Applied Ecology and Environmental Sciences, 2021, Vol. 9, No. 2, 225-235
Available online at http://pubs.sciepub.com/aees/9/2/14
Published by Science and Education Publishing
DOI:10.12691/aees-9-2-14

An Assessment of Land Use Land Cover Change and Urban Growth of Nashik City Using Geospatial Techniques

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Received January 02, 2021; Revised January 28, 2021; Accepted February 05, 2021

Abstract The major focus of this study is analysis of the relationship between land use and land cover (LULC) dynamics, built-up land expansion patterns, and underlying driving forces of change from 1981 to 2020. Many of the world's largest cities are dealing with the dilemma of the urban growth, but in recent years this situation is also seen in sub centres. The study of the LULC is useful to analyse the trend of an urban area and growth. The Spatio-temporal assessment of the urban growth in Nashik Municipal Corporation (NMC) administrative wards has been analysed using space-borne Remote Sensing (RS) data (series of Landsat Imagery (MSS/TM/ETM + /OLI) for the year of 1981, 1991, 2001, 2011 and 2020 with photogrammetry tools, Geographical Information System (GIS), Shannon's entropy model and accuracy assessment. The overall scenario of LULC in the NMC reveals that the open land, fallow land, vegetation has been decreasing and urban built up is increasing at the expanse of these areas. The urban built-up area has increased from 2 (1981) to 53 (2020) percent of geographical area of NMC. The Shannon's entropy model was applied to the six municipal wards and the value of the Shannon's entropy confirms randomly growing urban built-up in the NMC. The finding of this study will help to researchers, planner and policy makers for better assessment of the urban growth and trend of transformation of land uses and land cover.

Keywords: *urban growth, Urban Sprawl Shannon's entropy, LULC, Nashik*

Cite This Article: Santosh A. Bhailume, "An Assessment of Land Use Land Cover Change and Urban Growth of Nashik City Using Geospatial Techniques." *Applied Ecology and Environmental Sciences* vol. 9, no. 2 (2021): 225-235. doi: 10.12691/aees-9-2-14.

1. Introduction

LULC is continuous process and have to be understood for more information [1]. LULC change is very dynamic in character and the governing factors and their interaction in space and time also very complicated factors like climate, biophysical and anthropogenic activity. It plays key role in LULC change [2]. LULC is a major driver of a change, ecosystem, biodiversity, various natural cycles and anthropogenic activities [3]. LULC is the output not only of structure, altitude and slope but also socio-economic and institutional setups [4].

Urban areas cover very small portion of the earth's surface [5], but accommodates about 55 percent of the world's population. According to United Nation urban population is expected to increase to 68% by 2050. The acceleration in the urban areas both in intensity and area has led expansion of beyond their limits with their hinterland and periphery in order to accommodate the growing population. The unplanned and uncontrolled urban growth specifically in the developing countries resulted in deterioration of environment, natural space, and inevitably resulting into heath risk through multifield impacts. The fast rate of increase in urban population is mainly due to large scale migration of people from rural and smaller towns to bigger cities in search of better employment opportunities and better quality of life [5].

For monitoring the surface of the earth and its various aspects different modelling techniques in GIS and RS technology prove to be very useful. Several methods have been applied to monitor the urban dynamics, and for the LULC analysis becomes an important asset for analysing the anthropogenic impact on land. Many researchers have been carried out depicting the quantitative and qualitative changes in the LULC pattern and its drivers using different methods and techniques [6,7,8]. LULC change using remote sensing technology has long been used as advance technique for the change detection and there are many new models and techniques are being introduced [9-13]. The analysis of the LULC also provide possible explanation to the various aspects of man and environment relationship, also it provide great instrument for the study of urban growth sprawl with their relationship and impact. Studies like urban growth and Urban Heat Island (UHI) [14,15,16]. Urban Growth/Sprawl using Shannon's entropy [5,17-26]. Urban growth modelling using Chains-cellular

Automata (CA) and Merkov [27], Urban impact on environment [28-34].

Intense urbanization in the Indian cities has brought about phenomenal changes in the existing land use patterns [35]. 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 quite severe in some of the Indian cities, the trend of urbanization is increasing by 2050 about half of the population of India expected to live in urban centres [36]. Maharashtra is one of the most urbanised states in India with 45.23 percent of the state population living in urban areas [37]. Nashik being the sixth largest city of Maharashtra shows major urban growth from last two decades. From the perspective of economy, industry, agriculture, administration and culture of Nashik is an important place and thus attracting population. In year 2020 more than 50 percent of the geographical area of NMC is categories as impervious, and the figure is expected to increase in the upcoming years thus monitoring urban built-up becomes necessary. Various methods are have been applied to assess and monitor the urban land. But LULC change analysis is more convenient and accurate analysis for assessing the change and becomes an important way when wide part of the earth surface has changed and about one third to one half of the world's land cover converted into anthropogenic use [38]. The major objective of this study is to find out LULC changes for better understanding of the process of the urban growth in the NMC.

2. Materials and Methods

2.1. Study Area

Nashik is among one of the rapidly growing cities of Maharashtra State in India. It is the third largest urban area, covering an area about 259.10 sq.km. and sixth largest urban agglomeration with population of 15, 62,769 according to Census 2011. The administrative divisions of NMC are divided into 06 divisions and 61 general wards. It lies between 19°53' to 20°08' North latitude and 73°38' to 73°55' longitude at 536 meters above sea level, situated on the banks of river Godavari. The city has become the Centre of attraction because of its surroundings and cool and pleasant atmosphere. Temples and Ghats on the banks of Godavari have made Nashik one of the holiest places for Indians all over the World. Nashik is one of the places in India where the Kumbh Mela is held once in 12 years and also the wine capital of India [23].

