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ANALYSIS OF AQI DUE TO TRANSPORTATION & IT'S PREVENTIVE MEASURES.

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ABSTRACT

Urban air pollution is a major problem across the country. More than 80% of cities in India where air quality is monitored do not meet the standard of air quality prescribed by the Government of India. Transport sector has always been a significant contributor in emission estimates of cities. The source apportionment studies conducted in the six major cities of the country have shown that transport has significant contributions in PM2.5 and NOx concentrations. Moreover, the lower height of release of vehicular emissions leads to higher exposure. WHO has recently classified diesel exhausts as Class-I carcinogens. Air pollution in India has increased rapidly due to population growth, increase in the numbers of vehicles, use of fuels, bad transportation systems, poor land use pattern, industrialization, and above all, ineffective environmental regulations. Sulphur Dioxide, Nitrogen Dioxide, Particulate Matter are some of the pollutants which are contributing to environmental pollution. Purpose of this paper is to review the literature relating to the analysis of ambient air quality of some Indian cities and compare the same with Indian National Ambient Air Quality Standards. Also discuss of the use of Air Quality Index (AQI), seasonal variation in concentration of air pollutants. Use of health impacts due to increase in the concentration of air pollutants in Indian cities. With rising air pollution levels and deadly health risks, leading cities have developed clean air programs using the AQI. The AQI is the key tool in programs for protecting communities and triggering response actions. By calculating the AQI we will find the remedial measures to curb the pollution level from our Ahmedabad city zones. To examine the impact of transportation air pollution levels and to investigate the effects of air pollution on related health impacts, socio-economics and welfare of urban city.

Keywords: *Air Quality Index, pollution, vehicular emission, gases, atmosphere*

I. INTRODUCTION

At the beginning of the Industrial Revolution, our planet's atmosphere was still untainted by human-made pollutants. At least, that's what scientists thought until recently, when bubbles trapped in Greenland's ice revealed that we began emitting greenhouse gases at least 2,000 years ago. The gas methane naturally occurs in the atmosphere in low concentrations. But it's now considered a greenhouse gas implicated in climate change because of emissions from landfills, large-scale cattle ranching, natural gas pipeline leaks and land-clearing fires. Scientists often gauge past climate and atmosphere conditions from pristine ancient ice samples. The new research was based on 1,600-foot-long ice cores extracted from Greenland's 1.5-mile-thick ice sheet, which is made up of layers of snow that have accumulated over the past 115,000 years. It's possibly by spur- ring bacteria to break down organics in wetlands. That something else turned out to be human activity, notably metallurgy and large-scale agriculture starting around 100 B.C. The ancient Romans kept domesticated livestock cows, sheep and goats which excrete methane gas, a by-product of digestion. Around the same time, in China, the Han dynasty expanded its rice fields, which harbour methane-producing bacteria. Also, blacksmiths in both empires produced methane gas when they burned wood to fashion metal weapons. After those civilizations declined, emissions briefly decreased. Then, as human population and land use for agriculture increased worldwide over the centuries, atmospheric methane slowly climbed. Between 100 B.C. and A.D. 1600, methane emissions rose by nearly 31 million tons per year. According to the most recent data, the United States alone generates some 36 million tons of methane per year. The ice core data show that as far back as the time of the Roman Empire, human activities emitted enough methane gas to have had an impact on the methane signature of the entire atmosphere.

II. Need of Study

Air pollution, particularly in cities, is certainly not a new problem. Back in the Middle Ages the use of coal in cities such as London was beginning to escalate. During foggy conditions, pollution levels escalated and urban smog (smoke and fog) were formed. These often-brought cities to a halt, disrupting traffic but more dangerously causing death rates to dramatically rise. The effects of this pollution on buildings and vegetation also became obvious. The 1875 Public Health Act contained a smoke abatement section to try and reduce smoke pollution in urban areas. During the first part of the 20th century, tighter industrial controls lead to a reduction in smog pollution in urban areas. The 1926 Smoke Abatement Act was aimed at reducing smoke emissions from industrial sources, but despite the declining importance of coal as a domestic fuel, pollution from domestic sources remained significant. The Great London Smog of 1952, which resulted in around 4,000 extra deaths in the city, led to the introduction of the Clean Air Acts of 1956 and 1968. These introduced smokeless zones in urban areas, with a tall chimney policy to help disperse industrial air pollutants away from built up areas into the atmosphere. Air pollution is one of the serious environmental concerns of the urban Asian cities including India, where majority of the population is exposed to poor air quality. It causes health related problems such as respiratory disease, risk of developing cancer and other serious ailments etc. and contributes to tremendous economic loss especially in the sense of financial resources that are required for giving medical assistance to the affected people. Most of the Indian cities are also experiencing rapid urbanization and most of the country's population is expected to be living in cities within a span of next two decades. It has also resulted in a tremendous increase in the number of motor vehicles. The vehicle fleets have even doubled in some cities in the last one decade. This increased mobility, however come with a high price. Vehicles are now becoming the main source of air pollution in urban India. The growth rate of vehicles is the backbone of economic development and the Indian automotive industry (the second faster growing in the world). About 7-8 million vehicles are produced annually in the country today. In 2011 country reported 141.8 million registered motor vehicles. A motorization rate in India is 26 vehicles per 1000 population, and this is lower than many developing countries throughout the world (Brazil-222/1000 population in 2012, South Africa 153/1000 population.), but over the last three decades number of motor vehicles has been d In India, the number of motor vehicles has grown from 72.7 million in 2004 to approximately 141.8 million in 2011, of which two wheelers (mainly driven by two stroke engines) accounts for approximately 72% of the total vehicular population (Table 2 and Fig. 2). There is a direct relationship between road transport system and air pollution in a city.

