Urban Growth and Loss of Green Spaces: A Case Study of Surat

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Abstract

This paper demonstrates the significance of green spaces and the impact of urbanization on green spaces in urban areas. Green spaces are an important asset for the anatomy of urban areas. Rural-urban migration and prevalent industrialization leads to explosion of population into urban centers. This explosion of population give rise to unplanned, unorganized settlements around urban areas i.e. urban sprawl. One of the most prominent effects or urbanization is depletion of green areas. These green areas are of great importance in terms of health of the city as well as of the people living and for the sustainability. This article analyses the spatial-temporal change, extent and inequalities in the distribution of the green spaces with the help of remote sensing and GIS techniques.

Keywords: Green spaces, urbanization, urban centers and sustainability

Introduction

A continuous growth has been noticed in the urban population and number of cities as well towns, since the beginning of the twentieth century. According to Census of India, the urban population has been increasing from 58 million in 1951 to 216 million in 1991 and further 1,210.19 million in 2011. The pattern of rapid growth of urban population has been followed by Gujrat, which accounts for about 3 crore (42.6%) urban population and is India's the 5th most urban populous state. Thus, nearly half of the state's population has been living in urban Gujrat. Surat being one of the prominent cities due to its geographical location has been growing rapidly posing challenge to the sustainability of the city (Mitra et. al 2011; Jariwala, 2015).

Rapid urban growth not only brings about local ecological impacts but comes along with huge environmental footprints. Urbanization has various types of impacts: reduction of forest and agricultural lands, decrease in water bodies, increase in impervious surfaces which further makes the city vulnerable to disasters such as urban floods, pollution, excavating building materials in bulky quantity and deforestation (Kiani et al., 2014; Jain et al., 2013). Biotic and abiotic components of urban areas are subjected to direct exposure to harmful gasses which are released by vehicles and industries which effect the health of the city as well its inhabitants. Major contributor in the emission of greenhouse gasses is the urban atmosphere (Haq, 2011).

Urban areas have variety of problems like shortage of safe drinking water, degradation of land and occupation, inadequate green areas, flooding, improper waste management, pollution hazard etc. In urban landscape, green spaces have their own significance. Numerous social and environmental benefits are been provided by green spaces and they play a significant role in improving quality of air and water (Rai, 2017). Green cover improves our quality of life and environment as all the time these green spaces i.e. trees, shrubs, plants works 24 hours for our betterment. Therefore, in urban areas it is utmost necessary to preserve and care for these environmental assets. In developed countries, majority of towns and cities have blocks of trees, patches of forest and appropriate quantity of gardens and trees along streets (Qin et al., 2013).

Green space could be defined as a land parcel with vegetation. The vegetation covering the green spaces could be in form of forests, shrubs and grassland. Recreational areas such as parks, sports grounds and open land near built up (Balram et al., 2005). Different cities have different area of the city as green. For example, few green cities have 20 to 30 per cent green cover which accounts for roughly 15 to 25 m2 urban green space per capita. Environmentalist around the world have estimated a standard value of urban green spaces for striking a balance between oxygen and carbon dioxide in the atmosphere. According to them, minimum of 40 m2 of urban green spaces 140 m2 suburb forest area per capita are recommended for

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maintaining environmental equilibrium for the sustenance of mankind. Developed nations has adopted a standard value of minimum of 20 m2 green space per capita which is a big challenge for the rapidly growing metropolitan and mega cities in Asia.

The role of green spaces in today's era of urbanization cannot be neglected. Green spaces have numerous advantages, for example, cooling down the temperature of buildings, improving quality of air by filter the air particles etc. Besides all these factors, a healthy green cover around an area also helps in increasing the property cost (Nero, 2017). Green spaces are also of great benefit in terms of psychological well-being of people. Generally, one of the most foremost functions of urban green spaces is to provide a leisure context leading to upgrading of social interactions and physical and psychological health of communities through fashioning more direct contacts between people and nature to grant a more purposeful and pleasing lifestyle to city dwellers. Urban green spaces, exclusively public parks and gardens offer resources for relaxation and recreation. Preferably this helps in emotional healing (therapeutic) and physical relaxation (Herzele, 2003).

