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A Remote Sensing and GIS Integrated Study on Assessment of Change in Land Use and Loss of Agricultural Land due to Urbanization – A Case Study of Nashik City

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Abstract: ***Urbanization may be a process having a serious impact ashore use characteristics. Basically, as an impression of urbanization, the world is observed with rapid change within the land use character of agricultural land. Generally, the agricultural land is employed for various development activities like industrial establishments, residential colonies and other urban infrastructure during the method of urbanization. it's necessary to possess a periodical assessment of land use change for the developing populated area , which helps to make a decision the longer term expansion strategies for the world.***
Nashik city is located in the state of Maharashtra in the western part of India. It is one of the most dynamic cities of India with a rapid growth rate due to migration from various parts of Maharashtra. The Nashik city is presently spread over an area of 264.15 sq. km. with a periodical increase in municipal corporation boundary during the last few decades. As a result of urbanization and expansion of municipal corporation limits, the city has undergone drastic changes in land use character. In this study, land-use change is quantified for the existing six zones of Nashik city during the last 30 years using remote sensing and GIS. The study has analysed the relationship between urban expansion and the loss of agricultural land because of an increase in a built-up area and other land use.
The study present excellent scenario for land use change during the year 1991, 2001, 2011 and 2020. This can surely guide the development strategies for the study area of Nashik. Also the study can be extended for conducting a suitability analysis to assess future change of land use based on various criteria.
Keywords: Land use, Remote sensing, GIS, Supervised classification, Urbanization, Agricultural land loss

I. INTRODUCTION

Viewing the world from space is now crucial to know the influence of man‘s activities on the natural resources base over time. In situations of rapid and sometimes unrecorded land use change, observations of the world from space provide objective information of human utilization of the landscape. Over the past years, data from earth sensing satellites has become vital in mapping the Earth‘s features and infrastructures, managing natural resources and studying environmental change. Remotely sensed data like aerial photographs and satellite imageries cover large areas and provides an overall view, which are very useful in urban studies. Satellite images are often used as a working base map and for updating urban information and also are very useful for broad land use classification, like identifying built-up area densities, and in urban expansion studies. Urban land use/land cover mapping has received an increasing amount of attention from urban planners and scientists including geographers. Various techniques are applied for mapping urban land use/land cover. It helps in encroaching urban problems even of very small magnitude and dire.
The GIS techniques along side remotely sensed data can provide relevant results. GIS techniques are playing significant role in facilitating the mixing of multi-layer spatial information with statistical attribute data to reach alternate development scenarios. GIS helps us to research the info spatially, offering possibilities of generating various options (modeling), thereby optimizing the entire planning process. These information systems also offer an interpretation of physical (spatial) data with other socio-economic data, and thereby provide a crucial linkage within the overall planning process and making it simpler and meaningful.
Land use and land cover changes are dynamic spatial issues and so as to possess a sustainable development, these changes got to balance. In many cities this balance spoiled due to rapid increase in urban areas. the expansion within the urban population caused the transformation of the agricultural lands of the cities to the urban areas. For a sustainable development the transformations got to be balanced. It receives an enormous number of migrants from many regions of the state also as from outside the state. This migration is additionally playing a serious role in its high rate of growth.

The town is showing an incredible increase in its population as an entire . This increase in population is higher after 1961, but the physical area of the town is additionally increasing because the nearby villages were also included within the municipal corporation area. Intense urbanization within the Indian cities has caused phenomenal changes within the existing land use patterns. Ministry of Statistics and Programme Implementation estimated that, in 2020 about 35 percent of the population in India lives in urban areas. This condition is sort of severe in a number of the Indian cities, the trend of urbanization is increasing by 2050 about half the population of India expected to measure in urban centres. Maharashtra is one among the foremost urbanised states in India with 45.23 percent of the state population living in urban areas. Nashik being the third largest city of Maharashtra shows major urban growth from last 20 years. From the attitude of economy, industry, agriculture, administration and culture of Nashik is a crucial place and thus attracting population. In year 2020 quite 50 percent of the geographic area of NMC is categories as impervious, and therefore the figure is predicted to extend within the upcoming years thus monitoring urban built-up becomes necessary. Various methods are applied to assess and monitor the urban land. But LULC change analysis may be a more convenient and accurate analysis for assessing the change and becomes a crucial way when a good a part of the world surface has changed and about one third to at least one half the world's land cover is converted into anthropogenic use. The main objective of this study is to seek out LULC changes for better understanding of the method of the urban growth within the NMC.

II. OBJECTIVES

A. To create a land use classification scheme for the study area
B. To analyse changes in land use pattern over a period of time using the land use map.
C. To evaluate the loss of agricultural land due to urban expansion in each zone using land transformation map.

