CHAPTER 4

URBAN ENVIRONMENTAL HAZARDS

4.1 INTRODUCTION

The environment landscape in cities has been undergoing changes, resulting in a deterioration of the environment mainly because of an influx of population, pressure on limited land, inadequate infrastructural service facilities, and poor policy implementation by local administrative institutions. This has resulted in unmanageable urban growth and a host of related environmental problems.

Due to the multiplicity of these problems it is hard to give a single definition to describe urban environmental problems. Hardoy and Satterthwaite (1989), who have studied the urban environment of several developing countries for nearly a decade have provided the following definition:

The presence of pathogens or toxic substances in the human environment which can damage human health or natural resources such as forests, fisheries, and agricultural lands, or an inadequate supply of a resource essential to human health or urban production.

The latter category could include land, water, housing, energy and other resources required for human well-being.
4.2 ENVIRONMENTAL HAZARDS

The natural environment, the setting in which metropolitan development takes place offers resources in the form of goods and services that can be made to serve the objectives of the settlement development efforts. It also confronts metropolitan development with hazards that can threaten human welfare, cause development problems, and drain development resources (Environmental Guidelines For Settlement Planning and Management, Vol. 2, 1987).

Natural and man-made hazards such as earthquakes, cyclones, floods, unsanitary environmental conditions, contamination of air and water, and high noise levels, all endanger the lives and health of people. The extent of their impact and to what extent they can be controlled varies, but there is no doubt to the fact that they adversely affect human life.

Natural hazards such as earthquakes, cyclones or deep depressions and volcanic eruptions can in no way be controlled or eliminated. All that can be done is to take steps to reduce the extent of damage caused and mitigate the resulting human suffering. This can be done through planning in advance by identifying areas that are susceptible to these hazards, controlling development there and building structures that are resistant to these natural hazards.

On the other hand as the very name suggests man-made hazards are caused due to human activities. These hazards result due to the pollution by
man of his environment. M.W. Holgate (1979), gives the following definition to describe pollution:

The introduction by man into the environment of substances or energy liable to cause hazard to human health, harm to living resources, and ecological systems, damage to structures or amenity, or interference with legitimate uses of the environment.

Since time immemorial man has utilised the natural resources of the earth to meet his various requirements. At the same time man's activities have affected the natural environment due to the discharge of effluents into the soil and water and smoke into the air. All these activities had no adverse effect on nature for all these centuries because of the immense capacity of nature to assimilate these pollutants and rejuvenate itself. But in this last century the situation has deteriorated very rapidly resulting in the dwindling of the earth’s natural resources and its capacity to rejuvenate. This is because of the extreme pressure of population and rapid development without keeping in mind the carrying capacity of the earth. Carrying capacity is defined as the number of individuals of a given species that can be stably sustained by the environment (Thibodeau and Field, 1984). When the carrying capacity of a particular ecosystem is exceeded, it leads to damage.

Rapid urbanisation and growth of urban population has resulted in a large number of environmental problems. Such problems are seen to exist mainly in the cities of the developing countries such as Manila, Jakarta, Bangkok, Mexico City, and Indian metropolitan cities such as Delhi, Bombay,
Calcutta, and Madras. The main problems faced by the cities here are as follows (Urban Environmental Management in India: An Assessment, 1992):

1. **Water pollution**; this is mainly due to indiscriminate waste disposal, inadequate drainage and sewerage facilities, and improper disposal of industrial waste. Proper handling of wastes, both domestic and industrial is essential but grossly inadequate or totally absent. Either treatment plants do not exist at all, or when they do exist they are unable to handle the demands of an ever-growing population and rapid spread of residential areas especially in the form of multistoreyed apartments.

2. **Rapid industrial and commercial growth in urban areas leads to an increase in wastes generated**. Often these wastes are extremely toxic in nature, as in the case of effluents from leather tanneries, chemical and dye manufacturing factories, and other industrial units that use chemicals in their manufacturing processes such as battery manufacturers, printing units etc. Often due to general lack of awareness, and apathy on the part of the owners of these establishments these wastes are disposed off into water bodies and land sites without any proper treatment.

3. **Similarly other forms of solid wastes (both toxic and non toxic) and refuse from households, hospitals, hotels etc. are dumped into land fills without segregating the hazardous wastes such as those from the hospitals. These dumps then become breeding grounds for various**
disease causing organisms. If clearing process takes more than a week, than added health problems also arised. This is there in most of the Indian cities.

