In the last few decades, economic growth and technological development have prompted ecological disruption. This has an impact on both developed and underdeveloped countries. These include air pollution, water pollution, and land pollution in different forms. There are some differences between developed and underdeveloped countries. Population in developed countries is less, and its impact on human health is also less. But underdeveloped countries have more population, and the problems of environmental hazards are serious. People are not doing much environmental maintenance due to poverty. That is why underdeveloped countries have more diseases due to poor environmental quality. India is one of them.

Urban areas have more density than rural areas. Rural areas are comparatively environmentally less affected from industrial, domestic, and urban pollution. That is why rural areas have less diseases than urban areas, of which water-borne diseases are more common and have increased in urban areas. In India, thousands of children die due to water-borne diseases. Many factors are related with water-borne diseases. Along with environment drinking water, behavioural, socio-economic and ecological (climatic) and demographic factors are some of parameters which affect water-borne diseases. The following section deals with such major factors causing water-borne diseases.
(1) **MAJOR FACTORS:**

(a) **DRINKING WATER:**

(i) **Source of water in urban environment:**

Man's prime need in his environment is water. India has, over the years, progressively developed its supply of water. Surface water is the main source for drinking water. Sources of surface water mainly include rivers, spring, lakes and ponds. Source of water in urban environment for city area and for out of municipality area is ground water which is the main source of water.

(ii) **Availability of Water:**

Availability of water without adequate sanitation and drainage has led to the spread of diarrhoeal pathogens. Most of the rich people have adequate water. They can call tanker for water if they have less amount of water. The largest proportion of house-holds without water supply are the poorest and the socially disadvantaged group. These are also the sections with the highest incidence of water-borne diseases and the poorest access to medicare due to poverty and illiteracy.

(iii) **Source of Contamination:**

The quality of water on earth appears to be good. But in India only 25% of the people get pure drinking water and the rest quench their thirst from polluted water. Pollution of water has become a threat to the existence of plants and animals and ultimately has also threatened the survival of the human race. Water becomes polluted when it changes in composition by human activities.

All the major rivers in the country are today highly polluted, including the mighty Ganges. Sabarmati river of Ahmedabad city is no
exception. It is also a highly polluted river. Sewage effluents of the city are dotting the river banks and have polluted the river-water. The microbial contamination results mainly due to mixing of sewage water with drinking water. The diseases that are caused as a result of microbial contamination of water include through enteric bacteria and viruses like cholera, acute gastroenteritis, diarrhoea, dysentry, typhoid, viral hepatitis A and E and poliomyelities.

Water is life, one cannot live long without water, but if water is highly polluted it is dangerous for human life. As a result of use of contaminated water, water-borne diseases are found, which are very common in urban areas. In urban areas ground water is also used for drinking purpose. The ground water is also found to be polluted in Ahmedabad where water-borne diseases are very common. Ground water is polluted due to the rusted pipes, having contamination of drinking water pipe-line with that of sewage water, industrial and human waste.

(b) **ENVIRONMENTAL FACTOR:**

The Environmental factor has been analysed into two parts, inner and outer environment. Environment within the house (inner environment) and outside the house (outer environment) are the important factors for disease.

(i) **Cleanliness of the outer environment:**

Environmental pollutants are seen in residents' own houses and in their surrounding habitat, e.g. accumulation of garbage. Villages are more clean than any city. Like population, restaurant and hotels are more in urban areas. Garbage accumulates for many days in front of these hotels, restaurants and markets expose the people to health
hazards. People also throw their domestic garbage anywhere on the road or open space instead of putting them in garbage bins. It is also noticed that people are forced to throw garbage on roads as often there is no bins provided by the Municipality. Other than garbage, water logging of polluted water of industrial effluents is often visible in industrial cum residential areas.

(ii) Housing: The basic requirement:
Housing is one of the basic requirement of man for the physical and mental health as well as social well being of a family. The housing problem in urban centres has resulted in a very high density of houses due to heavy population. There is not enough horizontal space for housing facilities, as a result urban areas have high-rise congested buildings. Generally houses should be constructed with sufficient open space which is necessary for sunlight, ventilation and proper drainage. But people do not leave open space for these essential facilities in densely populated core city region of Ahmedabad. Due to very high population pressure on housing resources, overcrowding in a house is a very common feature in the urban areas. Many people share one room causing high room density. Due to lack of housing infrastructural facilities, diseases are found more in urban areas than the rural one. In rural areas internal housing facilities are less but due to open and cleaner outer environment, people are less prone to diseases.

(iii) Type of house:
Slums are most important than any other types of houses for the spread of water-borne diseases. Slums have high population density due to migration of rural people towards urban areas. Generally poor, rural
people migrate to nearest urban centres in search of employment. These slum dwellers are economically very poor. The housing environment in slums is very poor without any facilities of water, sewerage and electricity. Huts are erected in haphazard manner without proper drainage. Because of congestion the flow of fresh air gets affected. Most of the slum areas have water logging due to lack of drainage which is a serious health problem. The entire slum and surrounding areas become a breeding place for mosquitoes and flies.

Houses are often without toilet facilities and density per room is high. People are forced to use open-space as toilet. Human waste pollute the outer environment and ground water which is used as drinking water.