2.1. Vehicular Emission

Vehicular emissions depend on vehicle speed, vehicle/km, age of vehicle, and emission rate. In general, the average peak hour speed in Indian cities are far less than the optimum one. Growing traffic and limited road space have reduced peak-hour speeds to 5-10 Km/h in the central areas of many major cities. We must retain that the estimation of road transport pollutant emission should allow significant disaggregation of the result: By fuel type and composition, by vehicle type, by emission standard. In general, one differentiates also emission produces in and out of city, and time scale can be necessary, depending on the objectives of the environmental assessment. doubling against a 2-5% annual growth rate in Canada, the US, the UK and Japan. 1 Automobiles are the primary source of air pollution in India's major cities. In India transport sector emits an estimated 261 tons of CO2, of which 94.5% is contributed by road transport. According to data out of total 3,000 metric tons of pollutants belched out every day, close to two-third (66%) is from vehicles in Delhi. Similarly, the contribution of vehicles to urban air pollution is 52% in Bombay and close to one-third (33%) in Calcutta.2 The transport sector in

Fig: 2.1 Pollution Explosion (Source: Timesofindia.com Place: Bihar)

India consumes about 17% of total energy and responsible for 60% production of the GHG from various activities. The pollution from vehicles is due to discharge like CO; unburnt HC, Pb.NO2 and SO2 and SPM mainly from tail pipes. The approaches in the field of modelling air pollution from road traffic can be categorized in two categories: (i) Macroscopic (ii) Microscopic Macroscopic In this model the traffic is represented as a compressible fluid and the movement of each vehicle cannot be monitored. In the macroscopic representation road traffic is associated with compressible fluid, so the fluid mechanics theories can be applied. The road traffic is characterized by three variables: Traffic flow (Volume), Speed of vehicle and traffic congestion (density). It is not possible to get a detailed representation of travel speed variation associated with individual or categories of motor vehicle type, which compose the traffic flows. This issue creates limitation on the traffic modelling of macroscopic level. Microscopic Since, the speed fluctuation shows a considerable importance in modelling of air pollution by road transport. Therefore, we can use microscopic representation as an alternative way to the macroscopic representation of traffic flow to account the individual behaviour of vehicles and are used to forecast.

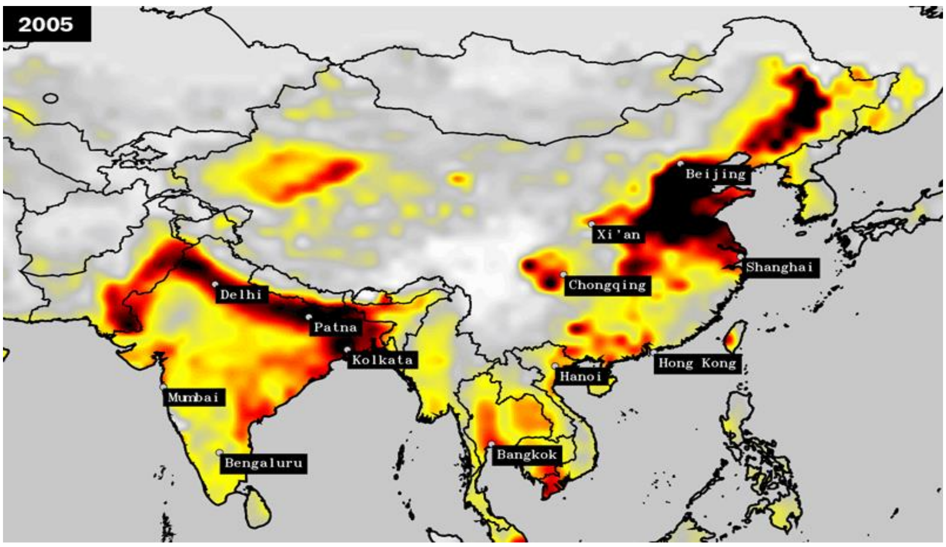
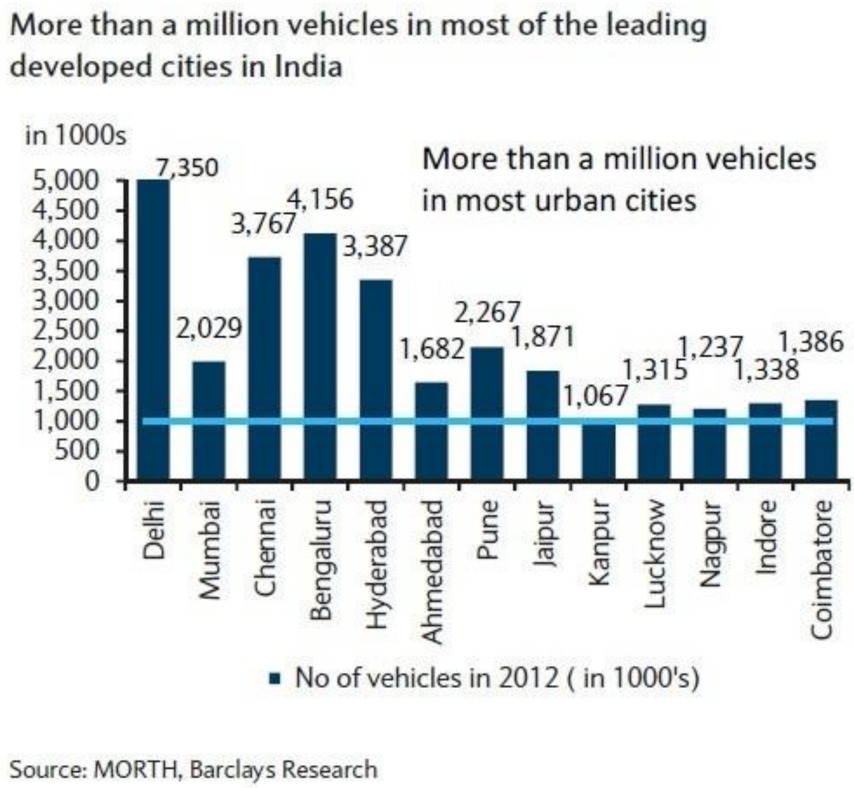