III. LITERATURE REVIEW

Fahim, M. et al. [1999] in their paper ―Identification of urban expansion onto agricultural lands using satellite remote sensing: two case studies in Egypt‖ presents the rate of urban expansion and corresponding loss of agricultural lands for two cities in the Nile Delta using satellite remote sensing. The extent of urban areas identified on SPOT images acquired in 1987 and 1995 was compared to areas identified on a topographic map published in 1950. For both cities, the rate of urban growth was much greater during the more recent 1987-1995 period than during the earlier 1950-1987 period.

Shahab, F. [2000] in his paper ―Urban expansion and loss of agricultural land – A GIS based study of Saharapur city, India‖ presents GIS based study of Saharanpur city. It includes details of the location of the agricultural land losses, the nature of the land use changes and quality of the agricultural land that was lost. Remote sensing combined with field checks and surveys were used to measure the loss of agricultural land to urban expansion in the Saharanpur City between 1988 and 1998. The study area had lost some 1,683 hectares of fertile agricultural land between 1988 and 1998, of which 1,091 hectares were recoverable and 592 hectares were not.

Anys, H. et al. [2002] in their paper ―GIS and high resolution SPOT imagery for evaluating the impact of urbanization on agricultural lands‖ used GIS and RS technologies to establish urban evolution maps and assess the impact of urbanization on agricultural areas over the last three decades. The results show an increase in dense urban area by 980.7 ha from the 1970s to the 1990s. This increase occurred at the expense of forests (24.7 ha), plantations (752.3 ha), rangeland (113.4 ha), non-irrigated land (69.7 ha), and irrigated land (20.6 ha).

Chauhan, H. et al. [2005] in their paper ―Land use/land cover changes near hazira region, Gujarat, using Remote Sensing satellite data‖ found out the rate of land use/land cover changes in Hazira area using IRS LISS III sensor data. In the study, land cover information about the period 1970 – 1972 from the Survey of India topographical maps, and satellite data of the year 1989 and 1999 – 2002 had been used and visual analysis had been carried out to measure the land use/land cover changes. Erosion and deposition had been observed around the newly constructed jetty. Forest area and agriculture area are found to decrease, whereas built-up area had increased.

Twumasi, V. et al. [2005] in their paper examined Mississippi from a temporal – spatial perspective with a focus at the county level between 1987 and 2002. Alternate strategies for farmland protection, based upon growth management, land information inventory and mapping, as well as community participation in the region were recommended.

Bassam, S. et al. [2006] in their paper ―Satellite monitoring of urban spatial growth in the Amman area, Jordan‖ analyzed the urban expansion over 1918 – 2002 using remote sensing and GIS. Its impact on the Amman area environment was assessed. Five land covers were identified in space and time using aerial photographs, LANDSAT and IKONOS images acquired on different dates.

The study showed that the urban area was increased by 162 km2 over the period 1918–2002, which represents 509 times the original urban area. The fertile lands decreased by 86 km2, which represents 23% of loss. Results were compared to other similar studies for Istanbul and Bangkok.

Tayyebi, A. et al. [2008] in their paper, presented a methodology through utilizing remote sensing imagery, GIS based neuro-fuzzy approach and variety of social and environmental factors for simulating land use change.

John, S. et al. [2011] studied the spatial differentiation of land use change of Tuticorin using high resolution LISS – III satellite imagery and maximum likelihood algorithms. The study warrants proper urban planning for Tuticorin for sustainable use of resource and environment.

Jusoff, K. et al. (2011) presented a paper on _An analysis of land use pattern in the industrial development city using high resolution satellite imagery'. The paper emphasizes the role of satellite remote sensing and its interface with other remotely sensed data to produce vital information necessary for land use planning in Malaysia. It intends to review specific examples of the applications of this technology to land use planning so that it can properly be harnessed in the future as an operational tool for land use planning and development programmes in Malaysia.

Anil, N. et al [2012] in their urban land use/land cover change monitoring in the Greater Visakhapatnam, used remote sensing and GIS techniques. LISS – III satellite images of different time period were used.

Govindu, V. et al. [2012] in their paper ―Land use/land cover changes through the applications of GIS and remote sensing and the implications on sustainable land management‖ studied Land use and land cover changes in Visakhapatnam city over a period of 70 years using remote sensing data. Image processing analysis was carried out by ERDAS Imagine. Land use and Land cover maps of Visakhapatnam city for various temporal periods, starting from 1941 to 2009 were prepared using topographical maps of Survey of India and updated by satellite data of IRS-1D LISS-III of 2003 and Cartosat-I satellite data of 2009. These maps were interpreted and land use and land cover changes were identified. Replacement of many agricultural villages by the establishment of steel plant in 1991 and replacement of fishing villages by the Gangavaram port in 2005 were important land use changes in the study area.

