International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878 (Online), Volume-8 Issue-2, July 2019

Land use/Land cover Changes in Sangamner City by using Remote Sensing and GIS

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Abstract: ***This paper examines that, with the help of Remotes Sensing (RS) and Geographical Information system (GIS) Land use/Land cover of the town area from period 1975 to 2017 are classified into different classes. The town information is extracted from Toposheet and Remote Sensing Landsat-7 ETM+ images of 1975 to 2017. There are five expansion types are considered during 42 years, including water body, built-up area, forest, Agriculture and exposed Rock. By analyzing the data from the year 1975 to 2017 we found that the natural feature area such as water body, the forest is decreasing continuously and the area of town that is built-up area increase partially etc. Shannon's Entropy approach identifies the degree of special concentration and dispersion growth, its value is close to 1 which indicates that space distribution is evenly dispersed. According to get the value of statistical Kappa Coefficient which lies in between 0.75 to 0.89 we say that there is accuracy in the requirement of research. Also, in addition to that population for the next three-decade help to define the built-up area of the city, the method used to forecast the population are Arithmetic increase method, Geometric increase method, Incremental increase method, Decreasing rate of growth method and Simple graphical method, this method gives a forecast of urban expansion from the year 2021 to 2041. The Land use/ Land cover changes classification is useful for proper planning, utilization and management of resources. Land use/Land cover changes are contributed to creating community spirit and a properly balanced population structure.***

Keywords: Landsat-7, GIS, Remote Sensing, Supervised classification.

I. INTRODUCTION

Land use and Land cover maps are prepared by using an alternative method which includes remotely sensed data and GIS. In this study for Land use / Land covers mapping the Landsat-7 Enhanced Thematic Mapper (ETM+) are used. Initially, a conventional method is used to gather the land use and land cover data. The conventional method is accurate but it leads to time-consuming, expensive and difficult to update. 'Exponential growth of the human population within the last two hundred years has caused important changes in the natural and built environment' (Sory et al., 2018). The majority of the world's population lives in urban centres, a shift from the past when people primarily lived in a rural area. Geographic Information System is the role model for Land use/Land cover classification (Prakash Shivpuje et al., 2016). The Optimum use of natural resources and to avoid its ill impact on the environment. Remote sensing satellite gives necessary information to monitor Land use/Land cover in an area (Mukherjee S. et al., 2009). The benefit of Landsat-7 data is that new data are periodically available for updating the Land use/Land covers information. The thematic map shows the man-made features along with its field feature. The Land use/Land cover changes are very important to have proper planning and utilization of natural resources and their management. The location of food crops fields shifts every season by clearing a parcel of fallow land, secondary forest or a new portion of primary forest, leading to perpetual changes in the landscape (Martin yemefack 2006). The dispersed development near the main road of a city is called "Urban sprawl". The different factors responsible for town sprawl are Infrastructural development, the road network of that area, different income group present to that town as well as income sources, socio-economic development of the area and census population growth of that city. As the population of the town is increasing at an extreme level, it automatically affects on resource present to that area its result is that in the small area occupied the larger population and impact that the scarcity of the resources (Radhakrishnan N. et al., 2014). In India generally observed that the development is near to the main road of that Town or city result as a hub of economic activity, it is difficult to identify the development pattern of the area. As per the study, town area near to the main area the development is in the form of the shopping centre, cafeteria and the small vegetable sellers. The nature of the development of the city is dynamic and it affects the environment condition of the area. That traditional method we used for land survey does not give the improved result. Nowadays we are using different digital method for land surveying such as differential Global Positioning System, Multispectral Satellite Imagery and different sensors based technology. Now a day's integrated method such Remote Sensing, GPS and GIS as are used for effective town planning. The statically technique is used to analyze the accuracy assessment of the city. The quantity of groundwater presence depends on Land use/ Land cover change (Singh Sudhir k.et al., 2010). The different Changes in the Mumbai city are observed such as infrastructural development, development in transportation and network, enormous growth of population etc, its result on Land use/Land cover of the city (Sansare D.A. and Mhaske S.Y. 2018).

