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URBAN FRINGE TRANSFORMATION AND ENVIRONMENTAL DEGRADATION: A CASE STUDY OF AHMEDABAD

Vrinda Ojha[*]

ABSTRACT

Urban fringe is the outskirt area of the urban agglomeration which convicts the land degradation and demeaning the quality of the environment with the inflation of problems of urban centers. Land use land cover analysis can define that when the built area of the urban region is increases thus the vegetation of the region decreases. The decentralization of the city can enlarge the boundary and causes the "urban sprawl", "Peri-urban", "sub-urban" or "urban-fringe". Urbanization and industrialization are plays a pivotal role in the augmentation of the outer boundary of the urban centers which comprehend the vegetation and cultivated land where the population is mainly engaged in the primary occupation but owing which are extend towards outside and degrade the land capability because when the urban infrastructure increases the capacity of mainly for agriculture purposes are degrade. Recently the population explosion became the vital factor for the research but the unequal distribution of resources and according to the uneven settlement of population is the major issue for the developing and undeveloped countries. Rural-Urban fringe is the transitional zone where the rural and urban both the pursuit are taking place but these can spawn the growing share of barren and uncultivated land which are antiquity a cultivable land contributed in state income. The expansion of urban fringe is measured with the method of normalizing differentiation of built up index and normalize differentiation of vegetation index (NDBI & NDVI) which represents that built up are increases with the passage of time and the vegetation are reducing. There is also a description of the spread of urban region through buffer zone analysis which is from 1995-2020 and the source of there is the zonal distribution of 5 km equal distance. Built-up area exceeds from 144 km2 (1995) to 415 km2 (2020) it describes that the built-up area of the urban sprawl is increases with decreasing natural vegetation which explains through from color combination of NDVI.

Keywords: *Urban Fringe, Environmental Degradation, NDVI, Peri-urban, Industrialization.*

Introduction

Urbanization is a rapid growth of the urban population of developing and undeveloped countries which convict the unplanned and there is a lack of governance in their extension of population. The main provocation of urban sprawl which can be developed as owing to urbanization is the diminishing management of urban population and its development because the urban fringe is the flooding of population towards the outer boundary of the urban center. The growth and expansion of these centers have rebel the analyses or to apprehended about the sustainable development of the city. This paper is concerned about the consequences of the urban fringe transfiguration and the diminishing in quality of the environment of living and also causing imminence to the agriculture and green belt of the city which can reduce the pollution of the city and maintain the living environment of the city. The urban sprawl persistence can accelerate the rate of migration most of the rural population are moving towards the city in order to acquire urban facilities and opportunities but due to this the unplanned extension or growth of population can take place.

[G] Research Scholar, Gujarat University, Gujarat, India.

As the population increase, the quality of the physical environment and the attribute of land decreases because when the pressure of population on land increases the fertility of land decreases. This stagnation of the peculiarity of the natural resources can evident in the growth of pollution, environmental problems, slum, asymmetrical settlement of population, and disturb the systematized situation of the city. Ahmedabad is the economic capital city of Gujarat, the forest cover area of the study area is above 0.92% - 1.00% as according to the census of India, 2011 whereas the forest area is above 1.55% - 2.00% it shows that the inclination in population can increase the expansion of city area which is considered as urban sprawl but also deteriorate the cultivable land and forest area of the city. Land use land cover analysis of the urban sprawl can interpret the condition of inadvertent growth of city towards the outer boundary and through from NDVI the vegetation index can also illuminate. The large scale expansion of the city can cause the movement of population towards the fringe zone because in order to acquire more living facilities but the main aim of this paper is to examine the growth of urban fringe but how this growth can become precarious for the environment and its sources such as land, air, and water. Although urbanization is essential for the development of the city but the exploitation of resources (natural) is not to be virtuous for the growth of the city. Urban fringe is a zone that includes both rural and urban characteristics thus the land is encompassed with both agricultural and industrial but as the exponential growth of population the cultivable land also comprehend with industrialization and diminish the land under agriculture use, deprivation of arable land, reduction in the green belt of the urban area, denudation erosion and desertification. Thus this paper can identify the correlation between the built-up area and the vegetation cover and also analyze the factor which is responsible for the deterioration of the vegetation and increase the environmental problems.

Study Area

Ahmedabad is the commercial capital of Gujarat, which occupies the western portion of India. Ahmedabad occupies 5th of India and 1st of Gujarat as the largest megalopolis city with 8,253,226. It is rich in the textile industrial market thus it is known as the textile capital of India. This study has included the boundary of AMC boundary which mainly governed the central part of AUDA, which takes the greater or outer Ahmedabad as under its administrative and the last one is the village boundary which includes the fringe or sprawl area of the Ahmedabad because as the human settlement increases in the central or interior of the city the population expand towards the village boundary and encompass the village which is located nearby metropolis city Ahmedabad. The study area defines the fringe expansion from Ahmedabad towards the Mehsana, Gandhinagar, Kheda, and Sabarkantha where the rurban area is used to expand since the urbanization has taken place in the central place of Ahmedabad. The urban agglomeration region of Ahmedabad lies between latitude 23.0225°N and 72.5714°E longitude.

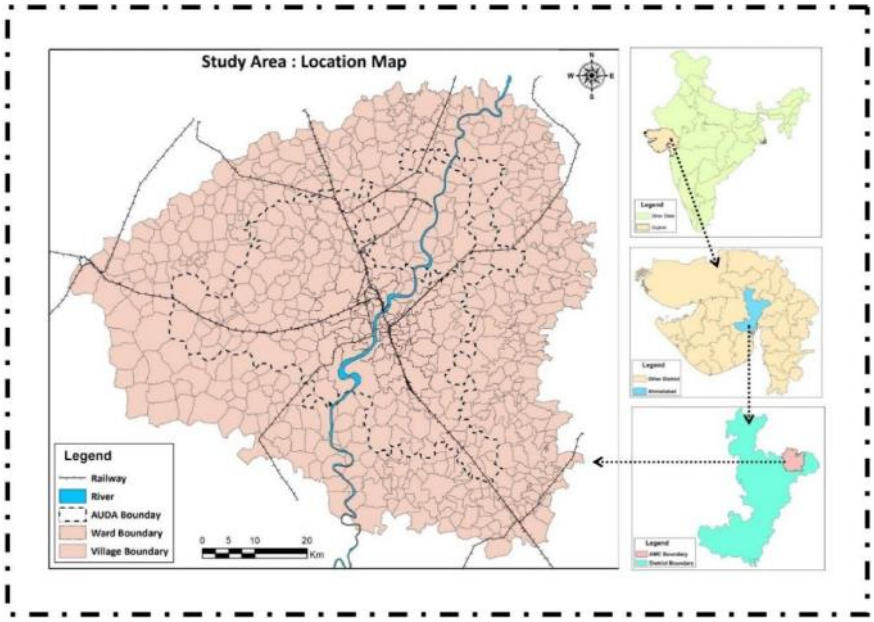


Figure 1: Location Map of urban fringe expansion of Ahmedabad urban agglomeration

The urban fringe and urban agglomeration of Ahmedabad are dilating towards the village boundaries which are enlarged towards these Talukas from the Ahmedabad urban agglomeration. Population density causes the population flood in the megalopolis city which are developed as a leapfrog intensity of expansion, Ahmedabad population mainly moves towards the Gandhinagar due to which the green belt between Ahmedabad and Gandhinagar that comprehend with cultivable agricultural land and forest area both but as the urbanized region can make a major unpropitious effect on the environment. The total area of study is above 5858sq.km which includes AMC, AUDA, Village boundary because expansion does not only include the outer fringe but also transpire by growth in density of population of the interior city of the metropolis city like Ahmedabad. The Daskroi Taluka of Ahmedabad district embraces the maximum growth of the city because of the high living standard of population and better settlement facility but the exploitation of land are began above the Daskroi and Sanand. The study area of this analysis has included the five Talukas where the immigration is taking place from Ahmedabad which is towards or above the village boundary of Ahmedabad.