4. Another victim of urban life styles is the quality of the air prevailing in cities. Apart from industrial fumes being thrown into it, automobile exhaust smoke is another major pollutant. All the major cities of the world such as London, Los Angles, Moscow, Mexico City, Bangkok, and Delhi have all become infamous due to extremely high levels of air pollution mainly caused by automobile fumes. While the developed countries such as the United States, Canada, and the west European countries have controlled the situation by stringent laws and controls the other developing countries of the world are yet to control them. Indian cities are still evolving strategies in this direction.

5. Noise pollution is another problem in most cities. Noise levels are well above permissible levels in most cities especially during the day in the commercial and business areas and surrounding residential areas.

6. Urban life styles with its ever-growing demands on land and nature has little care for natural landscapes and fragile ecosystems, such as mangroves and water bodies. These get taken over by the ever-growing urban landscape, destroying nature and its associated forms of wild life. This is what is happening in Delhi where the wooded ridge area in the heart of the city has all but vanished giving way to urban structures,
while the city has lost its only lung space. Similarly agricultural lands around Indian cities too get taken away for urban use.

7. Urban centres are characterised by high levels of congestion and overcrowding. Intensive use of land with concrete structures and without any open areas with vegetation leads to the development of heat islands. These micro-climatic zones within a city develop due to the specific kind of ground situations found on these areas with the temperature levels being higher than that experienced in the rest of the region. High levels of crowding and congested living take its toll on the health of the people living there. Low levels of hygiene and cleanliness resulting due to congestion and limited amenities results in the spread of numerous communicable and water borne diseases such as typhoid, jaundice, and malaria. Crowded living conditions and urban life styles affect the mental health of the people, resulting mainly from the stress of urban living.

8. Finally, the most degraded living conditions are associated with urban slums. These are characterised by congested huts, in extremely poor sanitary and hygiene conditions. Such conditions are seen in all the urban centres of the world, be they the Harlem slums of New York, or the slums of Mexico City, Dharavi in Bombay, or the canal bank slums of Madras.

The hazards resulting from these problems cause risk to human life in varying degrees depending upon the extent of damage caused to the
environment. It is essential that pollution of the environment be controlled and be protected from unacceptable levels of risk.

4.3 CLASSIFICATION OF ENVIRONMENTAL HAZARDS

As stated above environmental hazards can be classified as natural and man-made. In this section we shall discuss the types of these hazards and the means of handling them.

4.3.1 Natural Hazards

Acute natural hazards occur irregularly and by and large rarely, and often have a sudden onset. Some are unpredictable, while for others, there may be a warning period of from a few hours to a few days before they occur. Development of modern scientific equipment has to a large extent helped in accurate prediction of oncoming natural hazards such as cyclones, earthquakes, floods etc. In regions where acute natural hazards are known to occur, three predictions are essential. First, a surveillance system designed to give warning, secondly, accumulated local experience of how to deal with such hazards and a prepared plan of action in case of the hazards occurring, and thirdly design of buildings and urban areas to minimise the impact of a particular hazard (Environmental Guidelines for Settlement Planning and Management, Vol.2, 1987).
4.3.1.1 Earthquakes

The main effect of earthquakes is the shaking of the ground, which can result in the destruction of buildings and infrastructure such as sewage and water pipe lines. It can also cause liquefaction of the soil resulting in landslides and subsidence, also fires can result due to damage to electrical facilities, and tsunamis which may flood coastal areas. Major earthquakes such as that which struck Japan in 1995, Los Angeles USA in January 1994, and Lattur in Maharashtra in 1993, resulted in large scale destruction and human suffering. The Lattur earthquake also caused extensive loss of life mainly due to lack of preparedness and structures unable to withstand earthquake shocks.

Earthquake risk is generally regional in extent. But it is possible to identify areas that are most liable to be affected by consequences of an earthquake and thus plan accordingly. Hence, site layout should be done so as to ensure that dense residential areas and essential services, such as health and emergency services like fire fighters and police stations are located where they are least prone to damage. In earthquake prone areas infrastructure facilities such as water and sewerage lines, roads and electricity supply lines should be made in accordance with earthquake resistant standards. Similarly buildings that house essential services too should be built according to earthquake resistant standards. Construction of other buildings should be controlled, especially high rise multi-storeyed structures. Countries such as Japan and the USA which have areas that are earthquake prone, have developed technology for the construction of buildings that can withstand earthquakes.
4.3.1.2 Cyclones

High velocity winds accompanied by heavy rainfall, damage structures, causes floods, surge damage and mud slides. Coastal areas along the east coast of India in the states of Tamil Nadu, Andhra Pradesh, and Orissa, and in Bangladesh, suffer heavily due to cyclonic storms that hit them mainly during the pre monsoon months. Cities in these coastal areas often face this problem resulting in loss of life and spread of epidemic diseases.

