CHAPTER – I
INTRODUCTION

1.1 Introduction

The activities of man have a significant influence on the environment. This influence, local or global, is difficult to predict because the exchanges of energy, mass, and momentum are very complex. Urbanization increasingly has been responsible for dramatic environmental changes. The city with a compact mass of buildings and pavements exhibit a complex geometry of streets and a large spatial heterogeneity. This constitutes a profound alteration of the natural landscape, resulting in a large number of micro-environments. Alterations of the regional physics and microphysics occur together with the production of pollutant gases and particles. The complex and constantly changing mosaic influence urban ecology in a variety of ways by altering such things as the physiological comfort of humans, human health risks, cooling and heating requirements, seasonality, floral, faunal habitats etc. The coastal zones are characterized by highly diverse ecosystems that are important as sources of food and habitats for many species. In many areas in the world, population, economic activity and arable land are concentrated in coastal zones, which have led to a decrease in its resilience and adaptability to variability and change.

1.2 Global and Regional Aspects

At present, the signs and consequences of human activity can be found everywhere on the Earth. One of the typical features of environmental pollution is global dispersion of a number of contaminants. Numerous data undoubtedly indicate the existence of a large-scale contamination of the biosphere. Another important feature of environmental pollution is the existence of increased pollution levels in the urban areas as compared with the other areas.

The contamination levels also increase during the transition from the rural parts to urban areas, where the main industrial centers and main pollution sources are concentrated. Another distinctive and repeatedly registered feature of the general
picture of contaminants distribution in the environment is the localization of some pollution. It is significant that the number and diversity of pollution components is growing as well. The contaminants with global distribution combine with hundreds and thousands of ingredients of local and regional distribution. Most of these substances are wastes and discharges from different local industries and activities. Humans usually get to know about its existence in the environment from various signs of environmental trouble. These include the decline of abundance of various floral and faunal species, poisoning or diseases among people, degradation of coastal ecosystems, fouled beaches, unusual algae blooms, and so forth.

The different urban coastal ecosystem regions are subjected to various and specific impact factors. The combination of these factors under specific conditions ultimately defines the ecological situation in a given area. In particular, an effort to stress the alarming features of the ecological situation in many urban areas is necessary.

1.3 Review of Literature

The literature analysis is done based on the fields such Meteorology, Geology, Air Pollution, Noise Pollution, Hydrology, Solid Waste Pollution, Environmental Impact Assessment, Sustainable Development, Environmental Management, Geographical Information System and Remote Sensing Applications.

1.3.1 Meteorological Studies

Barett, E.C, (1964). investigated the local variations in the rainfall trends in Manchester. The study covered the years from 1925-59 and statistical techniques adopted show the variation between seasons.

Oliver, J (1964). studied the upland temperature and humidity in South Wales. The study analyzed the influence of the topography on the weather, altitudinal modification on the air masses, decrease in temperature inversion and seasonal variations.

Nigel, Arnel (1996), attempted to analyze the effects of global warming on the hydrological system like river flow and resources. A quantitative technique was
suggested to analyze the impact caused due to climate changes and its interactions with components of the hydrological system.

Lowry, W. P (1977) studied the difference in climate between the urban and rural areas by analyzing the climatic variables, background climate, departure caused by topography and geographical features, composition of the atmosphere, causing alterations in urban temperature both seasonally and diurnally.

Sathyanarayana, B (1987). analyzed the magnitude of heat island through Summers Theoretical Model on a daily basis for a period of three years. The study focused on the nature of urbanization and the meteorological variables. The study covered the major cities of India.

Hulme, Mike (1999). analyzed global mean surface temperature for the whole of Europe, using grid boxes ACAIA. The study prepared temperature anomalies model and also analyzed the influence of aerosols in global warming.

1.3.2 Geological Studies

Curry, D.A (1977), analyzed the geology of the Plymouth area in Devon County. The evolution, geological time scale, geological and geomorphologic transition in the region.

Maguire, J. David and Brayshay, Mark (1987). studied in detail the Plymouth region for field excursions for students and tourists interested in exploring the region.

