The Effect of Urban Green Spaces on Air Pollution Reduction: A Case of Ahmedabad

Shweta*† Rajvi Shirshita Avni Agrawal Ritu Utpal Gajjar

1 Introduction

The increased opportunities have drawn a huge amount of people to urban areas because of the employment possibilities in cities. Due to this, the number of people living in urban areas will increase 39% by 2036 (Climate Change and Environment Action Plan of Ahmedabad District). Due to this, the cities will have to grow towards the peri-urban areas to accommodate the increase in population from rural areas to urban areas leading to the number of people living in urban areas increasing by 40% in over a century (1913-2013) of each site was extracted from all the stations. This data was then compared to determine the AQI change in the area throughout the years.

According to the National Environment Policy, 2006; National Action Plan on Climate Change (NAPCC); AMRUT; National Mission for Green India; National Environment Policy, 2006; National Environment Policy, 57.13 km² of Ahmedabad have been selected for our study. Ahmedabad is one of the fastest developing cities of India. But its prosperity has come at the expense of its environment that is more than the city's built environment. Due to this, the city's built environment is more than the city's built environment. The city's built environment is more than the city's built environment. The city's built environment is more than the city's built environment.

In Ahmedabad city struggles with one of the highest ambient air pollution levels in India. To reduce the effect on land productivity, urban green spaces can be considered one of the best options. The Indian government has laid emphasis on multiple mechanisms dedicated for green infrastructure development that is people-centric. Incorporating green spaces into the urban development process and the necessity for urban planning and implementation guidelines (URDPFI) have been undertaken by government including Heat Action Plan and Urban & Regional Development Plan Formulation and Implementation Guidelines (URDPFI).

To understand the role of urban forests in the functioning of ecosystems, Urban Green Spaces (UGS) have been differentiated by the number of people living in urban areas; creating a green oxygen blanket has shrunken and the concretization has lead to dust envelopes. To counter this damage, various initiatives have been undertaken by government including High Density Plantation (HD) and Mission Million Trees, Heat Action Plan and Heat Action Plan. But its prosperity has come at the expense of its environment that is more than the city's built environment. The city's built environment is more than the city's built environment. The city's built environment is more than the city's built environment. The city's built environment is more than the city's built environment.

The main objective of the study is to understand how air pollution has changed in Ahmedabad city by air pollution monitoring stations and the physical variables of the sites. The physical variables of UGS were differentiated by the type of vegetation and the species in each site played an important role in pollutant reduction. A case of Ahmedabad city was considered in this study. Ahmedabad city has population of 5,436,508 inhabitants, and 57.13 km². The Effect of Urban Green Spaces on Air Pollution Reduction: A Case of Ahmedabad

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2 Air Pollution

2.1 Types of air pollutants and their sources

a) Particulate matter

b) Nitrogen Dioxide

c) Sulphur Dioxide

2.2 Impact of air pollution on human health

3 Urban green spaces (Green Infrastructure)

2.3 International Response and initiatives
3.1 Ecosystem Services

Table 1: Environmental Benefits

<table>
<thead>
<tr>
<th>Environmental Benefits</th>
<th>Economic and Aesthetic Benefits</th>
<th>Social and Psychological benefits</th>
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3.2 Need for Green Cover as a Response to Air Pollution

4 Study Area

5 Methodology
The monitoring stations selected are located at highest 4km from the urban forests. Hence, the air quality data of these sites collected were compared between three years 2013, 2019 and 2023. Through this, the change in air quality can be analysed after the introduction of urban forests in 2019. Additionally, Normalized Difference Vegetation Index (NDVI) data was compared between the above three years to understand their correlation and the impact of urban forests in the area.

Table 2. Selected urban forests

<table>
<thead>
<tr>
<th>Zone</th>
<th>Address</th>
<th>Area</th>
<th>Year of development</th>
</tr>
</thead>
<tbody>
<tr>
<td>East</td>
<td>111, F.P. 156, besides Naxatra Bungalows</td>
<td>4700</td>
<td>2019-20</td>
</tr>
<tr>
<td>North</td>
<td>Oxygen Park, Besides South International School plot, Naroda</td>
<td>6170</td>
<td>2019-20</td>
</tr>
<tr>
<td>North west</td>
<td>Oxygen Park, T.P. 41 Gota, F.P. 161 Nr. Ugati Lake, Science City Road</td>
<td>10828</td>
<td>2019-20</td>
</tr>
</tbody>
</table>

From urban forests, quantity of tree cover and tree species were identified to understand the air purifying power of a particular urban forest. This paper is able to cover only the aspect of vegetation for analysing pollution mitigation.

Figure 1: Selected urban forests from different zones of Ahmedabad

6.1 Sources of Air Pollution in the city

The amount of domestic fuel consumed by local residents affects the city's overall emissions (Source: Apportionment Study of Ahmedabad city). The consumption of liquefied petroleum gas (LPG), piped natural gas (PNG), Wood, Kerosene, and Coal in slum and non-slum areas has been highlighted as the source of emission for the domestic sector. In terms of CO and PM emissions, respectively, it has been found that emissions from coal and wood are fairly substantial. The city's construction & demolition industry is expanding. The city's estimated emission load, which includes emissions from both the construction of new buildings and additions and modifications, is 8.9 tonnes per day (26). Additionally, the city's estimated road emission load is relatively high, and it appears to be a significant contributor to the city's overall emissions. Estimates place the city's daily road dust emission load at 19 tonnes, including emissions from both major and small roads (Source: Apportionment Study of Ahmedabad city).