Accordingly areas subject to frequent cyclones should be avoided for large scale development. As in the case of earthquakes all structures here should be so built as to be able to withstand cyclones or damages caused by them should be minimal.

4.3.1.3 Flooding

It is a highly seasonal phenomenon, caused due to overflow from rivers, heavy rainfall, or a combination of both. Low lying areas and those located in flood plains of regions experiencing heavy rainfall are most prone to flooding. The effect of flooding on settlements is rather severe and can result in the following:

a. contamination of water supply, due to the mixing of rain water with the water supply lines;

b. overflowing of septic tanks and sewers;

c. erosion of hillsides and slopes, leading to landslides;

d. damage to buildings and property;
with water getting contaminated and standing for long durations there is a threat of spread of water borne diseases such as cholera and dysentery, and of diseases where water acts as a vector as in the case of malaria and filariasis; and

in extreme cases floods can wash away people and result in large scale loss of life.

Hence it is essential that steps be taken to control flooding, this can be done primarily by surface water drainage. In urban areas of developing countries such as the urban centres in India like in Delhi on the banks of the Yamuna, in Madras along the Adyar and Cooum, and in Ahmedabad along the Sabarmati river, low-lying areas and flood plains of the rivers are inhabited by the poor, where poor housing conditions worsen the situation. Here the objective would be to reduce flooding by use of technology that is cost effective, preferably labour intensive and easy to maintain by the residents themselves.

4.3.1.4 Water scarcity

Just as too much water is a hazard, too little water is also a hazard to human life and health. Hence drought prone areas should not be used for settlement development unless a cost effective source of clean water is available close by. Apart from its impact on health, drought situations have led to social unrest and political instability as is in the case of the African countries of Somalia and Rwanda which are seeing large scale violence and bloodshed. In Indian cities lack of sufficient rainfall results in drought, forcing
the authorities to dig wells and bore wells withdrawing excessive water often more than the recharge capacity of the water table.

Another problem associated with water related hazards is water that is unfit for human consumption. Apart from its pollution by man which we shall be discussing later on, natural processes in some areas make the waters unfit for consumption. These include excessive salinity, fluoride or iron, or certain heavy metals and other toxic chemicals that pollute the water. These occur in the earth and at times get mixed with the ground water, thus polluting it.

4.3.2 Hazards due to unchecked human activities

So far we have discussed hazards to human life and health caused due to natural occurrences. But in today's world the main threat to human life and health is from man himself. This is because when the carrying capacity of a particular ecosystem is exceeded it leads to damage (Urban Environmental Management in India: An Assessment, 1992)

As has been defined earlier the carrying capacity of a particular area identifies the number of individuals an area can sustain stably. In human systems the population density and the standard of living are the key variables that determine the carrying capacity of the ecosystem. Using knowledge and technology people are able to raise the natural carrying capacity by supplementing the natural ecosystems by bringing in energy and resources from outside (Thibodeau and Field, 1984). But there is a limit to which the carrying capacity of an area can be sustainably increased after which point
damage to the environment will set in. Also from an environmental perspective, it must be noted that high population densities in urban areas will necessarily generate wastes that might not be assimilated by the environment. Domestic wastes (sewage, sullage, and garbage), industrial and commercial wastes have to be collected and disposed in an environmentally sound manner. Otherwise they end up polluting the air, water, and land which in turn leads to ecological damage, disease and lowering of environmental quality (Urban Environmental Management in India: An Assessment, 1992).

4.3.2.1 Air pollution

Air pollution can occur as an acute incident caused by an accidental emission which can cause large scale injury to human health and even kill in extreme cases as occurred during the Bhopal gas tragedy when the killer gas methyl isocyanide leaked from the gas plant killing thousands and injuring many more and maiming even the future generations. Apart from such accidents there is a constant silent killer in our midst, it is the regular emissions from vehicles and industrial smoke that are continuously poisoning the atmosphere.

There is a clear link between atmospheric pollution and mortality from respiratory tract diseases. Smoke levels of 250 μg/ml3 and SO2 levels of 500 μg/ml3 over a 24 hour period lead to detectable increase in morbidity and mortality. Carbon monoxide from exhaust fumes also causes health hazards, and a combination of dense exhaust fumes and strong sun light can form an intensely irritating and phyto-toxic "photochemical smog". Lead in the
atmosphere from motor exhaust fumes, and other emissions from the burning of fossil fuels and industrial emissions are health hazards. Many other specific air pollutants such as, cadmium, vanadium, beryllium, arsenic, asbestos, and radioactive elements are associated with specific industrial processes (Environmental Guidelines for Settlement Planning and Management, Vol.2, 1987).