Revised Manuscript Received on 30 July 2019.
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The primary objective of the study is to classify Land use/ Land cover pattern of the town and secondary is by using the value of Kappa Coefficient accuracy assessment of research work are defined, in addition to this Shannan's Entropy Approach to understand the dispersal pattern of the city and also by using the population forecasting method the population up to the next 3 decade are found out. It aims to get various elements of planning in proper order and close to one and another.

II. THE STUDY AREA

The 'Sangamner municipal council' which is located In Ahmednagar district of Maharashtra, India. It is situated on the bank of River Pravara and there is a Sangam of three rivers i.e. Pravara, Mhalungi and Mahanati. It has a UTM zone 43N with an average elevation of 549 meters from mean sea level. Near about 170 villages are in Sangamner taluka and Sangamner city act as a nodal point for 170 villages for communication purpose. As per 2011 census, the population of Sangamner city is 487939. Sangamner is a municipal council which is divided into 27 wards. The zone classifications of the city are residential, commercial and industrial. Near the main area of the city, the population density is maximum, whereas in the case of village area the population density is low. The MIDC area located towards the north side of the city. The Sangamner city is connected by three types of the road network which is National Highway No.50, Other District Road and Village Road. The city has a wide range of transportation mode such as public transport, individual vehicles. The development of the city is not in a planned manner, which result is in arises of problem such as transportation and pollution problem of a city.

III. REMOTE SENSING – GIS-BASED ASSESSMENT OF LAND USE/LAND COVERS CHANGES

A. Data Source:

Remote sensing data of the pertaining area of Sangamner city are collected from http://earthexploer.usgs.gov. A Landsat-7 ETM+ data with a cloud-free scene data from Jan 1 to June 31 is chosen for this study (Table No.1), Shows the Landsat-7 satellite data are used as primary data. Secondary data used are the Arc GIS-10.4 software is used to analyze the data and to draw the thematic map. In order to classify Land use/Land cover of the study area these images are processed in Arc-GIS10.4 with projection system WGS1984 UTM 43N, To make research accurate and more reliable the Landsat-7 images and other data such as survey of India toposheet, city development plan, population data of city is used.

B. Land use/ Land cover classification:

To classify Land use/Land cover pattern of Sangamner city the primary data is required is satellite images. The four images were collected from USGS earth explorer with projection system WGS1984 UTM 43N. The area of interest file is taken from Bhuvan India. For Geo-reference the survey of India toposheet are used. The area of Sangamner city is 1705.06 km2 was extracted from the Landsat-7 images as shown in fig.no.2 and fig.no.3. To classify the Land use/Land cover pattern of the city four images of the year 1975,1980, 2007, 2017 are classified by using Arc GIS 10.4 software for the visual classification of the images the reference of Google earth is taken, based on these Land use/ Land cover classes are identify and then supervised classification are done. Identified classes are mentioned in table no.2. The classification is done on the basis tone, colour, and texture. After identifying various Land use/Land cover classes the subset image for the year 1975, 1980, 2007 and 2017 were classified using a supervised classification technique available in Arc-GIS software. The classification is done by selecting a different class sample shown in Table No.2. The statistical parameter such as mean, the variance is calculated for each land. Based on this individual pixel are assigned to related classes using maximum likelihood classifier. The success of classification depends upon the appropriate identification of the training sample and training sample is verified using Google earth and ground truth verification using a GPS system. Fig. no.2 and Fig. no.3 Shows classified images of the area. The main objective of the study is to classify the land use pattern of the city and based on them we can define the planning pattern of the city. To increase vegetation cover in Sangamner area dandakaranya Abhiyan is started in Sangamner area in the year 2014 on myamba hill station.