(iv) **Infrastructural facilities:**

Most of the rural migrants live in the core area or in outskirts of the city area i.e. suburbs of Ahmedabad city. These suburbs have gram-panchayat, they collect tax from the people but do not provide them enough facilities like water, road, and sewerage system. In short infrastructural facilities are not adequate. Lack of sanitation and drainage has led to the spread of diarrhoeal pathogens in these areas.

(c) **BEHAVIOURAL FACTOR:**

(i) **Eating habits:**

Behavioural factor like eating and drinking cold-drinks, water from restaurant and way-side stalls are very common among both poor and rich people. Rich people like to go in good restaurants which may not provide potable water and good quality of eatable food. Though rich are aware about mineral water, they do not use it while eating out and
they are more affected by water-borne diseases due to change in water. Poor also are eating out from way-side stalls, which are not hygienic and naturally are not able to provide potable water as well as good food.

(ii) **Habit of throwing garbage:**
Throwing of garbage in surrounding areas and on roads randomly is another bad behaviour which create breeding ground for mosquitoes and flies; which are the carrier of diseases.

These three factors have spatial variations but following factors equally affect all, e.g. Socio-economically both rich and poor, educated or uneducated are affected by the disease. Similarly, seasonal effect or demographic effects are somewhat similar on all residents in any part of the city.

(d) **SOCIO-ECONOMIC FACTOR:**
Socio-economic factor included are income, education, occupation, standard of living, cultural practices of people. Income and literacy are mainly related with diseases.

(i) **Income:**
Lower income group are affected more than higher income group, due to poverty and lack of hygienic condition. Density per-person per room is high in lower-income group which also plays an important role for diseases. However, higher income people also get diseases mainly due to the habit of eating out.
(ii) **Literacy:**

Literacy is another socio-economic parameter which affects more on diseases. Illiterate or those who have taken primary education are more affected than higher educated people. Here among poor the hygienic sense is less compared to that of well educated people. Knowledge of personal hygiene is also low in case of illiterates.

(e) **DEMOGRAPHIC FACTOR:**

Population, age-group and sex-ratio are the important parameters of demographic factor.

(i) **Population density:**

An increase in population needs more housing facilities as the room-density increases in poor residential areas. Due to lack of infrastructural facilities problem of diseases increases.

(ii) **Age-group:**

Children below 14 years are more affected by water-borne diseases. Moreover younger groups who go for services and business are also more affected by diseases as they have to eat out.

(iii) **Sex-ratio:**

Male are mainly working class people. Industrial workers are more male than female; they live without family nearby industries or working area, which is poor in environmental conditions. Hence male are more affected by diseases.

(f) **ECOLOGICAL FACTOR:**

Rainfall is taken here as the main ecological factor which affects
more on water-borne diseases. Different types of diseases are found in different seasons. Monsoon season is important for gastro-enteritis and cholera, while during pre and post-monsoon seasons typhoid takes place. Number of rainy days sometimes affect people with diseases. If rain occurs continuously for some days, water logging and contamination of water take place. This often leads to an outbreak of diseases.

There are several factors that affect the health of an individual looking at the different types of diseases to which a human body is exposed to. The water-borne diseases are the best examples of the influence of hazardous environmental factors on human body. Since last decade (1981-1991) water-borne diseases have increased in urban area.

This study focuses on four major water-borne diseases i.e. Gastro-enteritis and Dysentery (diarrhoea), Viral Hepatitis, Typhoid fever (entric-fever) and Cholera. This study has emphasized on these four main water-borne diseases as patients have to be hospitalized for these diseases and therefore data about cases are available. Such type of research has not been done in Ahmedabad city. Hence this study focuses on this topic for Ahmedabad agglomeration area.

(2) OBJECTIVE OF THE STUDY:
The main objectives of the study are to find out the distribution of water-borne diseases in Ahmedabad city and to understand the major factors causing such kind of diseases.

The specific objective of the study are as follows:

(a) To know the spatial pattern of distribution of water-borne diseases in Ahmedabad over time (1989-1993), at macro and
micro levels;
(b) To know the seasonal variations of the water-borne diseases,
(c) To know how water-borne diseases vary by availability of water for drinking purpose;
(d) To analyse the factors that are responsible for water-borne diseases;
(e) To know the perception of residents regarding water-borne diseases and to suggest measures to fight against such diseases.

The above objectives are made for the purpose of having better preventive measures against the water-borne diseases to ensure a sound public health of Ahmedabad.

(3) RELEVANCE OF THE STUDY:
Disease is a concept of understanding human health. The relevance of this study is to understand in which conditions water-borne diseases exist, reasons of spreading the diseases and distribution pattern of the main water-borne diseases in an Indian urban environment, which has problems of high density, contaminated drinking water with poor environmental quality and poor behaviour and low level of awareness of people to protect themselves against diseases.

