1.1. Definition-Environment

The word Environment is derived from the French word “Environ” which means “surrounding”. Our surrounding includes biotic factors like human beings, Plants, animals, microbes, etc and abiotic factors such as light, air, water, soil, etc.

Environment is a complex of many variables, which surrounds man as well as the living organisms. Environment includes water, air and land and the inter-relation ships which exist among and between water, air and land and human beings and other living creatures such as plants, animals and micro organisms (Kalavathy, 2004). She suggested that environment consists of an inseparable whole system constituted by physical, chemical, biological, social and cultural elements, which are interlinked individually and collectively in myriad ways.

The natural environment consist of four interlinking systems namely, the atmosphere, the hydrosphere, the lithosphere and the biosphere. These four systems are in constant change and such changes are affected by human activities and vice versa (Kumarasamy et al., 2004).

Components of Environment

Our environment has been classified into four major components: 1. Hydrosphere, 2. Lithosphere, 3. Atmosphere, 4. Biosphere.

Hydrosphere

Hydrosphere includes all water bodies such as lakes, ponds, rivers, streams and ocean etc. Hydrosphere functions in a cyclic nature, which is termed as hydrological cycle or water cycle.

Lithosphere

Lithosphere means the mantle of rocks constituting the earth’s crust. The earth is a cold spherical solid planet of the solar system, which spins in its axis and revolves around the sun at a certain constant distance. Lithosphere mainly, contains soil, earth rocks, mountain etc. Lithosphere is divided into three layers-crusts, mantle and core (outer and inner).
**Atmosphere**

The cover of the air, that envelopes the earth is known as the atmosphere. Atmosphere is a thin layer which contains gases like oxygen, carbon dioxide etc. and which protects the solid earth and human beings from the harmful radiations of the sun. There are five concentric layers within the atmosphere, which can be differentiated on the basis of temperature and each layer has its own characteristics. These include the troposphere, the stratosphere, the mesosphere, the thermosphere and the exosphere (Kalavathy, 2004).

**Biosphere**

It is otherwise known as the life layer, it refers to all organisms on the earth’s surface and their interaction with water and air. It consists of plants, animals and micro-organisms, ranging from the tiniest microscopic organism to the largest whales in the sea. Biology is concerned with how millions of species of animals, plants and other organisms grow, feed, move, reproduce and evolve over long periods of time in different environments. Its subject matter is useful to other sciences and professions that deal with life, such as agriculture, forestry and medicine. The richness of biosphere depends upon a number of factors like rainfall, temperature, geographical reference etc. Apart from the physical environmental factors, the man made environment includes human groups, the material infrastructures built by man, the production relationships and institutional systems that he has devised. The social environment shows the way in which human societies have organized themselves and how they function in order to satisfy their needs (Kumarasamy et al., 2004).

**1.2. Urbanization**

Urbanization is the process of population moving towards towns and cities from rural areas, and taking up the culture and work prevailing in the urban areas. The country’s population is spread over villages and also towards their nativity with formal occupation, mostly agricultural or its allied ones, making their living with or without ancestral property like lands or houses. An analysis of distribution of population between rural and urban areas of country will reveal the extent of urbanization. Deteriorating quality of urban and suburban environment is to a great
extent the result of injudicious land use and is a threat to the whole socio-economic system. Thus planned cities are as necessary as planned farms (Tyler Miller, 1992).

1.2.1 Urban Ecosystem

Ecology is simply the study of organisms and their surroundings. Most urbanites are unaware of the connection between their livelihood, quality of life and their dependence on the processes and cycles of the natural world. For those living in urban areas, many of the processes that explain the relationships between plants, animals and their natural habitats appear unfamiliar or inappropriate in a city. Urban ecology shows how these processes are the same ones that affect the urban communities’ humans inhabit (Nadine Anne Bopp, 2006).

1.2.2 Urbanization in World

The arguments of Kelly and William (1984) that the slow growth of agricultural land stock and high growth of population of labour force in developing countries are factors that presumably push rural population toward urban areas are not correct for the recent past. The sluggish performance of manufacturing (as compared to agriculture) remains largely responsible for the observed slower pace of urban growth in developing countries, and may have decelerated urban growth from what other wise would have been higher rates in the 1980s and 1990s by curbing net rural to urban migration. Even though manufacturing is performing well but cannot generate adequate employment being capital intensive is unlikely to accelerate rural to urban migration. The likely deceleration of rural to urban migration could be the important reason for the slowing down of urbanization in the developing countries in recent times.

The push factors like population growth and unemployment etc., and pull factors like opportunities in the urban areas are debated in the studies of India’s urbanization. The National Commission on Urbanisation (1988) has termed them as factors of demographic and economic momentum respectively.

Census is the main source of data on urban population for not only India but also most of the countries of the world. Census defines urban areas based on certain criteria. In India since 1961, two important criteria namely: i.) statutory administration and ii. ) economic and demographic aspects have been adopted to
declare certain settlements as towns. The former includes civic status of towns such as municipal corporations, municipality, cantonment board, notified area committee, etc., and the later includes criteria like population size, density of population and percentage of work force in non-agricultural sector. The former is also known as statutory town and the latter as census town. These two types of town based on two different criteria have added complexity to the urbanisation process in India. For example, the predominance of non-agricultural activities is expected to be found in urban areas, but surprisingly we have significant number of towns in the country which are predominantly agriculture oriented. Such paradoxical development creates doubts about the quality of urbanisation in India (Bhagat, 1992).

The United Nations estimates indicated that at mid 1990s, about 43 per cent of the world population lived in urban areas. With the urban population growing two and a half times faster than its rural counterpart, the level of urbanisation was projected to cross the 50 per cent mark in 2005. United Nations projections further showed that by 2025, more than three- fifth of the world population would live in urban areas (U. N. 1993).

The fertility decline could also be the another important factor for lower urban growth in several parts of the developing world particularly in Latin America where total fertility rate declined from 6 in the early 1960s to 3 in the early 1990s (United Nations. 1993).

The growth rate of urban population of developing regions has been declining recently. It was estimated to be 3.9 per cent per annum during 1980-85, which declined to 3.79 per cent per annum during 1985-90, 3.62, and 3.43 during 1990-95 and 1995-2000 respectively. The decline in the rate of urbanisation is also continuing in developed regions of the world. As a result, some of the European countries have experienced negative urbanisation during 80s (U. N. 1993).

The continued absence, namely, adequate data on rural to urban migration in most developing countries as well as on natural increase in rural and urban areas separately precludes attribution of the slowing down of urban growth in most of the countries to any single demographic process. It reflects the effects the host of factors like the relatively week expansion of urban industries and price shifts unfavourable
Scientists suggest that there is overpopulation when organisms (humans in this case) become so numerous that they degrade the ability of the environment to support their kind of animal in the future. The number of people Earth can support in the long term (without degrading the environment) given existing socioeconomic systems, consumption patterns, and technological capabilities is called the human carrying capacity of the planet at that time. This indicates that the study of population is not simply about population density, but also about the number of people in an area relative to its resources and the capacity of the natural environment to sustain human activities the area's carrying capacity. The biophysical aspect of the carrying capacity can be defined as the maximum population size that could be sustained under given technological capabilities. Likewise, social carrying capacity of a system can be described as the maximum population that could be sustained under a given social system and its associated pattern of resource consumption. It can thus be concluded that the critical difference between the terms overpopulation and population density lies in the amount of resources available and the number of human beings consuming them. Population growth and its environmental and social impact know no national boundaries. Environmental degradation is compounded by lack of food security, soil losses, uneven distribution of the water supply, consumptive lifestyles, and many other socioeconomic factors leading to loss of biodiversity and natural resources (Sabiha Daudi, 2002).