2.3. Data Source and Method

GIS, RS and Shannon's entropy techniques were used for LULC analysis. Cloud-free Landsat images data procured from United State Geological Survey (USGS) for detection of LULC changes for the period of 1981, 1991, 2001, 2011 and 2020. The details of spatial and non-spatial data used for the study are given in Table 1.

Layer stacking and mosaic processing were carried out on the downloaded data using Erdas Imagine 2015 software, to obtain Multi-band composite images and rectified, dataset was radiometrically, geometrically corrected for image enhancement.

Approximately, 125 ground control points (GCPs) were selected in order to register the images to the Universal Transverse Mercator coordinate system using a global positioning system. GCPs were dispersed throughout the images, to make sure the RMS error less than 0.5 pixel. The images were then resampled to 30 m pixels using the nearest neighbour method, while the first order polynomial fit was also used. Finally, by means of the GIS municipal boundaries layers, the administrative territory of NMC was extracted from the images using the 'Extract by Mask' function in the "Spatial Analyst Tools" module of ArcGIS 10.7 software.

2.4. LULC Classification

LULC classification is one of the popular methods for analysis of earth's surface and obtaining information [39]. For the LULC classification, supervised and unsupervised classification techniques are predominantly used. In the present study, the image was classified using maximum likelihood algorithm supervised classification technique where the training sets (signatures) were provided by the user based on the visual interpretation of image, assembling bands combinations of the Landsat MSS/TM/ETM+/ OLI for visual interpretation in order to correct classification. Visual interpretation gave an idea concerning land cover variation over a particular time period. False Colour Composite (FCC) images classified in six LULC classes (Table 2) and were considered for assessment of urban growth.

2.5. Shannon's Entropy

Shannon's entropy index proves to be an effective method for the urban growth monitoring. Several researchers have widely used Shannon's entropy technique for urban studies [24,40]. It can be used as indicative tool for spatial concentration or dispersion. Shannon's entropy is based on information theory and a great tool along with the geospatial science, as it can also specify the degree of urban expansion by examining whether the land development is dispersed or compact.

This Entropy (E_t) method calculated using following formula. Entropy value varies from 0 to 1. The lowest value (0) indicates that the distribution of built-up is most concentrated in one area and maximum entropy value (1) shows the distribution of built-up across space.

$$E_t = \frac{\sum_{j=1}^{m} \mathrm{PDj}\left(\log\left(\frac{1}{\mathrm{PDj}}\right)\right)}{\log(m)} \quad (1)$$

Where $PDj = \frac{\mathrm{Dj}}{\sum_{j=1}^{m} \mathrm{Dj}}$.

Dj is the density of land growth. That equals to quantity of Built-up land divided by the total quantity of land in the **j**th zone in the total of **m** zones.

While using Entropy to measure the distribution of a physical occurrence, the difference on entropy among two different time periods of time can be used to

indicate the change in the amount of circulation of urban sprawl.

$$\Delta E_t = E_t(y+1) - E_t(y) \quad (2)$$

Where ΔEtis the difference of the relative entropy values between two time periods, Et(y+1) is the relative entropy value at time period y+1, Et(y) is the relative entropy value at time period y [19].