From this study one can find immense use in management of diseases in coming years. The study has indicated regions which are disease prone. Location of potential areas of risk within the city is found out. The Municipal Corporation and Ministry of Health Department can enhance preventive and curative actions, like prompt supply of medicines to the dispensaries, specialists of diseases and mobile medical vans etc.
to such areas. The study has also revealed the peak season of occurrence of diseases and this would help municipality to take prior action at anticipated time of occurrence of diseases. The care of water taps, tanks, garbage cleaning can be done at least prior to rainy season. The use of environmental behavioural model will be useful and relevant for municipal authority to take an immediate action against spreading of diseases from vulnerable regions. The study shows the variations of factors that are responsible for causing diseases both at micro and macro levels.

Thus the study would help authorities as well as residents of Ahmedabad to manage diseases in different regions in different ways. Planning strategies are of much use as preventive measures of improving public health. Perception of residents has been studied to know their experience which can be the basis of planning strategy.

(4) STUDY AREA: AHMEDABAD URBAN AGGLOMERATION

The main reason of Ahmedabad city as the study area for water borne diseases is that, the city has a very high concentration of water-borne diseases. Nearly 94% of water borne diseases of Ahmedabad District is seen in this city. In general distribution is more in urban areas compared to that in rural areas.

Ahmedabad is the main city of Gujarat State of India. Urban Agglomeration area of Ahmedabad is located between 22° 56’ North to 23° 6’ North and 72° 28’ East to 72° 42’ East with an average altitude of 49 metres above mean sea level. Its topography is mostly flat with the maximum level of difference about 4 metres. The eastern and western areas slope gently towards the river Sabarmati, providing a
natural drainage into the river. The city experiences extreme weather ranging between 45°C in summer and 4°C in winter. Average rainfall is 750 mm.

The city of Ahmedabad was founded by Sultan Ahmed Shah in 1411 AD on a site close to the old village of Asaval. Under the British rule, Ahmedabad grew as the Manchester of India; the modern textile industry took roots in the city. Growing from 5.72 sq.km. in 1857, it has grown rapidly between 1971 and 1991, both in terms of population and in area. In 1971, the Ahmedabad had a population of 17.42 lakhs (17,42,000) with an area of 92.98 sq.km. which had increased to 29 lakhs and 190.84 sq.km. by 1991. The city has extended on the eastern side.

Ahmedabad city, administered by Ahmedabad Municipal Corporation is the seventh largest metropolis of the country. It is one of the most densely populated cities of India. Besides, it is also an important industrial and trading centre with people from different socio-cultural backgrounds, living together. Because of this cosmopolitan nature of the city one can notice diversities in terms of socio-cultural, religious and economic activities.

The tradition in trade and commerce is reflected in its structural, demographic and environmental landscape. There has been a gradual expansion of the city area since 1981 and considerable area was included in 1986 under municipal limits in the eastern side. Urban Agglomeration area is used as the study area.

The definition of an Urban Agglomeration area adopted in the 1991
census was as follows:

(a) All places with a municipality;

Corporation or notified area or a cantonment board;

(b) The remaining places were determined as 'urban areas' only if the following conditions were fulfilled.

(i) The estimated population at 1991 census should be at least 5,000 persons,

(ii) The density of population per square kilometer should not be below 400,

(iii) 75% of the male working population should follow non-agricultural pursuits.

The concept of Urban Agglomeration was introduced for the first time in 1971 census and continued in the 1981 as well as in 1991 census. An urban agglomeration was made up of the out-growths which should be treated as an urban sprawl. Population covered by such spreads being categorised as urban. An agglomeration might be made up of more than one statutory town adjoining one another such as military cantonment, a railway colony or a university campus etc. Similarly habitations which do not qualify to be treated as towns in their own right but are more or less peripheral out growths of the main town were also considered as part of the urban agglomerations. In other words, an urban agglomeration is a continuous spread comprising of the main town together with continuous well recognised out-growths of any of such towns.

There are total of 63 wards (Appendix - I.1) in the Ahmedabad Urban Agglomeration areas, having variations in environmental characteristics. Total population of Ahmedabad Agglomeration area is
LOCATION OF STUDY AREA: AHMEDABAD AGGLOMERATION (WITH SUB-REGIONS)

SOURCE: A.M.C. AND CENSUS OF INDIA
about 3,299,380 having 277.38 sq.km. area in 1991. An average density of area is about 11,873 per sq.km. varying high at core to low in the suburbs. The city has been classified into five regions having differentiation in composition of population, density, activities, land use pattern etc. For the study purpose, the city has been grouped into following five areal units based on the variations of physical, demographic, economic and socio-cultural aspects. (Fig. I 1)

The sub-region are as follows:-

- **a)** Core region (residential and main commercial area)
- **b)** Eastern region (Industrial-cum-residential area of labour)
- **c)** Western region (Mainly new residential-cum-commercial area)
- **d)** Eastern suburb (residential and industrial),
- **e)** Western suburb (mainly residential),

All this five regions have some difference in case of various factors. It is given in Table I.1.