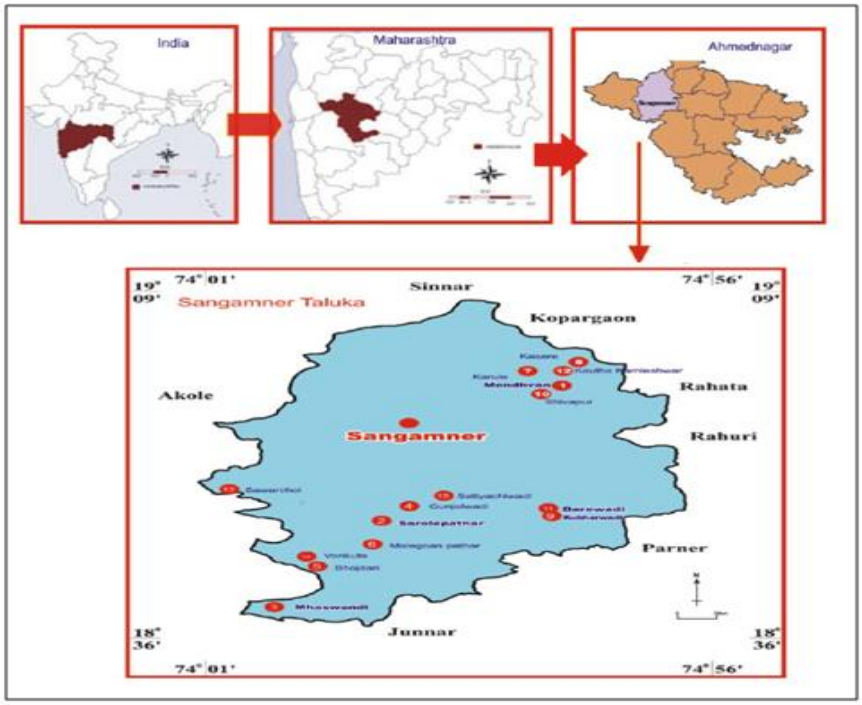


Fig.1 Location of the study area

Table 1 Details of satellite data used in this study area

Type	Date	Spatial Resolution (m)	Format	Source
Landsat-7	1975	30	Tiff	Earthexplorer.org
Landsat-7	1980	30	Tiff	Earthexplorer.org
Landsat-7	2007	30	Tiff	Earthexplorer.org
Landsat-7	2017	30	Tiff	Earthexplorer.org

Table 2 Land use/ Land cover identified classes in a square kilometre

Land use/ Land-Cover classes	1975 Classified image	1980 Classified image	2007 Classified image	2017 Classified image
Exposed rock	1	1	1	1
Water body	69	27	17	26
Built-up area	40	17	25	59
Agriculture	25	49	39	72
Forest	14	41	40	85