The City is a relatively recent form of social organization. Homo sapiens, the present human form has existed on earth for about 40,000 years, but cities have existed for less than 10,000 years. Jericho in about 7000 B.C. grew from village to a "city" of about 3,000. 3,500-4,000 B.C. first large city (population of about 25,000) were established in Mesopotamia. A "city" refers to a place of relatively dense settlement dense enough so that city residents can not grow their own food. A city population, therefore, is always dependent upon its "hinterlands" to provide it with food. Upuntil very recently about 200 years ago that proportion was limited to about 5% of an entire population. So cities existed, but there was no urbanization.
Urbanization refers to a process in which an increasing proportion of an entire population lives in cities and the suburbs of cities. Historically, it has been closely connected with industrialization. When more and more inanimate sources of energy were used to enhance human productivity (industrialization), surpluses increased in both agriculture and industry. Larger and larger proportions of a population could live in cities. Economic forces were such that cities became the ideal places to locate factories and their workers. At mid-century only 17.8% of the population of Developing Country societies lived in cities, but in the fifty years since 1950 that percent has increased to over 40%. By the year 2030, almost 60% of Developing country populations will live in cities. In just a few years the World will become predominately urban about 80-85 years after that happened in the United States (Fig1.1) (www.urbanization.com.2005).

Rapid economic development “industrialization, population growth and unplanned urbanization “were determined to be the main causes of these environmental problems. Some recommendations are also made for mitigating and managing these problems in the sustainable urban development perspective.

According to current estimates, cities occupy 4% or less of the world’s terrestrial surface, yet they are home to almost half the global population, consume close to three-quarters of the world’s natural resources, and generate three-quarters of its pollution and wastes. Moreover, the UN estimates that virtually all net global population and economic growth over the next 30 years will occur in cities, leading to a doubling of current populations. This growth will require unprecedented investment in new infrastructure and create undreamed challenges for political and social institutions.

Nowhere are the opportunities more promising or challenges to sustainability more daunting than in the rapidly urbanizing regions of the world. These transforming cities represent the engines of growth for the developing world and, in all regions, will continue to be the centres of innovation, culture, and the arts. These same cities, however, are the loci of increasing poverty, pollution, disease, political instability, and social inequality. The transformation of surrounding land due to urban expansion and urban dwellers ever-increasing demand for energy, food,
goods, and other resources is behind the degradation of local and regional environments, threatening basic ecosystem services and global biodiversity.

Although the growth of urbanized regions will be a major challenge in the coming decades, the rate of urbanization is not accelerating. In fact, urbanization rates were higher in the past decades than projected for in the coming years yet, because of their increasing population base, the absolute numbers of new urbanites is enormous (Cohen, 2004).

1.2.3. Urbanization in Big Cities

Virtually all the population growth expected at the world level during the next thirty years will be concentrated in urban areas. Also, for the first time, the number of urban dwellers will equal that of rural dwellers in 2007. These findings are from official estimates and projections of urban, rural and city populations prepared by the Population Division of the UN Department of Economic and Social Affairs. The “World Urbanization Prospects: The 2001 Revision” presents estimates and projections of urban and rural populations for major areas, regions and countries for the period 1950-2030. It also provides population estimates and projections of urban agglomerations with 7,50,000 or more inhabitants in 2000 for 1950-2015, and the population of all capitals in 2001. Major findings of the study, are:

- Half the world population is expected to live in urban areas in 2007. The urban population reached 2.9 billion in 2000 and 3 billion in 2010. It is expected to rise to 5 billion by 2030, whereas 30 per cent of the world population lived in urban areas in 1950 and the proportion of urban dwellers rose to 47 per cent by 2000 and is projected to attain 60 per cent by 2030.
- Almost all of the population increase expected during 2000-2030 will be absorbed by the urban areas of the less developed regions. During that period, the urban population of these regions is expected to increase by 2 billion persons, nearly as much as will be added to the world population, 2.2 billion.
- In 1995-2000, the world’s urban population grew at a rate of 2.2 per cent per year. During 2000-2030, it is projected to grow at an average annual rate of 1.8 per cent; at that rate, the world’s urban population will double in 38 years.
• The urban growth rate of less developed regions reached 3.0 per cent per year in 1995-2000, compared to 0.5 per cent in more developed regions. This rate will continue to be particularly rapid in the urban areas of less developed regions, averaging 2.4 per cent per year during 2000-2030, consistent with a doubling time of 29 years.

• In contrast, the rural population of the less developed regions is expected to grow very slowly at just 0.2 per cent per year during 2000-2030. The world rural population will remain nearly stable during 2000-2030, varying between 3.2 billion and 3.3 billion.

• The process of urbanization is already very advanced in the more developed regions, where 75 per cent of the population lived in urban areas in 2000. Nevertheless, the concentration of population in cities is expected to continue so that by 2030, 84 per cent of the inhabitants of more developed countries will be urban dwellers.

• There are marked differences in the level and pace of urbanization among the major areas constituting the less developed regions of the world. Latin America and the Caribbean, as a whole, are highly urbanized, with 75 per cent of the population living in urban settlements in 2000 - a proportion higher than that of Europe and twice as high as estimated for Africa or Asia. With 37 per cent of their respective populations living in urban areas in 2000, Africa and Asia are considerably less urbanized and, consequently, are expected to experience rapid rates of urbanization during 2000-2030. By 2030, 53 per cent and 54 per cent, respectively, of their inhabitants are expected to live in urban areas. At that time, 84 per cent of the population of Latin America and the Caribbean will be urban, a level similar to that of North America, the most highly urbanized area of the world.

• The proportion of people living in very large urban agglomerations or mega cities is small. In 2000, 3.7 per cent of the world population resided in cities of 10 million inhabitants or more, and by 2015 that proportion is expected to rise to 4.7 per cent. In 2000, 24.8 per cent of the world population lived in urban settlements with fewer than 500,000 inhabitants, and by 2015 that proportion will likely rise to 27.1 per cent. In 2000, 41.8 per cent of the population in developed countries lived in urban settlements with fewer than 500,000 inhabitants and by 2015, that proportion is expected to rise to 43.0
per cent. In less developed regions, where the majority of the population still resides in rural areas, the proportion of people living in small cities was 20.7 per cent in 2000 and will rise to 23.8 per cent by 2015.

- In 2000, 52.5 per cent of all urban dwellers lived in settlements with fewer than 500,000 inhabitants, a proportion that is expected to decline slightly by 2015, but still remain over 50 per cent. Consequently, the trend towards concentration of the population in larger urban settlements has not yet resulted in a marked decline of either the proportion or the number of persons living in smaller urban settlements.

- Large urban agglomerations do not necessarily experience fast population growth. In fact, some of the fastest growing cities have small populations and, as population size increases, the growth rate of a city’s population tends to decline.

With 26.5 million inhabitants, Tokyo is the most populous urban agglomeration in the world, followed by Sao Paulo (18.3), Mexico City (18.3), New York (16.8) and Mumbai (16.5). By 2015, Tokyo will remain the largest urban agglomeration with 27.2 million inhabitants, followed by Dhaka, Mumbai, Sao Paulo, Delhi and Mexico City, all of which are expected to have more than 20 million inhabitants (www.emeraldinsight.com).

1.3. Urbanization in India

The population is growing at the rate of about 17 million annually which means a staggering 45,000 births per day and 31 births per minute. If the current trend continues, by the year 2050, India would have 1620 million populations. Population explosion is one of the most threatening issues facing contemporary India particularly by the Indian cities. One of the most important reasons for population explosion in the cities of India is the large scale rural to urban migration and rapid urbanization (Kamal Raj, 2005).