In urban areas, green spaces should be easily accessible. There should be an even distribution of green spaces throughout the urban area, and the total extent of the green cover should be large enough to cater the demands of the population of urban areas. Promotion of importance of green spaces can encourage people to maintain the equilibrium of the environment which automatically leads to healthier living conditions in urban areas.

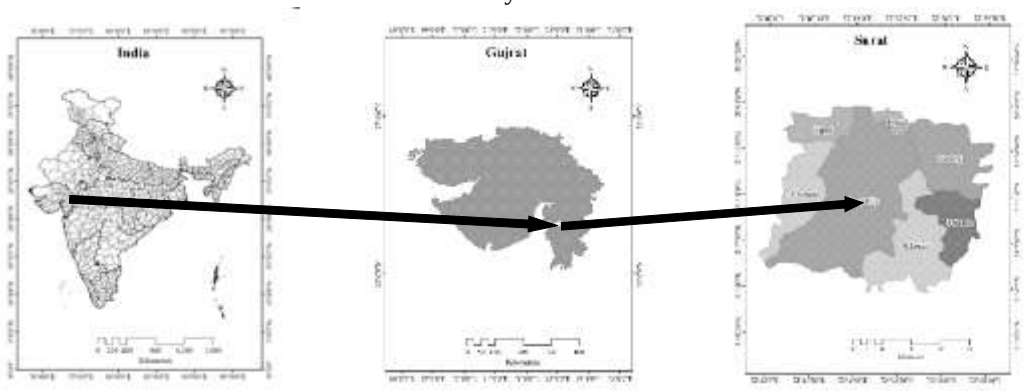
Thus, the study aimed at evaluating the impacts of urbanization and loss of green spaces in Surat over the periods of years (2001-2019) using remote sensing technology and spatial functionalities techniques in geographical information system (GIS).

Description of Study Area

The study area has been the planning region which includes the City of Surat and surroundings. Surat - an important industrial hub and commercial center of the country today boasts of a great historical and cultural heritage. The city of Surat has glorious history that dates back to 300 BC. Surat has a very diverse historical background and because of its textile industries it is known as 'The Silk City'. In recent time Surat has attained the title as one of the cleanest cities presently in India. One of the major factors responsible for rapid growth rates in Surat is immigration from different parts of India,

Surat is a port city near Tapi river. The planning area is located at 21°4'N 72°42'E. There are total five talukas, namely, Olpad, Chorasi, Kamrej, Palsana and SMC area. Presently there are total of 95 villages (17, 44, 17, 17 in Olpad, Chorasi, Kamrej and Palsana respectively) in all five talukas. A total of 220 wards are present in Surat. It has an average elevation of 13 meters. Due to location of Surat near to the sea, it experiences high tides mainly in the western parts, and average height of tides ranges from five to six meters. In monsoon season flooding becomes a common phenomenon due to occurrence of flash floods.

Study Area



Source: Prepared by the author based on satellite data

Fig 1

Materials and Method

The study has been done solely with the help of secondary data. The satellite data has been obtained by (USGS earth explorer) of 3 time periods, 2001,2011 and 2019. The data is of LANDSAT 4-5 (MSS and TM) and LANDSAT 8 (OLI-TIRS).

* Data source and information:

S NO.	Satellite	Date of acquisition	Row	Path	Resolution	Source
1.	LANDSAT 4-5 TM	31-3-2001	45	148	30 m	USGS
2.	LANDSAT 4-5 TM	29-3-2011	45	148	30 m	USGS
3.	LANDSAT 8 OLI-TIRS	3-3-2019	45	148	30 m	USGS

The data has been obtained by United States Geological Survey, (USGS) website of satellite LANDSAT 4-5 and LANDSAT 8 of three time periods. Pre-processing of the raw data has been done though ERADAS IMAGINE 2014 software. After extraction of study area supervised classification has been performed on all three time period data sets. For studying the urbanization and green space the help of one index has been taken, namely, normalized differential vegetation index (NDVI). Proximity analysis (buffer analysis) has been performed to get the amount to green space in a particular buffer zone of range of 2 km each. The area has been calculated in sq. km. The variation of green spaces over the period of time, from the city core has been helpful in planning for sustainable city development.

