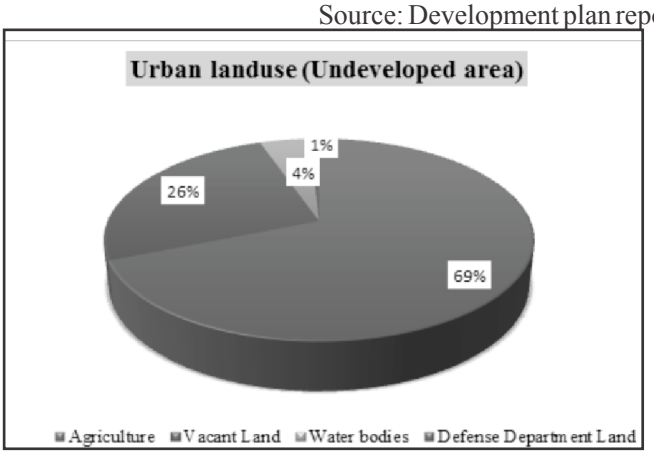


fig.2: Urban land use in undeveloped area.

Undeveloped urban area occupies major land of Ahmednagar city measure about 78.95% areas. It is a result of new addition of surrounding 12 villages in city with major agricultural land use. Extended area of city mostly comprises this land use.

Land under Agricultural use shares 4360 ha which is 68.85% of undeveloped land use and more than half of (54.36%) city area is under agricultural land use. Followed by land under no-use or unbuilt vacant or vacant land under construction shares 1635 ha land which is 25.81% of the total undeveloped area. Land under Nalas, rivers and other water bodies occupy 286 ha i.e. 4.52% of undeveloped area. Defense department occupy 51 ha land in Ahmednagar city, this land is 0.64% of the total area of city occupy by CQAV department.

1. Comparison between town planning and satellite land use data:

Development plan of Ahmednagar City Corporation provide data on urban land use comprises nine categories and satellite remote sensing data is grouped in to five land use category. To make this data comparable Town planning data is arranged as it can be compare with remote sensing data. Land use mentioned by Town Planning development is grouped as residential, industrial and commercial land use is grouped as built up area. Land under garden, open space, vacant land and defense department land in grouped as barren land. Land under rail and road ways is treated as land under transportation and communication, land under agriculture and forest is treated as land under vegetation. Town planning data of existing land use (2008) is compare with Remote sensing data (2011).

Table.3: Town planning (2008) and satellite land use (IRS 1C 2011) land use data

Sr. No.	Land Use	TP data (2008)		RS Data (2011)	
		Area (In Ha.)	Area (%area)	Area (In Ha.)	Area (%area)
1	Built up	1166	14.54	1182	14.64
2	Vegetation	436	54.36	1450	17.96
3	Barren Land	1 754	21.87	4967	61.53
4	Water Bodies	286	3.57	038	0.47
5	Trans. and Comm.	455	5.67	435	5.39
	Total area	8021	100	8021	100.00

Source: Computed by researcher from TP and RS data.

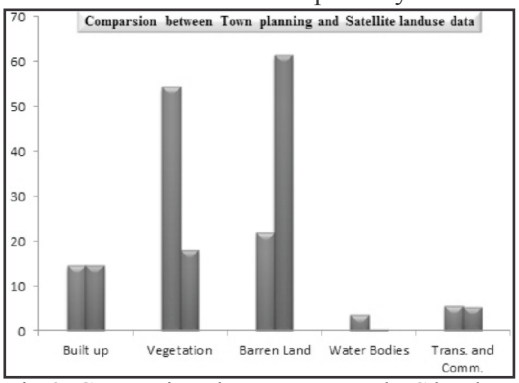
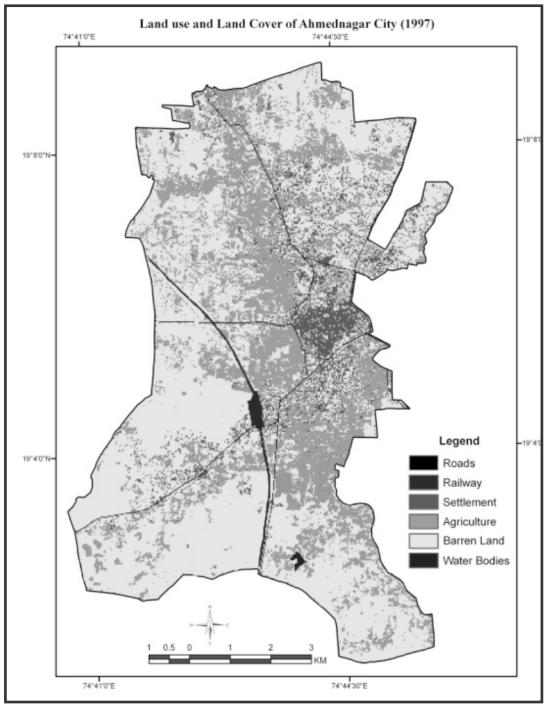


Fig.3: Comparison between TP and RS land use data.

