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Alternative assessment method for air quality using NDVI analysis to achieve SDG goals for Ahmedabad City, India

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ABSTRACT

The pace of urbanization and challenges accompanied by the development process for cities needs urgent attention from various perspectives. The recent trends of city development not only show the depleting environmental conditions but also the neglected attitude to address such issues. Deteriorating environmental conditions in urbanized areas have gained attention globally as well as locally through initiatives and efforts of governing local bodies. Globally, it is addressed using the Sustainable Development Goal agendas at different scales and locally they are resolved using the specific objectives. To negotiate the impacting factors of deteriorating environmental conditions and increasing pollution level, many approaches need to be addressed locally. Out of many such concerns, this research paper tries to focus on SDG 11 and its sub-objectives to gain the basic insight of the situation through a case study approach. This research paper tries to address the concern shown by Sustainable development goal agendas and objectives set in mitigating the situations. This paper describes the Air pollution aspect and situation arising in the city of Ahmedabad and tries to look at the prevailing practice of the Development process. It also tries to focus on alternative means of assessment using NDVI analysis for giving the informed decision-making process while the development of the city.

Key words : *Ahmedabad, Air quality, Development plan, NDVI, SDG*

Introduction

"Urbanization", an evidently proven phenomenon around the globe is linked with the various damages to the immediate natural surroundings and in turn disturbance in ecosystems. "Urbanization is the growth of cities as a result of increased employment opportunities, induced because of the development in industrial sector and enhancement of economic sector, moreover that leads to urban specific changes" (Uttara *et al.*, 2012). Urbanization brings complex set of challenges to address in case of cities which are going through a phase of development. The resultant outcome of urbanization process brings many challenges but the degradation of environment is a major concern. Unruly urbanization as in context of many Indian cities with ignored holistic approach of development plan process is instrumental in bringing the immense pressure on urban ecosystems. The rate at which cities are expanding opens up area of inquiry, detailed investigation and concern to be addressed immediately. As per the Ministry of Housing and Urban Affairs, there has been an increase in percentage urban population from the year 2001 to 2011, by 3.35% (MoHUA, 2020).

Urban population induces changes in environment in terms of consumption of food, energy, wa-

ter and land. However, waste is generated in order to produce such goods consistently for a luxurious lifestyle in urban areas, which hinders the processes of ecosystem in a negative way (Torrey, 2020). Frequency in usage of private vehicles for commuting, consumption of electricity, use of chemicals fertilizers are some of the reasons that lead to environmental degradation. It also plays a role in contribution towards increased greenhouse gases. Detailed investigation and attention is required while removal of green cover, as appropriate proportion of green cover absorbs and maintains the balance of greenhouse gases. It also adds up to the never-ending damage of environment, directly impacting the health of urbanites. Apart from natural causes few other important factors directly destroying urban ecosystem include, lack of urban governance, lack of good geographic system, and more importantly disputes between administrative boundaries regarding water, air, roads, housing and industrial development (Torrey, 2020). Overcoming the imbalance invited by the mentioned factors becomes necessary to preserve and protect the already degraded environment. As climate being the common sector for each and every settlement, it is important for a united stakeholder to regulate and govern the issues related to the environment.

Globally the environmental concerns, accountability, its mitigating measures, along with the issues are addressed on common platform under the flagship of United Nations known as United National Environmental programme (UNEP). The United Nation was initially formed in order to maintain peace and security after the World War – II. In due course of time it continued to work on protection of human rights, promoting democracy, providing assistance to the needy, upholding international laws and indeed climate change (UNDP, 2020).

During the initial years of formation, UN overlooked the sector of environment or climate change, however after almost 25 years of the its formation , it rolled out provisions to preserve and enhance the human environment during the first earth summit at Stockholm, Sweden. With passage of time, the impacts of chlorofluorocarbons on the ozone layer led to its protection pledged at Vienna Convention in 1985. However, the impacts of climate change became more prominent during the era of globalization. Thus environmental concern became global priority for research and discussion. In 1992 after the Rio De Janerio conference, United Nations Framework Convention on Climate Change or UNFCCC was formed. It focused on stabilization of atmospheric concentration of "greenhouse gases" at a level that it would prevent dangerous human interference with the climate system. In 1997 Kyoto protocol is considered to be most tide turning conference aiming to reduce carbon dioxide from the industrialized countries by at least 5% below 1990 level (Jackson, 2020). Gradually, the focused discussion started taking up shape and paved the way for Sustainable development goals to save the planet.