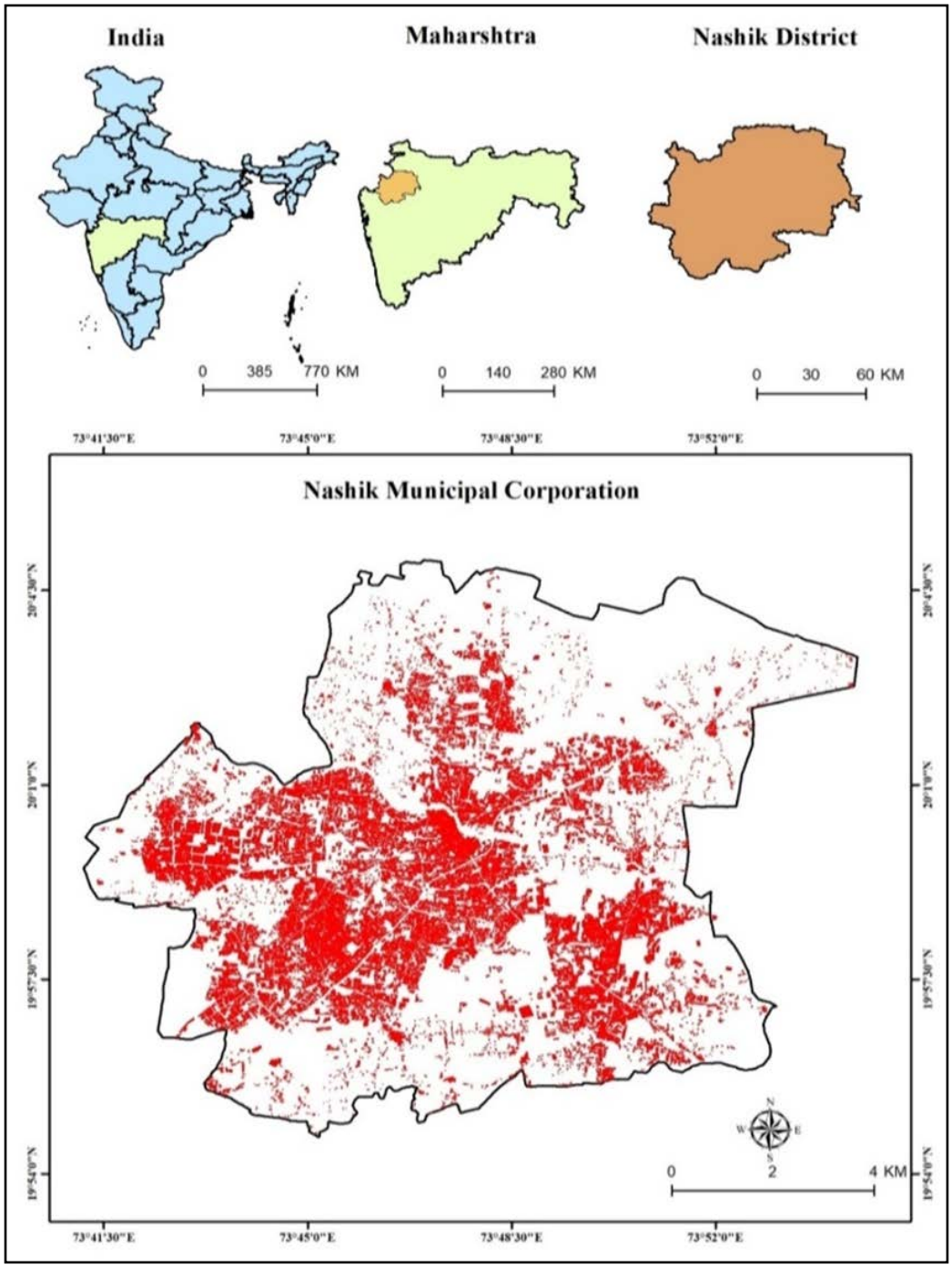

Figure 1. Location Map

Table 1. Spatial and non-spatial Data

Satellite Data				
Satellite	**Sensor**	**Path/Row**	**Resolution**	**Date of Acquisition**
LANDSAT-4	MSS	158/46	30 Meter	17/10/1981
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
Demographic Data				
Source	**Period**			
Census of India	1981, 1991,2001,2011			
https://populationstat.com	Projected population for year 2020			

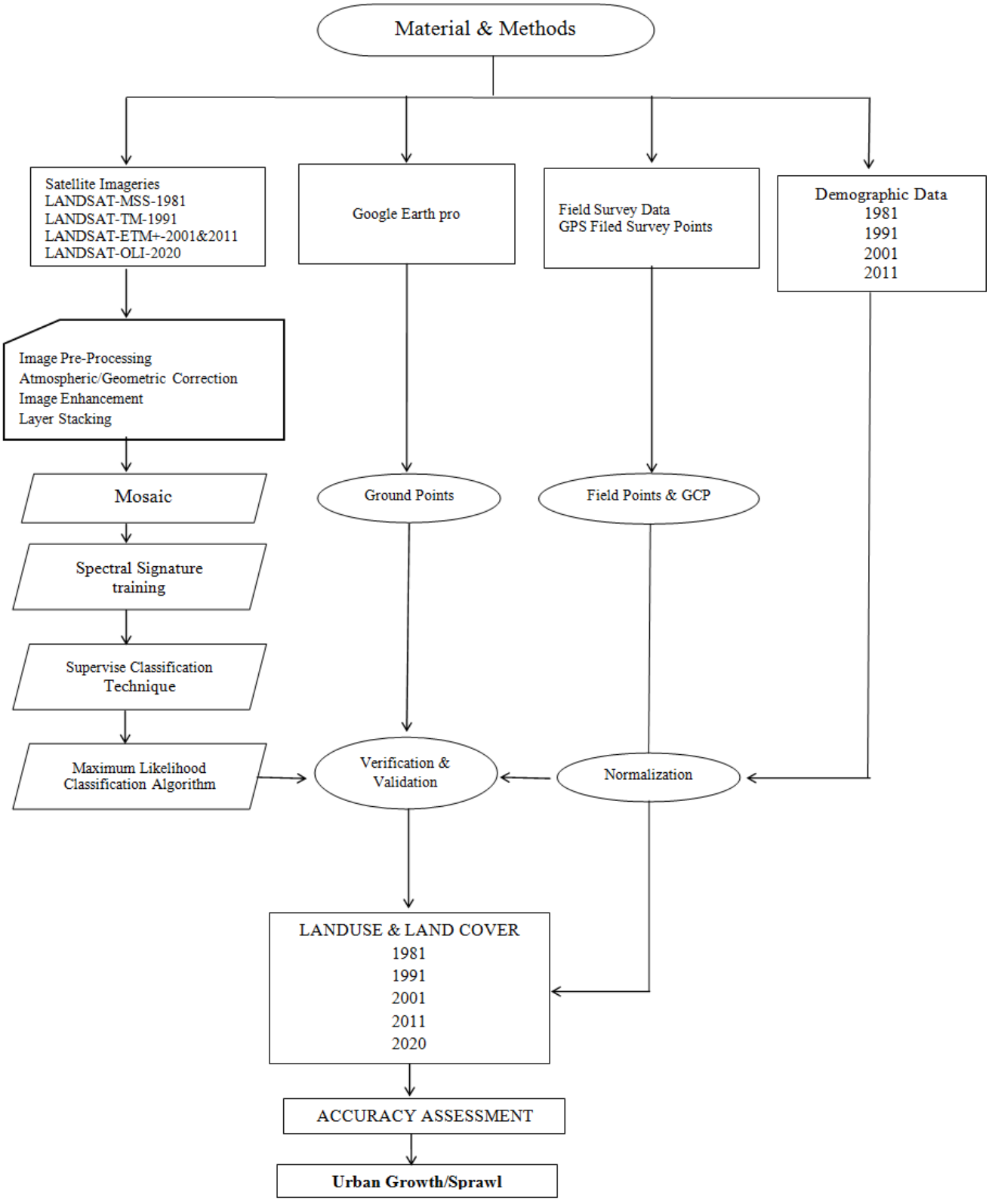

Figure 2. Methodology

Table 2. 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.