(a) **Core Region or walled city region (residential & commercial area):**

The 'walled city' founded in 1411 AD is on the eastern side of the river Sabarmati. It is comprising of ward number 1 to 12(refer to Appendix No.I.1). The core area, spread over an area of 572 sq km having population of about 398,410 according to 1991
### Table: I.1
The sub regions of Ahmedabad Urban Agglomeration with demographic and environmental condition

<table>
<thead>
<tr>
<th>Sub regions</th>
<th>Total popu. 1991</th>
<th>% Share to total Popu. 1991</th>
<th>Total area sq.km. 1991</th>
<th>Density per sq.km.</th>
<th>% Share to total area 1991</th>
<th>Houses 1991</th>
<th>Sex ratio 1991</th>
<th>%SC to total popu. 1991</th>
<th>%ST to total popu. 1991</th>
<th>% of total ST popu. 1991</th>
<th>% Literate to total popu. 1991</th>
<th>% Workers to total popu. 1991</th>
<th>% of total workers 1991</th>
<th>Weighted overall environmental condition (33 variable by)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I Core (Ward 1-12)</td>
<td>398410</td>
<td>12.08</td>
<td>5.72</td>
<td>69652</td>
<td>2.06</td>
<td>68839</td>
<td>933</td>
<td>0.62</td>
<td>5.29</td>
<td>0.06</td>
<td>7.52</td>
<td>8.82</td>
<td>13.55</td>
<td>3.48</td>
</tr>
<tr>
<td>II Eastern (Ward 19-36)</td>
<td>1275317</td>
<td>38.65</td>
<td>50.88</td>
<td>25065</td>
<td>18.34</td>
<td>235917</td>
<td>876</td>
<td>7.81</td>
<td>66.84</td>
<td>0.33</td>
<td>43.68</td>
<td>24.13</td>
<td>37.05</td>
<td>10.86</td>
</tr>
<tr>
<td>III Western (Ward 13-18)</td>
<td>575433</td>
<td>17.44</td>
<td>36.38</td>
<td>15817</td>
<td>13.12</td>
<td>107149</td>
<td>918</td>
<td>1.91</td>
<td>16.37</td>
<td>0.17</td>
<td>22.83</td>
<td>11.21</td>
<td>17.22</td>
<td>5.30</td>
</tr>
<tr>
<td>IV Eastern Suburb (Ward 37-47 &amp; 63)</td>
<td>679532</td>
<td>20.60</td>
<td>55.40</td>
<td>12265</td>
<td>19.97</td>
<td>139263</td>
<td>829</td>
<td>0.87</td>
<td>7.43</td>
<td>0.15</td>
<td>19.27</td>
<td>13.55</td>
<td>20.82</td>
<td>6.05</td>
</tr>
<tr>
<td>V Western Suburb (Ward 37-47 &amp; 63)</td>
<td>370608</td>
<td>11.23</td>
<td>129.00</td>
<td>2873</td>
<td>46.51</td>
<td>66903</td>
<td>910</td>
<td>0.48</td>
<td>4.07</td>
<td>0.05</td>
<td>6.50</td>
<td>7.40</td>
<td>11.36</td>
<td>2.87</td>
</tr>
<tr>
<td>Total 63 Wards</td>
<td>3299380</td>
<td>100.00</td>
<td>277.38</td>
<td>11873</td>
<td>100.00</td>
<td>618071</td>
<td>893</td>
<td>11.69</td>
<td>100.00</td>
<td>0.76</td>
<td>100.00</td>
<td>65.11</td>
<td>100.00</td>
<td>28.57</td>
</tr>
</tbody>
</table>

Source: Statistical outline of AMC (1991) and field work.
Density of population is very high, nearly 82,222 persons/km² according to 1981 census, but in 1991 the population density is 69,652 persons/km² has decreased because of migration of people from the core area to suburbs due to communal riots. Percentage share of total population is 12.08 and percentage share to total area is about 2.06. Sex-ratio of this region and in all five regions is high i.e 933 in 1991. Sex-ratio is high due to greater outflow of male migrants. People live here with their family. Percentage of S.C. to total population is 0.62 and percentage of total SC population is about 5.29. While percentage of ST to total population is 0.06 and percentage of total ST population is 7.52. Literacy rate is low in all five region i.e. 8.82 percent to total population, which is 13.55 percent of total literate population.

The area designated as the core area of Ahmedabad is characterised by relatively older trading community with low socio-economic status. Other characteristics are very high density of traffic, constant movement of goods, high density of buildings, little vegetation and open space. There are nearly 68839 houses in this region. Housing pattern is mostly single room apartments and chawls. The area is divided by 'poles' which are neighborhoods of different communities. Pole areas have less ventilation which is needed for good health. These areas are over crowded with about 5 to 6 persons per room. These houses have inadequate and irregular water supply and without certain basic residential facilities, such as lack of place for washing clothes, toilets etc. The hawking activity is extremely intense. But nowadays because of some municipality policy this hawking activity on road is decreased. This is done to reduce traffic problems. This is an
area of offices, recreation centres, commercial and retail activities, giving rise to a mixed landuse. The number of restaurants, hotels, hawkers are huge in number. Overall environmental condition of this region is poor. As a result of this, we find a high rate of water-borne diseases in this region.