A study of air pollution levels in several cities of India indicate an unacceptably high level of suspended particulate matter (S.P.M.). It is much above the W.H.O. guidelines for S.P.M. which are 60-70 micrograms per cubic meter for the annual mean. Nitrogen dioxide levels have also shown an increasing trend over the period 1978-87 in most metropolitan cities such as Delhi and Bombay, indicating higher levels of vehicular pollution (R.B. Sunderesan, 1991).

4.3.2.2 Noise pollution

The effect of noise on the health and well being of a person depends primarily on the loudness and duration of exposure. Loudness is measured on a scale of 1 to about 130 decibels, where 1 is the smallest difference in loudness detectable to the human ear. Excess noise can cause physical and psychological disorders, interference with speech communication, reduce job performance and disruption to rest relaxation and sleep. Noise induced loss of hearing is the most readily measured medical effect, and individuals exposed regularly or frequently to 90 decibels or more are at greater risk. Sources of noise outside of factories and work places are mainly, aeroplanes, motor

In India as per the Environment Protection Act, 1986 noise pollution is regarded as an offence. But a survey of the metropolitan cities indicates that the daytime noise varies from 60 decibels (dB) in residential areas to 90 dB in busy localities (S.P. Singal, 1991). During the day the levels exceed 100 dB at certain peak periods. Near airports noise levels were around 85 dB, with increases of 20-25 dB during landings and take-off. These levels are well above the standards recommended by the W.H.O. (S.P. Singal, 1991).

4.3.2.3 Water pollution

Water gets polluted by agents of infectious diseases, or by toxic chemicals, which render it hazardous for human consumption. The pollution of water bodies such as rivers, lakes, ponds and streams etc. is caused by four different sources, sewage, industrial effluents, storm and urban run-off, and agricultural run-off (Urban Environmental Management in India: An Assessment, 1992). In metropolitan areas sewage is collected but often let out without proper treatment into the nearest water body. Urban run-off contains sullage, garbage and other wastes such as animal refuse, which find their way into storm water drains and nullahs. The first flush of urban run-off after a rain contains numerous pollutants which make it similar to or even worse than sewage.
Similarly slums that are often found along waterways in the cities, as is in the case of slums along the Yamuna in Delhi, Agra, and Mathura, along the Ganga in Varanasi, Kanpur and Calcutta, they dump all their solid and liquid wastes into the waters of these rivers. Public conveniences also do not exist in these slums and hence these waterways also are used as toilets.

Industrial effluents which contain toxic chemicals or wastes that are not biodegradable cause severe pollution of water bodies. Agricultural run-off can become an urban problem if the water source for the city is polluted outside the city by discharge of fertilisers and pesticides (Urban Environmental Management in India: An Assessment, 1992).

As these various sources pollute the surface waterways, so does the ground water get polluted when the contaminants reach it through seepage from the soil. Another form of pollution of ground water is through sea water intrusion. This occurs in coastal areas where due to over exploitation of ground water, adjoining sea water begins to seep into the water table, thus making the ground water saline and hence unfit for human consumption.

The capacity of these water bodies to assimilate these pollutants is limited. In terms of quantities domestic wastes are substantially greater, but the environmental impact of toxic chemicals cannot be compared with sewage (Urban Environmental Management in India: An Assessment, 1992).

In India with its ever growing urban population, quantities of domestic wastes in water bodies is extremely high, and in many cases it has been found
that the waters in these water bodies ends up resembling sewage, as is in the case of the Cooum and Buckingham Canal in Madras city. But, with rapid industrial growth one now finds that presence of several toxic chemicals and metals in waters is growing at an alarming rate.

The presence of mercury, lead, chromium, and manganese in quantities above permissible levels has been reported in some river estuaries located very close to alkali and rayon plants in Trombay basin, coastal waters adjacent to Bombay and Cochin, in the working areas of some welding shops, electroplating, and thermal processing plants, and the effluents of chrome tanneries (Urban Environmental Management in India: An Assessment, 1992).

4.3.3 Environmental health hazards

Apart from hazards arising from natural calamities and pollution of nature, the condition of the neighbourhood and domestic environment also play a vital role in maintaining human life and health.