Due to uncontrolled urbanization in India, environmental degradation has been occurring very rapidly and causing shortages of housing, worsening water quality, excessive air pollution, noise, dust and heat, and the problems of disposal of solid wastes and hazardous wastes. The large and metropolitan cities present a particularly depressing picture today. The situations in metropolises like Mumbai,
Kolkata, Chennai, Delhi, Bangalore, Kanpur, Hyderabad etc., are becoming worse year by year. The problems of finding space and housing for all have been intensified. Slums have become an inevitable part of the major Indian metropolises. Environmental pollution in India can broadly be attributed to rapid industrialization, energy production, urbanization, commercialization, and an increase in the number of motorized vehicles (Maitra, 1993). Vehicles are a major source of pollution in cities and towns. The concentration of ambient air pollutants in the metropolitan cities of India as well as many of the Indian cities is high enough to cause increased mortality. The rate of generation of solid waste in urban centres has outpaced population growth in recent years with the wastes normally disposed in low-lying areas of the city’s outskirts (State of the Environment, 1995).

1.3.1. Urbanization in India and Metropolitan Cities

Urbanization is a process whereby increasing proportions of the population of a region or a country live in urban areas. Urbanization has become a major demographic issue in the 21st Century not only in India but also all over the world. There has always been great academic interest in the Indian urbanization process and a number of scholars have analysed India’s urban experience, particularly in the post independence period (Bose, 1978; NIUA, 1988; Mohan, 1996). The level of urbanization in terms of the proportion of urban population to the total is low in India but the urban population in absolute terms is high. Since the first regular census of India was taken in 1881, almost all census reports have commented on the urban growth. During the last three decades in India, the link between urbanization and environment and the threat to the quality of life have emerged as a major issue.

(i) Pattern and Trend of Urbanization in India during 1901-2001

The pattern and trend of urban population and number of towns in India during 1901 to 2001 shows that (Table 1.1) total urban population has increased more than ten times from 26 million to 285 million whereas total population has increased less than five times from 2387 million to 10270 million from 1901 to 2001. A continuous increase has been noticed in the percentage of urban population from 11% in 1901 to 17% in 1951 to further 28% in 2001. In the same fashion the number of towns had also increased from 1916 in 1901 to 2422 in 1951 and then to 4689 in 1991. This reveals the rapid urbanization process in India (COI, 2001).

Table 1.2 shows percentage growth of urban population in India by size class of town during 1901 to 1991. The process of urbanization in India reflects a certain degree of abnormality because of the fact that more than 60% of the urban population of the country lives in Class I town alone and remaining below 40% urban population lives in the smaller sized towns. An unremitting increase has been noticed for percentage of total urban population in Class-I city over the decades (1901 to 1991), while class IV, V and VI towns have experienced a continuous decline. However, class II and III towns have almost constant percent of total urban population over the decades. About three-fold increase has been found in the percentage of total urban population in class one city, from 23% in 1901 to 65% in 1991. This depicts a huge concentration of urban population in large cities. The urbanization in India shows the pattern of ‘inverted triangle’ where majority of the urban population resides in the Class I cities (COI, 2001).

(iii) Growth in the Number of Million Plus (1,000,000 Population or More) Cities in India during 1901-2001

Table 1.3 shows the growth in the number and population of million plus cities in India during 1991 to 2001. There was only one million plus city (Kolkata) in 1901 in India. It became two in 1911 (Mumbai added) and was constant during 1911 to 1941. Million plus cities increased to five in 1951 and continuously increased after this decade and became 23 in 1991 and currently it is 35 in 2001 census. Total population also increased in the million plus cities from 1.51 million in 1901 to 107.88 million in 2001, almost a fifty fold increase. The percentage decadal growth rate in the total population of million plus city was noticed highest during 1941 to 1951, because of the incidence of partition. After independence also, the decadal growth rate was more than 50% in each decades. This illustrates the realistic situation of exhausted growth in the million plus cities. Looking at the percentage of total population of India residing in million plus cities, it reveals that it has increased drastically from less than 1% in 1901 to 3% in 1951 and further to 8% in 1991. Again, the percentage of total urban population of India residing in million plus
cities has also increased drastically from 6% in 1901 to 19% in 1951 and further to 33% in 1991 (COI, 2001).

(iv) Trend in Total Population and Annual Growth Rate in the Four Metropolitan Cities of India during 1901-2001

More than thirty fold increase has been noticed in the population of Delhi in 100 years, from 0.41 million in 1901 to 12.8 million in 2001, whereas, there has been 20 fold increase in Mumbai’s population, from 0.8 million to 16.4 million from 1901 to 2001. However, Chennai has experienced more than 10 fold increase (0.59 million to 6.4 million) in its total population during last 100 years whereas, Kolkata has experienced the lowest increase (less than 9 fold) in its total population among the metropolitan cities in last ten decades. The maximum growth rate has been noticed during 1941 to 1951, highest in Delhi (90%) followed by Mumbai (76%) and Chennai (66%). However, Kolkata has noticed comparative low growth rate (29%) during the same period. This was the era of partition in India when a huge influx of migration has taken place to big cities because of the Hindu Muslims communal riot. A large numbers of population joined the big cities after the insurrection. After independence, Delhi experienced the highest decadal growth rate (close to 50%) in its total population in all the censuses (1951 to 2001), followed by Mumbai where growth rate was about 40% during those Census years. However, Kolkata experienced continuous declining decadal growth rate from 1951 to 2001. On the other hand, Chennai has experienced a mixed pattern of high and low decadal growth rate during last 50 years. Initially Kolkata was the most populous city of India till 1981, but Mumbai surpassed it in 1991 Census. Again, Delhi is expected to cross the population of Kolkata in the next Census of 2011 if both cities will experience same growth rate pattern. Thus it is evident with the table that Mumbai and Delhi metropolis are experiencing profuse growth in their population (Table 1. 4) (COI, 2001).

1.3.2. Impact of Urbanization on the Environmental Quality in the Metropolitan Cities of India

Urbanization and its allied process have made a profound impact on the environment of the metropolitan cities of India. It has been accepted by the United Nations that it is quite impossible for developing countries to provide in advance the
urban planning and design because it is not possible to accurately project the urban growth.

(i) Slum Situation in India and its Metropolitan Cities

The Govt. of India Slum Areas (Improvement and Clearance) Act of 1954 defines a slum ‘as any predominantly residential areas, in which light or sanitary facilities or any combination of these factors are detrimental to the safety, health or morals’. The vast majority of the people who migrated to the city were attracted by opportunity and comforts offered by modernization. They belonged to the working class and found it difficult to secure accommodation within their means. So, they squatted on every open space available, as near their workplaces as possible and put up huts with cheap building materials. In this way slums grew in number and population.

Total and slum population in India according to size/class of towns during 1991 shows that 41% of the total slum population was residing in million plus cities, where 27% of total population of India resides (Table 1.5). However, cities with population between 0.5 million to 1 million have only 9% of total slum population where 20% of total population was residing. Further, cities with population between 0.3 million to 0.5 million have only 6% of total slum population where 19% of total population was residing. This shows that cities with population between 0.5 to 1 million and city with population between 0.3 to 0.5 million have very less percentage of slum population whereas million plus cities have more percentage of slum population. It reveals that the opportunity in the medium city is less than the million cities. Therefore the unskilled population is more attracted towards the million cities and thus joins the slums for their residence. On the other hand, the towns with population less than 50,000 show little more percentage of total slum population (21%) than its share of total population (18%). It shows the poor housing quality in the small towns and also may be because the semi-pucca and kachcha houses may be identified as slum. Slum population is a serious problem of the mega-cities of India. A large population of Mumbai, Kolkata and Delhi lives in slum, despite of several Government housing policies.

Table 1.6 shows the percentage of slum population in the four metropolitan cities of India during 1981 to 2001. A continuous increase has been found in the
percentage of slum population over the last three decades in the four metropolitan cities of India in which Mumbai was highest. In 1981, 31% populations of Mumbai were residing in slum, and in 2001 nearly half of Mumbai’s population (49%) was living in slums. However, Kolkata and Delhi had not shown as severe condition as Mumbai. The proportion of slum population was 30% and 18% in 1981 in Kolkata and Delhi, which increased to 36% and 23% respectively. On the other hand, it is little bit comfortable sign for Kolkata and Delhi that in 2001 the proportion of slum population has decreased to 33% and 19%, respectively. Although Chennai has lowest slum population among the four metropolitan cities yet it has experienced continuous increase in the slum population over the three decades. There was 14% slum population in Chennai in 1981, which increased to 15% in 1991 and further 18% in 2001(COI, 2001).