(b) **Eastern Region (Industrial & Commercial Area):**

This area is located on the eastern side of the walled city area. It is comprising of ward numbers 19 to 36 (refer to Appendix No I 1). This region has about 50.88 sq.km. area which covers about 18.34 percent share to the total area of Ahmedabad Agglomeration Area in 1991, and has nearly 12,75,317 population, which is nearly 38.65 percent share of total population in 1991. Density of population is about 25065 per sq.km. The Eastern Ahmedabad is dominated by large industrial plots. This has remained almost a traditional region for low-income industrial workers, with relatively low sex-ratio, i.e., 876 in 1991. Percentage of SC to total population is about 7.81 and percentage of total SC population is about 66.83. While percentage of ST to total population is 0.33 and percentage of total ST population is 43.68. Here percentage of SC/ST population is high due to industrial area. Literacy rate is low in this region due to industrial workers. Percentage of literate to total population is about 24.13 and percentage of total literate population is about 37.05. Socio-economic condition of this area is low due to industrial blue-collar workers. As the large part of the area is covered under huge industrial plots, number of chawls and slums are higher in this region than any other region. Percentage of workers to total population is high in this region i.e., 10.86 while percentage of total workers is about 38.01, which is also higher among all five regions. The area exhibits poor housing conditions and has 65
percent of city's slum dwellers. The room density is the highest in this area. Due to lack of basic facilities in houses, people use public toilets and open spaces. Other residential areas have also high room density. Facilities and amenities are less than other areas. Due to industrial region, industrial waste and polluted water-logging areas are always found in this region. As a result of all these it is found that this area is having poor and fair environmental conditions. As this area is occupied by industrial workers belonging to low income and literacy group, their food habits are governed by their low economic standards. This area is much affected by water borne diseases.

(c) Western region (mainly new residential-cum-commercial area):
This is relatively a new part of Ahmedabad city whose development took place only since 1960. It is comprising of ward numbers 13 to 18. It covers 36.38 sq.km. area and has 5,75,433 population in 1991. Density of population is about 15,817 persons/km$^2$. Sex-ratio in this region is high i.e. 918 in 1991 because this is mainly a residential area. Percentage of SC to total population is 1.91 in 1991 and percentage of total SC population is 16.37 in 1991. While percentage of ST to total population is 0.17 in 1991 and percentage of total ST population is about 22.83 in 1991. SC and ST population according to 1991 in this region secured the second highest position out of all five regions. In this region, Vasana, Wadaj and Sabarmati wards have more slums and chawl area which have more SC/ST population. Due to this three major wards with lower income and literacy group environmental condition in this region is not much high.

There are well marked commercial and residential places with better
separations in landuse. However, in certain pockets poor conditions near to slum can also be noticed, these slums are inhabited mainly by workers engaged in activities of building construction. Percentage of workers to total population is 5.30, which is only 18.58 percent of the total workers. In residential areas houses are well constructed and maintained. It is mostly the venue of upper class residents except certain pockets like Wadaj, Sabarmati, Vasana, etc. People here are more social and often eat out in restaurants and hotels. However, some new societies do not have proper sewerage system, drainage of rainwater or metalled approach roads. The overall environmental condition is fair. It is good in few pockets of this region than other four regions. Except few pockets, cleanliness of area is good. Due to all these reasons, diseases are comparatively less than other regions. But exception is there in certain pockets.

(d) **Eastern Suburb :- (residential & industrial Suburbs)**
This newly extended area is found just a decade ago, in 1986. It is comprising of ward numbers 37 to 47 and 63. It covers few suburbs of Ahmedabad. It is an industrial and residential area. Ahmedabad is growing and due to the increasing population there is lack of space for residence and industry. People are forced to stay in the outskirts of the Ahmedabad Municipal Corporation area. It covers nearly 5540 sq.km. area. Percentage share to total area of Ahmedabad agglomeration area is about 19.97 in 1991, and this region has about 6,79,532 population. Which is nearly 20.60 percent share to total population in 1991. Density of population is about 12,265 per sq km. Sex-ratio is very low in this area compared to all other regions of Ahmedabad Agglomeration Area. Sex-ratio is 829 in 1991. This is due to more male industrial workers who live here without families and most of them are
migrants. Percentage of SC to total population is about 0.87 while percentage of total SC population is 7.43. Likewise percentage of ST to total population is 0.15 while percentage of total ST population is about 19.27. Literacy rate is not much high. Percentage of literate to total population is 13.55 while percentage of total literate population is 6.05 percent; while percentage of total workers is 21.17. People are engaged in different small scale industries In short most of the industrial workers stay over here. Small societies and "chawls" houses of rural type exist here. There are not enough housing and infrastructural facilities and amenities available here Chawl type of houses have common latrines, children defecate in open space. New societies have enough internal facilities, but lack of sewage system, transport and network of roads. Most of the societies have local sewage called "kharkuva" for sewage. Due to "kharkuva" underground water may be contaminated. There is not enough environmental cleanliness in this sub-region. Environmentally it can be considered as poor or fair region. Few pockets of this region have fair environmental condition.