Understanding Sustainable Development Goals

United Nations Development Programme (UNDP) is a global body involved in improvement of human life by addressing issues regarding poverty alleviation, gender discrimination, racial inequality, healthy environment, etc. UNDP extends its works in protecting planet in response to rising damages caused by global climatic variations. Currently about 170 countries and territories are part of UNDP's works.

The most promising Agenda came for promoting "Sustainable Development" in September 2015 with support of global leader and to achieve its target by 2030. In order to complete the goal, various subagendas were laid with detailed outline for achieving it. The 2030 Agenda for Sustainable Development aimed to eradicate poverty, protection of planet earth and ensuring peace and prosperity. Apart from solutions involving human rights, UNDP works to strengthen development frameworks, disaster risk reduction and climate change (UNDP). The 2030 Agenda also formulated various approaches focusing broadly to eradicate poverty, better governance for peaceful and prosperous society, improve resiliency and prevention of crisis, enhance mechanism for environment integrated development, affordable and alternative means of energy, strengthening the women power and promotion of gender equality.

UNDP being the lead body formulated and rolled out a set of 17 goals called Sustainable Development Goals (SDG). SDG were initiated in a United Nations Conference on Sustainable Development in Rio De Janerio in the year 2012. Before SDG, UNDP worked according to the targets sets under the name Millennium Development Goals (MDG). The Millennium Development Goals were introduced in the year 2000 (UNDP) which sets the tone

for better future and habitable planet. Millennium Development Goals achieved many heights in terms of eradicating extreme poverty, dropped ratio of child mortality, increase in children enrolment in schools, decrease in HIV/AIDS. Continuing the achievements for better future, SDGs were formed. SDGs are more filtered with detailed description and aim to enhance every aspect of human life.

SDGs are comprehensive set of 17 goals which pledge to "Leave No One behind". All the 17 goals are interconnected reflecting to improve the life of present as well as securing the future generations in every possible way. Broad aims of the Sustainable Development goal are to deal with threats of climate change and reduce its impact. It can be achieved by respecting the natural resources by managing them, helping economies to prosper, and overall spreading peace and increasing equality. One more promotion can be traced in the year 2015 as it pleased an historic agreement which was signed during a Conference of Parties (COP21) known as Paris Climate Conference. The agreement was regarding the inclusion of framework for disaster risk reduction and reduction in CO2 emissions. The framework was known as Sendai Framework, signed in Japan (UNDP).

17 SDGs are the reflection to achieve a better future in times where size of human population is increasing at accelerating pace. Increase in usage of natural resources and subsequently damaging the environment and other components necessary for future generation has raised greater concern. The paper tries to look at Goal 11 addressing Sustainable cities and communities out of the 17 SDGs.

Insight of Goal 11: Sustainable Cities and Communities

The rapid influx of population towards more opportunistic places in search of better living and personal aspirations brings them to cities. Thus, cities became hotspots of choices for many such aspirants. More than half of the world population resides in cities. By the year 2050, around 6.5 billion of population will be residing in cities as estimated by UN statistical calculation. To manage such higher influx and rapid rise of population, SDG 11 is aiming to build sustainable cities, by creating career and business opportunities, safe and affordable housing, and building resilient societies and economies (UNDP).

SDG formulated broad objectives providing the path way of development Goal 11 focusing on issues faced by cities facing rapid urbanization. As per goal 11 one of the focus is to develop a planned growth by covering sustainability factor for a better city. Objectives of Goal 11 cover specific parameters to make cities more resilient and sustainable. These include, providing sustainable public transport, providing basic services, economic prosperity, disaster risk reduction, Conservation of cultural and natural heritage, reduction of environmental impact, etc.