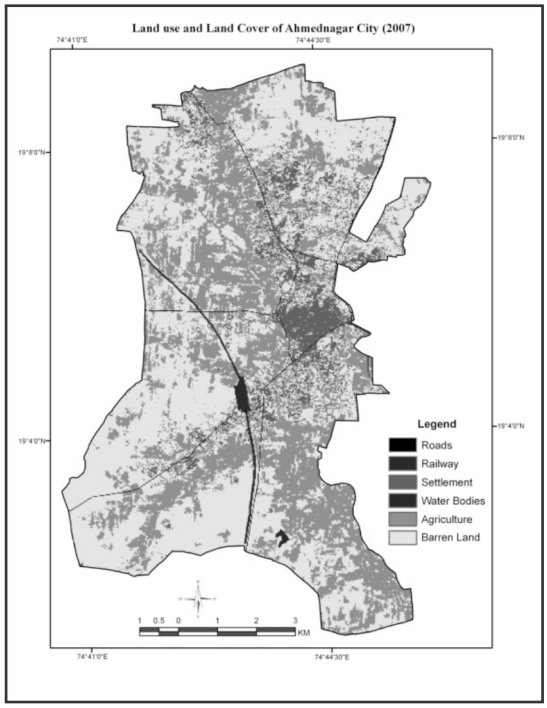
Land under built-up area of the Ahmednagar city is near about same in both years, which is 1166 ha (14.54%) according to the existing land use by municipal authority and 1182 ha (14.64%) according to satellite data. Land under vegetation is considerably decline from 4360 ha i.e. 54.36% to 1450 ha i.e. 17.96% of total area. Agricultural land use is replaced by vacant or barren land use. According to town planning data barren land is 1754 ha which is recorded 4967 ha by RS data. Agriculture land use is replaced by vacant or barren land use may be due to below average rainfall in study region during study period. Land under water bodies according to Town Planning data is 286 ha which is recorded only 38 ha in given period by RS data again due to scarcity of rainfall and small nalas and river basins are not recorded in RS data. Land under Transportation and communication is nearly equal for both town planning and RS data. Therefore it can be stated that satellite data is more accurate and reliable than the actual manual records, because there may be deficiency in updating the information of land use.

1. Spatial variation in land use/ land cover pattern - 1997-2011:

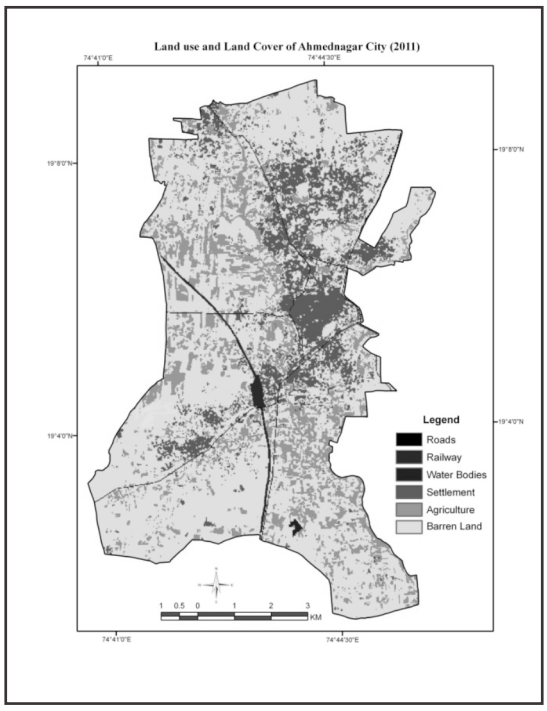
In this research an attempt to analyze spatial variation of city growth and to identify direction and trend of land use change of Ahmednagar city for future urban planning.



Map: 2: LU/LC-1997.



Map: 3: LU/LC- 2007.