4.3.3.1 Insects

Lice, fleas, flies, mosquitoes and cockroaches transmit many diseases. Of these flies and mosquitoes cause great concern. It is essential that steps are taken so as to control their breeding close to human habitation and protect people from the diseases they carry.

Flies can carry faecal matter of human or animal origin in or on their bodies and thus assist in the transmission of the enteric pathogens that cause
diarrhoea and dysentery. This fly-borne transmission is especially associated with those flies that breed in or feed upon faecal matter and also enter human dwellings and feed upon stored or prepared food (Environmental Guidelines for Settlement Planning and Management, Vol. 2, 1987).

Mosquitoes are both a nuisance and vectors for several serious diseases. The main nuisance biter in most tropical urban areas is culx quinquefas ciatus, it is also a vector for elephantiasis in Asia, Latin America, Egypt, and the coastal towns of East Africa. Their numbers have greatly increased as a result of urbanisation, because it prefers to breed in polluted waters, such as flooded latrines, septic tanks and blocked drains. The second mosquito threat to tropical urban areas is aedes aegypti. It transmits two viral diseases, dengue fever, found mainly in Asia and the Pacific, and Yellow fever an African disease. It is a domestic mosquito and breeds in small pools of clear water around houses. The third type which is of concern is the anopheles mosquito, the vector of malaria throughout the tropics. There are many different anopheles species, each having different preferred breeding sites, and there is recent evidence to show that in urban areas it has adapted to tolerate increasingly polluted waters for it's breeding. Malaria is one of the foremost causes of disease and death in the tropics, and increasing resistance of the parasite to drugs used to prevent and cure infection is a cause for alarm (Environmental Guidelines for Settlement Planning and Management, Vol. 2, 1987).

Keeping in view the extent of harm to human health these insects can cause it is necessary that adequate steps be taken to control their menace.
Past experience has shown that physical modification of the environment is a much more effective way of controlling them than through the use of chemicals and pesticides. For this it is necessary that they should not be allowed to breed and their breeding sites be cleared. This can be done through proper garbage collection and disposal. Also open defecation should not be allowed, latrines should be kept clean and covered and so also septic tanks. Storm water drains should be kept clean and water not allowed to stagnate, and no water should be allowed to stagnate around houses in open tubs, tyres etc. and storage tanks should be kept well covered. Apart from this it is essential to educate the people about these disease and the methods for their control (Environmental Guidelines for Settlement Planning and Management, Vol. 2, 1987).

4.3.3.2 Animals

The rearing of chicken, pigs, goats, and cattle is common in urban areas of developing countries as a source of food and income. Animals however are reservoirs for disease causing organisms, such as diarrhoea and dysentery. Animal dung is also a breeding ground for flies, and other parasites that cause skin infection such as hook worm (Environmental Guidelines for Settlement Planning and Management, Vol. 2, 1987).

Hence it is necessary that measures be taken to prevent accumulation of animal excreta. In view of the public nuisance these animals can cause their rearing in urban areas should be restricted if not all altogether banned. People should be encouraged to rear them outside the city where more space is available and contact between households and the animals minimal.
4.3.3.3 Hygiene

Good personal and domestic hygiene is of utmost importance in the control of diarrhoeal diseases, intestinal worm infections and other important health problems. Conditions which promote the maintenance of hygiene are as follows (Environmental Guidelines for Settlement Planning and Management, Vol. 2, 1987):

a. an abundant supply of clean water close to the dwelling;
b. adequate facilities for the disposal of human excreta;
c. adequate facilities for garbage collection, storage and disposal;
d. facilities for preparing, cooking, and storing food in such a way that it does not get contaminated;
e. public education on key aspects of hygiene;
f. reduction of crowding in dwellings; and
g. good drainage to prevent flooding and prolonged muddy and swampy conditions.

4.4 ENVIRONMENTAL HAZARDS AND HUMAN HABITATION

The extent of damage these various environmental hazards have on human health and life varies depending upon the extent of damage caused to the environment and the duration of exposure to these hazards. Often it is difficult to give a direct correlation between environmental hazards and human health, because in many cases there is a time lapse between the exposure to the hazard and the surfacing of the health implications. Also the person is
exposed to various environments such as his work environment, house environment, etc. and hence it becomes even more difficult to pin point a definite cause-effect relationship. This problem is further confounded by the ignorance of the people (especially in developing countries like India), who very often are unaware of the various hazards in their environment and are unable to make a correlation between them and their health problems.

In urban areas of developing countries environmental hazards are literally knocking at the doors of most people. These are the conditions that exist in cities such as Jakarta in Indonesia, Manila Philippines, Cairo in Egypt, and the Indian cities of Delhi, Bombay, Calcutta, and Madras to name a few.