Objectives

The principal aspiration of the present study is to discern the impact of urban fringe transfiguration on physical environment they are as-

- To evaluate the built up area of Ahmedabad urban agglomeration from NDBI (Normalized difference built up index).
- To assess the ascendancy of fringe expansion on the built up area and the agricultural zone of the Ahmedabad.
- To appraise the co-relation between the human settlement of the urban center and its green belt (vegetation)
- Urban sprawl metamorphosis and the diminution of vegetation from 2010-2020 and also explore the stimulation of 2030 estimation.

Data Sources and Methodology

Land use land cover analyses require the satellite imagery for the classification of NDVI and NDBI thus is to be obtained from the USGS Earth Explorer. Further works from the interpretation of the LULC map are done with ArcGIS software from which the image analysis and classification are taking place. The satellite image of 2010 and 2030 can be interpreted; the stimulated or predicted map is completed on the basis of present and past data base.

Image Preprocessing

Satellite image for the initialization of the classification of built up index and vegetation index the preprocessing of NDBI and NDVI include the NRG means near infrared/ green/red are the procedure to envision the infrared and other wavelength of light which are passes through from band 5 and band 4 in NDBI and from red is in NDVI thus it can reflected from built up area and vegetation zone of the study area. As the commencing stage the image of Ahmedabad from processed in the ArcGIS in order to pass the multispectral bands which restrain the visible and infrared wavelength. The data acquisitions are of 2010, 2020 and processed for the stimulated map of 2030. The image initializations are than accomplished in order to construct good CIR (color infrared) blended using not correlated extend. In order to acquire better information the bands are passes several times for obtaining better information of color interpretation. The image processing arrangement/order can carried out 3 band combinations by allocate another colors to particular band.

Classification of Image

The images after processing are further use for classification by using method of Georeferencing and supervised classification methods. The bands of multispectral comprise NIR (near-infrared), SWIR (short-infrared) and also using color of red and green are owned for this study. The classification obtains the land use land cover image of the study area. The training points are used in the classification by the selection of pixels for the use of training data in the software. The supervised and un-supervised classification can be done for the examine about the pixels which are used in study with different number. After using the above formula for NDVI calculation the final results of land use land cover of the study area. The bands are passes many times from the red and green and then the bands which are 5-4-3 (NIR, Red, and Green) are categorizing into Red, Green and Blue (RGB) color. The maps after supervised classification the RGB (Red, Green and Blue) color are obtained after CIR (Color of Infrared) image.

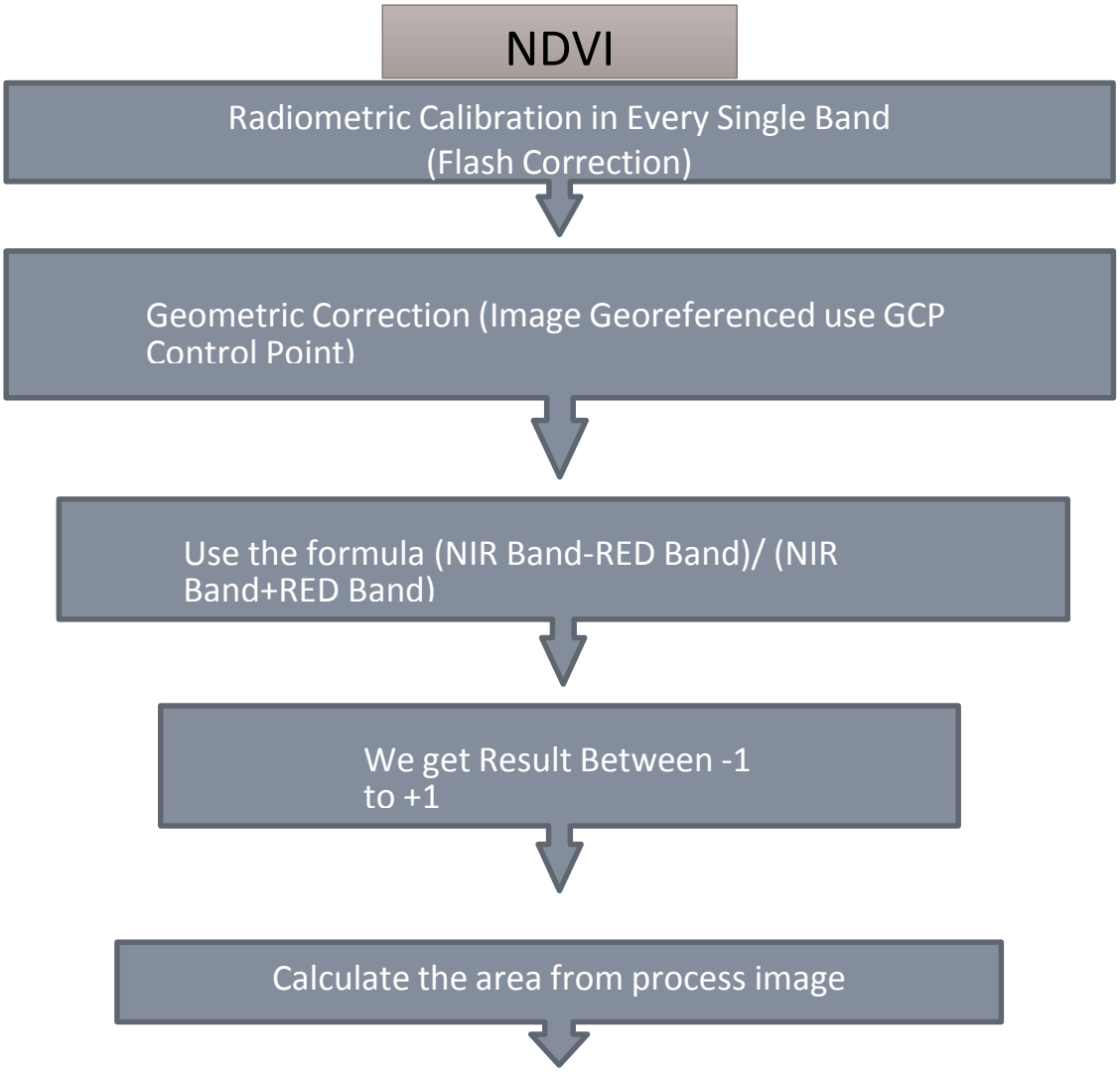
NDVI = NIR-Red/NIR+Red NDBI = NIR-SWIR/NIR+SWIR