On one hand, SDG is trying to bridge the gap but on the other hand, the issues are rising like mushrooms. As per UN reports, 90% of the estimated urban growth will occur in Asia and Africa in next 30 years. This kind of situation if not assessed and handled in appropriate manner will result into unforeseen disastrous future in urban context. It will show higher level of pollution and reduced standard of living along with degraded urban environment. According to United Nations, cities account for 60% to 80% of energy consumption and about 70% of human induced greenhouse gas emission. In addition, the world occupies about 3% of earth's surface but uses 60% to 80% of energy consumption. It is also responsible for 75% of carbon emission (United Nations). As estimated about 70% of population will be urban by 2050. It poses a huge threat on the environment with increasing percentage of carbon emission all over the globe (United Nations). These are alarming figures and enough proofs reflecting the adverse impact of unsustainable development.

The paper here considers the sub-objective of SDG 11 for further investigation. It states "reduction of adverse per capita environmental impact on cities, including by paying special attention to air quality and municipal and other waste management." (UNDP). The purpose to undertake the above objective from SDG 11 for study is due to the rising levels of pollution in cities.

Scenario of Air Pollution in Indian Cities

Pollution basically is the addition of any unwanted substance in the environment, that the environment could not decompose or recycle (Britannica). These unwanted things are summing up to an extent that the process of renewal has become unmanageable. It is the most appropriate time to ponder upon such unwanted substances from our environment and act towards its eradication. The unwanted substances or pollutant added in the environment beyond the

capacity of decomposition has become a greater concern. Pollution are of many kinds ranging from air, water, soil to noise and land pollution. The immediate atmosphere is affected majorly due to air pollution. According to World Health Organization (WHO), approximately 80% of the urban areas covered under the air quality inspection by WHO shows air quality exceeding the thresholds of WHO guideline (World Health Organization). Further the quality of air in developing world is of major concern. In the South East Asia region, over 2 million deaths occurred due to rising air pollution (World Health Organization). Major pollutants of air are released from vehicle emission, industrial smoke, deforestation, household and farming chemicals, waste, etc. (Collin).

Focusing on Indian context, about 21 cities from 30 are listed having worst air quality. Also adding to the fact that 6 out of 10 world cities with worst quality of air are located in India. Cities like Ghaziabad, Delhi, Noida, Gurugram, Greater Noida are among the worst air quality as per World Air quality report 2019. In addition to that, India ranks 5th in the list of most polluted country (World Air Quality). The average air quality falls in the 'unhealthy' range. The air quality overpassed the limit set by WHO during 2019 for PM2.5 concentration (World Air Quality). These need growing concern and awareness towards improvement of Air quality in fastest growing cities having high air pollution levels.

Integrating SDGs specific to cities and air pollution related targets, Goal 11 has the direct effect on the urban ecosystem. According to 2019 report on SDG index, India shows above average performance in achieving the targets set under SDG 11 (NITI Ayog). Target 11.6 talks about the urban waste collection and its treatment, neglecting other pollutants like vehicle emission, industrial smoke, dust etc. The target achievements and the results of integrating it is yet not clear. Adding to the aspect of air pollution, there is a particular mention regarding Indian cities and their quality of air. The report states it as a challenge for every city which further requires attention (NITI Ayog). These concern needs to be addressed by reinforcing the improved quality of vegetation cover and imposition of green concepts. In order to assess the relationship of green cover with level of air pollution, it requires the data available in the form of green cover in the context of urban area. In order to check the vegetation cover viz-a-viz air pollution level, the city of Ahmedabad is chosen for further investigation.

Selection of Case study area

Ahmedabad City is located in the western part of India in the state of Gujarat. The case study of Ahmedabad is chosen as it is the third most polluted city in India after Dhanbad and Ghaziabad in the category of pollution created by the dust and pollen. Also, despite Ahmedabad being an industry driven economy, a major part of the population is engaged in non-agricultural activities which gets affected by the high levels of pollution. Also, with the city having a population more than 5 million, it is a major hub for the GHG (Green House gas) Emissions. Around 0.8 million people commute only through the public transport and around 1.9 million uses private vehicles for commuting in the city. Hence, these create extreme traffic congestion leading to the increasing air pollution level. So, detail investigation is required to assess the air quality and density of green cover in the existing city jurisdiction.

Overview of Ahmedabad Air Quality

Ahmedabad City is the largest city of Gujarat state. The city has a Bus Rapid Transit System, along with Metro rail under construction. The city is the hotspot of opportunity and a driving economy of the state. Ahmedabad city predominantly is a manufacturing economy, with industrial, pharmaceutical and construction as its base. Apart from manufacturing, trade and commercial engagements major part of the city practices agricultural activities in the peri-urban area of Ahmedabad.