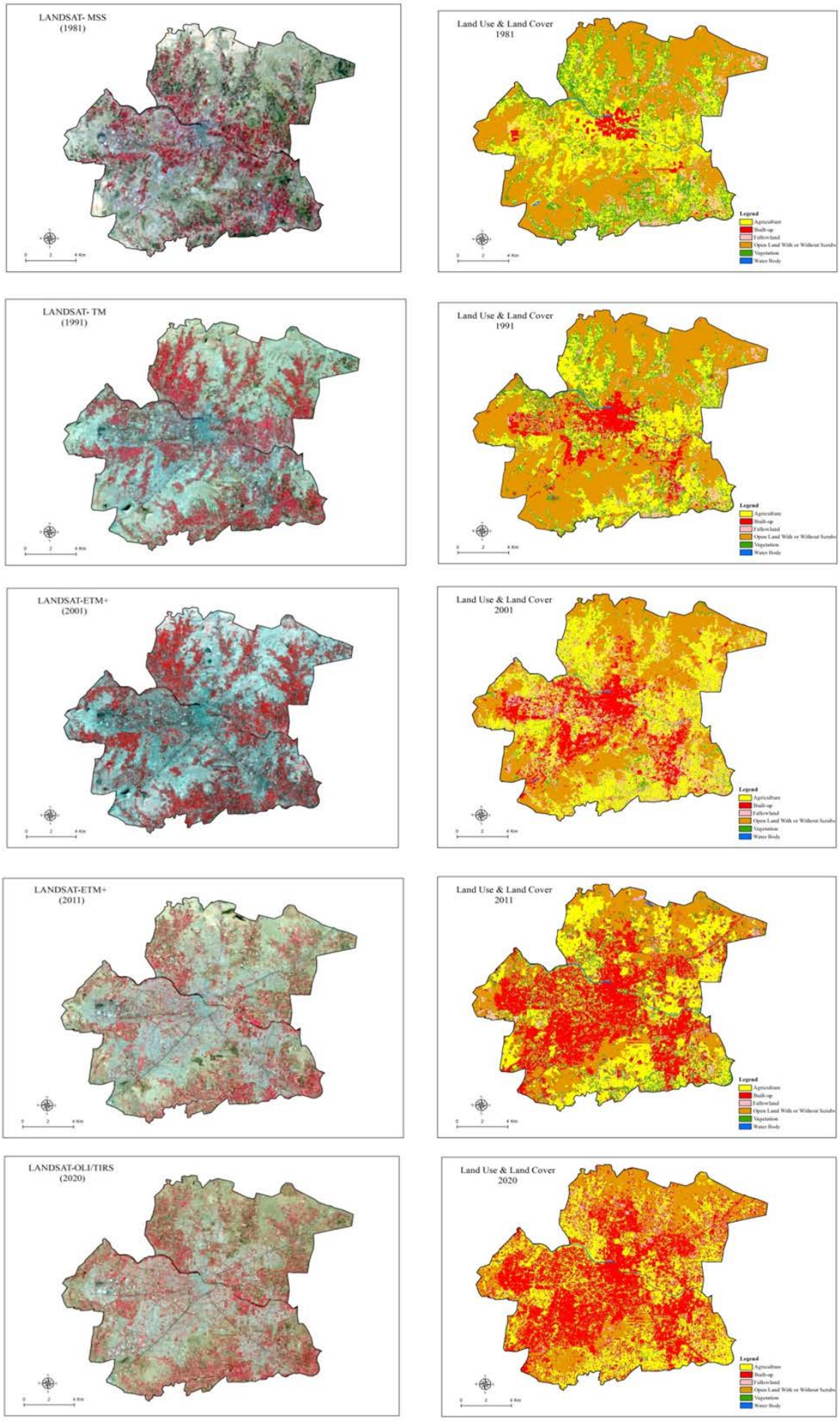

Figure 3. Land Use and Land Cover from 1981 to 2020

3. Result and Discussion

3.1. Land Use and Land Cover

LULC classification is classified in six different categories (Table 2). The changes in LULC for the period of five decades i.e., from 1981 to 2020 (Figure 3). The observed LULC for the year 1981, 1991. 2001. 2011 and 2020 shows rapid growth of the urban areas. The urban built-up area increased from 2.01 percent in 1981 to 7.15 percent in 1991, 22.63 percent in 2001, 39.97 percent in 2011 to 53.07 percent in the year 2020. In terms of the area the urban built-up was grown from 5.21 sq.km in 1981 to 137.51 sq. km in the year 2020. In 1981, there is predominance of open land with or without scrubs and agricultural land throughout the landscape, contributing about 75 percent of the total geographical area (TGA), embedded with built-up area in the central region and in random manner.

Open land with or without scrubs, fallow land, and vegetation were in continuous decline, between the period 1981 to 2020. Wasteland has shown tremendous decline as it contributed 47.55 percent in the year 1981 and it was reduced to 17.61 percent in the year 2020, indicating -63.0 percent changes. Fallow land has also declined drastically from 14.29 percent of TGA of NMC in the year 1981 to 4.33 percent of the TGA NMC in year 2020. Vegetation also shown continuous decline over the period, as it reduced from 6.95 percent of the TGAin 1981 to 2.65 percent of the TGA in the year 2020. During the same period the two land classes agriculture and water body has shown fluctuating characteristic.

3.2. Urban Growth - 1981 to 2020

In the NMC admin wards, during the period of 1981 to 2020 has shown the rapid urban growth in the six municipal administrative wards. Since 1981 Nashik East shows the highest urban concentration in 1981 the urban built-up was 6.17 percent of the total area which show continue to increase from 1981 to 2020. In 1991 about 17.61 percent area was categories as built-up, which increased in 2001 to 48.42 percent, in 2011 it was 76.27 percent and in 2020 it is 78.69 percent of the TGA. In terms of the total area the Panchvati has shown remarkable growth in urban built up in 1981 the urban built-up was 1.26 percent of the total area which drastically increase in 2020 to 40.53 percent (43.95 sq.km) of the total area. but in terms of geographical area Panchvati ward shows the maximum growth in built up in terms of area. Other administrative wards i.e., Nashik West, Panchavati, Nashik Road, Satpur and New Nashik also marked with consistent increase in the urban built-up.