Iyengar, R.V et al., (1990) an array of ocean bottom magnetometers across in the Bay of Bengal. The recordings show variations in the components of the magnetic field and determined from the inhomogeneous electrical conductivity of the crust or mantle. The study revealed that conductive layer is seen at a depth of 17km below the ocean bottom coinciding with Moho.

Mukhopadhyay, Manoj and Krishna, M.R (1990), study revealed the Eastern Margin of India (ECMI) evolved in consequence to the breakup of the Gondwanaland; the ECMI covers the offshore extensions of the five Mesozoic basins that were developed over the rifted and faulted continental crust. The
modeling revealed a transitional crust below the ECMI whose thickness varies from 16-24kms and the modeling postulates a thicker oceanic crustal wedge seaward of the transitional crust below the most parts of the ECMI.

Pateria, M.L, Raviverman, V et al., (1990), in the study of two seismic lines were shot from east coast of India around Madras to the west coast of Andaman in 1988,. The study revealed that the two oceanic ridges along the Bay of Bengal are the ancient structures both being older than the oldest sediment deposited over the oceanic basement.

Venkateswarlu, P.D and Bose, P.K (1990), the total field anomaly characters observed in relation to the bathymetric changes, along the eastern coast of India, show no correlation in the anomaly pattern, to identify any anomaly number. This study supports the hypothesis that the crust is more than continental plate in Bay of Bengal and presumably formed during the magnetic quiet of the Cretaceous age.

Dikshit, K.R, Kale, S and Kaul, M.N(1994), described the geomorphological diversity of India, the focus was on the influence of climate and geology on geomorphologic features.

Ballukraya, P.N and Ravi, R (1995), made a subsurface lithological mapping of the east coast along the Madras city, revealed the distinct influence of the ridge on checking the salt water intrusion in the fresh water areas. The study also revealed that part of the east coast maybe undergoing slow upliftment.

Srinivasan, R (1996), briefly explained the urban geology of Madras city and its environs and also analyzed the impact of development on the geology and the level of degradation caused due to the reckless exploitation of the fragile ecosystem.

1.3.3 Studies on Air Pollution

Stern, C.Arthur (1975), is an very important contributor to the field of air pollution studies, suggested various sources of pollutants, methods of measurement of pollutants, methodology for the analysis and last but not the least the impact of air pollution.
Jakeman, A.J. and Simpson, R.W (1985), assessed air quality impact from elevated point using hybrid model where the sector was averaged. The Gaussian Plume Model is used to analyze the spread of pollutants.

Rao, B. Srinivas et al..(1987), analyzed the Sulphur dioxide using diurnal and seasonal variations with the meteorological parameters like wind speed and temperature.

Rao, I.N, Rao, P.R. et al..(1991), made a thorough statistical analysis of the ambient air quality in Ramagundam Super Thermal Power Project. The pollutants sulphur dioxide and suspended particulate matter concentrations variance level was calculated using ANOVA table.

Kamalak Kanan, G and Sengupta, Sudeep (1993), studied the influence of industrial growth in Barauni and the environmental air quality deterioration. The seasonal data for the air pollutants is compared with the land use pattern and the wind speed.

Wagner, Erich (1994), analyzed how environmental management can control various forms of pollution to levels that do not pose threat to health of the people and environment. The paper studied the sources of local air pollution using a statistical approach to quantify the relation between economic activities, meteorological condition and air pollutant levels.

Ravichandran. C et al.,(1996), studied the influence of the automobiles in Tiruchirapalli which poses a serious threat to its air quality. The air pollutants sulphur dioxide, nitrogen dioxide and suspended particulate matter varying concentration levels is analyzed.

13.4 Hydrological Studies

The hydrological studies are further divided into riverine, marine and groundwater studies.

13.4.1 Riverine Studies

Ledger, D.C (1964), analyzed the hydrological characteristics of the Western African rivers with the parameters rainfall, pattern variation, catchments area, relief,
basal rock, land use cover, relief and run-off coefficient to calculate the output influencing factors.


Palanivel, S and Vasanth Kumar (1987), analyzed the geography of Upper Agniar and Vellar Basin in Tamil Nadu using climate, regional geological settings, stratigraphy, drainage, natural vegetation, population and land use as important parameters.