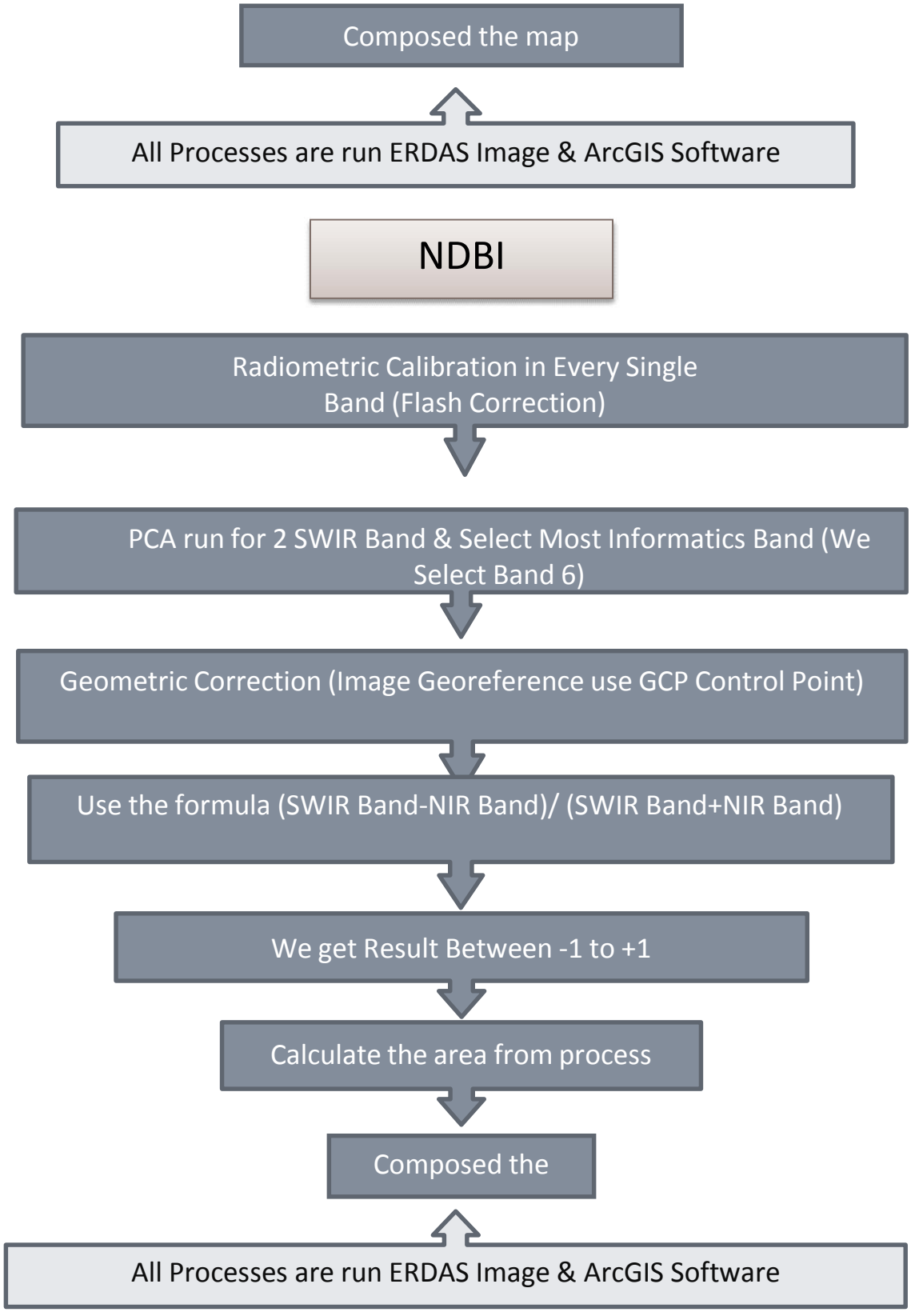
Because of maximum information found in band 5, 4, and 3 thus for the normalized differences these are used and passes through for several times in order to acquire the utmost result of interpretation and classification of satellite images for enumerate the correlation between vegetation and built up area.

Data Set

S.No.	Satellite	Acquisition Date	Sensor	Spatial Resolution	Projection	True Color Composition (TCC)	False Color Composition (GCC)	Band Name	Path	Row
1	LANDSAT 8	05-05-2020	OLI	30M	WGS-198,UTM-ZONE-43N	BAND 2,3,4,5	BAND 5,4,3,2	BLUE,GREEN,RED,NIR	1,48, 149	44
						For NDVI = BAND 4 & 5				
						For NDBI = BAND 5 & 6				

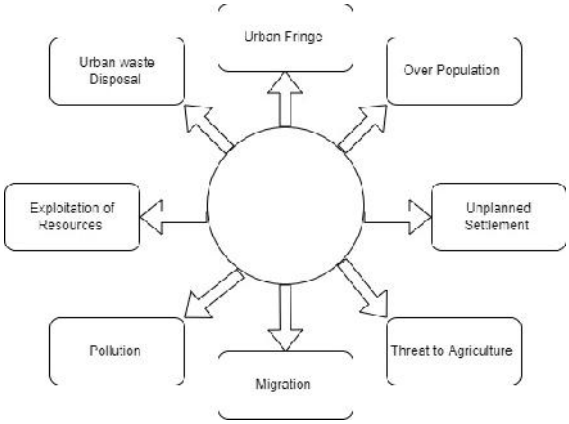
Methodology




Composed the map
All Processes are run ERDAS Image & ArcGIS Software
NDBI
Radiometric Calibration in Every Single Band (Flash Correction)
PCA run for 2 SWIR Band & Select Most Informatics Band (We Select Band 6)
Geometric Correction (Image Georeference use GCP Control Point)
Use the formula (SWIR Band-NIR Band)/ (SWIR Band+NIR Band)
We get Result Between -1 to +1
Calculate the area from process
Composed the
All Processes are run ERDAS Image & ArcGIS Software

Problems of Urban Sprawl

The growth of urban sprawl towards the outskirt area of the urban center becoming the base of their problems which are erected by the urbanism. Although the development of urban region and increasing human settlement is not contemplate as a menace or reason for causing an obstacle in the sustainable growth and evolution of the city but the density of the population in a particular region and their unplanned or uneven settlement are convicted the e environment issues and causes the loss of vegetation because of generating the infrastructural develop on the fertile land because of the leap frog growth of the population to the local government of the urban center.