Results and Discussion

For the estimation of green space in Surat, we have used normalized differential vegetation index (NDVI). The NDVI is an indicator of the quality of vegetation and extent of green cover. It is important method to distinguish the green cover from an area other than vegetation. The NDVI is based on the principle of spectral reflectance of vegetation in the Infrared band.

Normalized Differential Vegetation Index (NDVI)

Normalized difference vegetation index (NDVI) is one of the prominently used band ratioing method also called as numerical indicator which uses two bands, namely, red band and near-infrared band. As the names indicates, NDVI is related to vegetation. Values of NDVI ranges from +1 to -1. Values which reflects high in near-infrared band are said to have high NDVI values. Denser the vegetation higher the reflectance in near-infrared band. NDVI is an essential component of geo-spatial techniques and is used at wide scale, for example, crop determination, health status of the crops, monitoring vegetation cover of forest, green cover evaluation etc.

- LANDSAT 8 OLI: -

$$NDVI = \frac{BAND\ 5 - BAND\ 4}{BAND\ 5 + BAND\ 4}$$

Where, BAND 4 = RED
BAND 5 = NIR

- LANDSAT 4- 5 TM: -

$$NDVI = \frac{BAND\ 4 - BAND\ 3}{BAND\ 4 + BAND\ 3}$$

Where, BAND 3 = RED
BAND 4 = NIR

Pixel value in the output image ranges between -1 to +1. Dense vegetation cover of an area will show positive NDVI values, i.e., 0.3 to 0.8 all other land cover classes will show negative values. Targets showing values near 0 e.g., soils generally show values between 0.1 to 0.2. Very high positive values (say 0.6 to 0.8) indicate healthy vegetation, while value range 0.3 to 0.6 may be considered as stressed vegetation. However, this may vary from species to species and season to season. It is important note that the denser the vegetation higher the NDVI. Also, the health of the vegetation is an important factor affecting NDVI values. Thus, greener the vegetation, higher the NDVI.

In the study area, it has been examined that NDVI maps of 2001, 2011 and 2019 all of them have varying NDVI values. In 2001, NDVI values is between -0.34 to 0.62 and on the other hand in 2011 and 2019 the NDVI values is between -0.343 to 0.64 and -0.14 to 0.55 respectively. Now it can be analyzed or differentiate between the data as to which year has more green cover or healthy vegetation. In 2001 and 2011 the NDVI values are higher as compared to 2019 which shows that density of vegetation in Surat has been more than in 2019.

Thus, NDVI method is used to calculate all the threshold value of the band and give the spectral reflectance of BAND 4 and BAND 3. Therefore, we can conclude that most of the regions of Surat is going under worst condition due to decreasing green space.

Distribution of Green Spaces

The spatial extent of green spaces has been examined by nine buffer regions of 2 km each from Centre of the city to its periphery to study the quantity and quality of distribution of green spaces.

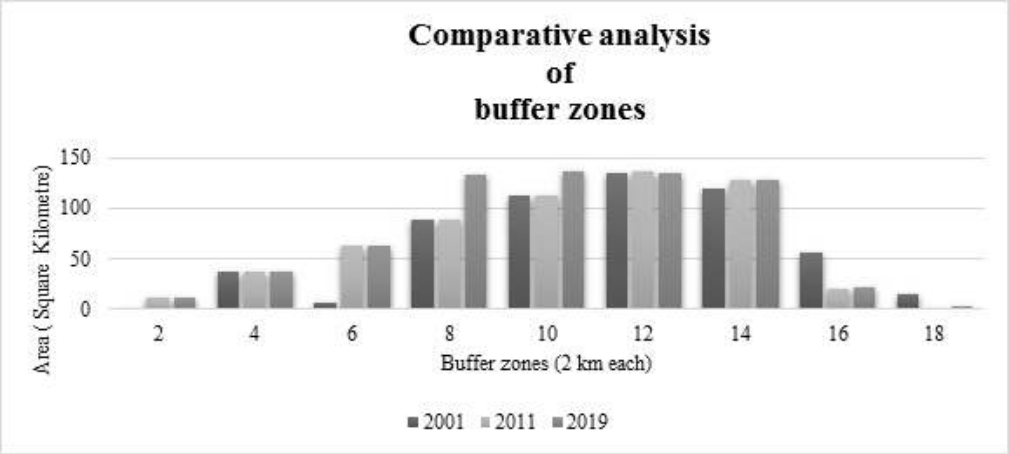
Table-1: Green spaces in Surat City (2001-2019)