Map: 4: LU/LC- 2011.

7.1. Built-up:

Land under built up land use is steadily increasing in Ahmednagar city. From the Land use, Land cover maps (map no. 2 to 4) it is clear that built up area increased on both sides of Manmad and Aurangabad road and it also increase in between areas of Gulmohar road, Pipeline road and Tapovan road. To the east of Mukundnagar (Bhingar) and Chahurana area the eastern boundary of city is restricted for built up development due to military acquisition. Built-up area continuously increases to the south of Gaonthan in the linear direction from north-east to south west in approach of Ahmednagar-Pune road.

7.2. Barren or Vacant land:

From the maps, it is clear that north, west and southern area in proximity of boundary of city are under vacant land use. Vacant or barren land to the north of city is result of convergence of agricultural land to the non-agricultural land use purposely for requirement of residential land use in future; these are the open non-agricultural plots. This area of vacant land is nearly static from 1997 to2007 but barren land use increased to the north especially from 2007 to 2011. Barren Land use is replaced by agricultural land use from 1997 to 2007 in north-western and western part of city may be due to seasonal change in rainfall and increase in cover crops or grass due to high amount of rainfall in study period. South western part of city on both side of Pune road is barren due to non-agricultural plots for commercial purpose and due to undulating topography of region so it is not suitable for any other land use. Barren land use increases in Kedgaon from 1997 to 2011. In east and south eastern part of Gaonthan area of Ahmednagar city, it is noticed that vacant land is replaced by agricultural land use from1997 to 2007 due to approach of river Sina. But barren land use increased rapidly from 2007 to

2011 in eastern and south eastern part of city due to nearness of market area.

7.3. Vegetation:

There is considerable variation in land use under vegetation from 1997 to 2007 and from 2007 to 2011. This land use is observed in main stream of river Sina, its tributaries and low lying area of local nalas like Bhingar Nala etc. Land use under vegetation shows fluctuating trend from 29.24% in 1997 to 34.08% in 2007 and 17.96% in 2011. This fluctuation may be result of variation in average annual rainfall (790 mm in 2007 and 425.6 mm in 2011) in Ahmednagar city.

7.4. Water bodies:

River Sina, its tributaries and some small lakes are the areas of water bodies. There is a small seasonal lake demarcated on map in Burudgaon area.

7.5. Transportation and Communication:

Transportation routes are passing in all directions from Ahmednagar city. Ahmednagar-Pune, Ahmednagar-Kalyan, Ahmednagar-Manmad, Ahmednagar-Aurangabad, Ahmednagar-Solapur, Ahmednagar-Daund these are main roads. Daund-Manmad railway route passing through Ahmednagar city is main railway transportation facility available for peoples of city. All other small town planning scheme roads are unable to read due to problem of resolution of data.

8. Temporal land use / land cover change 1997-2011:

Traditional sources like existing land use maps prepared once in twenty years by town planning department. So Satellite remote sensing data of land use/land cover change of Ahmednagar city.

Table.4: Temporal land use / land cover change 1997-2011.

Sr. No.	Land Use	1997		2007		2011	
		Area (In ha.)	Area (In %)	Area (In ha.)	Area (In %)	Area (In ha.)	Area (In %)
1	Built up	625	7.74	798	9.89	1182	14.64
2	Vegetation	2360	29.24	2751	34.08	1450	17.96
3	Barren Land	4899	60.69	4127	51.13	4967	61.53
4	Water Bodies	030	0.37	038	0.47	038	0.47
5	Trans. and Comm.	158	1.96	358	4.44	435	5.39
	Total area	8021	100.00	8021	100.00	8021	100.00

Source: Computed by researcher

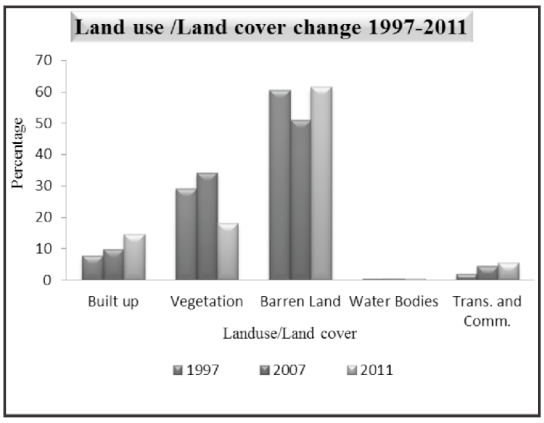


Fig.6.4: Land use / land cover change 1997-2011.