Ahmedabad is a metropolitan city where the fringe are expand towards the rural areas and thus also called “Rurban” , the main reason behind the growth is the locationalisation of industries and its commercialization in outer boundary of the Ahmedabad. Although the transport and communication are important for the economic development but due to lack of proper planning the environment factor such as air, water and land are degradation in their quality because of industrialization and its output of wastes in nearby water body same as with vehicles those which are causes the air pollution because of the emission of harmful gases in the atmosphere. Due to location of industries and also the residential construction at the boundary of the urban center or the outskirt area of the city can threat to the environment because it increases the traffic on highways and use the land which is cultivable or fallow land without any planning and administration of political bodies. Due to inappropriate avail of water and land can cause the exhaustion of these resources because of the heavy contraction (anthropology) population and industries both in a particular region can also diminish the availability of fresh water and cultivable (vegetation) land in the fringe area of the urban agglomeration. According to “Elsevier’s journal “current research in environment sustainability” are define that Ahmedabad ranks third after Dhanbad and Ghaziabad in India for air pollution which are cause due to air. Industrialization and urbanization can threat to environment because they are escalate without any planning and management.

Solution of Urban Sprawl

Population of urban fringe itself became a solution of its problems, the distribution of outer boundary for the residential and industrial purpose can be manage with planning for their settlements local government can promote the smart growth of the urban fringe in which are outskirt and the rural area are included. Migration and the urbanism have the same relation with each other; the population moves towards the urban sprawl from urban and rural both the regions and increases the density thus the government should from regulations for the sustainable growth and development as the urban fringe area, there can be systematic localization of market, residence and industries rather than they established in the remote areas. Population exploitation became beneficiary if they adopt the sustainable growth and conserve the natural resources.

Ahmedabad urban fringe are develop mainly towards Gandhinagar, kheda, Mehsana, and Sabarkantha because of migration of population or movement of large number of people. For the sustainable growth and development of the city “Paryavaran Mitra” for environment conservation, “Catch Formation” for cleanliness and hygiene, “Green Catalyst” for consciousness about the environment, “Zero Waste Ahmedabad” for encourages the sustainable growth with the preservation of environment etc. and recently the dumping of toxic waste in a Gauchar Land (Ahmedabad village) are same measures to control environment degradation and for increase the sustainable growth and development of the region.

Result and Discussion

The outcome of this study which is extinct with the use of census data and satellite data, maps are created with ArcGIS for the result of land use land cover analysis which is basically based on the vegetation index and built up index. The pixel that have been intimate the urban sprawl and green belt of the urban region are based on NDVI and NDBI indices. The co-relation between vegetation and built up area are also expound through from method of delineation of urbanization in Ahmedabad urban agglomeration which have been based on census data of primary workers and non-primary worker which can be set forth to the population either engaged in primary occupation mainly in agriculture and the population occupied in secondary or tertiary occupation. The measurement of urban expansion and its belongings to the land cover expansion are describe through from buffer zone analysis which can explain the transfiguration fringe area towards the outer boundary of the region.

Urban sprawl is a demographic transfiguration of the land area where population are increases with the escalation of availability of amenities of particular area. The below image of worker are as in which first define the delineation of urban fringe with reference to population during 2001 and the second define the 2011 data which can conclude that the rural area are included in the urban fringe have increase their population above 5000 thus the municipal can manage the area for the growth and development. The variance between the 2001 and 2011 are clearly describe that 2001 have some villages where population are below 5000 population but 2011 have the maximum area of the central boundary (ward boundary) with the population are above 5000 and the consistently increases with increasing urbanization towards the fringe area of the urban agglomeration of the Ahmedabad megalopolis.

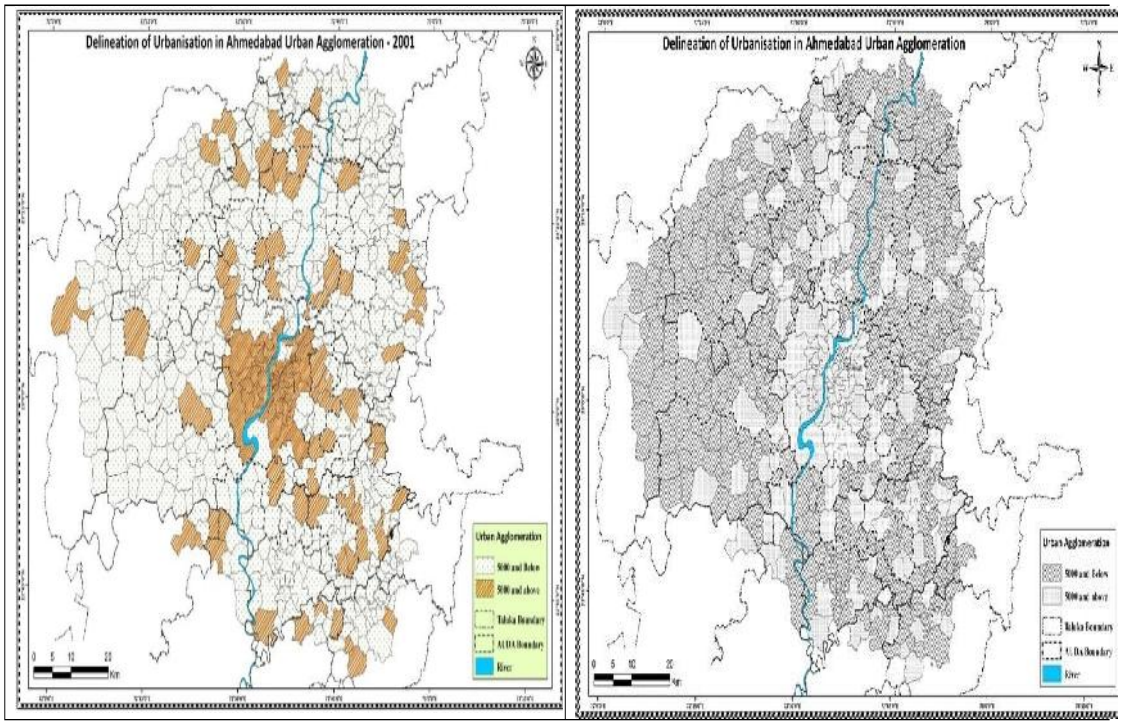


Figure 1: Delineation of Urbanization of Ahmedabad Urban Agglomeration of 2001 and 2011

Source - Census of India (2001) (2011), Directorate of Census Department, Gandhinagar, Gujarat

Built up are used to define thorough from buffer zone analysis of the fringe area of the urban agglomeration. The interpretation of built up area are variable in measurement which are going to be change with the passage of time. In the given table 1 the data are represented the built up cover of the urban area from 1995 to 2005 and such as the table 2 explain the data from 2010 to 2020 and the last table 3 define the calculation about the prediction of buffer zone expansion in the reference which is about the 2025 and are based on the past data scenario. There are 12 zones that are expanding from AMC boundary (ward boundary) to the AUDA boundary and the urban sprawl of the village boundary.