According to World Air Quality Ahmedabad City's average air quality for year 2018 was 76 ug/m^3 but in the year 2019 the average air quality reduced to 59 ug/m$^{3.}$ These are the figures recorded by World Air Quality from various setup station located in the city. Even though it shows the declining trend in average air quality, it falls in the range of unhealthy environment (World Air Quality). The monitoring and recoding station at national level also shows the unpleasant picture of average air quality. According to National Air Quality Index, AQI was about 126 for the year 2019 stating a satisfactory air quality for the city (National Air Quality Index).

Ahmedabad city with its regional connectivity is the prioritized preference for the citizens of the state

to reside and dwell. Over the past few years the cities air quality has taken a shocking deep. The major source of contaminants being Industrial emitters, dust emission from road re-suspension and construction activities, and transport emission, open waste burning, brick kiln (Urban Emissions). The statistical analysis and reports on pollution shows increased air pollution. Such increase in air pollution affects the urban environment affecting the lives of the citizens. Apart from human health increased air pollution requires a sponge for soaking all the bad particles and converts it into good quality air. Unfortunately, the conversion of land use for the purpose of development has affected the urban air quality of Ahmedabad. Land Use Land Cover (LULC) shows the rapid conversion of vegetation into built up and vacant land from 1991 to 2019. Vegetation and green cover are an important part of the urban fabric effecting the overall air quality. The presence of vegetation cover definitely improves the quality of air which directly affects the lives of urban citizens. Over a period of time the city has witnessed a constant degradation of vegetation cover for implementation of projects for boosting the economic gain.

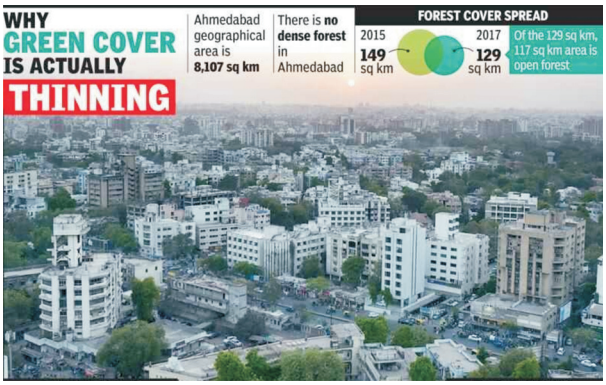

Fig. 1. District data for green of Ahmedabad District (The Times of India)

Establishing a connection between air pollution of Ahmedabad city and the SDG 11 sub target 11.6 stating the reduction of adverse per capita environmental impact on air pollution is of greater necessity. Out of all the types of air pollution present like carbon monoxide, nitrogen oxides, particulate matter, sulphur oxides, and volatile organic compounds in case of Ahmedabad, the particulate matter (PM) is a major concern. Data suggest the major contributor to PM10 for Ahmedabad is road dust, power plant, vehicle exhaust, and industries (Ahmedbad Municipal Corporation). Transportation including the re-suspension of dust and vehicle exhaust account for higher percentage contributor to pollution of air. Due to such pollutants the average temperature of city rises and effects the overall functioning and quality of life in a city. The urban heat island effect is also evident bringing the challenges at many levels for city of Ahmedabad.

Controlling air pollution level for Ahmedabad city covers wide range of sectors like managing and mitigating the source of pollution. Sectors are basically derived from the parent source of pollution. In the vehicle sector, as described above are the major pollutants of air. The steps taken to control or reduce air pollution is through elimination older vehicles, use of Compressed Natural Gas (CNG), mandatory for vehicles to get PUC certificates, synchronizing traffic movements, regular cleaning of dust, and most importantly provision of green buffer along the transit corridors (GUJARAT POLLUTION CONTROL BOARD). Further the action plans recommendation shows the need of developing green belts, gardens, parks.