(ii) Composition of Solid Wastes in the Four Metropolitan Cities of India

Delhi exhibits the highest percentage of ash, which is about 52% of the weight of all the solid waste, followed by Mumbai, Kolkata and Chennai. The reason that Delhi has the highest percentage of ash as solid waste may lie in the fact that Delhi is a large industrial centre with mainly metal industry, which uses coal as a source of power and the number of industries is growing day by day because of the growing urbanization. About 10% of all the solid waste generated in the metropolitan cities is paper. Textile waste generation ranges between 3 to 5%. Leather waste is generated mostly by Chennai and generated lowest in Mumbai. Kolkata generates the largest amount of plastics among all the metros, which accounts for 8% of all the weight of the solid waste materials. This is a serious problem and will increase in future because of increase in packaging of consumer’s goods, if proper management will be not available. Also this has an irreversible health hazards (CPCB, 1998).

(iii) Status of Municipal solid waste generation and collection in Metropolitan Cities of India

Mumbai generated the largest amount of Municipal solid waste in 1996, which was 5355 tonnes/day followed by Delhi (4000tonnes/day), Kolkata (tonnes/day) and Chennai (3124 tonnes/day) (Table 1.8). But if we consider the per capita generation of solid waste, it was largest in Chennai. The lowest per capita waste
generation was in Kolkata, which is about 350gms/day. Again about 90% of the
generated Municipal solid waste in Mumbai and Chennai were being collected.
However, in Delhi there was not adequate system of collection as only 77% of the
generated Municipal solid wastes were collected (CPCB, 1998).

(iv) Growth in motor vehicles in India and in Metropolitan Cities

Motor vehicles, which are the main source of vehicular pollution, are
constantly increasing in number since the year 1990 (Table 1.9). With in 10 years
from 1990 to 2000 there has been almost a three-fold increase in the number motor
vehicles in India. On an average 10% increase has been found in each year, which is
a serious concern for air pollution. Again, the number of vehicles in Delhi has
increased from 1813 thousand in 1991 to 2630 thousand in 1996, a one and half
times increase in 6 years followed by Chennai. This is because of lack of the sub-
urban train facility in Delhi with a huge number of commuting population. On the
other hand, increase in the number of vehicles was quite less in Mumbai and
Calcutta compared to Delhi and Chennai (Table 1.10). The 15.15 kilometer long
Inderlok-Mundka line, the first gauge (4 ft 8.5 inches) Metro line of India, is now a
part of the metro network. This line is expected to benefit over one lakh commuters
residing on west delhi localities (www.transport in Delhi.com).

(v) Vehicular Emission Load

Table 1.11 shows the estimated vehicular emission load in tonnes per day in
the three metropolitan cities of Delhi, Kolkata and Chennai in 1994. Among all the
vehicular emission loads, the amount of Carbon monoxide (CO) was found highest
followed by Hydro Carbon and Nitrogen Oxide in all the three metropolitan cities.
The total amount of all type of vehicular emission load was found highest in the
atmosphere of Delhi (1046 tonnes/day) followed by Mumbai (660 tonnes/day) and
Calcutta (294 tonnes/day). Carbon monoxide contributes to more than 65% in all
the three metro cities, which was 651 tonnes/day in Delhi followed by Mumbai (497
tones/day) and Kolkata (188 tonnes/day). The amount of Suspended Particulate
Matter (SPM) in the air was highest in Delhi (10.3 tonnes/day) followed by Mumbai
(5.6 tonnes/day) and Kolkata (3.3 tonnes/day). As the previous table shows that in
Delhi the numbers of registered vehicles are highest, the vehicular emission load
also substantiates it, as all the elements were found highest in Delhi. The ingredient
of vehicular emission load affects the health of the people and deteriorates the quality of life of the residence of metro cities (Transport research wing, 1997).

(vi) State of Ambient Air Quality in Four Metropolitan Cities of India

Although air pollution is only one of the many environmental hazards in urban centers of the world, along with water contamination, hazardous wastes, overcrowding, congestion, and so on, it is a unique problem as it affects every resident, it is seen by every resident, and is caused by every resident (Maitra, 2000).

Table 1.12 shows the state of ambient air quality in the four metropolitan cities of India during 1991 to 1995. Here air quality has been measured by the presence of SO₂ (Sulphur dioxide), NO₂ (Nitrogen dioxide) and SPM (Suspended Particulate Matters) in µg/cu.m in the air, which causes air pollution. One good sign is that the presence of SPM in the air of the metro cities has been declining over the years but only exception is Delhi where the presence of suspended particulate matter has been increased from 390 to 410 mg/cu.m from 1991-95. The concentration of SO₂ has increased in Mumbai over the five years but in Kolkata it has declined significantly.

(vii) Waste Water Generation, Collection and Treatment in Metropolitan Cities

Like air pollution, water pollution is also one of the increasing problems due to the growing population. Water resources are diminishing not just because of large population numbers but also because of wasteful consumption and neglect of conservation. With rapid urbanization and industrialization, huge quantities of wastewater enter rivers. Table 1.13 shows the volume of wastewater generated (in millilitre per day) from different domestic and industrial sources, the volume ultimately collected and the amount of waste water treated before it is ultimately disposed off, in the four metropolitan cities of India.

The volume of domestic wastewater generation was highest in the metropolitan city of Mumbai, which was 2228.1 ml/d followed by Kolkata (1383 ml/d) and Delhi (1270 ml/d) and the lowest was in Chennai (only 276 ml/d). The generation of industrial wastewater was also highest in Mumbai. Again looking at the percentage of waste water collection from the four metropolitan cities, Chennai and Mumbai performed better than Delhi and Kolkata. Regarding the treatment of
the collected waste water in all the metro cities, the water is disposed only after primary and secondary treatment. Again the collected wastewater in Mumbai was mainly disposed off in the Arabian Sea and in Kolkata some amount was disposed in the Hugli river and the rest was used in the fish farming. However, in Delhi and Chennai the waste water was mainly used for agricultural works and the remaining water was disposed in the Yamuna river in Delhi and in the Bay of Bengal in Chennai (Anon, 1997).

(viii) Noise Levels in the Metropolitan Cities

Table 1.14 shows the average noise levels in various metropolitan cities of India both during the day and night in the industrial area, commercial area, residential area and as well as in the silence area during 1997. The noise pollution was noticed above than the prescribed standard in all the metro cities. Kolkata experienced the highest noise pollution level in all the areas like residential, commercial, and Industrial in both during day and night. Mumbai was in better situation than Kolkata but worse than Delhi in respect of noise pollution in all areas. In 2010 Mumbai had highest noise level both day and night.

1.3.3. Living Condition in the Metropolitan Cities in India

Table 1.15 shows housing characteristics of the four Metropolitan Cities and urban India in 1998-99. In Mumbai 34% of the household lived in semi-pucca and 3% in kachcha houses followed by 33% and 9% respectively in Chennai. However, in Delhi, 11% household resides in semi-pucca and less than 1% in kachcha houses. It is a good sign for Kolkata that there were only 5% semi-pucca houses and almost negligible kachcha houses. This shows that in Mumbai and Chennai housing situation was poorer than Kolkata and Delhi. On the other hand, the houses in these metros are very much overcrowded. More than three people residing in a single room, is condition for 56% of the population of Mumbai followed by 43% population of Kolkata, 30% population of Chennai and one-fourth population of Delhi. Further, five and more person residing in a room, such miserable condition, was faced by 28% population of Mumbai followed by 17% of the population of Kolkata and about 10% population of Delhi and Chennai both. Looking at the sanitation condition of the metro cities, it is apparent that, almost universal flush toilet facility is available in Mumbai followed by 90% in Kolkata and 89% in Delhi.
However, the matter-of-fact is that more than half of this facility in Mumbai is available in public place and not in house premises. Kolkata and Delhi might have the similar situation. Again it is unfortunate to note that about 9% population of Kolkata and Delhi uses pit toilet. Further what is the worst situation that 9% of Chennai’s population does not have toilet facility at all followed by 6% in Delhi. This shows the inadequate planning of Municipal Corporation because of unprecedented population pressure.