Table 1: Built Up area of Ahmedabad urban fringe zone of 1995-2005

Year	Zones (km)	Area (sq.-km)	Year	Zones (km)	Area (sq.-km)	Year	Zones (km)	Area (sq.-km)
1995	1	35.23	2000	1	37.94	2005	1	39.4
1995	2	57.82	2000	2	67.69	2005	2	79.86
1995	3	10.2	2000	3	12.72	2005	3	17.29
1995	4	5.9	2000	4	6.52	2005	4	9.89
1995	5	7.12	2000	5	9.32	2005	5	12.45
1995	6	6.12	2000	6	6.87	2005	6	7.39
1995	7	5.65	2000	7	5.95	2005	7	6.29
1995	8	4.03	2000	8	4.25	2005	8	5.61
1995	9	3.43	2000	9	4.11	2005	9	6.46
1995	10	5.09	2000	10	6.75	2005	10	8.15
1995	11	2.64	2000	11	2.87	2005	11	3.95
1995	12	0.77	2000	12	0.80	2005	12	1.45
Total		144	Total		165.79	Total		198.19

Table 2: Built Up area of Ahmedabad urban fringe zone of 2010-2020

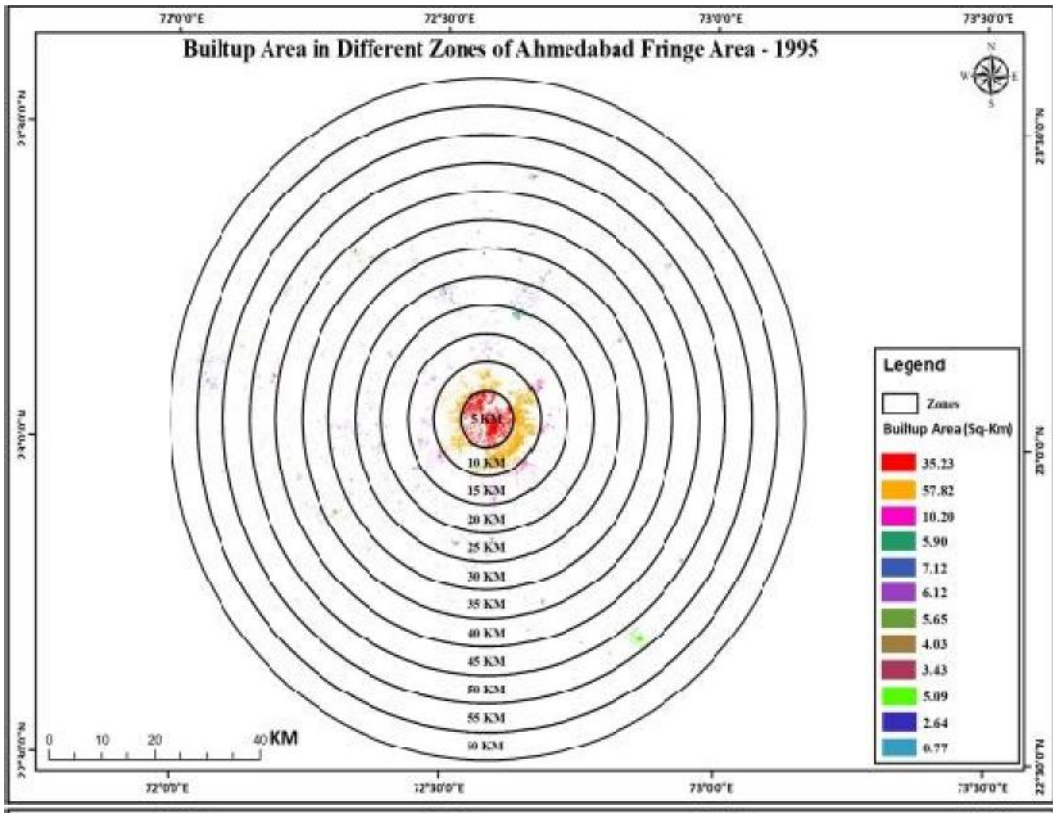
Year	Zones (km)	Area (sq.-km)	Year	Zones (km)	Area (sq.-km)	Year	Zones (km)	Area (sq.-km)
2010	1	42.24	2015	1	45.81	2020	1	46.73
2010	2	95.18	2015	2	109.95	2020	2	113.56
2010	3	22.24	2015	3	30.27	2020	3	41.36
2010	4	13.69	2015	4	18.63	2020	4	25.35
2010	5	16.94	2015	5	21.53	2020	5	27.39
2010	6	10.75	2015	6	14.88	2020	6	20.97
2010	7	8.48	2015	7	12.36	2020	7	18.68
2010	8	7.31	2015	8	15.93	2020	8	22.09
2010	9	8.48	2015	9	10.36	2020	9	13.65
2010	10	12.12	2015	10	13.67	2020	10	15.42
2010	11	5.93	2015	11	6.12	2020	11	7.23
2010	12	1.71	2015	12	2.05	2020	12	2.53
Total		245.07	Total		301.56	Total		354.96

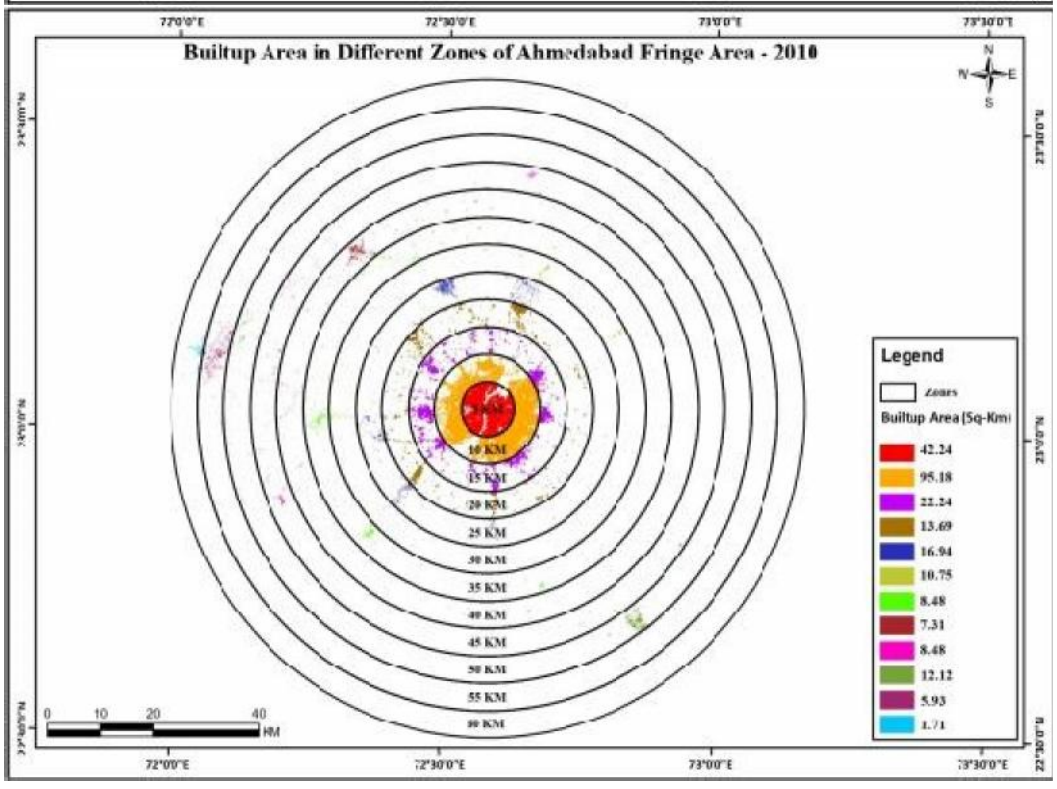
Table 3 – Prediction of Built up area of Ahmedabad urban fringe zone 2025