Fig. 2.2 Rise of pollution in the darkened zones annual basis
(Source: yourarticlelibrary.com)

Your car runs by burning petrol or diesel (a complex blend of lots of different chemicals collectively called hydrocarbons) to produce harmless Carbon Dioxide and water. There are, however, some by-products of this process.

Some of these hydrocarbons do not get burned in your engine and pass through the exhaust unchanged. There are two, called Benzene and 1:3 Butadiene that can be harmful. Not all the fuel burns up completely, so some Carbon Monoxide (CO) is also produced. These are the main pollutants produced by older, petrol driven cars, with diesels of all kinds burning their fuel much more completely, so producing negligible amounts of them.

If your petrol car was registered after 1993, it will be fitted with a catalytic converter which removes 95% of these three pollutants from the exhaust as compared with a similar 1976 model.



Graph 2.1 Vehicle rise in Major cities.

Exhausts can also contain Sulphur Dioxide (SO_2) from impurities in the fuel, but only 3% of the total emissions of this substance come from transport, the rest mainly from industry and power generation.

Recently, a health threat has been identified from Particulates, or PM10s, which are microscopic soot particles produced in the combustion process. Very little particulate emission (5%) is from petrol engines, though, with much more (19%) coming from diesels, disproportionately from the larger diesels in trucks and buses. The National Environmental Technology Centre (NETCEN) recently suggested that one bus can produce as many particulates as 128 typical cars.

III. Effects on Ozone Layer

The final element in exhaust pollution is Ozone (O_3). This is not emitted directly but made in the air by the action of sunlight on other pollutants to form "ground level Ozone", which, unlike the "Ozone Layer" in the high atmosphere, is regarded as a bad thing if levels are too high. Ozone is actually broken down by Nitrogen Oxides, so one tends to be lower where the other is higher.

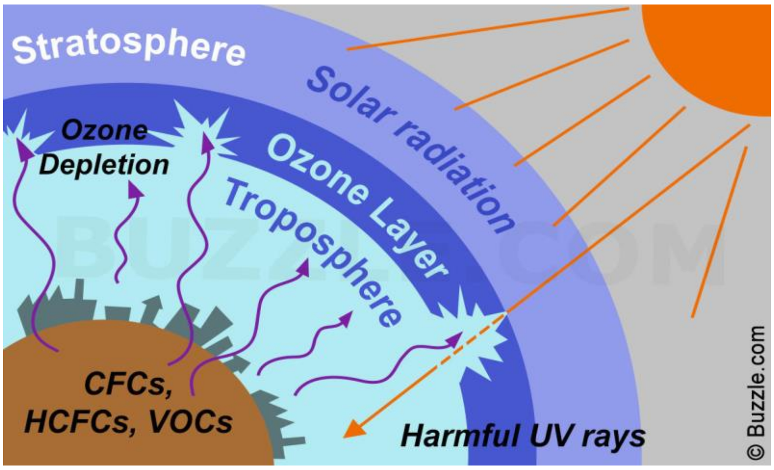


Fig 3.1 It represents depletion of Ozone layer due to emission of harmful gases.
(Source: jagranjosh.com)

Levels of these seven pollutants are monitored across urban and rural areas around the country. The measurements are made public the best place to see them is on BBC1 Ceefax pp 412-417 where they are updated hourly. Most toxic substances are only dangerous when a certain level is exceeded. This has reached a point where transportation activities are a dominant factor behind the emission of most pollutants and thus their impacts on the environment. These impacts, like all environmental impacts, can fall within three categories:

- Direct impacts. The immediate consequence of transport activities on the environment where the cause and effect relationship are generally clear and well understood.
- Indirect impacts. The secondary (or tertiary) effects of transport activities on environmental systems. They are often of higher consequence than direct impacts, but the involved relationships are often misunderstood and difficult to establish.
- Cumulative impacts. The additive, multiplicative or synergetic consequences of transport activities. They consider of the varied effects of direct and indirect impacts on an ecosystem, which are often unpredicted.

Table 3.1 Vehicular Growth-Gujarat Ahmedabad

Year	All Vehicles		Two Wheelers		Three Wheelers		AMTS Buses	
	Total	Growth	Total	Growth	Total	Growth	Total	Growth
1971	62922	-	21702	-	4865	-	525	-
1981	165620	163%	86550	299%	16741	244%	610	16%
1991	538182	225%	361372	318%	38359	249%	756	24%
2001	1210278	125%	863003	139%	65868	72%*	886	17%
Total Growth (71-2001) 1823%			3877%		1253%		69%	

Source: Transport Department, Gujarat, Ahmedabad, 2004

The complexities of the problems have led to much controversy in environmental policy and in the role of transportation. The transportation sector is often subsidized by the public sector, especially through the construction and maintenance of road infrastructure which tend to be free of access. Sometimes, public stakes in transport modes, terminals and infrastructure can be at odd with environmental issues. If the owner and the regulator are the same (different branches of the government), then there is a risk that regulations will not be effectively complied to. It can also lead to another extreme where compliance would lead to inefficient transport systems, but which costs are subsidized.