Govardhan, V (1990), calculated the drinking water quality in the mandals of Nalgonda district, which revealed the pollution gradient in command and non-command areas. The drinking water quality in the command areas recorded higher quantities of nutrients, elements and pesticide residue than the non-command areas, because of the land utilization pattern.

Tiwari, T.N and Mishra, Manorama (1995), calculated the water quality indices for 18 major Indian rivers taking into account 10 parameters. The investigation revealed that the rivers had slight to moderate pollution and can be used for drinking only after proper treatment.

Saraf, A.K, Goyal, V.C et al...(2000), analyzed the springs in Gharwal in Himalayas using Remote Sensing data products and processed the information using Geographical Information System (GIS) technique. The study investigates the influence of geographical area, climate, physiography, lithology and economic activity to analyze the changes in the watershed. The IRS and PAN images were merged to get False Colour Composite (FCC) which showed the latest ground condition, which is further utilized to prepare the lineament and land use map of the area. Thus, this increased the accuracy of the investigation and modeling of the area.

Zanting, H.A and Chemmens, A.M.C (2000), estimated the water pollution sources in Lake Victoria in East Africa, applying the rapid assessment methodology
or pollution sources assessment put forth by WHO 1982. The various sources of pollution were assessed and the penetration levels were calculated to estimate the variations in the nutrient balance.

1.3.4.2 Groundwater Studies

Stanley, N. Davis and De Wiest, J.M Roger (1966), explained the usefulness of the tri-linear diagram in analyzing the water quality and developed three dimensional block simulation models showing the influence of the geology on the groundwater.

Lloyd, J.W. (ed) (1967), analyzed the need for the proper utilization of the groundwater. The factors influencing the water table level like geology, precipitation and evaporation are considered.

Todd, Keith, David (1981), explained about the salt water intrusion in fresh water areas citing Long Island in New York and Miami in U.S. The various factors controlling are the saline intrusion are explained in depth and the technique in early identification of the intrusion is suggested.

George, Mattews (1982), explained the properties of groundwater and explained about the techniques of conversion of concentrations of water equivalent. A classification of groundwater based on the dissolved constituents and the atomic weights was proposed.

Bhavani Shankar, V and Muthu Krishnan, N (1994), analyzed the chemical composition of groundwater in Chennai city. The land use pattern in the city influences the groundwater quality and the investigation revealed that the groundwater is contaminated and is unsuitable for drinking purpose.

Malcolm, Newson (1994), highlighted the importance of predictive modeling to channel the future of the groundwater quality. The importance of the statistical technique to analyze the current state and future trend is clearly explained.

Ravi, V, Reddy, P.J and Reddy, R.C (1996), developed a multivariate statistical categorical regression model to assess the potability of groundwater based
on the physio-chemical parameters. The weighted probability and potability index are used to analyze the potability of water in the study area.

Collin, M.L, Secunda, S et al.,(1998), analyzed the groundwater vulnerability using composite model combining DRASTIC with extensive agricultural land use in Israel. To assess the vulnerability the areas critical for the maintenance of the groundwater quality is identified with empirical methodology that is adopted to integrate aquifer media and land use information of the area using GIS.

Jain, K. Pradeep (1998), analyzed the hydrogeology in Hirapur area. The chemical analysis on the groundwater samples, revealed the influence of the base rocks on the water quality that was slightly saline and hard. The chemical concentrations of the various parameters were found to be within the drinking water standards of WHO and ICMR.

Murthy, K.S.R (2000), made a scientific approach for the management of natural resources like groundwater potential in semi-arid regions of Andhra Pradesh which requires a periodical revision of the data base. The GIS software is utilized to quantitatively assess the consequences of heterogeneity in ecological system in spatial and temporal scales. The parameters land use, geology, hydro-geomorphology, drainage density, rainfall, and location are given weightage to calculate the influence on the groundwater potential in the watershed.

Shahid, S, Nath, S.K and Roy, J (2000), developed groundwater potential modeling using GIS, the hydro-geological parameters of the area were given weightage and ranked. An integrated layer merging was used to calculate the Ground Water Potential Index (GWPI).