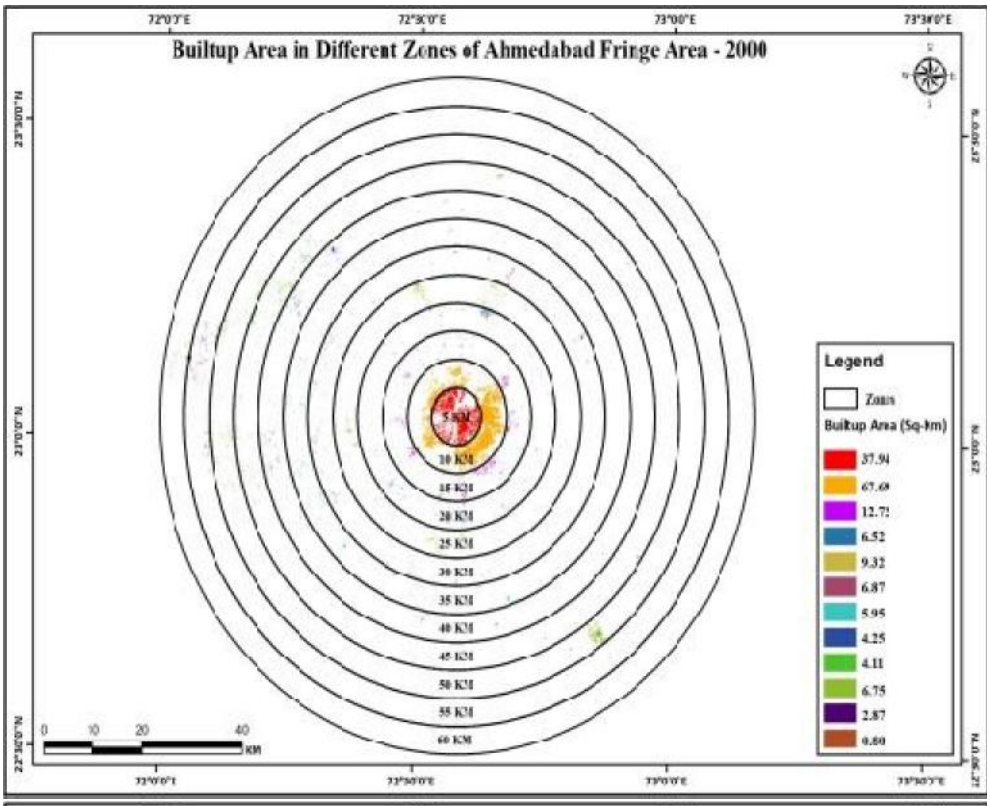
Year	Zones	Area (sq-km)
2025	1	48.73
2025	2	125.41
2025	3	51.61
2025	4	31.23
2025	5	32.87
2025	6	28.01
2025	7	25.94
2025	8	26.46
2025	9	15.75
2025	10	17.31
2025	11	8.94
2025	12	3.01
Total		**415.27**

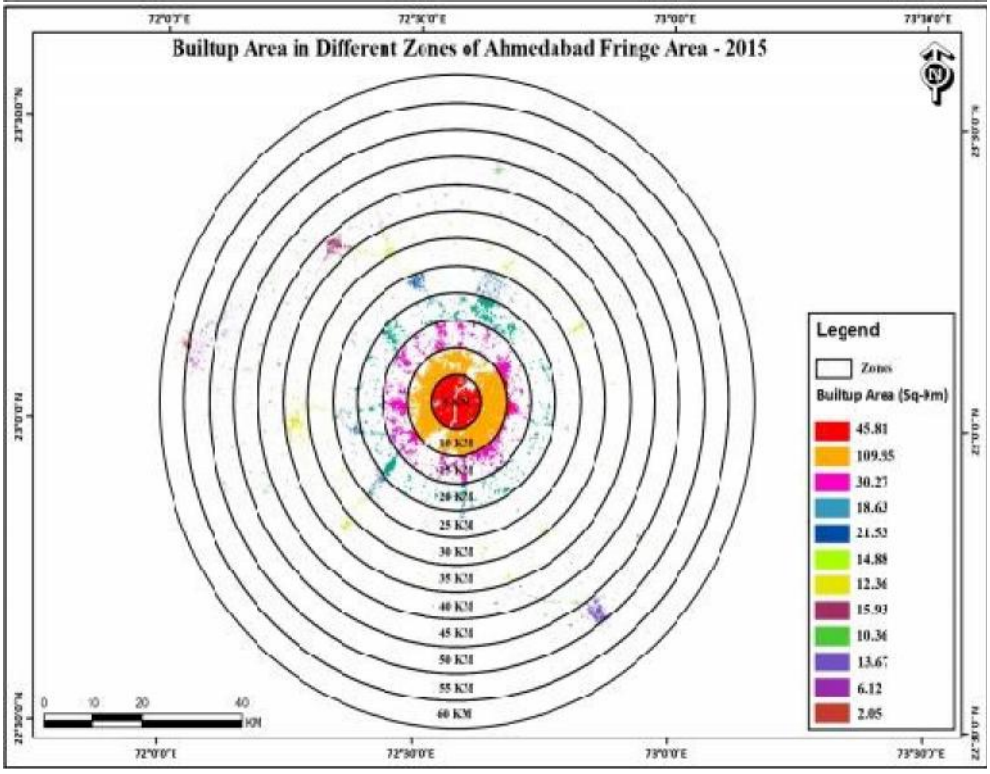
Urbanization causes the conglomerated megalopolis which is analyzed with the buffer zone interpretation about the total built up area of the urban agglomeration. The below map are explain the aggregate of built up area with the interval of 5 km between the buffer zone. The color composition of the human settlement which are dominant for the urban fringe expansion towards the village boundary of the urban agglomerated region.

The stimulation of the built up area about 2025 are explain the prediction of the human settlement expansion, the color composition of this map represents that urban patches are found beyond the village boundary of the urban region. The total study area is above 5858sq.km buffer zone are develop towards the outer boundary of the region. The analysis of the built up area also relate with the urbanization which are from 1995 to 2020 as in 1995 the total built up area are 144 sq.km which can increases by 165.79 sq.km to 198.19 sq.km from 2000 to 2005 as with the same process the built increases by 245.07 sq.km to 354.96 sq.km from 2010 to 2020 in the period of 10 years the major changes are taking place in the land use area where the built up increases with rate of urbanization.