IV. Role Of Transportation

Total costs incurred by transportation activities, notably environmental damage, are generally not fully assumed by the users. The lack of consideration of the real costs of transportation could explain several environmental problems. Yet, a complex hierarchy of costs is involved, ranging from internal (mostly operations), compliance (abiding to regulations), contingent (risk of an event such as a spill) to external (assumed by the society). For instance, external costs account on average for more than 30% of the estimated automobile costs. If environmental costs are not included in this appraisal, the usage of the car is consequently subsidized by the society and costs accumulate as environmental pollution. This requires due consideration as the number of vehicles, especially automobiles, is steadily increasing.

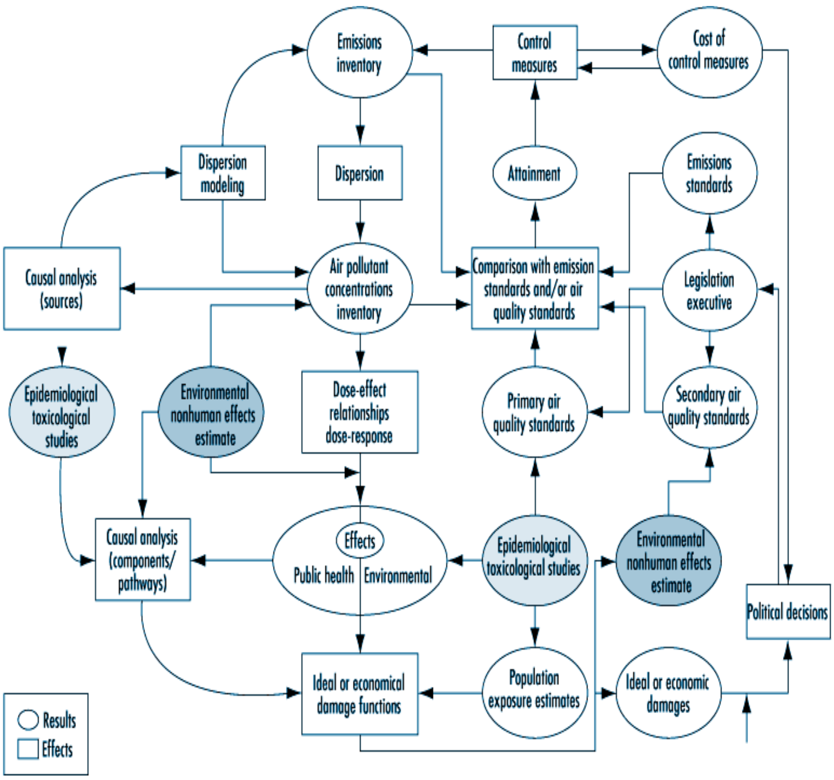


Fig: 4.1 Global Environment System Management
Source: www.ilocis.org/documents/chpt55e.htm

The relationships between transport and the environment are multidimensional. Some aspects are unknown, and some new findings may lead to drastic changes in environmental policies, as it did in regards of acid rain and chlorofluorocarbons in the 1970s and 1980s. The 1990s were characterized by a realization of global environmental issues, epitomized by the growing concerns between anthropogenic effect and climate change. Transportation also became an important dimension of the concept of sustainability, which is expected to become the prime focus of transport activities in the coming decades, ranging from vehicle emissions to green supply chain management practices. These impending developments require a deep understanding of the reciprocal influence between the physical environment and transport infrastructures and, yet this understanding is often lacking. The main factors considered in the physical environment are geographical location, topography, geological structure, climate, hydrology, soil, natural vegetation and animal life. The main environmental dimensions of transportation are related to the causes, the activities, the outputs and the results of transport systems. Establishing linkages between these dimensions is a difficult undertaking. Furthermore, transportation is imbedded in environmental cycles, notably over the carbon cycle. The relationships between transport and the environment are also complicated by two observations:

- First, transport activities contribute among other anthropogenic and natural causes, directly, indirectly and cumulatively to environmental problems. In some cases, they may be a dominant factor, while in others their role is marginal and difficult to establish.
- Second, transport activities contribute at different geographical scales to environmental problems, ranging from local (noise and CO emissions) to global (climate change), not forgetting continental / national / regional problems (smog and acid rain).

V. Study Area

Ahmedabad

Ahmedabad is located at 23°02′N 72°35′E in the State of Gujarat at an elevation of 53 metres (174 ft). The city is the seventh largest metropolis in India and the largest in the state of Gujarat. In western India, Ahmedabad has been one of the most important centres of trade and commerce. River Sabarmati cuts the city into two parts: eastern walled city and western Ahmedabad on either side of its banks. The Ahmedabad Municipal Corporation (AMC) area is spread over 190.84 sq. km and the Ahmedabad urban agglomeration (AUA) area is about 350 sq. km. Population in AUA has increased from 4.5 million in 2001 to 5.6 million in 2011.