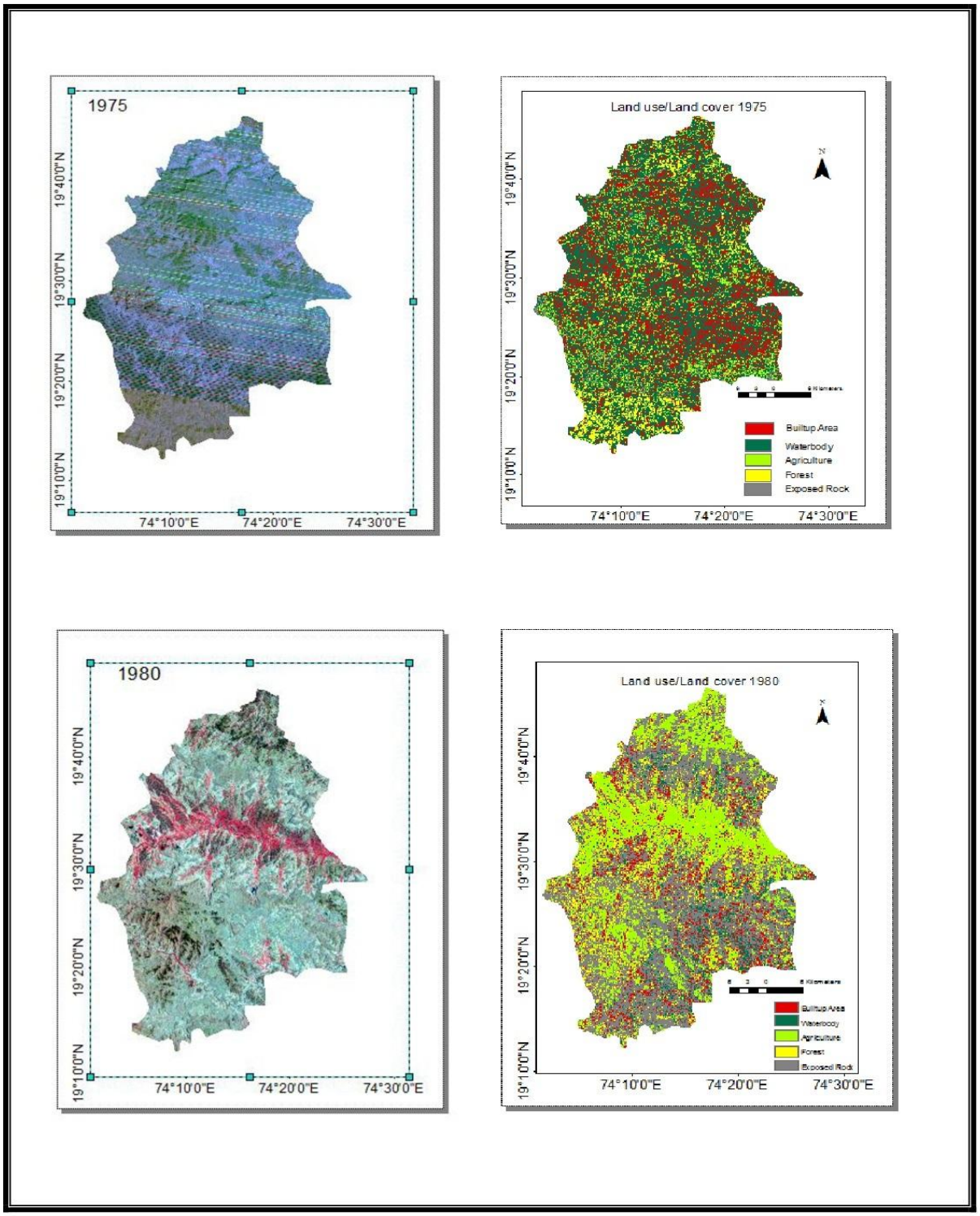


Fig. No.2. Land use/Land cover of Sangamner of 1975 and 1980.