(e) Western Suburb (mainly residential):
This region is mainly residential. It is comprising of wards numbering from 48 to 62. This region covers maximum area of Ahmedabad Agglomeration Area. It covers 129.59 sq.km. area in 1991 having population is about 3,74,608. Percentage share to total area is about 46.51 in 1991. Percentage share to total population is only 11.23 in 1991. Density per sq.km. in this region is about 2873 in 1991 which is lowest. Sex ratio is 910 in 1991. Percentage share of SC to total population is 0.48 while percentage of total SC population is about 4.07 in 1991. Percentage share of ST to total population is 0.05 while
percentage total ST population is 6.50 in 1991. Percentage of SC/ST population in this region is very low. Percentage of literate to total population is 7.40 while percentage of total literate population is 11.36. Percentage of workers to total population is 2.87 while percentage of total worker is 10.06 in 1991. Here density of population, literacy, workers are low compared to other regions of Ahmedabad Agglomerated area. Now-a-days people do not like noisy area as well as areas with communal riots. Due to these reasons people have shifted from the core area to the outskirts of the city area for clean and peaceful environment. This outskirts area of Ahmedabad Municipal Corporation is originally a rural area, but because of migrants from Ahmedabad Municipal areas new societies have developed. Development of residential zone towards the suburbs without much more development of sewerage and transportation. Here infrastructural facilities are not enough. Overall environmental condition is fair in this region due to the absence of industrial area. Cases of diseases are less because of fair environmental condition.

The city has been classified into above five regions for a detailed analysis of water-borne diseases. Factors that are mainly responsible are of both spatial and non-spatial in this city. Among the spatial factors are environmental, behavioural and drinking water factors. These factors vary from one area to another, while non-spatial factors without having much spatial variation, are socio-economic, demographic and ecological in nature. These factors have been analysed at a macro level (total city), meso-level (region wise) and micro-level (ward wise within a region). Details are needed for the purpose of planning an appropriate strategy.
Among the several disciplines which study the health of the people in one form or another, geography is one. There are a number of geographical factors which influence and sometimes even determine the health and reproductive capacity of living beings, including man.

(a) Medical Geography:
Medical Geography is the analysis of the human and environmental relationship of diseases, nutrition and medical care systems in order to elucidate its interrelationships in space. Thus three conceptual themes emerge in medical geography: the characteristics of place which differentiate one from another, the analysis of spatial relationship at various scales, and the inter-relationship of humans and the environment. This study is based on the above three characteristics.

A systematic study of the spatial distribution of diseases, health and ill health and the causes thereof, fall within the field of what we call Medical Geography, which is a branch of Bio-Geography.

(b) Cartographic and Statistical Study:
Medical geographic studies have to a large extent to be cartographic and statistical in nature.

1. In 1852 Heinrich Berghans published his physikalischer Atals, one of its eight sections included a number of medical maps and charts.

2. The most famous 19th century disease map was done by John Snow in 1854, e.g. dot map of cholera around broad street water pump in London. The clustering of cholera in the vicinity of well, supported Snow's view that nature of the subject,
medical geography is broadening its scope and also increasingly becoming interdisciplinary in concept, substance and technique.

(iii) There is a definite linkage within the traditional and contemporary Medical Geography which is well illustrated by the diagrams given by David Phillips.\(^3\)

(iv) The atlas of diseases published by the American Geographical Society must be mentioned as a pioneering work of Dr. Jacques, M. May. The Ecology of Human Diseases, World Distribution of polio myelitis in 1900-1915, other diseases mapped in later issues that included cholera, helminthiases, dengue and yellow fever, leprosy, plague, rickettsial diseases, leishmaniasis, spirochetal diseases, leptospirosis, typhus, hunger, malnutrition and malaria vectors in 1951 to 1955\(^7\).

(v) In Germany, the world Atlas of epidemic diseases (Welt-Senchen Atlas) was edited in three volumes by Rodenwaldt in 1952-56\(^9\).

(vi) In the UK, the National Atlas of Disease Mortality was edited by G Melvyn Howe and published by the Royal Geographical Society in 1965.\(^5\)

(c) **Ecology of diseases and malnutrition:**

American Geographical Society has brought out several volumes dealing with ecology of diseases and malnutrition. The first three volumes of this series are 'The ecology of diseases' (1958), 'Studies in Diseases Ecology' (1961) and 'The ecology of Malnutrition in the Far and Near East' (1961).
(d) **Epidemics:**

During the last two decades medical Geography has acquired an increasing importance among the relatively newer fields of Geography.

(i) Modern medical geography began in Europe during the late 18th century: the yellow-fever epidemics of the late 18th and 19th centuries.

Cholera: The cholera outbreaks of the 19th century generated the disease maps for the first time. A lot of work has been done on cholera epidemic. The epidemiology of cholera has been the most widely researched topic though it was not until the late 1920's that a cholera epidemic was first conceptualized within a framework which allowed such factors as influx of pilgrims at different fairs and festivals to be examined in detail (Rogers, 1928, 1944). There is now a formidable body of literature or global incidence of cholera by Pollitzer (1954, 1955, 1959), Felsenfeld (1963), Swaroop and Pollitzer (1962), Cvjetanovic and Barua (1972), such that it may not serve much useful purpose to make any other review of the topic. But until very recently the basic processes of cholera diffusion had been highly neglected because most of the work done were by medical men whose attention had been more on the epidemiological and chemical characteristics of the diseases rather than on its nature of spread on space.