The urban built-up has shown tendency to transform other classes of LULC. It can be clearly seen that open land with or without scrubs as shown transition to urban settlements from 1981. Initially the growth was limited to the urban centre near old Nashik but later the urban growth can be seen gradually spreading towards the outer periphery. With the increased land demand as result of population growth the open spaces are converted into the urban built-up. The administrative ward wise population has growing from 1981 to 2011 [37] and population estimated for the year 2020 (Table 5).

Table 3. Land use and land cover Classification 1981 to 2020

Classes	1981		1991		2001		2011		2020	
	Area	Percent	Area	Percent	Area	Percent	Area	Percent	Area	Percent
Built-up	5.21	2.01%	18.53	7.15%	58.64	22.63%	103.57	39.97%	137.51	53.07%
Agriculture	71.3	27.52%	79.34	30.62%	68.9	26.59%	55.95	21.59%	60.1	23.20%
Vegetation	18.01	6.95%	15.64	6.04%	11.08	4.28%	9.55	3.69%	6.87	2.65%
Fallow land	37.03	14.29%	29.64	11.44%	19.66	7.59%	11.22	4.33%	5.11	1.97%
Open land	123.2	47.55%	112.02	43.23%	96.55	37.26%	75.43	29.11%	45.64	17.61%
Water body	4.35	1.68%	3.93	1.52%	4.27	1.65%	3.38	1.30%	3.87	1.49%
TOTAL	**259.1**	**100%**	**259.1**	**100.00%**	**259.1**	**100.00%**	**259.1**	**100.00%**	**259.1**	**100.00%**

Table 4. Administrative Ward wise Built-up 1981 to 2020

Administrative Wards	Area (Km^2)	Year									
		1981		1991		2001		2011		2020	
		Area (Km^2)	%	Area (Km^2)	%	Area (Km^2)	%	Area (Km^2)	%	Area (Km^2)	%
Nashik-East	18.63	1.15	6.17	3.28	17.61	9.02	48.42	14.21	76.27	14.66	78.69
Nashik-West	21.23	1.05	4.95	3.80	17.90	10.89	51.30	13.11	61.75	15.49	72.96
Panchavati	108.45	1.37	1.26	4.10	3.78	10.97	10.12	28.17	25.98	43.95	40.53
Nashik Road	41.39	0.98	2.37	3.55	8.58	11.41	27.57	18.28	44.17	23.03	55.64
Satpur	23.03	0.39	1.69	2.0	8.68	6.98	30.31	10.95	47.55	15.87	68.91
New Nashik	46.37	0.27	0.58	1.80	3.88	9.37	20.21	18.85	40.65	24.51	52.86

Table 5. Ward wise population of NMC from 1981 to 2020

Administrative Wards	Population				
	1981	1991	2001	2011	2020*
Nashik-East	106224	158278	165423	300974	415689
Nashik-West	55536	68698	123481	161023	201582
Panchavati	16022	111137	214950	293234	465890
Nashik Road	119976	126931	190326	257934	335980
Satpur	98511	112133	214256	271354	336987
New Nashik	21992	79748	168800	201534	325489
Total	**418261**	**656925**	**1077236**	**1486053**	**2081617**

*Estimated Population.