During the recent pandemic COVID-19, a nationwide lockdown showed improved quality of air in many cities. But in the case of Ahmedabad the air quality remained moderate 107 AQI. Suggesting that only controlling the air quality will not help the city. The city apart from renewable energy needs CO2 convertors i.e. trees or vegetation cover. Driving an E vehicle along with improvement in vegetation cover will contribute in improving the quality of air. The image gives us the idea regarding the reason of bad quality air in Ahmedabad city. It can be evidently integrated with the LULC map. This is one of the indicators which is required to be incorporated to filter down the factors affecting the sustainability of the city.

According to Urban Greening Guidelines report, urban green spaces are an integral part of sustainable, healthy and energy efficient development (Town and Country Planning Organisation). Apart from these broad benefits, vegetation cover in a city helps the city to absorb and filter the surplus CO2. Integrating SDG 11 target 11.6 with the sources and quality of air in Ahmedabad filters down the process approached in achieving the goal.

Possible Mitigation strategy

The vegetation cover has always been a lifeline for

survival and sustenance of biotic life. It is not just an important aspect of survival but it also adds for regulating and maintaining the air quality. Research reports have addressed the relationship of vegetation cover and air pollution level in different patches of city using the air quality monitoring devices. Different types and scale of vegetation cover has direct impact on overall status of environment and improvement in air quality. All types of vegetation space, from single green walls to large urban forests, have been associated with relief from heat stress, reduced urban heat islands and air pollution reductions (Tara Zupancic).The city scale air pollution mitigation is not possible through small scale enhancement and interventions of vegetation cover. Rather, the correct strategies adopted would definitely give better results. The approaches adopted with strict regulatory approach to mitigate pollution would definitely result in improvement of air quality. An alternate way to avoid the air pollution is by increasing the density of vegetation cover with appropriate category of species selection. It is only possible by aligning the vegetation cover with development process in urbanizing cities.

Urgent Need for Green Cover

The city of Ahmedabad is urbanizing at a rapid pace, inducing a change in spatial characteristics. The 2011 population in the limits Ahmedabad Urban Development Authority (AUDA) is about 6.5 million. This 6.5 million population is spread over an area of 1866 sq. km (AUDA). In 2001, the population about 4.7 million and the year 1991 the population under AUDA jurisdiction was approximately 3.7 million (Mahadevia, Desai and Vyas). As the population increase the demand to accommodate them exerts pressure on the spatial character of the city. It is estimated that by 2035 the population of AUDA jurisdiction will increase to 10.9 million according to a report published by Gujarat Infrastructure Development Board (GIDB). A report published by GIDB predicts the area of AUDA to increase by 500 sq. Km. by 2035 (GIDB).

Rising population also exerts pressure on surrounding environment. To accommodate such rise in population the surrounding agriculture land available is converted for urban use. These impacts the natural ecosystem and as a resulting consequence the degraded environmental condition is evident in overall urban ecology of the city. As per the Urban Green Guideline, population growth and high densities impact the natural and environmental resources. Urban green cover in form of vegetation cover ensures the balance and is an essential link to biodiversity chain (Town and Country Planning Organisation).

Hence, increase in population and changes in land-use are a major driver of environmental degradation. The gap between ensuring basic needs to all and protection of urban environment in most crucial in present situation. Insufficient vegetation cover impacts the quality of living and sustainability of the city. The only way is to take the accountability of available vegetation cover on regular basis for taking informed decision for landuse planning of new developments in cities. Thus monitoring and mapping the vegetation cover will give the necessary direction towards correct land use planning.

Mapping Perspective- case study area

Mapping the desired geographical area using the geospatial analysis will generate the scope for taking the decision of selected areas. This research work tries to extract the data related to Ahmedabad city for the administrative boundary delineated by urban development authority for preparation of Development plan 2021. The city of Ahmedabad has gone through various phases of development over a period of time and has legacy of living heritage city as its core. The city has seen the leapfrog development during the industrialisation era and as a commercial capital of state, it has seen many transformations in physical land-use planning. This development process for land use planning in case of Ahmedabad city has resulted into advantages as well as disadvantages. This research paper will briefly discuss the impact of land-use planning using temporal scale for change in land use.

Development Plan of Ahmedabad

The city of Ahmedabad has long history of its establishment in the year 1411 on the bank of Sabarmati River. It has grown manifold over a period of time and has emerged as one of the fastest growing city in India. The administrative responsibility for city of Ahmedabad is taken care of by Ahmedabad Municipal Corporation (AMC) and Ahmedabad urban Development Authority (AUDA). At the moment, Development of Ahmedabad is designed and regulated by AUDA, whereas operation and maintained by Ahmedabad Municipal Corporation.