9. Change detection:

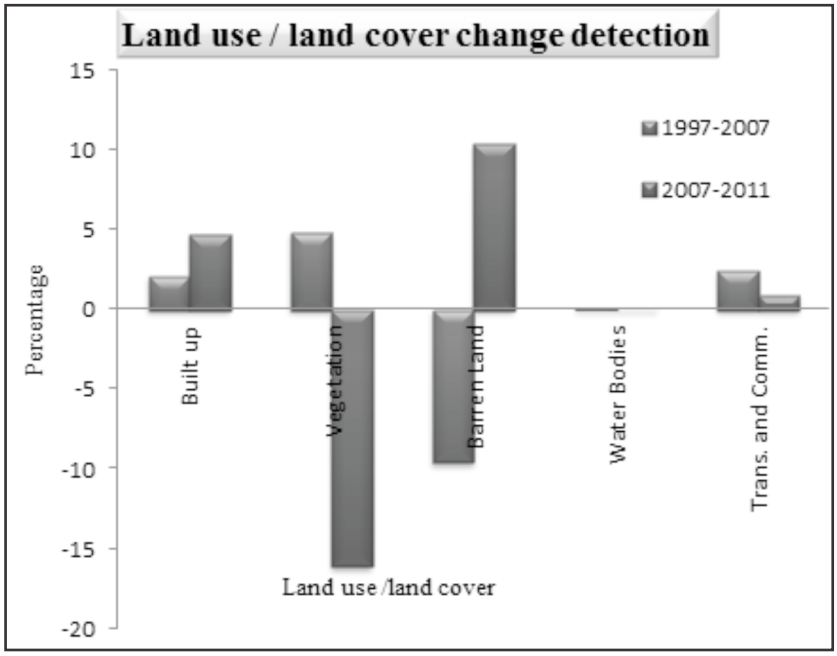
Built up area of Ahmednagar city increased by 173 ha from 1997 to 2007 and it is increased by 384 ha (4.75%) from 2007 to 2011. In the span of 10 years from 1997 to 2007 built up increased by 2.15% but in the span of just 5 years from 2007 to 2011 built up land area increased by 4.75%. There is constant increase in built up area in city and in total study period of 15 years it increased by 557 ha.

Table.5: Land use / land cover change detection 1997-2011.

Sr. No.	Land Use	Change in area			
		1997 -2007		2007 -2011	
		Change (In Ha.)	Change (In %)	Change (In Ha.)	Change (In %)
1	Built up	173	2.15	384	4.75
2	Vegetation	391	4.84	-1301	-16.12
3	Barren Land	-772	-9.56	840	10.4
4	Water Bodies	8	0.1	0	0
5	Trans. and Comm.	200	2.48	77	0.95

Source: Computed by researcher

Table.5: Land use / land cover change detection 1997-2011.



Land under vegetation increased by 391 ha from 1997 to 2007 and rapidly declined by 1301 ha in 2011. This 4.84% increase and sudden decrease of 16.12% may be result of seasonal change is green cover of seasonal grasses. Change in Land under vegetation is replaced by barren land; barren land declined by 772 ha from 1997 to 2007 and it is increases by 840 ha from 2007 to 2011. This increase in barren land is replaced by vegetation and decrease in barren land again is replaced by increase in land under vegetation. There is slight change of 0.1% from 1997-2007 in land under water bodies and no change is noticed from 2007 to 2011. Land under transportation and communication increases by 200 ha from 1997 to 2007 and it increased by 77 ha from 2007 to 2011. There is no change in rail transportation, only land under road ways increased by 277 ha from 1997 to 2011.

10. Conclusion:

The existing land use map prepared by Town Planning Department of the city represents the different urban land uses of the city, but the chronological changes in land uses cannot be represented by the manual map. It requires door to door survey for preparing existing land use map so it is very tedious task. For cites like Ahmednagar, Development Plan prepare once in twenty year. Therefore satellite imagery produced by NRSA, Hyderabad is the most reliable and convenient tool, which depicts the actual situation of the urban land use of a time. Satellite imagery clearly shows the nature of the recent outgrowth of city as well as the changes occurred over the built-up area within the municipal boundary of the Ahmednagar city. In recent period, the outgrowth of the city is very prominent towards north, south and south-west side of the city; but still city has large vacant area because of recent addition of twelve (12) surrounding villages in the municipal jurisdiction. The merged area of villages has larger area under agricultural land use.