As regard to the sources of safe drinking water, the situation was best in Mumbai where almost the entire population had access to piped drinking water. However, a substantial population was dependent on hand pump in Kolkata (35%) followed by Chennai (31%) and Delhi (13%). On the other hand, in Chennai, 6% of population was dependent on the sources other than hand pump and taped/piped water. Considering the methods of purification of drinking water, again it is a very deplorable fact that, half of the urban population in India does not purify drinking water at all. In Kolkata three fourth populations did not purify drinking water followed by 62% of population of Delhi. However, the situation was little bit better in Mumbai and Chennai where 27% and 43% population respectively, did not purified drinking water. But at the same time, majority of the Mumbai population purified drinking water by straining by cloths only. The situation reveals the danger of diseases related to water-borne. This may cause serious health problems especially to the slum dwellers and low-income population.

Electricity facility was almost universal to Mumbai’s population whereas 10% population of Chennai and 6% population of Kolkata did not have the electricity facility. Main type of fuel used for cooking in urban India was LPG followed by biomass fuel and kerosene. However, in Kolkata and Chennai more than 50% population used kerosene. There was very less percentage (less than 9%) of user of biomass fuel and others in all the four metro cities, except Kolkata where 15% population uses it. This enhances the problem of indoor pollution in the metro cities (Kudesia and Tiwari, 1993).

### 1.4. Urbanization in Tamil Nadu

As per the 2001 Population Census, Tamil Nadu’s urban population is placed at 27.2 million accounting for 43.79 per cent of the State population. While
urbanization in Chennai was cent per cent, in the districts of Dindigul and Coimbatore 66 per cent each and more than half of the population in Kanyakumari, Nilgiris, Thirunelveli, Madurai, Thiruvallur, Theni and Kancheepuram in Ariyalur, the least urbanized district, urban population accounted for only 11 per cent of the total population. Urban population accounted for less than 20 per cent in the districts of Thiruvannamalai (18%), Pudukkottai (17%), Dharmapuri (16%), Perambalur (15%) and Villupuram (14%).

1.4.1 Slum Population: A Profile
The salient features of slum population as per the Census 2001 are given below:

i. The number of persons living in slums was placed at 28.38 lakhs (14.32 lakh Males and 14.06 lakh Females).

ii. Among the six Corporations in the State, the relative share of slum population was the highest in Chennai (25.6%) followed by Tiruchi (21.7%), Salem (20.0%), Madurai (19.1%), Tirunelveli (13.8%) and Coimbatore (6.5%).

iii. In the concentration of slum population Chennai district tops with a total slum population of 10.79 lakhs followed by Madurai (1.76 lakhs) and Tiruchi (1.62 lakhs).

iv. Regarding literacy rate among slum population, slums in Kanyakumari district had the highest literacy rate of 90.0 per cent followed by Dindigul with 87.91 per cent and Thiruvallur district (85.77%). In terms of male-female literacy rate of the slums male literacy rate was highest in Dindigul district (93.55%) and the female literacy in Nagercoil (86.66%).

Mushrooming growth of slum population in the State exerts increased pressure on provision of minimum basic services such as education, health, water supply, housing and other basic infrastructure including sanitation. (Population dynamics, 2001).

Urbanization status in Tamilnadu was represented in tables (Table1.16 to Table1.18). Due to uncontrolled urbanization in India, environmental degradation has been occurring very rapidly and causing shortages of housing, worsening water
quality, excessive air pollution, noise, dust and heat, and the problems of disposal of solid wastes and hazardous wastes.

Recently released provisional Census 2001 results place the population of Tamil Nadu at 62.1 million comprising of 31.3 million males and 30.8 million females (Table 1.19). The rural and urban population are 34.9 million and 27.2 million. The density of population is placed at 478 per sq.km. and the sex ratio 986 per 1000 males. The total working population is estimated at 27.8 million comprising 23.7 million main workers and 4.1 million marginal workers. The number of non-workers has been placed at 34.3 million. In total population, 0-6 age group accounted for 10.98 per cent. The literacy rate increased to 73.47 per cent from 63 per cent in 1991; 82.33 per cent for males and 64.55 per cent for females. The proportion of urban population rose to 43.9 per cent from 34.2 per cent.

Among the 15 major States in India, Tamil Nadu is the sixth largest populous State and Tamil Nadu’s population accounted for 6.0 per cent share of national population at 1027.02 million. Among the districts, Coimbatore (42.24 lakhs) has emerged as the most populous district, followed by Chennai (42.16 lakhs). The districts of Nilgiris (7.65 lakhs), Perambalur (4.87 lakhs), Karur (9.34 lakhs) and Ariyalur (6.94 lakhs) had a population of less than one million.

1.4.2. Decadal Growth

There is a drastic deceleration in growth of population during 1991-2001 compared to the preceding decade (1981-91). The growth rate obtaining at 11.19 per cent during 1991-01 is much lower than the 15.39 per cent recorded during the previous decade. Tamil Nadu has the second lowest growth of population, next only to Kerala (9.42%), among the 15 major States in India.

1.4.3. Density

With Tamil Nadu’s geographical area of 1.3 lakh sq.km. being constant, the increase in population from 55.9 million in 1991 to 62.11 million in 2001 had pushed up the density of population from 429 in 1991 to 478 in 2001 per sq.km. Similarly, at the all-India level, the density had increased at a faster rate from 267 to 324 in 2001 per sq.km. West Bengal (904) was found to be the most densely populated State and Rajasthan the least dense (165). Tamil Nadu took the sixth
position in this regard. Among the districts, excluding Chennai, with 24231 persons per sq.km, Kanyakumari had the highest density of 992 and Sivagangai the lowest with 275 persons per sq.km.

1.5. Pudukkottai Town – The Study Area

Pudukkottai was the capital of the only princely state of Tamilnadu during the British time (1686 to 1948) and presently is district headquarters. It is one of the planned towns of India; Home of one among the earliest cave temples (about 1300 years old) with a continuous tradition till date; A notable centre for arts and temple architecture during the period of royalty. The Government Museum, the Palace and impressive public buildings are a few other attractions to this town. It is located on Tiruchirappalli - Rameswaram NH 210, about 50 km south-east of Tiruchirappalli and about 60 km south of Thanjavur. Pudukkottai is connected with Tiruchi, Madurai, Thanjavur, Karaikkudi with Regular bus service. It has a notable station of southern railways which connects Pudukkottai with Chennai, Chidambaram, Thanjavur, Tiruchi and Rameswaram. It is situated in the valley of the Vellaru - 6½ km to the north of the river. It stands on a ridge that slopes gradually towards the south.

1.5.1 History of Pudukkottai

- In 1784 Pudukkottai was a thick forest (It is a MARUTHAM). In 1799 Veerapandia Kattabomman entered into this thick forest for their protection. (i.e) Collector office and Town RC church were situated in the centre of the forest.
- In 1826 Kings destroyed the forest trees and practiced agriculture. Then Vellalar people changed the Vellar basin environment and stagnated for irrigation. They converted forests into fields. North of Vellaru is called Konadu and South area is Kanadu.
- During 1680-1730 Regunatharaja Thomdaimon constructed New Kottai. So this was named as “PUDUKKOTTAI”. Old name was Thondaimon Nadu.
- In Tamil Nadu in 1901, the first Car was purchased by Pudukkottai King. In 1904-Pudukkottai King donated one steam bus. It ran between Trichy and Pudukkottai. Before the introduction of buses, people travelled from Pudukkottai to Trichy and Thanjavur people by Judka.
In 1912 Pudukkottai Corporation was started.