Figure 2: Sources of Air Pollutants (Source: Appointment Study of Ahmedabad City)
7 Data Collection

7.1 Monitoring Stations

Out of these monitoring stations, 4 were selected from the four zones of Ahmedabad. For the analysis, secondary data on the GPCB Monitoring Programme (SAQM), these results are posted. Additionally, the GPCB with ambient air and meteorological data for compilation provides the Central Pollution Control Board (CPCB) with ambient air pollution levels. For all the stations in Ahmedabad under the National Air Quality Monitoring Programme (SAQM), these results are posted.

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In Ahmedabad, there are more than 20 monitoring stations that include crematoria (Source: Air Quality Monitoring Stations surrounding the selected urban forests). If open areas are not included and just green spaces are taken into account, this figure drops dramatically to 7.2 m² per person, respectively. Ahmedabad has much less green and open space per person than the WHO and URDPFI guidelines, which are considered to be point source. For PM, SO₂, NO₂, and CO, the concentrations measured from 2016 were used to determine annual averages for air pollution levels. For all the stations in Ahmedabad, these results are posted.

7.2 Urban Forests

In cooperation with the AMC, Power, and numerous more by the Gujarat Pollution Control Board (GPCB). In the city region, vehicular emissions are a substantial cause of air pollution. Even while individual vehicle emissions are often low, their massive population, which increases the number of automobiles on the motorway and subsequently increases emissions. Second, vehicle emissions from industries and crematoriums are therefore important contributors of carbon monoxide (CO), nitrogen oxides (NOₓ), and other pollutants. The city has a sizable population, which increases the number of automobiles on the motorway and subsequently increases emissions. Second, vehicle emissions from industries and crematoriums are therefore important contributors of carbon monoxide (CO), nitrogen oxides (NOₓ), and other pollutants.

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While AUDA is spending Rs 10 crore, 25,000 trees will be planted beside a 75 km stretch of the SP Ring Road and service roads, and 75,000 trees are being planted by Ahmedabad's two municipal agencies. AMC is planting 21 lakh trees for ₹ 20 crores. The city should have 14% of the city's geographic area that act as green and open areas, according to norms for global cities. Additionally, there are only 2.5% of the city's geographic area that act as green and open areas. The research indicates that the per capita green space of Ahmedabad does poorly when compared to other Indian cities and is significantly below the WHO and URDPFI guidelines, which are taken into account. Overall, road dust is reported to be the city's main contributor, followed by domestic, industrial, and building & demolition activities too.

To improve the scenario of greens in the city, 22 lakh trees are being planted by Ahmedabad's two municipal agencies. AMC is planting 21 lakh trees for ₹ 20 crores. The city should have 14% of the city's geographic area that act as green and open areas, according to norms for global cities. Additionally, there are only 2.5% of the city's geographic area that act as green and open areas. The research indicates that the per capita green space of Ahmedabad does poorly when compared to other Indian cities and is significantly below the WHO and URDPFI guidelines, which are taken into account.
8 Analysis and result discussion

8.1 Urban Forests

Table 3. Pollutant data is shown in the table 3.

Table 4. AQI showed a marginal decrease.

8.2 Air Quality Index (AQI) Comparison

\[ Ip = \frac{(BPHi - ILo) + ILo}{BPHi - BPLo} + ILo \]
8.3 Vegetation Analysis

The size of the selected urban forests varied in different zones as seen in Table 3. Hence, the number of trees and tree species also differed in these sites. This causes differences in absorption of pollutant concentration.

To study the influence of vegetation composition on AQI, vegetation data was collected from all 4 sites. These four sites were then compared on the basis of total number of trees and tree species in urban forests. It was further compared to AQI of the year 2021. Area having high species variation and high number of trees would be able to purify air faster.

Other factors also determine the value of AQI. In this instance, by comparing the number of trees and no. of species, it was determined that South has highest number of trees and second highest species variation. But the AQI recorded is also highest. This is attributed due to the high number of industries and Pirana dump present.

9 NDVI Analysis

The Normalized Difference Vegetation Index (NDVI) is one approach for assessing the vegetation index of a certain location. Water, barren rock (including sand or snow), shrubs and grasslands, thick flora, or tropical rainforest are all described by index values between -1 and +1 (The range from 1 to 0.1 represents water, 0.1 to 0.2 represents Barren Rock, sand, and snow, 0.2 to 0.5 represents shrubs and grasslands, and 0.5 to 1 represents thick vegetation and tropical rainforest).

The NDVI analysis and the collected data from Ahmedabad demonstrate the biased approach to development. The trend shows a decreasing trend of vegetation cover from 2015-2023, in Fig 8a, 8b, 8c, 8d.

Although initiatives for greening of Ahmedabad have been introduced, on field it is yet not visible. As a result of urbanisation and industrialization, the city’s green plant cover has been declining. The direct result of the shrinking vegetation demonstrates the city’s rising pollution levels.

In the case of Ahmedabad, other air pollution-related factors are also noticeable. A surge in the quantity of private automobiles, indiscriminate solid waste disposal and burning, and the emission of manufacturing waste into the air are some of the factors that contribute to rising air pollution. Such activities have an impact on air quality.

Figure 5: Trend of AQI

Figure 6: Number of trees in Urban Forests

Figure 7: Number of tree species in urban forest

Figure 8a, 8b, 8c, 8d: NDVI images of the sites
10 Conclusion

While there are multiple factors attributed to analysing AQI, the paper is not able to cover every aspect. With consideration of all the factors, the analysis can effectively address this issue, it is necessary to firmly support the quest for high quality, the city needs to implement more environmentally friendly activities. To improve the overall environmental quality, ensuring natural gas reaches all residences. Older vehicles should be promoted. This can be done by ensuring natural gas reaches all residences. Older vehicles should be promoted. This can be done by

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