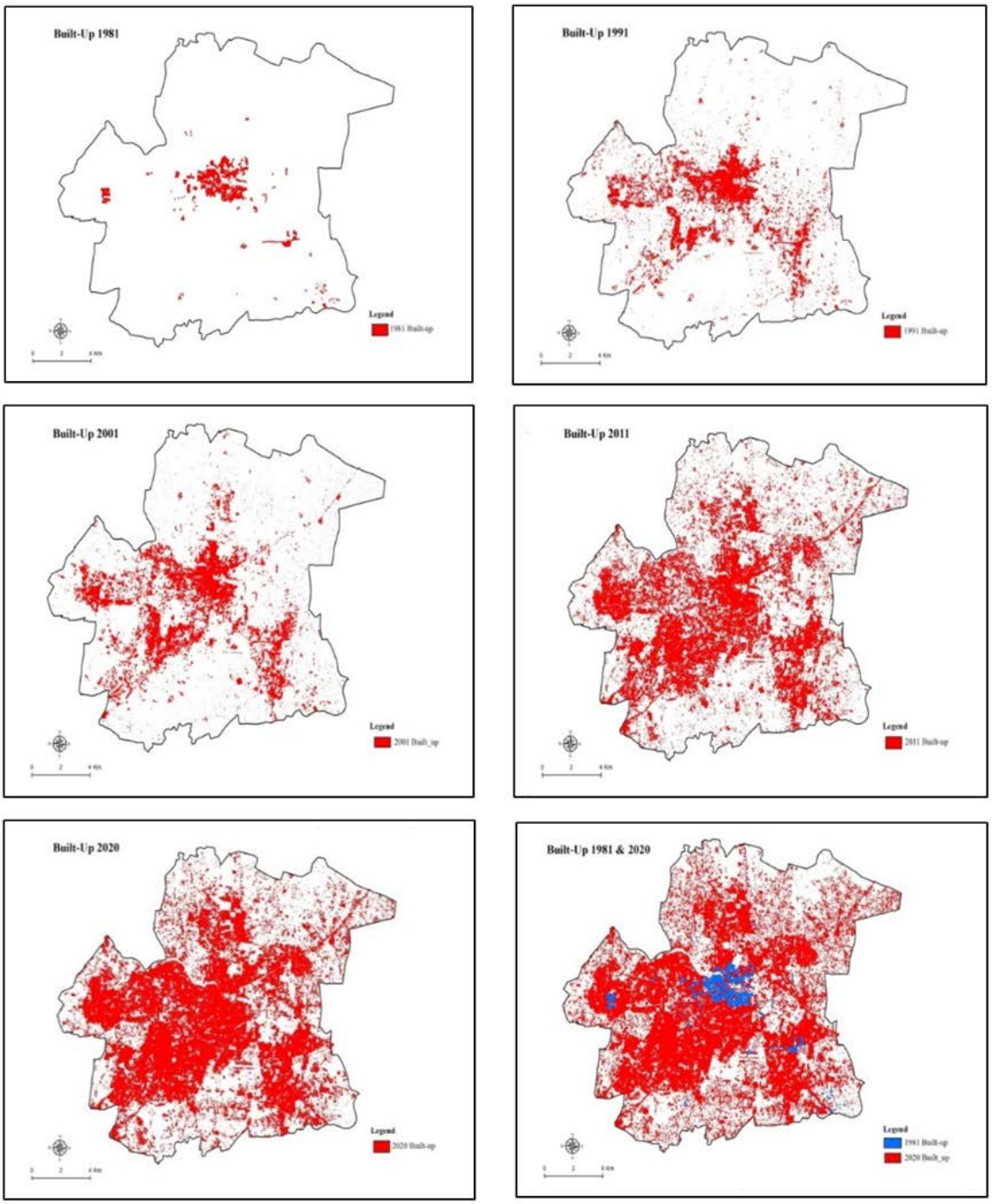

Figure 4. Urban Built-up from 1981 to 2020

3.3. Shannon's Entropy

The Shannon's Entropy calculation was performed for NMC from 1981-2020. Six spatial buffer units i.e. municipal wards namely Nashik-East, Nashik-West, Panchvati, Nashik Road, Satpur and New Nashik covered all of the legal city boundaries are used.

Table 6. Shannon's Entropy 1981

Sr. No.	Admin Ward	TGA	Built-up (1981)	Density (Dj)	PDj	1/PDj	Log (1/PDj)	PDj*log (1/PDj)
1	Nashik East	18.63	1.15	0.0617	0.3626	2.7581	0.4406	0.1598
2	Nashik West	21.23	1.05	0.0495	0.2905	3.4424	0.5369	0.1560
3	Panchvati	108.45	1.37	0.0126	0.0742	13.4774	1.1296	0.0838
4	Nashik Road	41.39	0.98	0.0237	0.1391	7.1906	0.8568	0.1192
5	Satpur	23.03	0.39	0.0169	0.0995	10.0537	1.0023	0.0997
6	New Nashik	46.37	0.27	0.0058	0.0342	29.2395	1.4660	0.0501
		259.1	**5.21**	**0.1703**				**0.6685**

log (m) = Log 7 **Et = 0.6685/0.8450**
Log 7= 0.8450 **Et = 0.7911**

Table 7. Shannon's Entropy 1991

Sr. No.	Admin Ward	TGA	Built-up (1991)	Density (Dj)	PDj	1/PDj	Log (1/PDj)	PDj*log(1/PDj)
1	Nashik East	18.63	3.28	0.1761	0.2914	3.4323	0.5356	0.1560
2	Nashik West	21.23	3.8	0.1790	0.2962	3.3761	0.5284	0.1565
3	Panchvati	108.45	4.1	0.0378	0.0626	15.9842	1.2037	0.0753
4	Nashik Road	41.39	3.55	0.0858	0.1419	7.0455	0.8479	0.1203
5	Satpur	23.03	2	0.0868	0.1437	6.9584	0.8425	0.1211
6	New Nashik	46.37	1.8	0.0388	0.0642	15.5671	1.1922	0.0766
		259.1	**18.53**	**0.6043**				**0.7059**

log (m) = Log 7 **Et = 0.7058/0.8450**
Log 7= 0.8450 **Et = 0.8353**

Table 8. Shannon's Entropy 2001

Sr. No.	Admin Ward	TGA	Built-up (2001)	Density (Dj)	PDj	1/PDj	log(1/PDj)	PDj*log(1/PDj)
1	Nashik East	18.63	9.02	0.4842	0.2577	3.8811	0.5890	0.1517
2	Nashik West	21.23	10.89	0.5130	0.2730	3.6633	0.5639	0.1539
3	Panchvati	108.45	10.97	0.1012	0.0538	18.5768	1.2690	0.0683
4	Nashik Road	41.39	11.41	0.2757	0.1467	6.8165	0.8336	0.1223
5	Satpur	23.03	6.98	0.3031	0.1613	6.1999	0.7924	0.1278
6	New Nashik	46.37	9.37	0.2021	0.1075	9.2992	0.9684	0.1041
		259.1	**58.64**	**1.8791**				**0.7282**

log (m) = Log 7 **Et = 0.7282/0.8450**
Log 7= 0.8450 **Et = 0.8618**

Table 9. Shannon's Entropy 2011

Sr. No.	Admin Ward	TGA	Built-up (2011)	Density (Dj)	PDj	1/PDj	log(1/PDj)	PDj*log(1/PDj)
1	Nashik East	18.63	14.21	0.7627	0.2574	3.8855	0.5894	0.1517
2	Nashik West	21.23	13.11	0.6175	0.2084	4.7993	0.6812	0.1419
3	Panchvati	108.45	28.17	0.2598	0.0876	11.4096	1.0573	0.0927
4	Nashik Road	41.39	18.28	0.4417	0.1490	6.7104	0.8267	0.1232
5	Satpur	23.03	10.95	0.4755	0.1604	6.2331	0.7947	0.1275
6	New Nashik	46.37	18.85	0.4065	0.1372	7.2904	0.8628	0.1183
		259.1	**103.57**	**2.9637**				**0.7553**

log (m) = Log 7 **Et = 0.7553/0.8450**
Log 7= 0.8450 **Et = 0.8938**

Table 10. Shannon's Entropy 2020

Sr. No.	Admin Ward	TGA	Built-up (2020)	Density (Dj)	PDj	1/PDj	log(1/PDj)	PDj*log(1/PDj)
1	Nashik East	18.63	14.66	0.7869	0.2129	4.6967	0.6718	0.1430
2	Nashik West	21.23	15.49	0.7296	0.1974	5.0654	0.7046	0.1391
3	Panchvati	108.45	43.95	0.4053	0.1097	9.1199	0.9600	0.1053
4	Nashik Road	41.39	23.03	0.5564	0.1506	6.6423	0.8223	0.1238
5	Satpur	23.03	15.87	0.6891	0.1865	5.3633	0.7294	0.1360
6	New Nashik	46.37	24.51	0.5286	0.1430	6.9922	0.8446	0.1208
		259.1	**137.51**	**3.6959**				**0.7680**