In 1929 Train transport was started.

1.5.1.1. Early History

Of the founding and early history of the town, there is very little hard evidence. 'Pre-historic' burial sites in Sadaiyap-parai, west of Thirugokarnam and on either sides of Thirukkattalai ‘cart-track’ indicate that this region of the town, as other parts of this tract, was the home of early men. When and how such a megalithic settlement crystallized into a populous town mangalam or nagaram, is not quite clear.

According to ‘A Manual of the Pudukkottai State (2004)’, the megalithic settlements may have grown into a populous town of Kalasa-mangalam, which became an important settlement of the Chettiyars and Karala-Vellalar communities. The mercantile part of this town grew into a nagaram, called Senikula-manikka-puram with a merchant-guild. With the accession to power of the Pallava-rayars of Vaiththur, Kalasa-mangalam became the capital of a Palayam. To the west of Kalasa-mangalam, was Singa-mangalam. Parts of these two mangalams became the eastern and western halves of the modern Pudukkottai town. Near them grew up another nagaram, Desabala-manikka-puram by name.

1.5.2. Mythological Story of Origin

There is also mythological story about the origin. A General History of the Pudukkottai state (1916) recounts the following story. According to this, one Muchu-kunda-chakravarti, a Chozha king, who had his capital, Thiruvarur in the Thanjavur district, in one of his tours through his dominions was so struck with the beauty of the tract to the north of the Vellaru that he thought of building a town there. The Rishi Parasara fixed an auspicious hour for commencing operations, and Kalasa-mangalam, consisting of 'nine cities', (blocks) was brought into existence. The king Muchukunda applied for inhabitants to the God Kubera, who sent him 1,500 families. The story was probably invented, after the town had become rich and its merchants were found to be very wealthy. In this account fact and fiction are inextricably mixed (Venkatarama Ayyar, 2004).
1.5.3. Pudukkottai Town Past and Present

Pudukkottai may be considered as divided into the following blocks: The town proper, a densely populated block, consists of wide straight streets running east to west and north to south, and intersecting one another at right angles. In the centre are now the ruins of the 'fort' with thick and high ramparts (only part of the western wall remains.). Within it at the centre stood what was called the 'old palace' containing a shrine to Dakshina-moorthi, a Durbar Hall that was used on state occasions by the former Rajas of Pudukkottai, and the palace stable. State functions and ceremonies, including the Dassara, were conducted here. Abutting on the inner fort on its eastern side are situated the temple of Santha-natha-swami, and the picturesque Sivaganga tank, popularly known as Pallavan-kulam, with its central mandapam, flights of steps and substantial parapets.

Outside these run the four main streets, called Raja Veedhi-s in Tamil. Thus there are four main streets (Raja Veedhi-s); East Main Street (Keezha Raja Veedhi), West Main Street (Mela Raja Veedhi), North Main Street (Vadakku Raja Veedhi) and South Main Street (Therku Raja Veedhi). Beyond these the naming of the street is regular, like East Second Street, East Third Street, etc. South Main Street is the bazaar street, and is the commercial centre of the town.

Machuvadi, Rama-chandra-puram, Ganesh Nagar, Gandhi Nagar, Marthanda-puram, Santha-natha-puram and Lakshmi-puram in the south and Rajagopala-puram near the railway station were residential suburbs. Sandhaippettai, to the west of the town proper, was and is, as its name implies, the market place. The market, which was formerly held on the roadside, has been shifted to an open space to the south of the road where permanent sheds have been erected for the sale of commodities. The market, which is held every Friday, is the largest in the district. Also there is a ‘farmer’s market’ where the farmers sell their produce without the middlemen, in the west fourth street.

To the west of the town lies Thirugokarnam at the foot of a rock. Here is the famous temple of Gokarnesvara and Brahadambal. The Goddess was the tutelary deity of the former Rajas of Pudukkottai, who consequently styled themselves ‘Sri Brahdamba-dasa’ or the ‘servants of Sri Brahadamba’. They were ceremonially
installed on the gadi and anointed at this shrine. It is in the name of this deity that the coin called the Amman-kasu was struck. Thiruvappur is another suburb. This suburb was once a centre of silk weaving and was mostly inhabited by the silk-weaving Sourashtrian community called Patnool. According to the Statistical Account of Pudukkottai (1813) there were 30 looms in the place in 1813, and according to Pharaoh's Gazetteer, it was an emporium with an 'extensive weekly market', and 'numerous bazaars in which cloths of various qualities and the best in the province' were sold. The weekly market referred to here, was subsequently transferred to Sandhaippettai. The dyers of the place prepared pink dhotis which had a wide reputation, but at present their craft is moribund. Near is the Kavinattuk-kanmai, the largest tank, in the district.

There is a Government Museum in Tirugokarnam. It was opened in 1910. It consists of different sections like

- Arts and Industries-representing local arts and industries with specimens from outside the State for comparison and study
- Economic section containing a representative collection of local cereals, fibres etc.,
- The Natural History section
- Ethnology-with a fine selection of arms and armour and of musical instruments
- Numismatics-a fairly representative collection of Indian coins
- Archaeology-illustrative of the large field of ancient monuments and sculpture for which the State is famous
- Paintings
- Zoology

1.6. Geography of Pudukkottai District

The original princely state of Pudukkottai was a land-locked territory, with Tiruchirappalli, Thanjavur and Ramanathapuram as its neighbours. At the time of being made as a separate district in 1974 the coastal strip of Aranthangi was added to it. Presently, the boundaries of the Pudukkottai District are the Bay-of-Bengal in the east, Thanjavur and Tiruchirappalli in the north, Tiruchirappalli in the west and
Sivaganga and Ramanathapuram in the south. It is having a 36 km. of seashore in the east. Area: 4661 square kilometres.

1.6.1. Location and Area

Pudukkottai is one of the new districts formed after the 1971 census, on 14th January, 1974. It is one of the small districts of Tamil Nadu with an area of 4661 sq.Kms. The district lies between 78 degrees 25' to 79 degrees 15' of the eastern longitude and 9 degrees 50' to 10 degrees 40' of the northern latitude. This district is bounded by Tiruchirappalli in the north, Thanjavur in the north-east, Bay of Bengal in the east and Ramanthapuram in the south. It has a coastline of about 36 Kms. Total area of the district is 4651 sp. Kms. Headquarters of the district is Pudukkottai.

1.6.1.1. Terrain

The terrain of the district is generally flat; Dry open lands with cultivation as well as semi-barren wastelands form the basic Pudukkottai country. On the western surface of the plain emerge rocks of low and middle elevation. The scrub jungle, once plentiful, is to be met with now in a few pockets only. The terrain is divisible into two broad portions with distinctive physical aspects, eastern and western. The dividing line may be taken as a north-south line passing through the town of Pudukkottai. The lands west of this line comprise the greater portion of Kolattur and Thirumayam taluk-s and are rocky. In the east are Alangudi Pudukkottai, Aranthangi and part of Thirumayam taluk-s, and are bereft of hard rocks. Alluvia and soft rock are found here.

1.6.1.2. Hills

Though the Tamil word used for the hills of Pudukkottai is malai, that is mountain, none of the outcrops would meet the requirement of the definition. There are numerous hills and lofty rocks are to be found in Pudukkottai. The important among them are the Narttamalai hills, Sevalur hills and Annavasal hills. Fine quality granite is available in plenty. Names of a number of places bear malai as suffix or prefix like Narttamalai, Viralimalai, Malayadippatti, Malaiyakkoil, etc.
1.6.1.3. Plains

The Pudukkottai terrain studded with hills in the west of the district gently slopes towards the flatland, estuaries and seacoast in the east. The plains of east Pudukkottai consist of miles of open country, ploughed fields and tidal mudflats. The presence of alluvial soil on the east Pudukkottai surface makes it fertile and suitable for agriculture.