	2001		**2011**		**2019**	
Buffer zone (Km)	**Area (Km^2)**	**Per cent area (%)**	**Area (Km^2)**	**Per cent area (%)**	**Area (Km^2)**	**Per cent area (%)**
2	1.25	0.19	12.56	1.99	12.56	1.86
4	37.69	5.73	37.69	5.98	37.69	5.60
6	6.28	9.82	62.85	9.97	62.82	9.34
8	87.96	13.75	87.95	13.96	133	19.79
10	113.07	17.68	112.92	19.72	137	20.38
12	135.35	21.16	136	12.59	135.25	20.12
14	118.76	18.57	127.54	20.25	128.45	19.11
16	56	8.75	21.03	8.10	22.64	3.36
18	15.26	0.23	1.25	0.19	3.14	0.46
Total area	***639.51 Km^2***		***629.82 Km^2***		***671.95 Km^2***	

Source: Prepared by the author based on satellite data

The total area containing green spaces has been 639.51 sq. km according to Table 1 in 2001. It can be seen that largest share of green space is in buffer zone 12 (24%) covering total area of 135.35 sq. km whereas the core of the city has only (0.19%) area as green spaces which is 1.25 sq. km. It can be seen that most of the green spaces are found within zones 8-14 (Fig.2) which indicates that in 2001. In 2011, it has been observed that the total green space area (629.82 sq. km) decreased from 2001(Fig.3). It has been found that largest share of green space is in zone 14 (20.25%) area covering total area of 12.75 sq. km. On the other hand, least share is with the outer most zone, which is zone 18 (0.19) covering only 125 sq. km area.

Again, it has been observed that major share of green spaces is between zone 8-14. Once again it shows that the core area has been lacking green space since 2001 and this trend continued in 2011 also. In 2019, it has been found that maximum share of green spaces is between zone (8-14). This dominance of green spaces in between zones (8-14) has been noticed since 2001 and this trend continues till now. The least share of green spaces is observed in the outer most zone that constitute only 0.6%. The core area of Surat has shown a slight decrease in percentage of green spaces as compared to 2011 (Fig.3).



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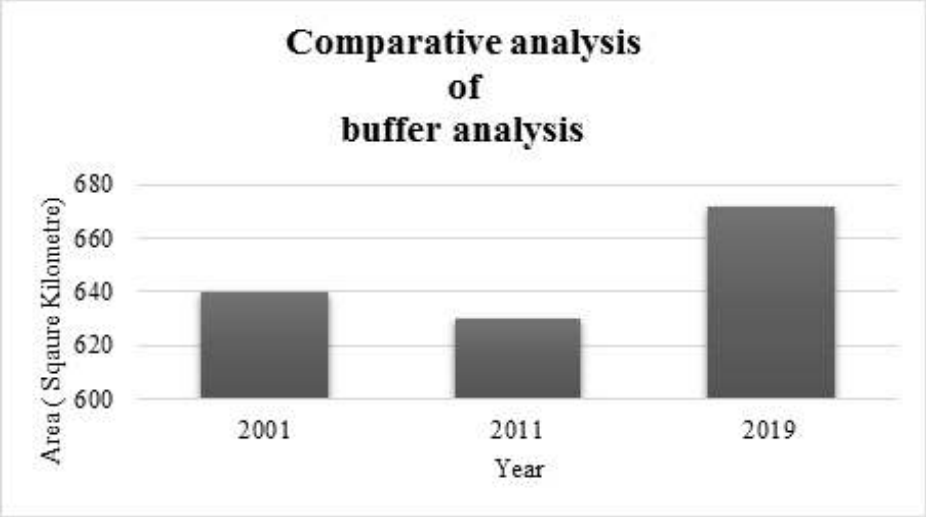