log (m) = Log 7 **Et = 0.7680/0.8450**
Log 7= 0.8450 **Et = 0.9088**

The calculation of Shannon's entropy measured indicated that the NMC continue to sprawl from 1981 to 2020. The entropy value for 1981 was lowest than that of 2020. In the year 1981 the calculated entropy value was 0.7911, in the consequent study years i.e. 1991, 2001, 2011 and 2020, the entropy value shows the gradual increase i.e. 0.8353, 0.8618, 0.8938 and 0.9088 respectively. The Shannon's entropy values close to 0 (zero) indicate built-up areas with compact structures, and values close to 1 indicate the presence of spread. The increases in the entropy values in NMC show that the built-up areas are dispersed and that urban sprawl increased with time as entropy value that is close to 1 indicates urban growth has occurred as spread-urban sprawl. The trend of population growth and entropy value also indicates that with the growing population the urban growth has co-occurred.

Table 11. Differences Shannon's Entropy

Year	Entropy (Et)	ΔEt
1991-1981	0.7911	0.0442
2001-1991	0.8353	0.0265
2011-2001	0.8618	0.032
2020-2011	0.8938	0.015
2020	0.9088	

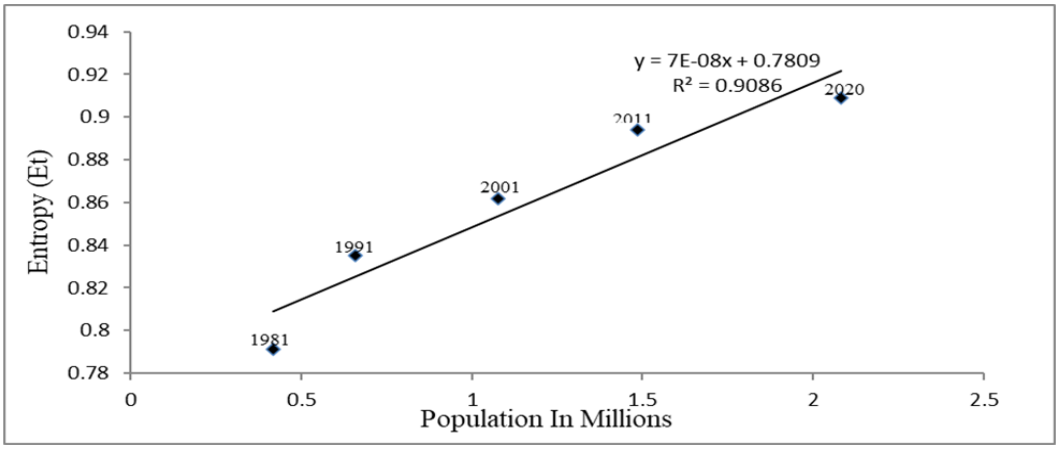

Figure 5. Population vs. Entropy

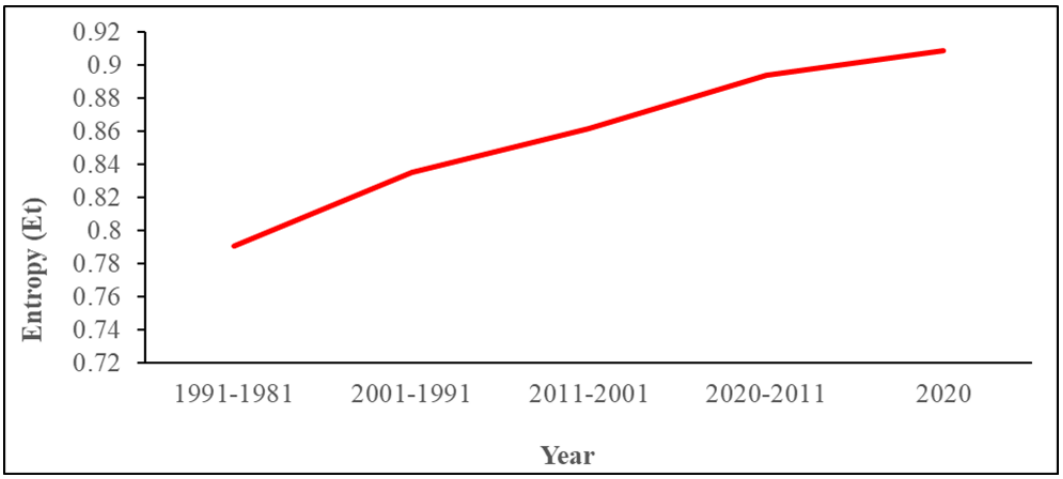

Figure 6. Shannon's Entropy relative values

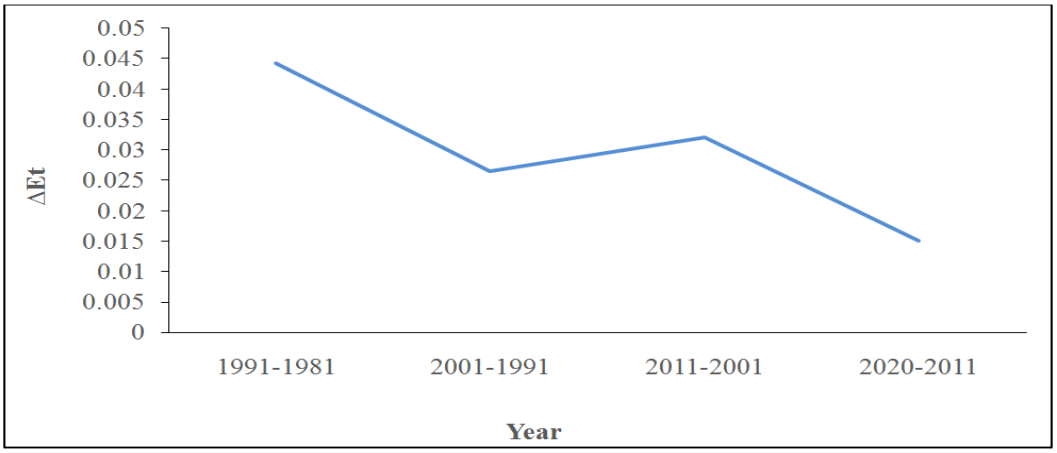

Figure 7. Differences of Relative Entropy Values in Each Pair Years

Population growth show positive association with Shannon's entropy (Figure 5) and relative Entropy gradually increases from 1991 to 2020 (Figure 6). But in the same period relative Entropy has decreases (Figure 7). The analysis shows the relative Entropy (Et) for the different years 1991-1981 was 0.7911 for a population of 4.18 lakhs, in comparison with 2020, Entropy value was 0.9088 for a population of 20.81 lakhs estimated. Even then the Entropy values in both were more than 0.5, represents a higher rate of growth or sprawl.

3.4. Accuracy Assessment

Accuracy assessment is a crucial step in the image classification for evaluating the quality of the classified images [41]. The post classification accuracy assessment is essential for precise LULC classification and mapping [42]. The classification accuracy quantifies the quality of maps produces and helps to evaluate the applicability of a map for a particular use. For an accurate interpretability and identification, the minimum accuracy of a classified map should not be less than 80 per cent [43].

Table 12. Accuracy Assessment

Land Use Classes	1981		1991		2001		2011		2020	
	PA (%)	UA (%)	PA (%)	UA (%)	PA (%)	UA (%)	PA (%)	UA (%)	PA (%)	UA (%)
Built-Up	94.5	92.9	96.18	92.28	97.52	98.5	96.85	97.6	98.66	99.15
Agriculture	92.5	91.8	91.97	93.33	93.97	94.1	92.54	91.06	94.33	98.3
Vegetation	88.65	92.38	88.9	95.69	90.9	92.1	96.66	97.85	98.1	98.4
Fallow land	90.3	91.7	92.5	89.49	92.5	92.5	94.61	95.6	97.8	98.5
Wasteland	89.9	89.85	94.1	91.9	94.1	95.08	99.5	98.82	100	100
Water body	98.25	91.4	99.25	98.6	99.25	99.75	98.3	98.2	100	100
Overall	**91.67**		**93.55**		**95.33833**		**96.52167**		**99.06**	
Kappa Coefficient	**0.911**		**0.924**		**0.947**		**0.951**		**0.97.9**	