Development plans of Ahmedabad city kept on

updating to fulfil the need for physical growth of city. The development plan of 1987, had provisions addressing environment of the city by conceptualizing the green belt around city. The city at that time had 2098 acres of green belt around the settlement limits. This green belt was gradually converted into vacant land and partly converted for new proposed 132 feet ring road for physical development. During the 2011 development the green belt reminisce was reduced to about 875 acres. The neglected attitude for promotion of green belt is evident in case of Ahmedabad.

Vegetation cover in the city of Ahmedabad kept fluctuating with pace of development. The major impact resulted into environmental issues like air pollution, water pollution and noise pollution. The vision of 2021 development plan proposal showcases a vision to make Ahmedabad city liveable, environmentally sustainable and efficient city of every citizen. It also tries to incorporate city with vibrant economy and robust physical and social infrastructure.

Prior to the vision document and other research reports published regarding the deteriorating environmental condition the green initiatives was not evident. Still, the city lacks in green cover and inadequate open space to balance against the rising pollution. Even, citizens are becoming more aware about changing atmospheric conditions. Hence, development plan of Ahmedabad must consider environmental concerns before it gets too late to breathe fresh air.

Provision of green belt around the settlement limits along with compact development is the need of the hour. Introduction of innovative and intrinsic ideas of development is a way forward to achieve sustainability.

Considering the methods to reduce air pollution as per the Sustainable Development Goal 11, Ahmedabad City has infrastructure developed for door to door waste collection, is monitored under Swatch Bharat Mission (SBM). Apart from waste collection Ahmedabad City has an action plan formulated to tackle the rising problems of air pollution, monitored by Gujarat Pollution Control Board. Suggestive measures are also formulated for improvement of green vegetation cover by promoting the concept of urban forest. These efforts will surely result into better air quality in future but the present status is an alarming situation for healthy living. So, polluted city will have to wait for the results in coming years with successful mission of promoting better green initiatives and its implementation.

This paper tries to assess the status of Green cover over a temporal scale and tries to compare the corresponding Air quality index for finding the inferences for case of Ahmedabad city.

Method

The overall research framework follows an inductive research method to understand the phenomenon of development process in temporal and spatial paradigms and its impact on environmental condition assessment. The Normalised difference Vegetation Index commonly known as NDVI is used to analyse the level and quality of vegetation index of a place. The remote sensing data required for the preparation of the NDVI maps is acquired from USGS site having Landsat images of years selected for case-study purpose (1991-2019). Following table summarizes the data used for analysis of NDVI.

Year	Landsat Data	Date of Path 148	Date of Path 149
1991	Landsat -5 (TM)	23-Jan-91	30-Jan-91
1996	Landsat -5 (TM)	21-Jan-96	28-Jan-96
2001	Landsat 7 (ETM+)	10-Jan-01	02 Jan-01
2006	Landsat 7 (ETM+)	Landsat 7 Data for 2006 have stripping error and there is no data available of landsat 4-5 TM in required time period, therefore data of three dates from Jan to feb are used each for both the Path, so total 6 tiles are used to create data for 2006 by mosaicing all datasets	
2011	Landsat -5 (TM)	30-Jan-11	21-Jan-11
2016	Landsat 8 OLI and TIRS	28-Jan-16	19-Jan-16
2019	Landsat 8 OLI and TIRS	20-Jan-19	27-Jan-19

Fig. 2. Data Used for Analysis of NDVI

NDVI Analysis of Case study

Few methods such as NDVI, NDBI provides with specific index related to vegetation. Index values between -1and +1 describes classes such as water, barren rock (including sand, or snow), shrubs and grasslands, dense vegetation or tropical rainforest. (Here the range from -1 to -0.1 is water, -0.1 to 0.2 is for Barren Rock, sand and snow, 0.2 to 0.5 shows shrubs and grass lands, and 0.5 to 1 depicts dense vegetation and tropical rainforest.) The index for Ahmedabad city ranges from -1 to +1.