Ahmedabad Geographical Map :-

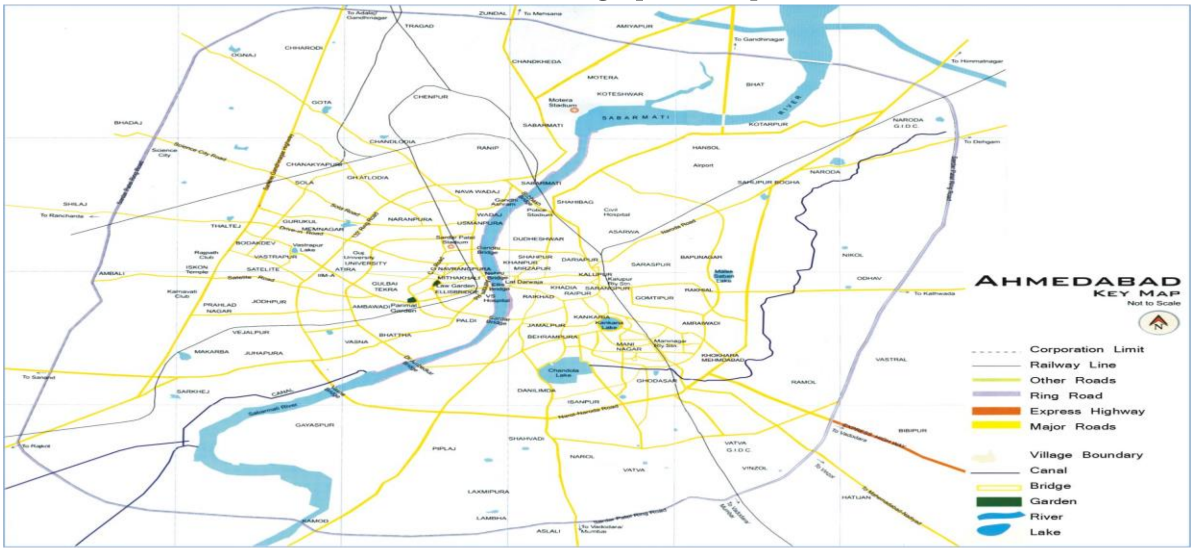


Fig 5.1 , Source : googlemaps.com , Ahmedabad Geographical Maps

Ahmedabad is the administrative centre of Ahmedabad district and also was the capital of Gujarat from 1960 to 1970; the capital was shifted to Gandhinagar thereafter. Like the other major cities of country, Ahmedabad is witnessing a major construction boom. The climate in Ahmedabad is hot and semi-arid. Other than the monsoon season, the climate is dry. In the months of March to June—the temperature reaches average daily maximum of 42 °C and in the months of January it reaches to an average daily minimum of 12°C. Cold northerly winds are responsible for a mild chill in January. The city receives an annual rainfall of about 803 mm through the southwest monsoon, mainly during June to September. The average number of rainy days is mere 36 but infrequent heavy rains cause flooding of the river.

Ahmedabad Road Map: -

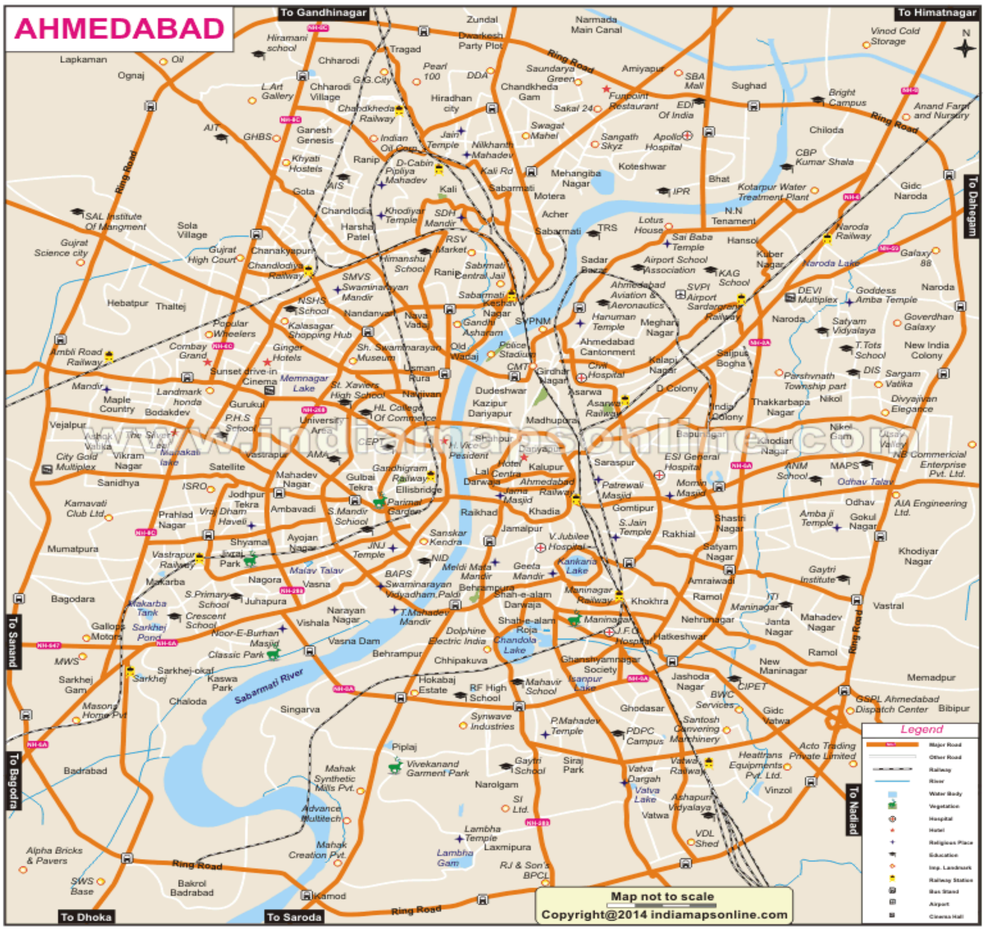


Fig 5.2 , Ahmedabad Road maps , (Source : Googlemaps.com)

The road network in the Ahmedabad city which would be further studied to assess traffic patterns in the city. Western part of the city has developed as a mainly residential area and the eastern part has the industrial estates. Thus, in the morning the traffic flow is very heavy from west to east and vice-versa in the evening leading to serious traffic congestion and frequent traffic jams on the city roads during morning and evening peak periods. Auto rickshaws and buses are the most popular forms of public transport in the city. Bus service is run by the Ahmedabad Municipal Transport Service (AMTS). In 2005, AMTS began a drive to convert all its petrol and diesel engine buses to run on compressed natural gas (CNG) engines to reduce the effects of air pollution. Moreover, many auto rickshaws in Ahmedabad were also switched to CNG to reduce pollution.