This study, Kappa coefficient technique is used to evaluate the accuracy of LULC maps of NMC using 150 randomly selected points. The points were selected in a way that covers each LULC classes in almost equal proportion and from all parts of the study area. The ground observation for 1991, 2001 and 2011 were taken from Google Earth Pro domain as the field data was not available for these years. Further, for 2020, the ground observations were taken partially both from field visit as well as using Google Earth pro domain for the areas having either no or difficult access. Accuracy for year 1981 assessed with the help of toposheet, details of the accuracy levels obtained for the images of different period. The overall accuracy is estimated 91 (1991) to 99 percent (2020) with 0.91 to 0.97 Kappa Coefficient.

4. Conclusion

Shannon's entropy is effective technique for understanding distribution of urban built-up. The analysis of the LULC and Shannon's entropy in Nashik city area, using series of Landsat imagery from 1981 to 2020. Entropy measured shows that Et = 0.7911 to 0.9088 value for 1981 was lowest than that of 2020 respectively. The consequent study of between decadal years from 1991, 2001, 2011 and 2020, while the entropy value gradual increased to 0.8353, 0.8618 and 0.8938 respectively. The trend of population growth as well as entropy value indicates that with increasing population, urban growth or built-up has co-occurred. LULC analysis shows that urban growth is found predominant in the NMC and it is rapidly spreading up in non-contiguous and random way. This basic study directs the unplanned urban growth in the NMC area. During 1981 to 2020, open land with or without scrubs, fallow land, and vegetation were in continuous declined. Thus, waste land has shown tremendous decline as it contributed 47.55 percent in the year 1981 and it was reduced to 17.61 percent in the year 2020, indicated -63.0 percent change. Fallow land has also declined drastically from 14.29 percent (1981) to 4.33 percent (2020). Vegetation also shown continuous decline as it was reduced from 6.95 percent (1981) to 2.65 percent (2020) and agriculture as well as water body has shown fluctuating characteristics. Urban built-up from1981 to 2020 observed values was 5.21 sq.km. (2.1%) in 1981, which was increased to 137.51 sq.km. (53.07%) in the year 2020. The Nashik East shows maximum built-up area in percentage as about 78.69 (14.66 sq. km.) of the total area, in terms of Panchvati shows maximum spatial growth of built-up from 1.37 sq. km. (1.26%), 43.95 sq. km. (40.53%). The core area which is also the oldest area of the urban centre shows dense clustering throughout the study period in the initial phases the built-up started to randomly distribute around the centre and around the Nashik road urban cluster with the passage of the time most of the vacant lands were altered to built-up area. The active process of urban growth is still active in Nashik and around municipal corporation area. In the accuracy assessment, Kappa coefficient value shows more accurate assessment in 2020 compared to 1981.

Acknowledgements

The author would like to express his sincere thanks to Indian Council of Social Science Research, New Delhi, for funding the current major research project under IMPRESS research grant scheme (IMPRESS/P2832/2018-19/ICSSR). Also, thanks to K.V.N. Naik Shikshan Prasarak Sanstha's Arts, Commerce and Science College Nashik for encouraging me to complete this research.

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