1.3.4.3 Marine Environment Studies

Lewis, James (1989), analyzed the changes in the sea level and its implication in Tuvalu. The change has resulted in affecting the marine species composition in the region.

Simpson, J (1994), highlighted the use of remote sensing technique in analyzing the marine resources, for the better management and exploitation of the
same, thereby increasing the production. The aspects like the movement of the fish, forecasting the production for the period had also been discussed.

Venugopal, A, Kolkar, A et al, (1996), analyzed the influence of the activities of the port and harbour, discharge of sewage, effluents form the industries along the Pondicherry coast. The coastal water quality of the stations was studied and compared with the permissible limits.

1.3.5 Noise Studies

Tiwari, T.N, and Ali, Mansoor (1988), studied the noise levels in the commercial areas in the Nagpur city. The study revealed that the noise level is highest during the day especially during the time of loading and unloading of goods. The noise levels fell sharply during the night time. To reduce the noise pollution measures like ban on playing loud music, allocation of time for loading to unloading goods etc had been suggested.

Rao, P. Ramalingeswara, Dev, K. Srinivas et al.,(1989), correlated the influence of the vehicular traffic on noise generation. The study focused on influence of vehicular traffic on noise generation. The time factor analysis on the noise pollution had also been analyzed and measures to reduce the noise pollution like reduced use of horns, creation of silent zones, construction of noise barriers etc had been suggested.

Rao, P. Ramalingeswara and Rao, M.G. Seshagiri (1990), studied the influence of the industrial activities on the local and the surrounding environment. The analysis revealed that noise levels in the industrial areas are within the guidelines set by the Central Pollution Control Board. The noise levels is high during the industrial activity and the loading and unloading times, the rest time period it is within the limits suggested.

Sengar, C.B (1993), reviewed about the various types of noise quality measurement, using different methodologies based on the need to analyze the noise quality. The various methods to control noise generation from different sources and measures for blocking the spread of noise in the form of barriers had been suggested.
Jena, R., Pal, A.K., Saxena, N.C (1996), analyzed the impact of noise generated from different land uses on human health. The noise tolerance levels and its impact on human hearing and health had been described. The various causes for the noise pollution and measures to reduce the noise levels are suggested.

Pandya, G.H and Verma, R.R (1997), analyzed the impact of noise pollution due to vehicular traffic in the different types of land use and its impact on human beings. The paper also suggested methods to control noise pollution in Nagpur city. The land use based classification studies revealed that noise pollution was greatly influenced by the time factor.

Gaffari, Hadi (2000), analyzed the determinants of noise pollution and the consequences of noise pollution. The noise levels for various areas based on the listening distance were put forth. The noise control strategies in the form of noise control in the source, noise specification levels, noise transmission path control, absorbent materials, creation of awareness etc had been discussed.

1.3.6 Solid Waste Pollution Studies

Geswein, A.J (1975), explained the impact of the deposition of domestic and hazardous waste in landfill sites. The infiltration of liquid waste and obnoxious mineralized leechate, affects the groundwater quality over a long period.

Viraraghavan, T (1981), studied the various aspects to be considered when selecting a landfill site. A methodology approach for the selection of the site had been put forth, where a systematic and environmentally conservative aspect had been equal importance.

Curtis, F.A and Viraraghavan, T (1990), analyzed the various factors when selecting a site for solid waste disposal. All factors required to be focused when selecting a landfill had been clearly analyzed, the influence of the factors and the influence of each factor on the environment had also been of discussed.

Sivarama, A.V. Prasad and Somasekaran, N (1990), analyzed the different processes and technological availability, for the location and the disposal of the solid
waste in an eco-friendly manner. The hierarchy in the available processes had also been dealt in detail.

Yhdego, M, Vidal, R.V.V and Overgaard, C.M (1992), discussed about the planning procedure for the location of disposal sites in Tanzania. The aspects of finance, administration, time factor, feasibility, environmental aspects etc, had been integrated in the planning in the location of the site.

Patil, A.D and Bhide, A.D (1998), used weightage method to analyze the suitability and management of landfills. The weightage focused on the management of disposal, recipient of pollution and characteristics of solid waste to calculate the Sensitivity Index.