1.6.1.4. Tanks

The district's tanks are ubiquitous. Irrespective of the geology, tanks, called kanmai in Tamil, can be seen distributed over the entire district. These tanks irrigate the district's agricultural fields.

1.6.1.5. Rivers

Rivers in Pudukkottai are only jungle streams that themselves take their rise from tanks. Since the tanks have surplus only for a short period around the monsoon time, most rivers are dry for most part of the year. The most significant stream is Vellaru. The other streams or rivers are the Pambaru('Snake-river'), the Agniyaru('Fire-river'), the Ambuliyaru etc.

1.6.1.6. Seacoast

The length of seacoast in the district is about 36 kilometers. Where the rivers of the district enter the sea, estuarine islets have been formed. The point off Mimisal, where Kolavanaru joins the sea, is one such islet. The Pudukkottai seaboard, like the rest of the Coromandal coast, has a simple structure.

1.6.1.7. Climate

The district has a hot tropical climate, humid near the coast. The summer season is from March to May, May being the hottest (Temperature about 37 °C). South-west monsoon lasts from June to September. October and November constitute the retreating monsoon season. The north-east monsoon is over by the second-half of December.

The relative humidity is between 50 and 80 per cent, but during February-July the air is drier. The annual rainfall is 950 mm. The sky is generally cloudy during the monsoon. In the rest of the year it is mostly clear. Recorded history of
Pudukkottai lists a succession of years that have witnessed drought and the consequent famine.

1.7 Transportation

There are no national highways passing through the district. The total length of roads in this district is 3243 Kms. Comprising of 78.10 Kms. of state highways, 434.30 Kms. of major district roads and 2730.60 Kms. of panchayat roads. The total length of metre-guage railway line in the district is about 84 Kms. with 12 railway stations connecting Pudukkottai town with Tiruchirappalli as also Karaikkudi and Manamadurai in the adjacent Ramanathapuram district, meter guage is now converted into broad -guage. Arantangi is connected with Thiruvarur in the adjacent Thanjavur district. The railway line from Chennai to Rameswaram passes through this district. The transport handled by the railways in the district is very meagre on account of the low route length and limited potential for transportation in the hinterland.

1.8. Industries

Pudukkottai district is not gifted with wealth. There are no mineral deposits worth mentioning in the entire area of the district. However, a narrow belt of good grade feldspar and quartz is reported to be available in Kulattur taluk ; pink granite deposit is reported to be available in Ponnamaravati area of Tirumayam taluk. The reserves of limestone reported to be available in Adanakottai area of alangudi taluk is estimated at about 8230 tonnes and the present level of exploitation is only 200 tonnes. The district is industrially backwards and the three taluks, viz. Alangudi, Tirumayam and Kulattur had already been declared by the State government as backward area entitling industrial units to be set up there for a central subsidy of 15 per cent on fixed capital investment. There are six large scale industries in the district as given below: (1) M/s. Cauvery Spinning and Weaving Mills Ltd., Cauvery Nagar. (2) M/s. Pudukkottai Textile Mills Ltd., Pudukkottai. (3) M/s. Sri Nadiambal Textile Mills Ltd., Arantangi. (4) M/s. Ramachandran Chemicals (P) Ltd., Kiranur. (5) M/s. Sundaram Industries Ltd., Pudukkottai. (6) The State Government Printing Press, Pudukkottai. Among the six large scale industries mentioned above, three are located in Pudukkottai itself. There are 392 small scale units. The main industries are engaged in wood based industries, tinkering, fabrication of metal products,
printing and binding, manufacture of agricultural implements, manufacture of agricultural implements, manufacture of cement tiles and other cement products, automobile servicing and repairing and safety matches. In addition to the small scale industries, there are a number of village and cottage industries. Prominent among them are pottery, blacksmithy, carpentry, small lime kilns, small brick kilns, basket making, rope making and synthetic gem cutting.

1.8.1. Important Industries

1. National Oxygen Ltd.: Trichy Pudukkottai Road, Mathur Village, Pudukkottai, Tamil Nadu. It is a manufacture and traders of industrial gases such as Oxygen gas, dissolved acetylene gas, medical Oxygen, Nitrogen gas, liquid Oxygen, liquid Nitrogen high purity Nitrogen.

2. SRF Ltd.: (Formerly known as Shriram Fibers Ltd.) Viralimalai, Dist. Pudukkottai, Tamil Nadu. It is a manufacture of Nylon industrial yarn tyre cord/fabrics leather auxiliaries, fluoro carbon refrigerant gases and hydrofluoric acid, besides nylon moulding powder in technical collaboration with chemtex fibres INC. USA.

3. M/s. SRF NipponDenso Ltd. is a joint venture with Nippon Denso Co. Ltd. of Japan for manufacture of automotive electricals.

4. M/s. SRF Transnational Holdings Ltd. is a subsidiary company.

1.9. Tourism

List of Tourist places are,

- Sri Kokaraneswarar temple
- Government Museum
- Sittannavasal
- Kudumiyalai
- Kodumbalur
- Viralimalai
- Narthamalai
- Tirumayam
- Avadaiyarkovil
1.10. Education

In the urban areas Pudukkottai, there are 59 Higher Secondary Schools, 85 Secondary Schools, 124 Middle Schools and 202 Primary Schools per every 10000 population. Kiranur, Alagapuri and Alangudi have the highest proportion of Higher Secondary Schools (151), Secondary Schools (327) and middle Schools (347) respectively per 10,000 urban population. But the case of primary schools the highest proportion of 993 schools per 10000 population is found in Kadiapatti.

1.10.1 University and Colleges


1.11. Population Trends

The story of population growth in Pudukkottai is fairly in tune with the classical theory of demographic transition. The total population for the town in 1901 censes was only 20,347 whereas it has grown upto 1,01,723 in 2001. The absolute term, the population of Pudukkottai increased by whopping 2,86,382 during 1991-2010. Although the net addition in population during each decade has increased consistently.

- In 1901-1921 had stagnant population
- In 1921-1951 had steady growth
- In 1951-1991 had rapid hith growth
- In 1991-2010 has high growth.

1.11.1 Trend in Birth/Death rate and infant mortality rate

The birth rate for Pudukkottai is 21.7 in 1991 which is nearly half of the rate as compared to the birth rate in 1951. The first three decades showed a significant decline in birth rate (Table 1.24). In respect of death rate the decline is gradual every year and the death is only 7.3 in 1991, which is below the state average. The infant mortality rate has also come down from 76.3(1951) to 30.9(1991). In 2010 mortality rate is reduced to 14.5%
1.12. Resource

1.12.1. Land Resource

The total geographical area of the district is 4657.24 Sq.Km. The biggest taluk area wise being Kulathur and smallest Pudukkottai (Table 1.25).

The utilization of land area in Pudukkottai is up to 66%. About 29.4% land are not available for cultivation. About 22% of the soil is reported to be suffering from salinity/alkalinity (Venkatarama Ayyar, 2004).

1.12.1.1. Soils

The major soil types, on the order of their extent, are laterite, mixed and red loamy types. About one fourth of the soils suffer from one problem or other, the main problems being salinity/alkalinity (Venkatarama Ayyar, 2004).

1.12.1.2. Crops cultivated

The important cultivated crops are shown in Table 1.26. Cereals such as Rice, Cholam, Varagu, Ragi, Maize and Cumbu were cultivated. Pulses such as Red gram, Cow Pea, Horse gram, Black gram and green gram were cultivated. Oil m seeds, Condiments, sugars and fiber crops were also cultivated.