Kanagalakshmi, A. et al. [2012] carried out a study on the impact of land use on environmental quality due to urbanization for Tirumangalam Taluk, Madurai. The study was carried out using Quantum GIS environment using ASTER satellite images. The analysis results show that there was a significant increase in settlement and reduction in water bodies and agriculture.

IV. STUDY AREA PROFILE

Nashik, a city located in the north-west of Maharashtra State in India, is one hundred eighty kilometre off from Bombay and 202 kilometres from Pune. The minimum Temperature recorded in the month of January is 4.4°C and maximum temperature recorded in the month of May is 41°C. Two rivers, river Godavari and river Nasardi, flows through the centre of the city in west- east direction.

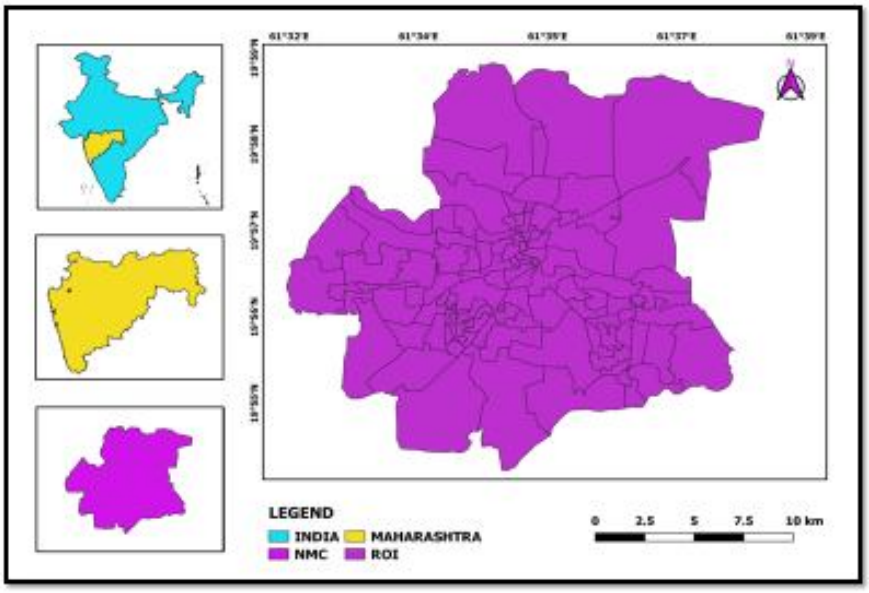

Fig. 1 Study Area Profile

Table I
Demographic Characteristic (Sex And Age Composition)

Year	No of Person	Males	% of Total Males	Female	% of Total Female	No of Females Per 1000 Males
1991	733000	388000	52.93	345000	47.06	889
2001	1077236	575737	53.44	501499	46.55	871
2011	1486053	782517	52.66	703536	47.34	899

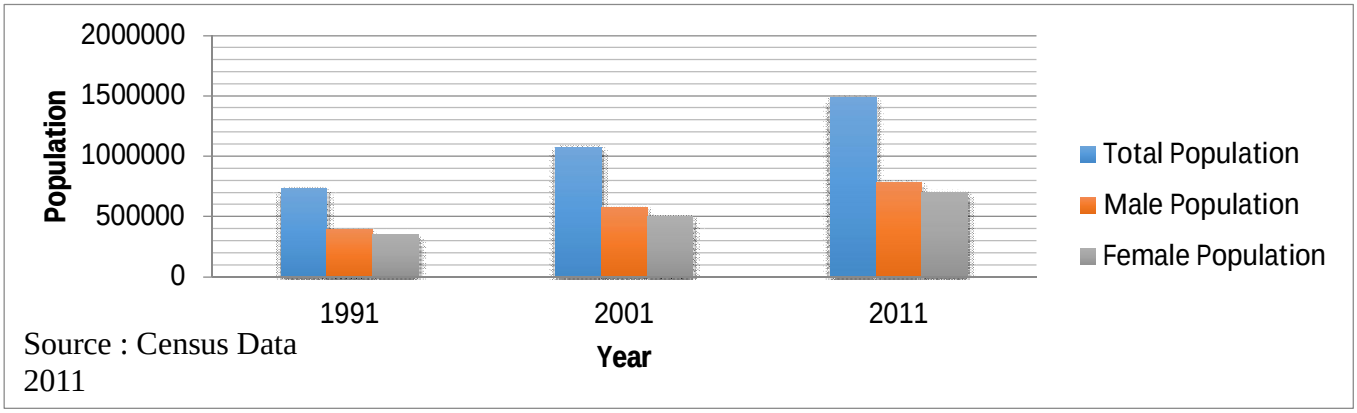

Fig. 2 Demographic Characteristic (Sex and Age Composition)