Builtup Area in Different Zones of Ahmedabad Fringe Area - 1995
72°0'0"E
72°30'0"E
73°0'0"E
73°30'0"E
N
W
E
S
5 KM
10 KM
15 KM
20 KM
25 KM
30 KM
35 KM
40 KM
45 KM
50 KM
55 KM
60 KM
0 10 20 40 KM
Legend
Zones
Builtup Area (Sq-Km)
35.23
57.82
10.20
5.90
7.12
6.12
5.65
4.03
3.43
5.09
2.64
0.77


Builtup Area in Different Zones of Ahmedabad Fringe Area - 2010
72°0'0"E
72°30'0"E
73°0'0"E
73°30'0"E
N
W
E
S
5 KM
10 KM
15 KM
20 KM
25 KM
30 KM
35 KM
40 KM
45 KM
50 KM
55 KM
60 KM
0 10 20 40 KM
Legend
Zones
Builtup Area (Sq-Km)
42.24
95.18
22.24
13.69
16.94
10.75
8.48
7.31
8.48
12.12
5.93
1.71


Builtup Area in Different Zones of Ahmedabad Fringe Area - 2000
Legend
Zones
Builtup Area (Sq-km)
37.94
67.68
12.72
6.52
9.32
6.87
5.95
4.25
4.11
6.75
2.87
0.60
5 KM
10 KM
15 KM
20 KM
25 KM
30 KM
35 KM
40 KM
45 KM
50 KM
55 KM
60 KM
0 10 20 40
KM


Builtup Area in Different Zones of Ahmedabad Fringe Area - 2015
Legend
Zones
Builtup Area (Sq-km)
45.81
109.55
30.27
18.63
21.53
14.88
12.36
15.93
10.36
13.67
6.12
2.05
5 KM
10 KM
15 KM
20 KM
25 KM
30 KM
35 KM
40 KM
45 KM
50 KM
55 KM
60 KM
0 10 20 40
KM

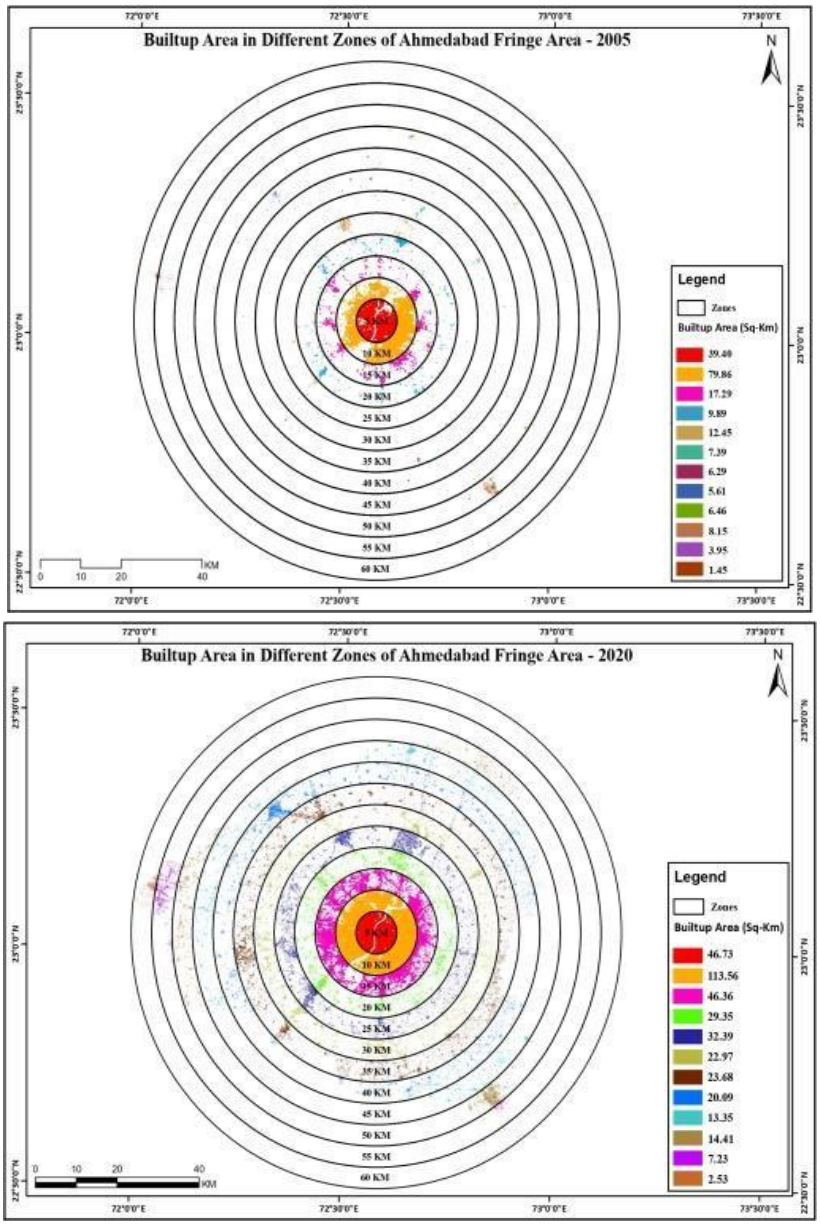


Figure 3: Built up area towards buffer zone of the Ahmedabad urban agglomeration

The urban agglomeration consist the expansion of human settlement because of leap frog increment in the total population of the outer boundary of the urban region. The buffer zone analysis of the 2020 are use top interpret the built up area of 2025 time period where the urban expansion can takes place with rapid exploration. The prediction about the built up area of the urban agglomeration can takes place through from the human settlement of the region. The measurements of the aggregated settlement area of the Ahmedabad study area of 2025 are 415.27 sq.km which are comparatively higher than the past years. The zone wise development and growth of the urban region as in the hierarchical form from 1995-2025 where the urban settlement increases in upsurge but due to management and administration are highly required for the development and government of urban expansion.

The stimulated measurement are advantageous for the administrative units in the reference of management of area, the exploration of population till 2025 defines that the upcoming time of population and urbanization with the enlargement of city size towards the outer boundary of the agglomerated city.