Living in over-crowded, unhygienic conditions exposes the urban poor to water-borne diseases, infectious diseases like tuberculoses, influenza, meningitis, and respiratory problems from open fires and inefficient stoves, and lack of proper ventilation. Slums are often located on land ill-suited for human habitation such as banks of rivers, canals etc. or near dangerous industries, since these are the only affordable, or available sites in most large cities (Hardoy and Satterthwaite, 1989). The Bhopal gas tragedy was a clear indicator of the vulnerability of the urban poor to industrial accidents for these were the people located closest to the industrial site.

Absence of proper landuse zone planning and monitoring and haphazard growth of these, result in residential areas located close to busy commercial and business districts and hazardous industries. This makes them susceptible
to all forms of air pollution caused by vehicular emissions and emission from industries. Unless in cases of acute accidents as in the case of the Bhopal gas disaster, air pollutants are silent killers. Their impact on the health of the people, especially diseases associated with the respiratory tract come to be realised by the patient much later, when the damage has already been done.

Uncontrolled and non-monitored development results in the improper and unsustainable use of resources such as land and water and the consequent lowering of environmental quality. Waste disposal also becomes a problem when population pressures increase certain thresholds. Septic tanks begin to fail, drainage starts to overflow, collection and disposal of garbage becomes a problem, slums emerge, quality of the environment begins to deteriorate, and there is a lowering of the natural carrying capacity (Urban Environmental Management in India: An Assessment).

Thus, in order to maintain a good quality of the environment, free from hazards it is essential that all growth and development in an urban setting be undertaken so as not to exceed the carrying capacity of the existing ecosystem. A system of checks and standards also needs to be set up in order to maintain the quality of the environment (Fig.4.1) This would help protect man and environment from being exposed to unacceptable levels of damage and risk.

We must ensure that; a). there are adequate natural resources for human existence and urban economic activities; and b). wastes generated by households, industries and other establishments are disposed off in an
POSSIBLE POINTS ON THE POLLUTANT PATHWAY AT WHICH STANDARDS MAY BE SET

SOURCE: M.W. Holdgate (1979) "A Perspective of Environmental Pollution", P. 145.
environmentally sound manner (Fig.4.2) (Urban Environmental Management in India: An Assessment, 1992).

4.5 ENVIRONMENTAL HAZARDS IN M.M.A. AND MADRAS CITY

The above cited salient features does give the existing scenario in Indian cities. Now, it is appropriate to look into the conditions in M.M.A for the proposed comprehensive study.

MADRAS city and it’s surrounding areas which constitute the M.M.A. face numerous environmental hazards associated with indiscriminate exploitation of nature.

As regards natural hazards, cyclones coupled with heavy rain fall and sea erosion are the only ones that pose a threat to the residents of the city and its environs. Cyclones are associated with rains that hit the Tamil Nadu coast during the period of the north-eastern monsoons during the months of October to January, and during the summer months of May to July. The flat terrain of the city makes the natural draining away very difficult, and water logging takes place in low lying areas such as Mambalam, Santhome, Saidapet, and Tiruvottiyur. In the city storm water drains cover only half the roads and is non-existent in the rest of M.M.A. This further aggravates the problem of drainage of rain water. Sea erosion has taken its toll on the land along the coast to the North of the Madras City in the Thiruvottiyur-Ennore area. The sea has gnawed away chunks of the Ennore express way, mainly between Thangal and Ernavur hamlets. The sea has obliterated the full width of a road
HUMAN EXPOSURE ASSESSMENT TO HAZARDOUS WASTES

near a private container freight station at Thiruvottiyur. The 14 km. four lane 100ft. Ennore coastal highway from Kasimode (Royapuram) to Ennore has now been eroded to just 15ft. These roads are extensively used by heavy vehicular traffic as they link the city to the industrial regions of Thiruvottiyur, Ennore and Manali. Thus the destruction of the roads causes extreme hardship to all vehicles having to travel in the direction, leading to heavy congestion as it acts as a bottleneck to the smooth flow of traffic. The people living along the coast in this entire stretch are at constant threat of having their homes washed away by the sea.

With regard to man-made hazards, and those associated with hygiene conditions Madras city and its environs pose innumerable risks to the health and life of its residents. To further worsen the situation is the incapacity of the infrastructural facilities to meet the requirements of the ever-growing population.