Nashik is amongst one of the swiftly developing towns of Maharashtra State in India. It is the third-biggest city area, overlaying a place approximately 264.59 sq. km. and 6th biggest city agglomeration with a populace of 15, 62,769 in line with Census 2011. The administrative divisions of NMC are divided into 06 divisions and sixty-one widespread wards. It lies among 19°53' to 20°08' North range and 73°38' to 73°55' longitude at 536 meters above sea level, located at the banks of river Godavari. The metropolis has emerged as the Centre of enchantment due to its environment and funky and nice atmosphere. Temples and Ghats at the banks of Godavari have made Nashik one of the holiest locations for Indians all around the World. Nashik is one of the locations in India wherein the Kumbh Mela is held as soon as in 12 years and additionally the wine capital of India

V. DATA COLLECTION

A. LULC Classification

LULC category is one of the famous techniques for the evaluation of the earth's floor and acquiring information. For the LULC category, supervised and unsupervised category strategies are predominantly used. In the prevailing study, the photograph turned into categorized the usage of most chance set of rules supervised category approach in which the schooling sets (signatures) have been supplied with the aid of using the consumer primarily based totally at the visible interpretation of the photograph, assembling bands combos of the Landsat MSS/TM/ETM+/ OLI for visible interpretation to be able to accurate category. Visual interpretation gave a concept regarding land cowl variant over a selected time period. False Colour Composite (FCC) snap shots have been categorized in six LULC lessons and have been taken into consideration for evaluation of city growth.

Table 2. Spatial and non-spatial Data

Satellite Data				
Satellite	Sensor	Path/Row	Resolution	Date of Acquisition
LANDSAT-5	TM	147/46	30 Meter	01/02/1991
LANDSAT-7	ETM+	147/46	30 Meter	18/10/2001
LANDSAT-7	ETM+	147/46	30 Meter	15/11/2011
LANDSAT-8	OLI-TIRS	147/46	30 Meter	28/09/2020

Table 3. Classification of LULC

Sr. No.	LULC Class	Description
1	Agriculture Land	All cultivable land, seasonal and temporal cropland,
2	Built-up	Residential, Industrial and commercial areas and all impervious areas
3	Fallow land	Temporary and permanent agriculture fallow land
4	Vegetation	All kind of natural and urban vegetation etc.
5	Open land	Areas with open places, parks, playground, scrub land, grass lands, pastureland etc.
6	Water Body	River, canals, ponds, reservoirs etc.