A BRTS (Bus rapid transit system) has been developed by Gujarat Infrastructure Development Board (GIDB) for the city of Ahmedabad. First corridor connecting Pirana to R.T.O. was opened to public in 2009. Gujarat Government and Ahmedabad Mahanagar Sevasadan had initiated the Ahmedabad Metro feasibility study. Recently, a 10.9 km East-West metro line has also been proposed initially for the city.

Ahmedabad, Gujarat

• Area: 466 square kilometers

• Population: 7.3 million

• Population Density: 11,948 per square kilometer

• Climate: Semi-Arid

• Average Rainfall: 782 millimeters per year

• Relative Humidity: 60 percent

5.1 ROUTE OF STUDY: -

- **NANA-CHILODA CIRCLE TO RAMOL CIRCLE (AHMEDABAD)**

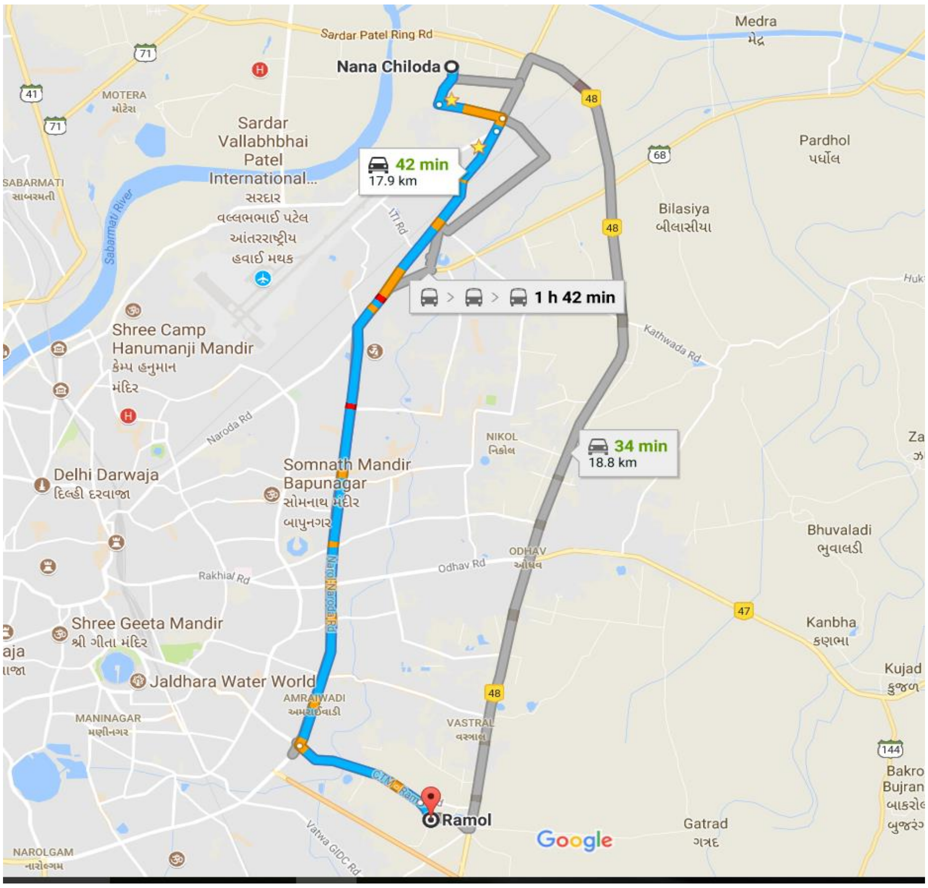


Fig 5.3, Study area route , Source: Google maps

Study Area Details: -

Total Distance: 18.8kms

Total population: 200,063

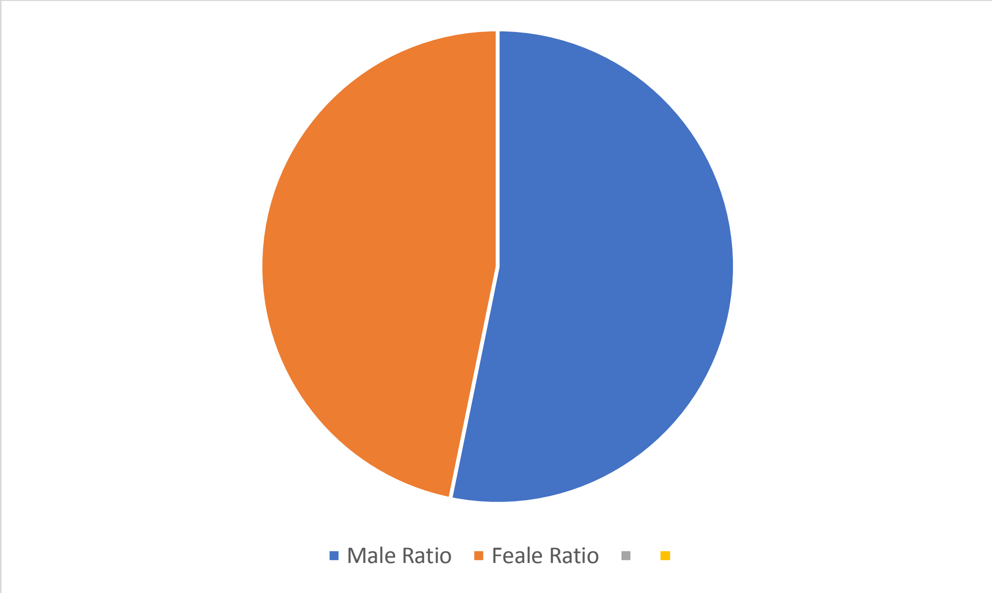
Vehicular traffic: Heavy

Route: NH-43

Ward wise Population Details: -

Sr. no.	Name of Ward.	Ward No.	Total no. of House Holds	Total population	Total Male population	Total female Population
1	Naroda Road	0020	14896	79926	42100	37826
2	Chandlodia	0046	36320	120137	64339	55798