NDVI for Ahmedabad city reflects on the biased development approach. Dense vegetation cover on the periphery of the city is being decreasing from the year 1991 to 2001. But, Positively due to better

implementation of 2011 development plan the vegetation of the city increases in the year 2011. LULC data supports the arguments observed form the NDVI index. The LULC change Graphs shows, initial decrease in vegetation cover from the year 1991, and subsequent increase in the built-up area. From the maps it can be seen and observed the conversion of land. Integrating the results of change in population and response of development.

As can be observed in the graphs, the vegetation cover of Ahmedabad city is converted to built up, suggesting the ignorance shown by the developers in protecting the vegetation cover. Further such conversion of land-use affects the urban ecology of the city. As per the vision of development plan the developers on paper believe to improve the environmental condition of the city, but fall short to implement the vision.

Due to rapid urbanization and industrialization the area of vegetation cover has decreased. Hence, affecting the life of people and increasing the pollution levels in the city. Air Pollution in Ahmedabad is increasing with majority of people using private vehicles, re-suspension of roads, industrial waste release, burning of municipal waste. As mentioned earlier such actions affect the quality of air, as well as causes heat island effect resulting in temperature level rise.

Analysing air quality index of Ahmedabad city enables us to understand the effects of the reduced vegetation cover in urban areas. Average air quality of Ahmedabad for the year 2014 was about 163, for