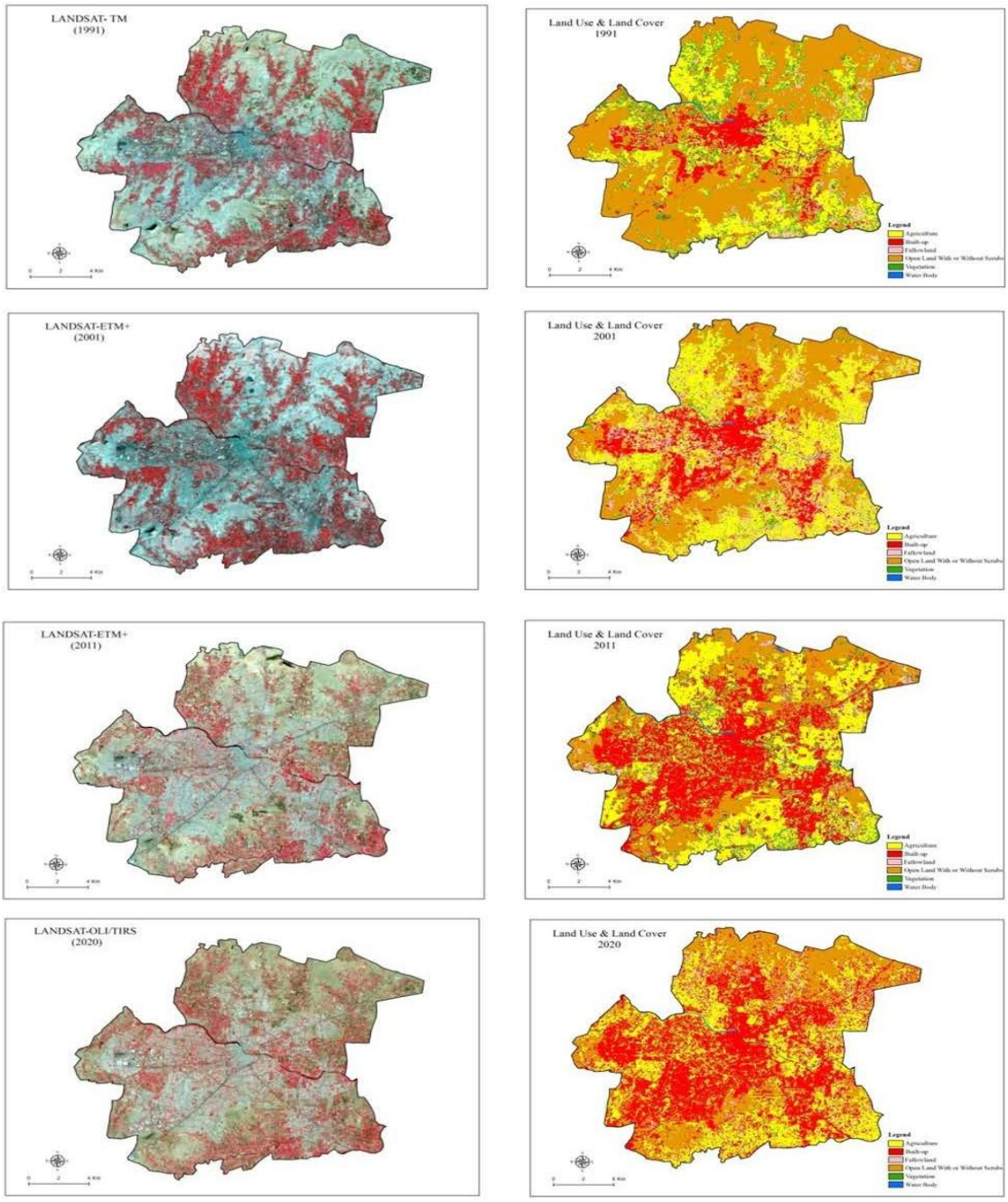

Fig. 3. Land Use and Land Cover from 1991 to 2020

VI. RESULT AND DISCUSSION

A. Land Use Land Cover

LULC category is classed into six special categories. The adjustments in LULC for the duration of 4 many years i.e., from 1991 to 2020. The located LULC for the yr. 1991. 2001. 2011 and 2020 display speedy boom of the city areas. The city built-up location extended from 2.01 percentage in 1991, 22.63 percentage in 2001, 39.ninety seven percentage in 2011 to 53.07 percentage within side the yr. 2020. In phrases of the location the city built-up changed into grown from 5.21 square km in 1991 to 137.51 sq. km within side the yr. 2020. In 1991, there's predominance of open land without or with scrubs and agricultural land all through the landscape, contributing approximately seventy five percentage of the whole geographical location (TGA), embedded with built-up location within side the critical place and in random manner. Open land without or with scrubs, fallow land, and plants had been in non-stop decline, among the length 1991 to 2020. Wasteland has proven exceptional decline because it contributed 47 percentage within side the yr. 1991 and it changed into decreased to 17 percentage within side the yr. 2020, indicating -63.zero percentage adjustments. Fallow land has additionally declined considerably from 14.29 percentage of TGA of NMC within side the yr. 1991 to 4.33 percentage of the TGA NMC in yr. 2020. Vegetation additionally proven non-stop decline over the length, because it decreased from 6.95 percentage of the TGA in 1991 to 2 percentage of the TGA within side the yr. 2020. During the equal length the 2 land lessons agriculture and water frame has proven fluctuating characteristic.

B. Urbanization of Nashik City

In the NMC admin wards, during the period of 1991 to 2020 has shown the rapid urban growth in the six municipal administrative wards. The Nashik city has seen an unprecedented growth in the last four decades, recording one of the highest growth rates in the country. It is one of the most dynamic cities of India with one of the fastest growth rate. Migration is a significant contributor to urbanization. The main factors for migration are the growth of textile and diamond industries. The city area has expanded with time and presently covers 264.59 sq.km. In Nashik, land use pattern has undergone a remarkable change due to rapid economic development. Crop land has been gradually disappearing each year, converted into urban or related uses.