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Fig 3

Dominance of built-up area has been observed in the core area. Keeping in mind the green spaces there is urgent need to increase the quantity of green areas in the core of Surat as there are mostly commercial and industrial areas which are one of the major contributors to various type of pollutions (air, water etc.) which affects the quality of life of the people residing in the city.

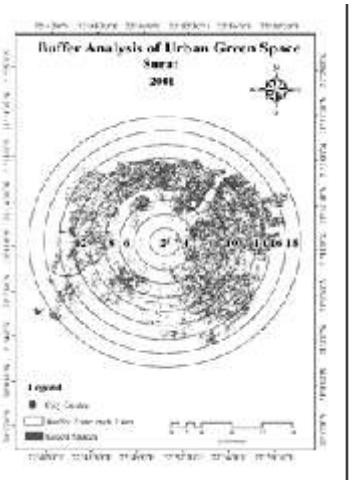

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Fig 4

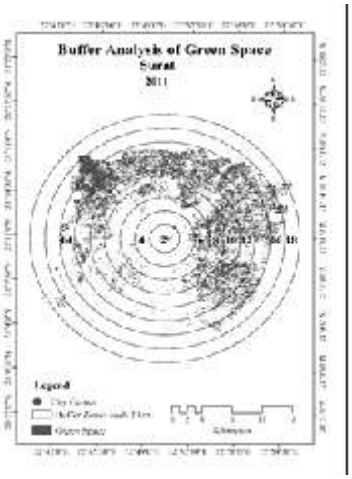

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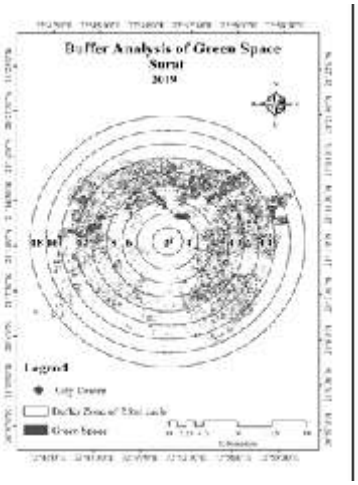
Fig 5



Source: Prepared by the author based on satellite data
Fig 6

The spatial pattern of green spaces (Fig.4, Fig. 5 and Fig.6) for the year 2001, 2011 and 2019 the loss of green spaces and growth of city at its expense. The city has been expanding in the south and eastern direction affecting the density of green spaces.

Conclusion

The analysis shows that though, in 2001, total green space area was 639.51 sq. km. In 2011, it decreased to 629.82 sq. km. But in 2019, total green space area has increased to 671.95 sq.km but this increase has taken place only near the river area which includes free floating plants i.e. algae, wild bushes shrubs rather than increase in parks, playgrounds, community parks etc. To ensure the sustainability steps have to been taken to maintain green spaces in Surat city There have been many plans and policies for setting up green buildings and green cover as well as green spaces which can assist to reduce heat and help to reduce the increasing pollution but implementation of such schemes has not shown any significant mark. It has been observed that in peripheral areas there has been a significant amount of decline of green spaces which indicates that in peripheral area concretization of land has been taking place. Green areas are one of the finest solutions for reducing air pollution, psychological disease and socio- economic complications in urban areas and it represents that green spaces both indirectly or directly affect people's quality of life. Hence, in case of Surat, only the middle portion of the city has the highest proportion of green spaces and the core as well as peripheral area is lacking in term of green spaces which a serious matter of concern. Therefore, adopting strategies to develop green areas i.e. vertical gardening as well as green spaces i.e. parks is one of the finest techniques to tackling various environmental problem and moving a step towards eco-friendly and sustainable city.

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