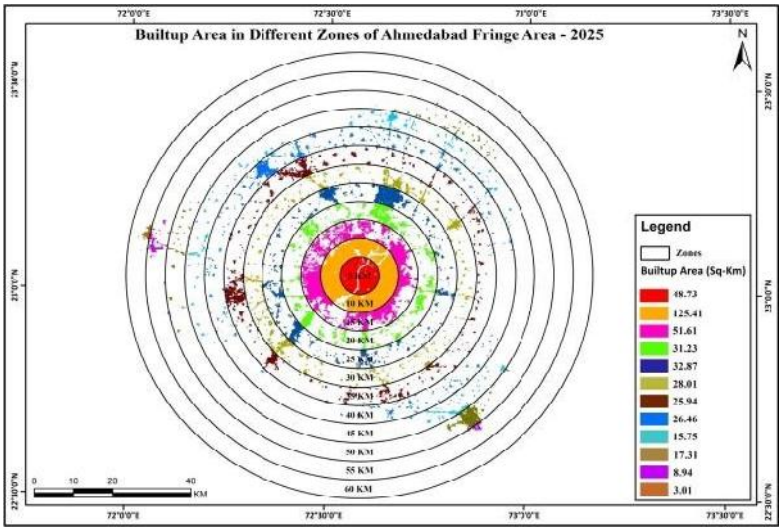


Figure 4: Built up area towards buffer zone of the Ahmedabad urban agglomeration

Relation between NDVI and NDBI

The correlation between the indices of vegetation and built up area of the urban fringe agglomeration shows the inverse relation between each other. Urbanization and industrial localization are causes the exploration/augmentation of the urban rural belt towards the rural area thus the villages which are included in the peri-urban region which incorporate both rural and urban characteristics. According to the map as given below are used to define the NDVI and NDBI scenario of Ahmedabad urban agglomeration which can also explain the association of relationship between vegetation cover and the built up area of the urban sprawl. Sub urban or peri-urban are dynamic in nature or it is variable that are varying in covered area of the urban region. The below map define the NDVI and NDBI of the year 2010 and 2020, in this there are four band combination such as 5, 4,3,2 as TCC and FCC . These are obtained from the LANDSAT 8 satellite of USGS earth explorer. When the band are passes through and then the resulted data are interpret than the output are considered as the actual area of the vegetation and built up area of the urban region, which are increases towards the outer boundary of the urban agglomerated region of Ahmedabad.

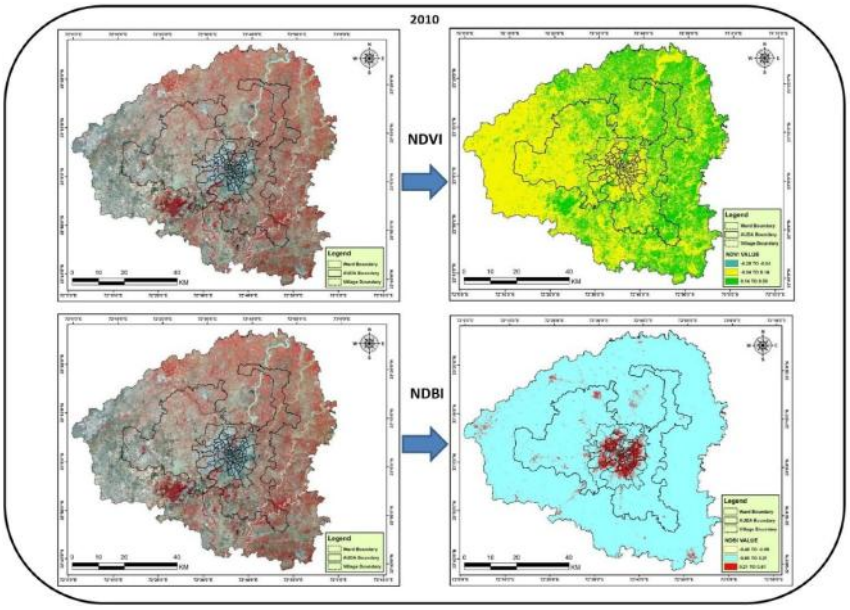


Figure 5: Normalized difference of built up and vegetation of Ahmedabad urban agglomeration, 2010

The above map showing the vegetation and built up value of Ahmedabad urban agglomeration for the year 2010 and 2020, where the true color in the right and false color in the left are defined the band combination which are resulted after analysis and interpretation of satellite data after that the value of vegetation and built up area are concluded. The color combination of red showing the densely populated areas of human settlement which are varied from 0.30 to 0.69 whereas the vegetation of this region is from 0.20 to 0.55 thus it explain that when built up increases the vegetation decreases.

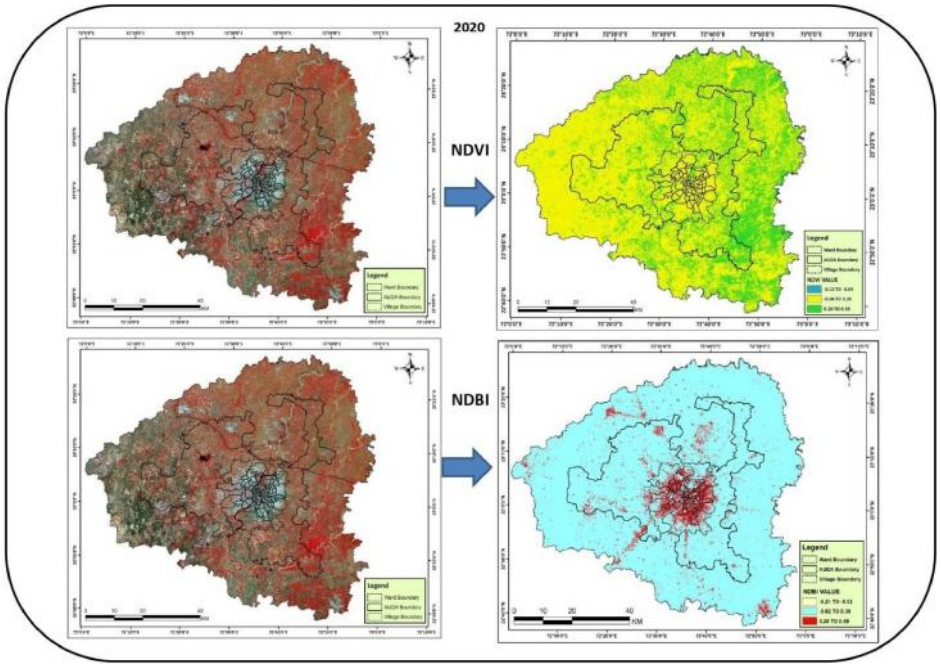


Figure 6: Normalized difference of built up and vegetation of Ahmedabad urban agglomeration, 2020

Conclusion

Urbanization and Industrial growth can deplete importance of the vegetation thus the most significant question is how to make a sustainable growth of urban and conservation of urban forest area. This study also initiates or found a remarkable depletion of vegetation in the built up area of human settlement of urban agglomeration. From the review of literature related to this study can also define that urbanization are outspread thus the green belt are getting shrink, because the pressure on land are escalate which lead to the diminishing of vegetation/agricultural land area.

This study also indicate the normalized difference between the built up and vegetation of the urban landscape, it can define that when built up increases the vegetation decreases thus there is correlation between the NDBI and NDVI of the urban region. The output of the delineation of urban fringe of Ahmedabad can interpret that from 2001 to 2011 the outer fringe and its population density can increases without any management thus this study can give the present and past calculation of the depletion of vegetation with leap frog escalation of population which are considered for the growth of urban sprawl in a sustainable manner.

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