The study of urban land use land cover of Ahmednagar city will help for the future planning of the city. The proper planning through reliable information will help to accommodate the rapidly growing population of the city. In future Ahmednagar city will be capable to accommodate growing population over the available physical space by extending infrastructural facilities over the undeveloped urban area.

References:

* A. M. Chandra and S. K. Ghosh (2007), Remote sensing and geographical information system, Narosa Publication House, New Delhi, 110 002.
* A. Shelkar (2008), The Maharashtra Regional and Town Planning Act, 1966, Nashik law houses, Aurangabad, 431003.
* Batty M (2005) GIS and remote sensing as tools for the simulation of urban land-use change. Int Remote Sens 26(4):759–774
* Bhatta B, Saraswati S, Bandyopadhyay D (2010), Urban sprawl measurement from remote sensing data. Appl Geogr 30(4):731–740
* Chandra. A. M & Ghosh. S.K. (2007), Remote Sensing and Geographical Information System, Narosa Publishing House Pp 97-115
* Farooq S, Ahmad S (2008) Urban sprawl development around Aligarh city: a study aided by satellite remote sensing and GIS. J Indian Soc Remote Sensing 36:77–88
* H. Carter (1995), the study of urban Geography, Rawat Publication, Jaipur, 302 004.
* H. K. Doniwal, (2009), Urban Geography, Gnosis, Delhi-92.
* H. Mayer and C. F. Khon, (1967), Reading in Urban Geography, Central book depot, Allahabad.
* IIPS (1999), Urban and regional planning, International Institute for Population Sciences, Mumbai.

Jitendra Kumar(2011), 'Mapping and Analysis of Land- Use/ Land Cover of Kanpur City

* Using Remote Sensing and GIS Technique, 2006', Transaction, Institute of Indian Geographers, Volume 33, No. 1 Winter 2011, pp 43-54.
* M. Anji Reddy (2009) Text Book of Remote Sensing and Geographical Information Systems, BS Publications pp 389-390
* M. T. Cadwallader (1985), Analytical urban geography, spatial patterns and theories Prentice Hall, Englewood Cliffs, New Jersey, USA.
* S A Borude (2015), "Geo-environmental perspectives of urban growth a case Study of Ahmednagar City" unpublished Ph.D. thesis Sovani, N. V. (1966): Urbanisation and Urban India, Asia Publishing House, Bombay
* T.M. Lillesand, R. W. Kiefer and J.W. Chipman (1976), remote sensing and image interpretation, printed in India by, Replika Prss Pvt. Ltd., Kundli, 131028.
* Thomas. M., Ralph.W and Jonathan. W. (2004), Remote Sensing and Image Interpretation, Library of Congress Cataloging-in- Publication Data pp 551-584

Nilesh Kale, Jyotiram More: Hybrid Classification Of Land Use Land Cover In Change Detection Of Upper Ghod Basin In Pune (Maharashtra) Using Remote Sensing Techniques.Impact Factor 1.906Peer Review International Journal of Maharashtra Bhugolshastra Sansodhan PatrikaJan-Jun 2015 Vol- 32, No. 1PP- 9-17108ISSN (print/online): 0971- 6785.URL/DOI: http://www.mbppune.org/index

* Sunil Thakare, Jyotiram More: –Delineation And Mapping Of Saline Lands Using GIS A Study Of NiphadTahsil, Dist- Nashik. Impact Factor 1.906Peer Review International Journal of Maharashtra Bhugolshastra Sansodhan PatrikaJan-Jun 2015 Vol- 32, No. 1, PP- 90-96108ISSN (print/online): 0971- 6785.URL/DOI: http://www.mbppune.org/index
* ShivramKorade, Jyotiram More: Geographical Study of SexRation in Ahmednagar District (M.S.) Impact Factor 3.1402Review of ResearchVol. 4, Issue 11, Aug 2015, PP- 1-5ISSN 2249-894, http://sijournals.com/IJAE/?page_id=253
* Dattatrya Ghungarde, Jyotiram More: Impact of Farm Ponds On Agriculture- A Case Study of ParnerTahsilImpact Factor 2.561 Peer Review International Journal of Maharashtra Bhugolshastra Sansodhan Patrika Jul-Dec 2015 Vol- 32, No. 2, PP- 90-96 108ISSN (print/online): 0971- 6785.URL/DOI: http://www.mbppune.org/index

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