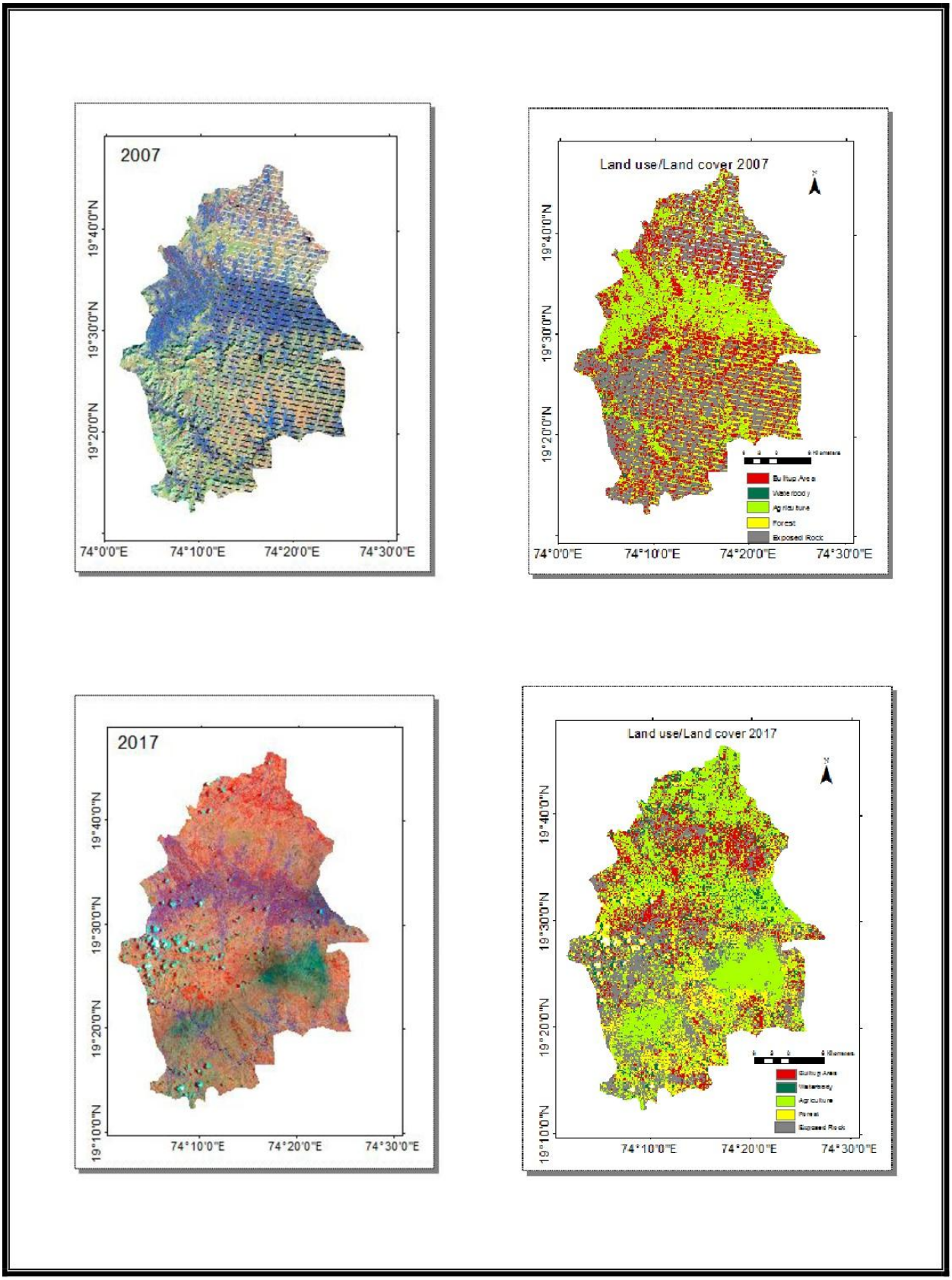


Fig. No.3 Land use/Land cover of Sangamner of 2007 and 2017

IV. ACCURACY ASSESSMENT

Accuracy assessment is helpful to define the accuracy of classified images because practically it is not possible to check the accuracy of each point. The accuracy is checked by taking the reference point with the help of global positioning system and Google earth map. Initially study area image of Landsat-7 is taken and on that known reference point are marked by taking the reference of GPS point and Google earth image. The five classes of land cover are selected and 50 reference points are selected for each. By using Arc-GIS 10.4 software the error matrix generated in them is shown and then commission and omission error are found out. The overall classification accuracy observed was 0.80, 0.826, 0.85, and 0.83 for 1975, 1980, 2000, and 2017 respectively with the value of kappa coefficient statistics is ranging between 0.75 to 0.89 respectively. The overall class accuracy of the individual is ranging between 76% to 92%, it shows that, Land use/Land cover classification within the acceptable range from supervised classification.

$$\hat{K} = \frac{N\sum_{i=1}^{k} x_{ii} - \sum_{i=1}^{k}(x_{i+} \times x_{+i})}{N^2 - \sum_{i=1}^{K}(x_{i+} \times x_{+i})}$$