Table 5. Land use and land cover Classification 1991 to 2020

Classes	1991		2001		2011		2020	
	Area	Percent	Area	Percent	Area	Percent	Area	Percent
Built-up	19.53	7.38%	59.62	22.53%	104.57	39.52%	138.51	52.35%
Agriculture	80.36	30.37%	69.9	26.42%	56.95	21.52%	61.18	23.12%
Vegetation	16.32	6.17%	12.35	4.67%	10.55	3.99%	7.87	2.97%
Fallow land	30.61	11.57%	20.66	7.81%	12.22	4.62%	6.21	2.35%
Open land	113.02	42.72%	97.55	36.87%	76.43	28.89%	46.95	17.74%
Water body	4.75	1.80%	4.51	1.70%	3.87	1.46%	3.87	1.46%
TOTAL	264.59	100.00%	264.59	100.00%	264.59	100.00%	264.59	100.00%

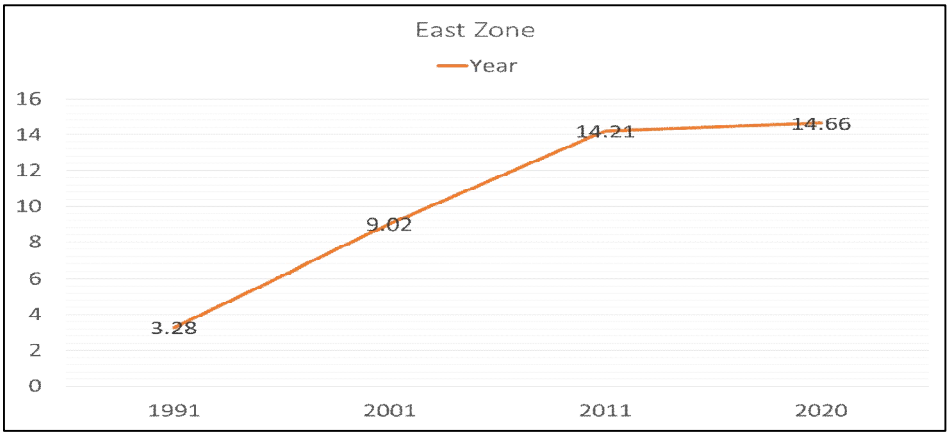

Fig. 4 Change of Built up Area in the East zone