Water is a life giver, but in the case of Madras city and its environs it is a double edged weapon. During the summer months from May to September Madras faces extreme shortage of water supply. According to metropolitan requirements, 150 liters per capita per day (lpcd) is the average requirement. But in Madras during a normal monsoon year the average supply of water is 78 lpcd, and falls to a mere 26 lpcd for the city. The rest of M.M.A. has an even lower average of 25-40 lpcd of water for all time periods (P.N.Reddy, 1993).

During the rainy season which is from October to December most of M.M.A. gets flooded. Madras receives an average annual rainfall of 1270 mm.
and over two-thirds of this is received during the rainy season (P.N. Reddy, 1993). The havoc caused by these rains is as a result of a combination of natural and man-made factors. The terrain of the region is nearly flat and hence natural flow is very slow and limited. There are numerous pockets of low-lying areas in the regions, such as Kottupuram, Adyar Estuary, Santhome etc. that are highly susceptible to flooding. As in other parts of the Deccan lakes and tanks have been the natural storage areas for rain water. The existing tank system in the Cooum, Adyar and Red Hills sub-basins play an important role in water supply, flood control, and ground water recharge. Urban growth and an ever-growing demand for land has jeopardised the future of most of the tanks in the area. Most of the tanks within the city have been taken over as building sites or are so polluted that they no longer serve the purpose of rain water storage. Moreover their supply channel are also cut off due to the growth of brick industries and other urban activities. The Vyasarpadi group of tanks is under threat. The Velachery tank has nearly been completely taken over by buildings. Tanks outside the city in M.M.A. which are experiencing rapid urban growth are now under threat of being taken over for construction by the people. These tanks include the Madipakkam tank, Korattur tank, and the Ambattur tank. Another problem is that the natural seepage of rain water into the ground, which caused the recharge of ground water too has been very much reduced. This is due to the reduction in open areas which allowed for rain water to seep into the earth and also due to the loss of tanks, for the tank beds too allowed for water to percolate into the water table. Large scale urban development has resulted in
most of the land being built upon for buildings and roads, with little care for these natural processes.

There are three waterways that flow through this region, the Kotralaiyar which forms the northern boundary of M.M.A., and the Cooum and the Adyar which flow through central M.M.A. traversing the city until they flow into the sea. Apart from this there is the Buckingham Canal that runs north-south, parallel to the coast linking these rivers. The Otteri Nallah starts from the Villivakkam tank just outside the city and flows eastwards and joins the Buckingham Canal. The waters of all these waterways flowing through the city are extremely polluted and often end up to resemble sewers. The main reasons for this are the discharge of untreated wastes at several locations such as Central Station, Nesapakkam, Saidapet and Otteri in the city and its environs. The sewage treatment plants themselves are unable to handle the load of waste water and discharge large quantities of untreated effluents. The Adyar river receives about 10 tons of BOD per day from the Nesapakkam treatment plant, the Cooum receives 12 tons of BOD per day from the Koyembedu treatment plant, and apart from this large quantities of untreated effluents are discharged into these waterways by those living along their banks, the canal bank hutsments, and the waters from the storm water drains. Thus it is not surprising that these waters are extremely polluted and hazardous to human health.

The water available to the residents of Madras city and the rest of M.M.A. is the ground water in the area and the piped water supplied by the Madras Metropolitan Water Supply and Sewerage Board (M.M.W.S.S.B.). The
piped water comes from water from the Red Hills lake the Cholavaram tank and the Poondi reservoir. Though the water supplied by the M.M.W.S.S.B. is treated before it is supplied, it is not free from contamination during the supply process. Large parts of the distribution system are too old for safe usage. About 40% of the system has served out its life span of 50 years. Water contamination is an eminent threat due to the proximity of sewage pipes. The areas most under threat are the old developed residential areas like Pursawalkam, Otteri, Triplicane, and Mylapore.

Piped water supply is mainly confined to Madras city alone. The rest of M.M.A. is solely dependent on ground water to meet its water requirements. Ground water is a fast depleting resource as a result of over exploitation, and drastic reduction in recharge potential due to the reasons indicated earlier. Also it is becoming more and more susceptible to pollution. One important cause of pollution in Madras is through sea water intrusion. This has occurred due to the over exploitation of the coastal aquifer, resulting in the seepage of sea water. The Minjur well field in the Kotralaiyar basin faces pollution of the ground water due to sea water intrusion. The coastal aquifer south of Tiruvanmiyur is also at risk of such pollution due to its proximity to the coast, hence it is necessary to control its exploitation. Ground water is also susceptible to pollution from other sources also, as is in the case of wells located close to the Cooum and Adyar rivers. As the soil in the entire area is mainly alluvium there are chances that the polluted waters of these rivers can seep into the water table especially when the water table drops as tit does during the summer months. Wells in areas such as Egmore, Chintadripet,
Saidapet, Jafferkhanpet, Adyar, are at threat of such pollution. A large number of domestic wells in Madras city and the rest of M.M.A. are shallow wells and hence are at risk of surface contamination.