Where

N=Number of sampling points

K= Kappa coefficient of agreement

K= Number of rows

A. Shannon's Entropy approach

Shannon's Entropy is used to give an idea about the pattern of town development. Shannon's Entropy (E) identifies the degree of special concentration and dispersion of growth. The different geographical parameter such as exposed rock, water body as well as build-up area, the forest is helpful to determine dispersion exhibited in the town area. The value of Shannon's Entropy is determined by using the following formula,

$$E \sum_{t}^{n} PDEN_i . \log\left(\frac{1}{PDEN_t}\right)/\log(n) \qquad \text{(Eq-1)}$$

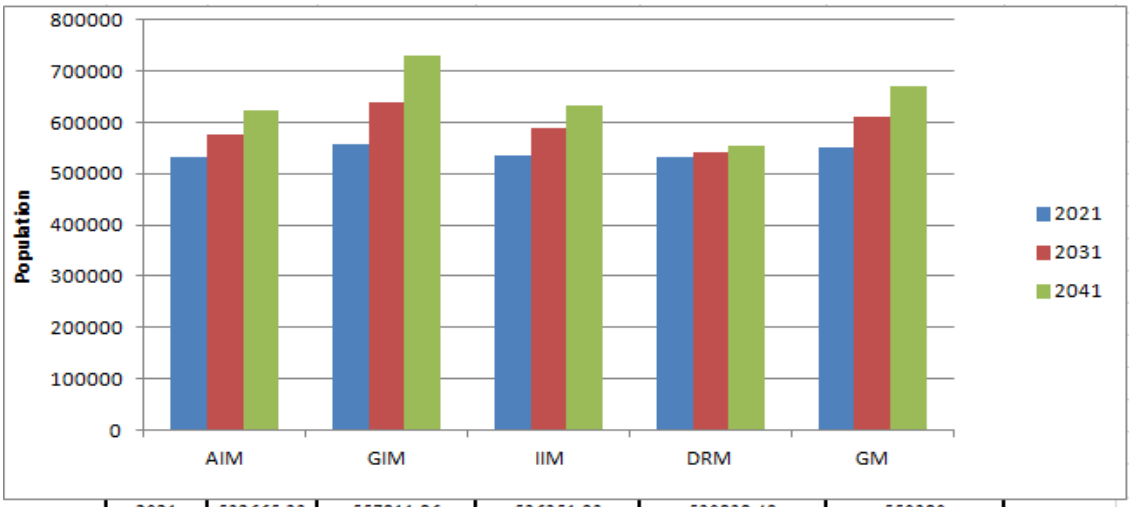
Where

$$PDEN_i = DEN_i / \sum_{i}^{n} DEN_i$$

The primary data source is Remote Sensing Images are to be main data sources. The study year taken is to be 1975, 1980, 2007 and 2017 respectively. The detail is to be mentioned in table no.3. Shannon's Entropy approach value is close to 1 which indicates that space distribution is evenly dispersed. The maximum value of Entropy is in the main city area. The Entropy value is helpful to define that, land development is dispersed or compact. DENi is the density of land development which equals to the amount of Land use/Land cover of a particular zone divided by the total amount of covered area that is an ith parameter is total of n parameter. To analyze the expansion of the city, five zones considered for study and boundary of each zone was digitized. Within the digitization, training sample was selected and then supervised image classification is done and then the density of each area parameter is calculated by, particular area parameter divided by total area. It is shown in table no.3. Shannon Entropy approach value is calculated from equation no.1.From the analysis, Shannon's entropy value was 0.9974, 0.9997, 1, and 0.9996 for the year 1975, 1980, 2007, 2017 respectively. This value indicates expansion of the city, it indicates that the nature of the city in an unplanned manner and may cause a serious problem in future. It dispersed activity may cause serious problems such as traffic congestion, pollution and unplanned developed city.