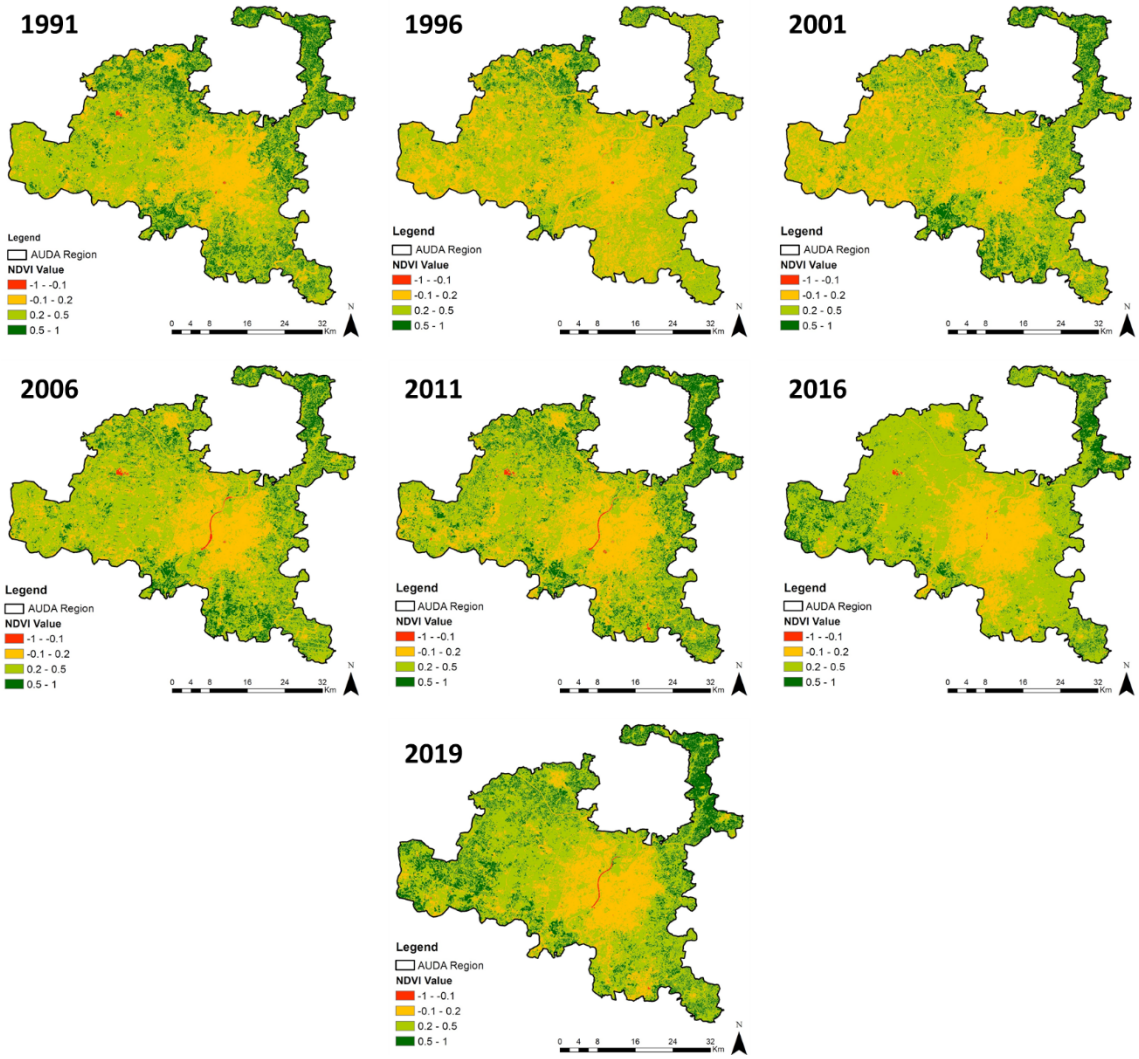

Fig. 3. NDVI Analysis from 1991-2019

2015 the air quality was 150. During the year 2016 the average AQI for city increased to 177. AQI increased further to 180 in 2017. In 2018, average AQI fortunately reduced to 173. In 2019 the index continued to reduce. It came down to 136. In 2020 till the month of August the AQI average further reduced drastically to 105 (Air Quality Historical Data Platform, 2020). So, the improving trend of Air quality index is showing positive trends but are way behind to be mitigated. For good AQI index, the range should be between 0-50 but for the average AQI index level has to range from 50-100 and as per the standards. Thus for reaching satisfactory level of AQI, improvement on vegetation cover is best alternate. The need of an hour is to strongly promote the qualitative green vegetation drive for mitigating such concern.

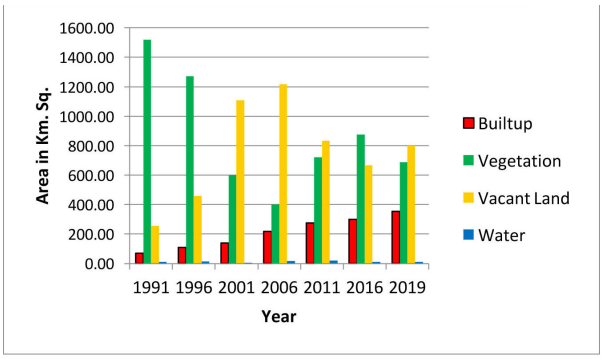

Fig. 4. LULC Change Graph

Results

The above data shows promising results for the efforts of authorities who is trying to improve air quality. But as per the scale of National Air Quality index, the city of Ahmedabad falls under the range of 'Moderate' standard of air. This unhealthy air quality badly affects citizens having lung, heart diseases. It Includes minors and elderly citizens and arises the question reading the promotion of healthy air quality. Such standards for any urban area are an alarming situation to take extreme efforts towards improving the conditions of air quality.

Conclusion

Overall, the data and maps suggest a strong change is taking place in most of the urban areas, where Ahmedabad city is no less in harming the ecosystem. This can be observed specifically from the maps of NDVI, it evidently resonates the changes that human intervention has forced upon environment. Continuing the urbanization factor, the master plan of the city does not adapt for the needs of the preserving the natural ecosystem. Rather it gives human activities an advantage which has a major impact on environment as well as it is continuously threatening the present and future quality of life of the citizens.

More importantly, decrease green vegetation cover in the city, have pressurised the natural system to absorb CO_2 and release oxygen, which resulted in increased concentration of air pollutants. Adding to the existing problem of deforestation the development plan did not possibly took promising steps to conserve and protect the ecosystem of Ahmedabad. Lastly, it boils down to the management and efficiency of local municipality or urban local body, to answer in terms of managing priorities according to the bigger challenges rather than just making small changes to the immediate demands of increased population that impact the well-being of urban ecosystem.

Concluding the argument, conservation of natural green covers and even increasing the amount of it, is really the need of the hour particularly for the city, before it gets too late to overturn the results caused due mismanaging urban population. Secondly, stricter and more encouraging laws must be amended in order to reduce privatisation of vehicles, adding to its air pollution from solid waste must be managed. Where non-biodegradable waste must be completely stopped from burning and also production of such waste should be reduced.

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