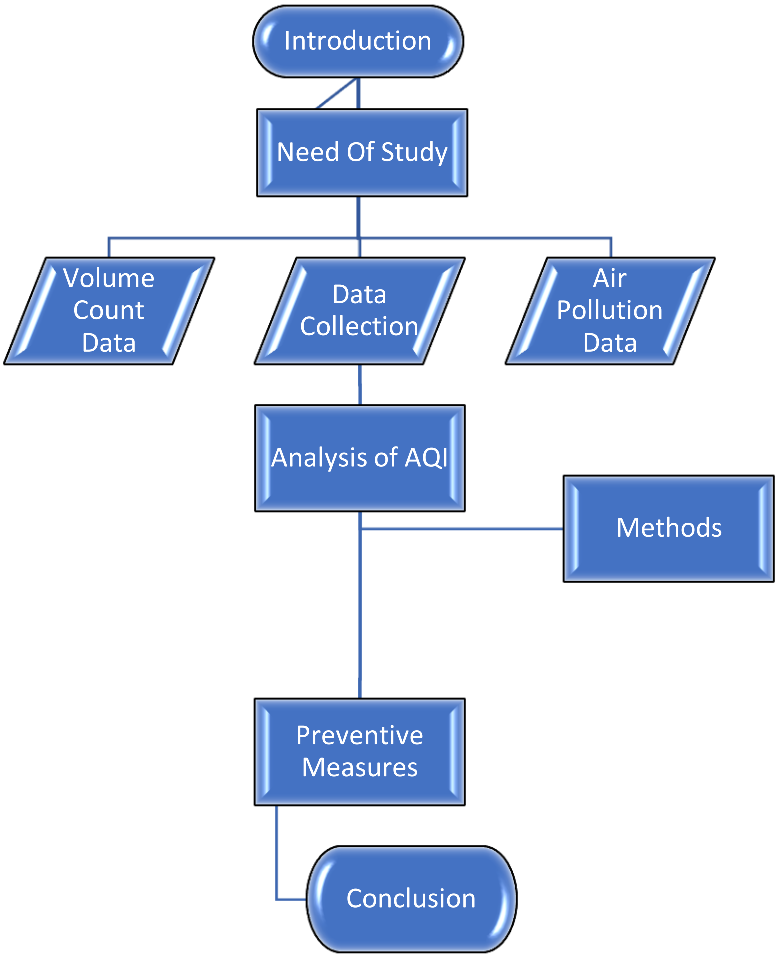
Table 5.1 Source : AMC ward wise Data



Graph 5.1 , Source : AMC ward wise data Pie chart representation of Male/Female Ratio

VI. METHODOLOGY: -

6.1 STUDY



6.1 Table representation of Methodology

- **INTRODUCTION:** It is the base of any thesis work, it gives us basic information related to the topic of thesis, as air pollution, causes of air pollution, types of pollutants, effects of pollutants on human health, ways to measure AQI, how to improve the AQI.
- **Need of Study:** As for the current scenario of our surroundings, air pollution is on the rise the quality of air we breath in is getting degraded day by day, the poisonous elements are on the rise, affecting every element supporting the cycle of life.
- **Data collection:** To gather all the required information & readings which will help us to progress our research work on our topic further.
- **Volume count data :** A volume count is a count of vehicular or pedestrian traffic, which is conducted along a particular road, path, or intersection. A traffic count is commonly undertaken either automatically or manually by observers who visually count and record traffic on a hand-held electronic device or tally sheet. Traffic counts can be used by local councils to identify which routes are used most, and to gather information on toxic gas emission. Traffic counts provide the source data used to calculate the Annual Average Daily Traffic (AADT), which is the common indicator used to represent traffic volume.
- **Air Pollution Data:** It is method to collect all the required data about the quality of air, the pollutants present in air carcinogens, asbestos, SOX, No2, CO, Co2, NH3, O3, Pb, As, Ni, Benzene.
- **Analysis of AQI:** In this stage, data collected from different methods will be analysed.
- **Methods:** GIS, PCU, Air Quality Particle Count Meter, Air Quality Monitor.
- **Preventive Measures:** After analysing the data acquired in the various methods AQI studies, the desired steps will be suggested & taken to prevent the raise of pollution by vehicular activity.
- **Conclusion:** It will cover the outcome, results and concluded points for different chapters and survey work.