Table 3 $PDEN_i$ for all five zones

Sr. No	Geographical Parameter	DEN_i 1975	$PDEN_i$ 1975	DEN_i 1980	$PDEN_i$ 1980	DEN_i 2007	$PDEN_i$ 2007	DEN_i 2017	$PDEN_i$ 2017
1	Exposed rock	0.020	0.020	0.427	0.4431	0.33	0.35	0.2591	0.270
2	Forest	0.10075	0.1044	0.1144	0.1187	0.0839	0.089	0.1485	0.1548
3	Agriculture	0.079	0.081	0.253	0.2625	0.2695	0.286	0.3381	0.3526
4	Built-up	0.2383	0.247	0.0981	0.1018	0.2419	0.2586	0.14710	0.1534
5	Water body	0.5263	0.545	0.071	0.0736	0.01	0.0106	0.066	0.0688
	Total	0.96435	0.9974	0.9635	0.9997	0.93539	1	0.9588	0.9996



2021	532665.33	557811.86	536351.93	530838.49	550380
2031	577391.6	637690.52	588451.46	541206.53	610583
2041	622117.9	729007.8	633177.71	552776.45	670489

Fig.No.4 Predicted population

V CITY EXPANSION AND POPULATION FORECASTING

City Expansion results in urbanization. Urbanization is increase due to an increase in the growth of population. The city expansion can competently found out by analyzing population forecasting, Land use/Land cover of the city and population density. The population data are collected from block development of taluka for 5 decades from the year 1951 to 2011. The main aim is here to define, how city expansion depends upon the population growth. The present study shows a forecast of urban expansion from the year 2021 to 2041. The population for the year 2021, 2031 and 2041 are predicted by using the different method of population forecasting. The population forecasting is a workout by using statistical methods such as Arithmetic increase method, Geometric increase method, Incremental increase method, Decreasing rate of growth method and Simple graphical method.

Table 4 Population data

Year	Population
1951	219281
1961	259281
1971	309281
1981	349281
1991	399281
2001	429806
2011	487939

Table 5 The required area for 1lakh persons

Built-up area in 2017	250.809Km^2
Population of 2011	557811.86
Area per 1,00,000 persons	0.0004481Km^2

Table 6 Projected built-up land and growth

Year	Built-up land (Km^2)	Growth (%)
2021	257.98	
2031	263.68	9.71
2041	283.726	7.6

The factors identified are population, density and Land use/Land cover. In this study, the population is considered as the main factor. The above-mentioned method is used to find out the population data of the next decade (fig.no.4) to determine to forecast of city expansion for the year 2021, 2031 and 2041, at first it is necessary to determine how much land area would be required for 10,0000 persons for the year, which land use information is available. Secondly to calculate the built-up area for the year 2021, firstly known built-up area of year is required. The Incremental Increase Method is providing the maximum projected population and therefore it is as a consideration.

VI CONCLUSION

The rate of land development in the study area of Sangamner is increasing slowly and the population growth rate is getting saturated after the year 2031. The land development is slowly increasing because the study area also contains the town and village and most of the population living in the village area. From the year 1981 to 2011 populations are increasing slowly it was near about 7% and the rate of land development is 9.9% from the year 1981 to 2017. From the study, using Shannon's entropy approach the value get is 1, it indicates that the growth rate of the city is in an unplanned way and it may cause a serious problem in future. The city expansion is an effective indication for the sustainable planning of the city.

The Remote Sensing and GIS is the major tool to understand the city expansion and it helps to create develop plan city and to solve the different issue related to the environment. In this study Landsat-7 images are used for Land use/Land cover classification but for the effective Land use/ Land cover classification Cartosat-2, Quickbird images are essential which is having a resolution less than 1m. Using these images it is possible to define more number of Land use/Land cover classes such as industrial, commercial, open land, public and semi-public, transport and communication and barren land etc. If identified classes more in number, they may useful for detailed analysis of the city.

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