(e) **Indian Scenario:**

During the 1960's medical geography in India appeared to have become strongly established in the northern area in contrast to its dominance in southern India during the 1940's.

(i) In Bengal work on cholera incidence gained greater importance with
regard to cholera in the latter part of the 1970's, yet another centre of medical geography was established at Madras, where among other topics, cholera incidence at the state and city level was studied (Hyma and Ramesh, 1976, 1977).\(^{(54)}\) The Geology of cholera in West Bengal was studied by B.Banerjee and J. Hazra.\(^{(17)}\)

(ii) **Malaria**

A lot of work has been done on Malaria. A collaborative study on the resurgence of malaria in India by R.Akhtar and A.T.A. Learmonth was published in Geo-Journal (1977)\(^{(9)}\). It was the first paper to cover the country as a whole. Later a monography, entitled 'Malaria Annual Parasite Index maps of India by Malaria Control Unit Areas 1965-1976' by R. Akhtar and A.T.A. Learmonth was published by the Open University, (1979) UK\(^{(10)}\). S.Pacholis attempted in studying the relationship between type of vector species and Malaria is yet another approach towards medical geography (1977).\(^{(82)}\)

Another joint paper by A.K.Dutta, R. Akhtar and H.M. Dutta (1980) deals with the geographical aspects of malaria incidence in Madhya-Pradesh and Gujarat.\(^{(36)}\)

(iii) **Infectious diseases:**

Important infectious diseases such as leprosy and small pox were also attracted geographers attention. B.Banerjee and J. Hazra's work on geography of Leprosy in West Bengal (1982)\(^{(16)}\) and Mathur's small-pox in Rajasthan (1971)\(^{(70)}\) together with S.Singh and H.M. Dutta's small pox in Patna city 1981\(^{(98)}\) are significant efforts towards the development of medical geography in India.
(iv) **Cancer:**

A.T.A. Learmonth tried out the concepts of positive and negative residuals above and below the generalised surface were drawn for lung cancer in Victoria, Australia for 1961-1964.\(^{(64)}\)

R. Akhtar (1978) contributed a paper entitled 'Geography of cancer in India'.\(^{(5)}\) He also contributed a paper on the distribution of lung cancer (1980).\(^{(6)}\) A number of physical, socio-economic and cultural factors were considered in R. Akhtar's Geographical Distribution of cancer in India (1983)\(^{(7)}\) as the influencing motives for the occurrence of different types of cancer in India.

(v) **Health Care Delivery Systems:**

There are large disparities in the distribution of health care delivery systems in our country. Though medical geography has not yet contributed significantly in the health planning process of the country, but some attempts have been made in this direction R. Akhtar (1978) highlighted and disparities in the distribution of health facilities is Rajasthan during 1961-71\(^{(8)}\). A joint paper by R.Akhtar and Nilofar Izhar was concerned with the growth and disparities in the provision of hospital and bed facilities in India during 1957 and 1975.

(f) **Spatial distribution of disease:**

Dr.G.M. Howe, a foremost British medical geographer, in a paper read before the IGU Commission on medical geography, defines it as "an interdisciplinary field of study concerned with areal variations of disease incidence as expressed by mortality and with the demonstration of possible cause-effect relationship with elements of physical,
biological and socio-cultural environments in space. It assists with answers to the question "who has what and where' but it does not presume to answer the question 'why' except in a limited sense. Medical geography may offer pointers to possible answers but not the proof. That must remain the function of the medical men, where relationships have been demonstrated and apparently adequate hypothesis advanced, the data of medical geography are such that they cannot be regarded as having proved its truth. Correlations in space can be as misleading as correlations in time, and the data provided by medical geography are usually of this character. Proof of causation in ordinary sense of the phrase requires detailed evidence of conjuction of cause and effect in the individual as well as in the community.'

Diseases are found to be associated with the sex and the age-group as well as locality. Some of them are found more in urban than in rural areas. Certain areas and countries are immune to certain diseases even if they turn out to be pandemic. Some diseases are peculiar to certain types of topography, climate and flora and fauna.

**Regional factors:**
Probably Mc clelland made first scientific attempt to identify the regional factors associated with the prevalence of disease in India.

**Geographical factors:**
Machamara studied in detail the geographical factors influencing the occurrence of various diseases, particularly goitre in the Himalayan and Sub-Himalayan region. Pioneering efforts in this direction were also made by Joseph Fryrer in his 'Climate and Fevers in India'.

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Chevers in 'Diseases in India' (26) and Moore in the 'Tropical Climates and Indian Diseases' (75).

(iii) Cultural factor:
L.S. Fonaroff and A. Fornaroff (1966) discussed various cultural factors as the cause of malnutrition (40). "India: cultural pattern and progress" by A.T.A. Learmonth and R. Akhtar (1971) examines the relationship between cultural patterns and health in India (65).

(iv) Environmental factor
Although the term 'medical geography' is fairly recent, medical geographic studies were quite common even in ancient times. The Greeks studied the influence of topography, climate and other environmental factor, on the health of the people. Paracelsus went even to the extent of saying that a physician cannot understand the extent of saying the essence of disease unless he is a geographer too.