VII. Data Collection & Survey Work

7.1 Data collection

Ambient Air Quality Monitoring data of Amdavad city at selected locations

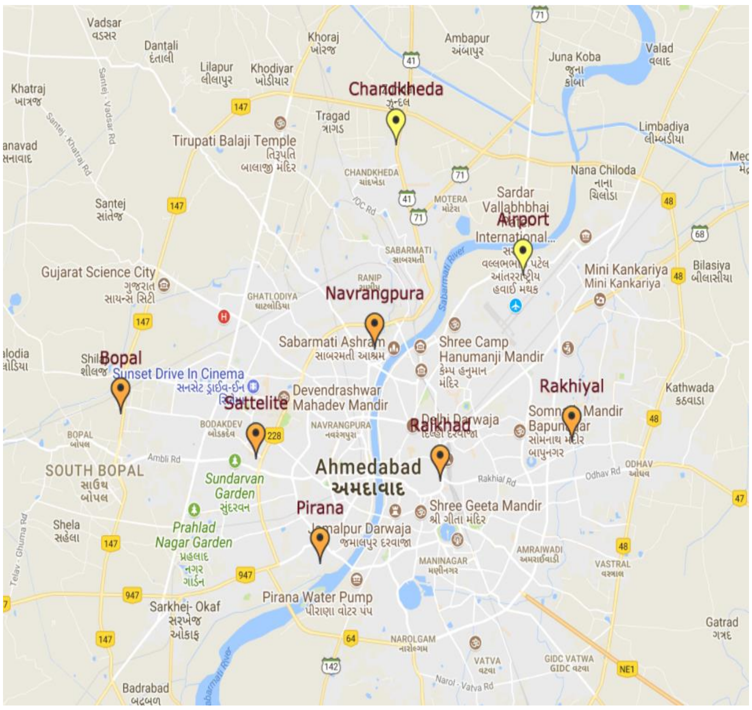


Fig 5.1 , Ahmedabad Study zone (Source : GPCB.gov.in)

Ambient Air Quality Monitoring Programme (AAQM)

Gujarat Pollution Control Board is monitoring ambient air quality at 62 strategic locations in the state of the Gujarat under the Ambient Air Quality Monitoring programme (AAQM) including Ahmedabad, Ankleshwar, Bharuch, Bhavnagar, Bhuj, Gandhinagar, Jamnagar, Rajkot, Surat, Vadodra, Vapi, Morbi, Sanand, Sarigam total 14cities.

The ambient air quality samples are collected as per the standard norms for ambient air quality monitoring. The parameters determined during analysis include SO2, NOx, O3, NH3, CO, PM10, PM2.5, LEAD, ARSENIC, NICKEL, BENZENE and BENZO-A-PYRENE. The data pertaining to the ambient air and meteorological data are regularly submitted to the CPCB [Central Pollution Control Board] for compilation and preparation of report.

1. NATIONAL AIR QUALITY MONITORING PROGRAMME (NAMP)

Under this project Ambient Air Quality monitoring is carried out at 38 stations in the state with the financial help of the Central Pollution Control Board, Delhi. The ambient air quality samples were collected as per the standard norms for ambient air quality monitoring prescribed by CPCB. The parameters determined during analysis include SO2, NOx, O3, NH3, CO, PM10, PM2.5, LEAD, ARSENIC, NICKEL, BENZENE and BENZO-A-PYRENE.

Status of Ambient Air Quality monitoring NAMP Project

Related to Ahmedabad Zone :

Sr No	Location	PM 10	PM 2.5	SO2	NoX	O3	NH3	CO	Pb	As	Ni	Ben-zene	Benzoa-Pyrene
1	Naroda GIDC	94	35	14.5	22	11.7	10.6	1.75	0.14	<1	1.6	1.6	<0.5
2	Cadila Narol	91	33	13.6	20.9	12	10.2	1.42	0.09	<1	2.1	1.8	<0.5
3	L.D Engg Cldg	83	29	12.4	20	11.3	9.5	1.28	0.08	<1	1.3	1.4	<0.5
4	Shardaben Hosp	83	30	12.3	19.5	12.4	9.8	1.35	0.07	<1	1.4	2.1	<0.5
5	R.C Technical High School	84	30	12.3	19.4	12.1	9.7	1.4	0.08	<1	1.4	1.6	<0.5
6	Behrampur Referal Hospital	85	31	12.9	20.5	12.7	10.3	1.59	0.07	<1	1.5	1.5	<0.5
7	Bhagvati Estate	93	37	13.8	21.1	11.6	10.6	1.48	0.1	<1	1.8	1.8	<0.5
8	Reliable Products	92	32	13.4	20.7	12	10.2	1.28	0.07	<1	1.4	1.9	<0.5

Table : 5.1 Source : GPCB.com/Safar.com , AQI report from various points of data collection

2. STATE AIR QUALITY MONITORING PROGRAMME (SAMP):

Under this project Ambient Air Quality monitoring is carried out at 24 stations in the state. The ambient air quality samples were collected as per the standard norms for ambient air quality monitoring prescribed by CPCB. The parameters determined during analysis include SO2, NOx, O3, NH3, CO, PM10, PM2.5, LEAD, ARSENIC, NICKEL, BENZENE and BENZO-A-PYRENE.

Status of Ambient Air Quality monitoring SAMP Project

Sr. No.	Location	PM10	PM2.5	SO2	NoX	O3	NH3	CO	Pb	As	Ni	Benzene	Benzoa-Pyrene
1	Mukesh Ind Narol	99	42	14.9	22.4	12.3	11.2	1.8	0.19	<1	2.1	2.2	<0.5
2	VIA Hall GIDC Vatva	95	35	14.6	21.8	11.3	10.4	1.48	0.09	<1	2.1	1.9	<0.5
3	H.P Petrol Pump	89	31	13.2	20.4	12.2	11	1.45	0.19	<1	1.9	2.5	<0.5
4	Nehru Bridge	95	36	14.9	22.3	12.6	9.8	1.63	0.19	<1	2.3	2.7	<0.5
5	Satellite	80	29	13.9	20.8	12.8	10.4	1.28	0.08	<1	1.5	1.9	<0.5

Table : 5.2 Source : GPCB.com/Safar.com , AQI report from various points of data collection

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