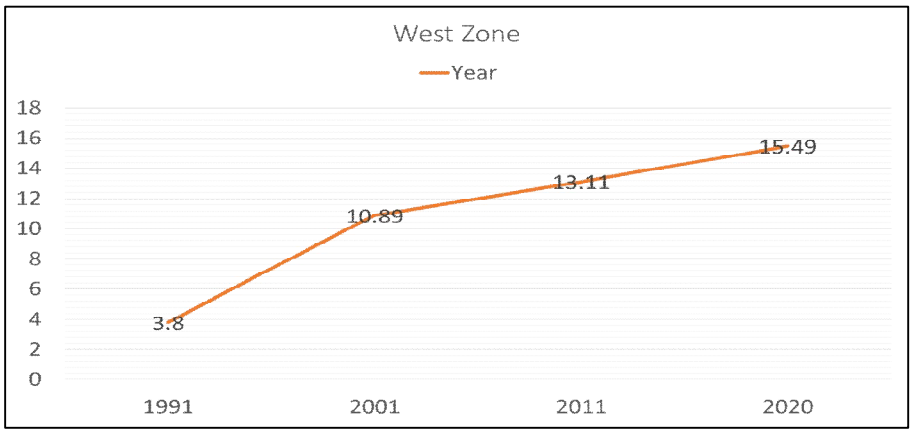

Fig. 5 Change of Built up Area in the West zone

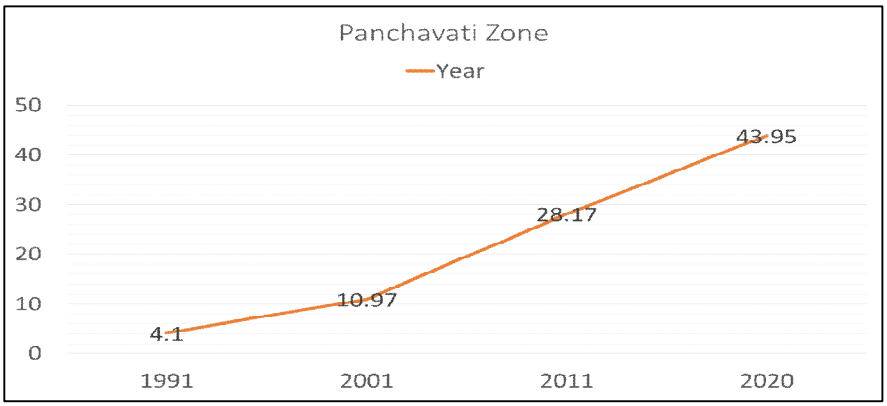

Fig. 6 Change of Built up Area in the Panchavati zone

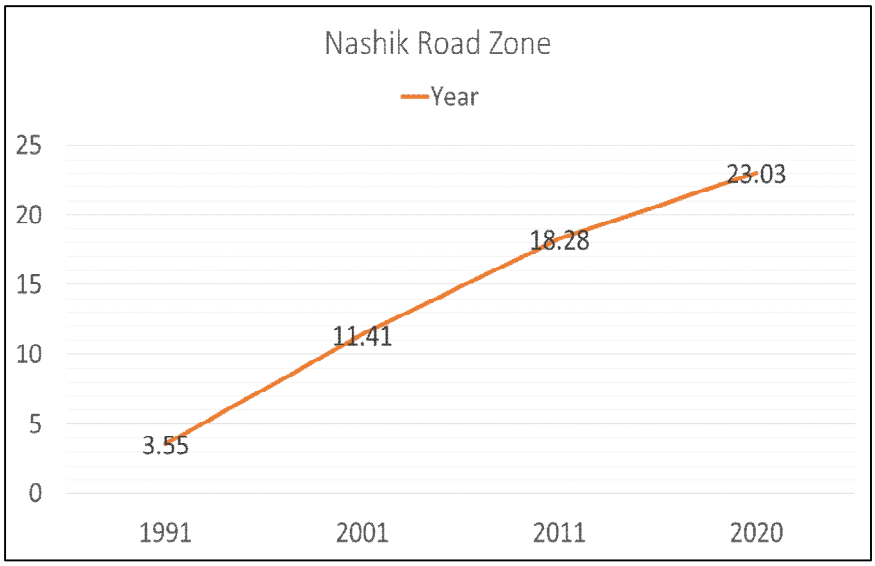

Fig. 7 Change of Built up Area in the Nashik Road zone

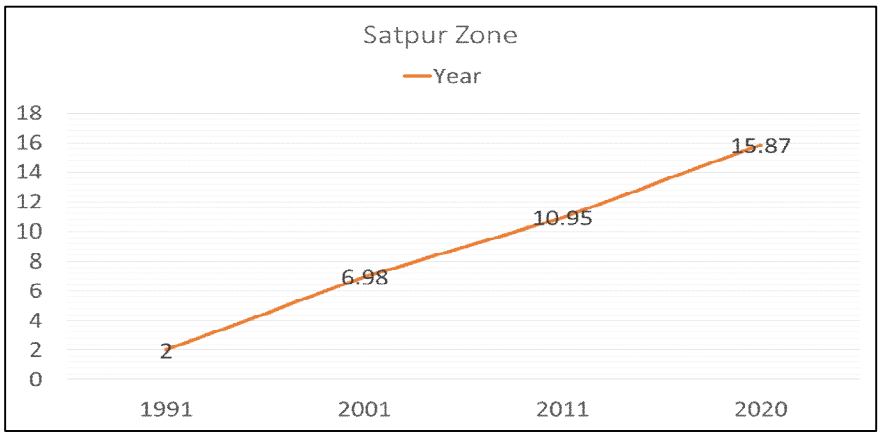

Fig. 8 Change of Built up Area in the Satpur zone

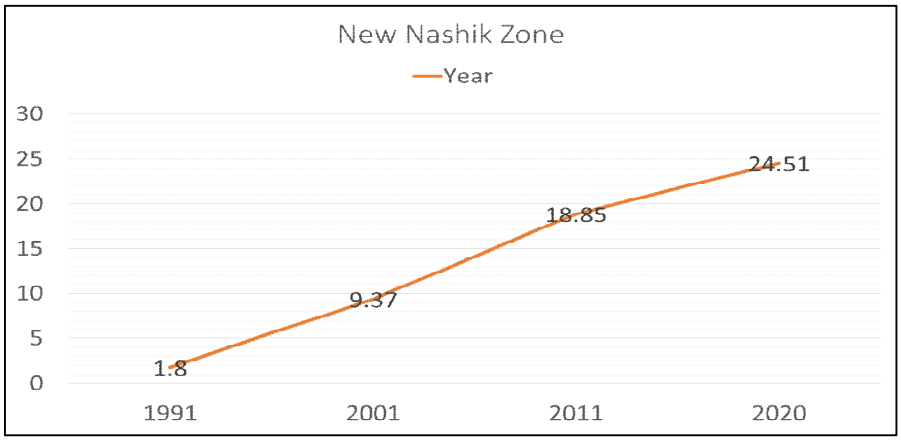

Fig. 9 Change of Built up Area in the New Nashik zone

VII. CONCLUSION

This study enabled the analysis of urbanization in the area over the period of 1991 – 2020.
Some of the main findings of the present study are as follows:

A. Built up area has increased from 18.53 sq.km (7.15%) to 137.51 sq.km (53.01%) between 1991 to 2020.
B. Crop land has decreased from 79.34 sq.km (30.62%) to 60.01 sq.km (23.20%) between 1991 to 2020.
C. Maximum transformation of crop land to built up area between 1991 to 2020 was occurred in East zone and New Nashik Zone.
D. Area of other water bodies has decreased from 3.93 sq.km (1.52%) to 3.87 sq.km. (1.49%).
E. The vegetation area decreased from 15.64 Sq. Km to 6.87 Sq. Km between 1991 to 2020.
F. Open field area is located mostly in Panchavti and Satpur zone of the city. Area of open land has decreased from 112.02 sq.km (43.23%) to 45.64sq.km (17.61%) and altered in another land use from 1991 to 2020.

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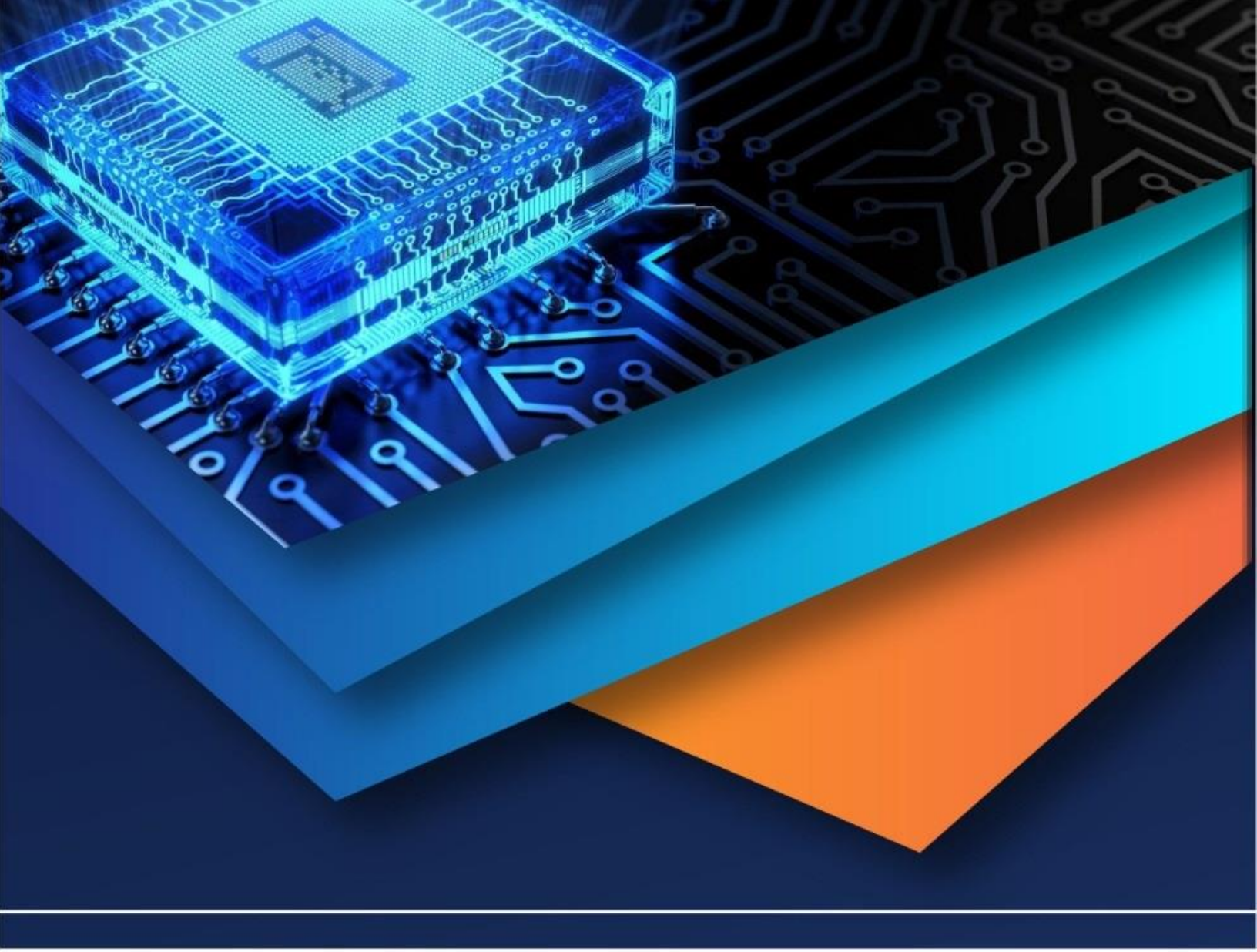

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