The foundation of modern medical geography in India was laid down in the 1930s. Captain A.M.V. Hesterlow was the first researcher who threw light on the possible relationship of environmental factors and diseases in South India (51).


(v) Disease with contaminated water, soil and air
Numerous studies have been made in investigating the relationship of disease with contaminated water, soil and air and another pollution...
caused by men water-borne epidemics, for example, were well studied by Dr. John Snow (1813-58). However not much work was done in this aspect until the mid twentieth century, when scientific developments led to the analysis of soil and water in order to study the impact of these elements on the health of the people.

Quality of water plays an important role in human-health as pointed out in "Water Resources; issues and strategies" by Adrin T Mcdonald and David K (1988). In the United States, concern for water quality can be traced back in 1647 in the Massachusetts colony, enacted legislation designed to prevent the pollution of Boston harbour. The main impetus for pollution prevention came however, in the nineteenth century as a result of the spread of water-borne diseases in the emergent conurbation of North America and Europe (Luckin 1988, Burly ed.at.1983).

At a time when pathogenic micro-organisms had not been isolated and the faecal-oral route for disease transmission was not fully understood, John Snow in the UK had established the causative relationship between a polluted water supply and disease transmission. He achieved thus by demonstration a higher incidence of cholera among Londoners who consumed polluted water from the Southwark and Vauxhall Company. Disease rates were lower in similar social classes supplied by the Lambeth company which obtained its water from a less polluted source. Snow's study provided the essential evidence for Sedgwick (USA), Chadwick (UK) and Pefinkoffer (Germany) who were campaigning for the provision of clean water supplies as a means of preventing disease epidemics (Shuval 1980). We must not forget the fact that the causative factors of cholera in London, i.e.
contaminated water, was discovered and demonstrated by Dr. John Snow in 1849 by means of a map.

(h) **Other Studies**

Joshi and Deshpande's (1972) joint paper highlights the significance of water shed in the distribution of diseases in Southern Asia. Andrew T.A. Learmonth, however, provided the scientific base to the researches in medical geography in India.

Arthur Geddes dealt on the relationship between the general conditions of health and population growth in India. Andrew T.A. Learmonth, however, provided the scientific base to the researches in medical geography in India.

The developed nations are concerned themselves with problems of water-quality. An esthetic and ecological instability caused by acidic deposition in the developing nations are responsible for water-borne, typhoid diseases. It is still a cause of some 10 million deaths per year and 500 million cases of illness (WHO, 1986), Krenkel and Novothy 1980).

Naturally occurring contamination may be harmful to man. Health may be also adversely affected where there is absence or deficiency of essential elements, such as iodine, copper or zinc. Environmental deficiencies are overloads of trade elements which are meditated through the consumption of drinking water and locally grown food stuffs, reflecting customary, dietary patterns. Akhtar Rais has noted the incidence of goiter in relation to iodine deficiency in water and soil, in the Kumaon Region (1978).

Environment and health aspects of medical geography have been studied either in relation to the incidence and distribution of diseases or as
a part of ecological or nutritional studies. The well established effects of environmental pollution on human health have as topics gained little attention from Indian Geographers.

(6) CONTRIBUTION OF THIS STUDY:

A lot of work has been done on cholera epidemic, malaria, cancer and infective diseases in the world. The epidemiology of cholera and malaria have been the most widely researched topics. So many work have been done in cholera disease in India, especially at meso and micro levels.

(a) This study has taken up four main water-borne diseases namely: Gastro enteritis, Viral-Hepatities, Typhoid (entric-fever) and Cholera, with affecting six factors like ecological, demographical, drinking water, socio-economic, environmental factor (including inner and outer environment) and behavioural factor with 33 variables. This study has taken up the analysis by different scales - micro-level study by ward, meso-level study by region and macro level study for the city as whole. Out of six factors ecological, demographical and socio-economic factors have not much spatial variations at meso and micro-levels. Parameters like rainfall, income group, age-group etc. are equally important irrespective of space. But other three factors namely drinking water, environmental and behavioural factors vary from region to region within the city. It is very much variable according to space. "Environmental behavioural model" has been prepared to explain, how factors in different regions of the city differ to explain the causes of
diseases. The model is very much useful for planning at a meso level.

(b) GIS software has been used to find out the total environmental quality of the city by overlaying above three spatial factors with 22 variables. This information will be useful to the Municipal authority as well as the people of the city for taking precautions against diseases.

(c) Spatial and temporal distribution pattern of four main water-borne diseases by main cities and districts of Gujarat over a period of five years (1989 to 1993), according to macro, meso and micro levels with the help of GIS overlaying have been done which can give an idea about diseases prone areas of the city. Control of the incidence of occurrence of diseases over space, knowledge of such kind of work will be useful for the department of health in urban areas where such diseases spread very rapidly. Planning of such urban problems can save many lives. Ahmedabad is having the highest concentration of diseases on the share of district level of data.

A study of the environmental conditions which give rise to diseases in various forms is indeed important. But equally important is the study of conditions which keep us in good health. This study will be most useful to the people, planners and administrators who are concerned to eradicate water borne diseases from this city.