A large number of slums in Madras are located along the waterways in the city. The Cooum, Adyar, Buckingham Canal, and Otteri Nullah have a population of over 1,40,000 people living in slums all along their courses (Paul Appasamy, 1989). These slums do not have any facilities for sewage and waste disposal, with the waterways serving as open toilets and garbage dumps. Analysis of the quality of these waters show high levels of bacteriological contamination, and the Biochemical Oxygen Demand (BOD) of all the waterways is extremely high with maximum levels well above 200 mg/unit, indicating very high levels of organic pollution (Paul Appasamy, 1989). These waters pose a constant threat to those living close to them, and also to pollute the ground water in the water table in the area.

Apart from water another life sustainer is air, which again is being continually polluted. Air pollution is caused by emissions from automobiles and industries. Automobiles pollute the atmosphere through emissions of carbon monoxide, hydrocarbons, nitrogen oxides, suspended particulate matter and lead. The polluting industries in M.M.A. are mainly the petrochemical industries, its ancillary industries, and the thermal power plant, the main pollutants from these are sulphur dioxide and fly-ash. Studies (National Air Quality Monitoring Network, Table 5.2) have shown that the industrial areas in and around Manali, Tiruvottiyur and Kathivakkam have high levels of air
pollution. Also the crowded commercial areas that have high traffic congestion have high levels of air pollution.

Along with air pollution vehicles and industries also cause high levels of noise pollution. Noise levels in Madras city and other parts of M.M.A. are found to be extremely high. Within the city especially during peak traffic hours noise levels exceed 100 dB, and even rising to about 117 dB along major transport arteries (P.N.Reddy, 1993).

Another major environmental hazard in Madras is that arising from improper handling of solid wastes. About 4520 tons of solid wastes are generated per day, of which 1500 tons is cattle waste. In the absence of proper handling and disposal methods, this garbage gets dumped in landfills and low lying areas. Dumping grounds in Madras city are at Velachery, Kodungaiyur, Foreshore Estate, Otteri, and Korukupet. In the absence of any proper system for handling these wastes all garbage, domestic, industrial, commercial, as well as hospital wastes are dumped together in open grounds where they become breeding grounds for flies, rats, and other disease causing organisms. As these dumping grounds are located in well populated areas they pose severe health hazards to people living in these areas.

Pollution caused by the industries located in M.M.A. is another hazard for the residents of the area. In the northern part of M.M.A. at Ennore, Manali and Tiruvotriyur are located various chemical and petrochemical industries. Apart from the pollution caused by these industries due to the discharge of pollutants such as sulphur dioxide and hydro carbons, the very nature of the
chemicals being handled in these plants gives rise to risks due to accidents caused by mishandling and spillage. Another set of hazardous industries are the tanneries. These are located in the south-western part of M.M.A. in Pammal, Pallavaram, and Tirunirmalai. Effluents from these industries pollute the soil and ground water in these areas, the most hazardous being chromium.

The health implications of such pollution is enormous but at the same time it is extremely difficult to directly relate a particular pollutant and the occurrence of a disease in an area, especially on a short term basis. Out breaks of epidemics of cholera, jaundice, and gastro enteritis are known to be caused by polluted water. Also the occurrence of malaria and filariasis can be related to proximity to stagnant and polluted water bodies. But other health implications such as those related to air pollution, noise pollution or exposure to carcinogenic chemicals are very slow to manifest themselves and it is very difficult to pinpoint a single causative factor.

Thus we can say that the natural environment in today's world is being threatened by the implications of the activities of man. Man has always exploited nature to fulfil his various needs, and nature has provided for them but now man's requirements are beyond the capacity of nature to satisfy and the resulting slaughter of nature has resulted in large scale degradation of the environment. Urban societies are most destructive of nature. High densities of population has put immense pressure on the environment, leading to
widespread degradation of the air, water, and natural environment in the urban areas. Madras city and the rest of M.M.A. are no exception and the region faces widespread degradation of the environment due to pollution of surface and ground water, high levels of air pollution, high noise levels, and destruction of natural flora and fauna. In tune with these observations the next chapter tries to do a detailed study of environmental hazards in M.M.A. and identify environmentally sensitive areas, where these hazards are widespread and endanger the health and well being of the residents.