1.12.2. Trends in Production and Productivity

Though agriculture is the main source of sustenance for a majority of the population, the scenario is not quite encouraging. Dry land farming which is predominant suffers badly due to frequent poor monsoons affecting agricultural production. Cereals have shown fluctuations both in area cultivated and production from 1980-81 to 1995-1996 (Venkatarama Ayyar, 2004).

1.12.3. Horticulture

An interesting feature in the farm sector is the development of orchards using dry farming techniques and minimum irrigation in the formation stage. Banana is the main fruit crop under irrigation. The major fruit crops are,

Jack, Guava and Acid lime are raised only on a very limited scale. Except for banana, the rest are raised on the red or lateritic soil belts (Table 1.27).
1.12.3.1. Vegetables

Brinjal (*Solanum melongena*) and ladies finger (*Hibiscus esculentus*) are the two major vegetables cultivated here.

1.12.3.2. Plantation Crops—Cashew

A noteworthy feature of this area is the cultivation of cashew as a rainfed crop over extensive areas in the lateritic belt. However no cashew processing unit has been established locally. The nuts are taken to numerous processing units that have sprung around Panruti in Cuddalore district (Venkatarama Ayyar, 2004).

1.12.4. Forest Resources

Major portion of the forests of this area was the personal preserve of the kings of Pudukkottai. Large forest areas were preserved as the hunting grounds for the rulers, their families and friends. The control of the forests were transferred initially to the Revenue Department in 1948 and subsequently to the forests department in 1950.

1.12.4.1. Flora

Much of the natural forests have been converted into plantations. Only isolated patches of natural forests like Narthamalai R.F are being managed by the forest department and these forests support the following forest types:

**Tropical dry evergreen forests**

These forests are unique in nature and the floristic compositions are as follows.

**Characteristic species**

- *Manilkara hexandra*.
- *Mimusops elengi*.
- *Albizia amara*.
- *Memecylon umbellatum*.
- *Diospyros ferrea syn maba buxifolia*.
Top Canopy

- *Mimusops elengi.*
- *Diospyros ebenum* (Occasional)
- *Strychnos nux vomica* (Occasional)
- *Strychnos potatorum* (Occasional)
- *Diospyros chloroxylon* (Occasional)
- *Drypetes sepiarea* (Rare)
- *Syzygium cumini.*
- *Canthium decoccum* (frequent)
- *Zizipus glaberrima* (frequent)
- *Acacia leucophloea* (frequent)
- *Catunaregam spinosa* (frequent)
- *Buchanania lanzan* (Occasional)
- *Sapinda emarginatus* (Occasional)
- *Albizia amara.*
- *Albizia lebbek.*
- *Tamarindus indica.*
- *Azadirachta indica.*
- *Borassus flabellifer.*

Under wood

- *Cassia carandas* (abundant)
- *Flacourtia indica* (locally abundant)
- *Diospyros ferrea* (frequent)
- *Grewia sp* (abundant)
- *Gymnosporia spp* (frequent)
- *Ixora arborea* (frequent)
- *Tarenna ascatica* (frequent)
- *Memecylon umbellatum.*
- *Garcinia spicata.*
Shrubs
- *Strobilanthes*
- *Dononaea viscosa* (abundant)
- *Glycosmis pentaphylla.*
- *Ochna asiatica.*

Herbs
- *Hemidesmus indicus.*

Southern Carnatic umbrella thorn forests. This is an economically important forest type supporting many valuable fuel wood species (Table 1.28) (www.National Information System.com)

1.12.4.2 Fauna

Eventhough forests of this area were the game resources of the former rulers and supported a variety of fauna, degradation have reduced the wildlife wealth. The animal commonly found are catalogued in table 1.29.

Around Viralimalai murugan temple, Peafowls are seen in large numbers in tank bed plantations, private fields and a top trees.

1.12.4.3. Man made Forest

The entire Pudukkottai area abounds in cashew and Eucalyptus tereticornis plantations and the Arimalam series of Eucalyptus plantations is justly famous. Casuarina on a limited scale.

1.12.4.4. Rare and Threatened species

Rhyncosia velutina and Santapura madurensis are the two plant species which have become vulnerable and endangered, respectively.

1.12.5. Surface water

The district is one of the good rainfall regions with an average monthly rainfall of 77.13 mm (Table 1.30). This is ensured a high percent of water table in the district as indicated by the following data for 1995-1996.
Agniyar basin is the main source of surface water in Pudukkottai. An important point to be noted in this basin is that there are no reservoirs across any of the rivers of this basin, the main reason being none of the rivers has copious flow. No drought, flood or cyclone has been reported between 1985 and 1996.

1.12.6. Heritage Resources

The rare collection is the sections of Geology, Zoology, Painting, Anthropology, Epigraphy and Historical records are very interesting and informative. The beautiful bronze sculptures of various periods are really attractive pieces of this museum.

1.13. Tourist Arrivals

Fig 1.2 shows the information on tourist flow indicates that there has been a steady increase in number in the district between 1990 and 1994. In the later period the flow declined (1994-96) (ENVIS, 2005).

1.14. Growth of Vehicle population

The vehicle population in general has increased over eight times in Pudukkottai town. Four wheelers have registered a three fold increase in their population. Similarly two wheelers have recorded a manifold increase in numbers from 1,472 to 1,93,479 (1986-96) (ENVIS, 2005).

1.15. Density of Population

The overall density of the population has registered an increase from 246 persons/ sq.km to 317 persons/sq.km. The density of population was 3000 persons per sq.km in urban sites during 1996. Table 3.1 show the population status in the year 2001 (ENVIS, 2005).

1.15.1. Urban slum population

The recorded slum population in this area was around 30,000 during 1991. No relevant data is available for comparative analysis of slum population over the period 1981-96.
1.16. Urban Services

1.16.1. Water supply

Ground water is the major sources of supply in the district and the designed capacity is 126.95 lakh litres. The averages per capita water supply is 60lpcd (Litres pr capita per day) with per capita water availability of 67 lpcd at Pudukkottai. Over 85% of the town population is covered by protected drinking water supply. The estimated sewage generation is 51.8 lakh liters. There is no under ground sewage system. There is no treatment plant in the town and therefore there is no organized disposal of sewage (ENVIS, 2005).

1.16.2. Municipal Solid waste generation

The total daily solid waste in urban areas of Pudukkottai district is 45.5 tonnes with collection efficiency of 89%. Of these 25 tonnes are generated in Pudukkottai town itself. Primary component of the waste is compostable matter and accounts for 85% of the total waste.

1.16.3. Health and Hygiene

Over a period of 10 years (1987-96), largely reported water borne diseases have been gastroentitis, Diarrhoea and malaria. The reported incidence of death occurred only due to diarrhea (Table 1.31 and 1.32).

Under Indian Medicine systems hospital and bed facilities are available for Siddha and Homeopathy. There are totally 314 registered practitioners in various form of medicines.

1.17. Poverty Line

96,733 families are reported to be below poverty line (ENVIS, 2005).

1.18. Industrial Development and Environmental Status

There is not much industrial activity in this area. There are only 29 large and medium units operating while as many as 3000 units are reportedly working in the small scale sector. A major facility available to industrial enterprises in the district is the developed plots and built-up sheds provided by SIPCOT and SIDCO respectively.
1.18.1. SIPCOT Complex

The SIPCOT complex is situated 7km from Pudukkottai on the Pudukkottai-Trichy road in an extent of 412 acres. Of this area, around 51 acres are allotted to SIDCO Industrial Estates where build up sheds are made available to entrepreneurs (ENVIS, 2005).

1.19. Acqa Culture activities

The acqa culture activities practiced in Pudukkottai have been of semi intensive type. There are 50 such units covering 231 hectares of area (ENVIS, 2005).

1.20 Environmental Institutions

There are 16 NGOs rendering their services for creating environmental awareness and campaigns (Venkatarama Ayyar, 2004).