1.3.7 Environmental Impact Assessment Studies

Gole, Prakash (1983), analyzed the river water quality of Mula and Mutha that flow through Pune and are carriers of urban waste. The influence of river pollution on bird species population distribution had also been studied.

Couliard, Dennis (1984), reviewed the existing impact assessment methodologies. The principles and applications of Coherence Graph on gradual decomposition for various applications are explained.


Neville, Warwick (1993), focused on the close relationship between economic development and its impact on the land functions in Singapore analyzing the major land functions like industrial and commercial activities.

Dawson, Alastair (1994), studied the changes and the impact of global climate change. An in-depth analysis on the factors affecting the climate change had been discussed, using case studies. The role of man-made changes and nature-triggered changes on the climatic variations including the changes in the atmospheric composition is explained.
Pendleton, H. Linwood and Mendelsohn, Robert (1998), linked models of global climate circulation, ecology and economic valuation to value the impact of global warming on fisheries in North-East U.S. The Random Utility Model (RUM) showed that the atmospheric carbon dioxide is predicted to generate a net benefit for the region, depending on the climate scenario.

Nayak, S.C. Pal, A.K et al. (1999), analyzed the impact of iron ore mine using Impact Index Scale (IIS), the various aspects of pollution based on 15 parameters had been analyzed. The impact on the environment is further classified into six impact values on the basis which the impact on the environmental quality is graded.

Smith, V.H et al., (1999), classified the different types of eutrophication in the coastal and inland water bodies and provided guideline measures to identify the level of eutrophication of the water body. The various causes and sources leading to the eutrophication of the water body had been described.

Carreras, H.A and Pignate, M.L (2001), compared the influence of air pollutants on the meteorological parameters and vice versa in Argentina. The overall impact of the variations on the lichens was also studied.

1.3.8 Environmental Management and Sustainable Development Studies

Anion (ed)(1993), is a collection of case studies written by various authors, to analyze the coastal zone for economic development when subject to intense development to conserve and develop interests. This book illustrates coastal zone problems and resources, coastal management approaches that promote policy integration and regional co-operation in international coastal zone management.

Nagabooshanam. P (ed) (1995), focuses attention on legal constitutional provisions pertaining to the environment, which constitute a mandate for environmental protection. The various types of pollution is discussed, the impending dangers of progressive increase in pollution, particularly in big cities is analyzed. The aspect right to development versus right to environment in connection with the International Law is analyzed.
Satterthwaite, David (1997), analyzed the environmental transformation that occur within cities as these get larger, wealthier and better managed, improves the capacity of the consumers and producers concentrate to transfer some of the costs to other regions or into future. The different categories and the change within the cities, environmental problems have been studied.

Cicin-Sain, Billana and Knecht, W. Robert (1998), is a detailed study of the coastal management theory in 29 countries. It addresses the problem of managing overlapping jurisdictions, competing coastal and ocean uses. The book is a synthesis of major concepts and methodologies to the establishment, implementation and operation of the integrated coastal zone management. The book focuses on the measures to overcome the fragmentation inherent in both the management and the splits in the jurisdiction to accomplish the harmonization of coastal management to conserve the distinctive character of the coastal area for the current and future generations.

Juanita, Sundberg (1998), examined the sources of environmental degradation in Maya Biosphere Reserve of Guatemala in the structures engaged in the implementation, conservation measures of emerging landscape. The development planners advocated models to protect the remaining wilderness and simultaneously encourage national and international tourism, thereby provide an ideal solution to environmental degradation and poverty in developing countries.

Salomons, W, Ramachandran, S et al.,(ed),(1999), studied the use of Integrated Coastal Zone Management for better socio-economic benefits, sustainability and bio-diversity if the coastal environments. Several case study approaches had been adopted to analyze the regional practice and experiences in the areas like South-East Australia, North Sca, Latin America, Cuba, Indonesia, India and small south Asian nations.

1.3.9 Geographical Information System (GIS) and Remote Sensing Studies

Cheshire. M. Heather and Khorram, Siamak (1985), used Landsat Multi Spectral Scanner (MSS) digital data combined with surface measurements of water quality mapping of Neuse River Estuary, in North Carolina to analyze the water
quality for which regression model for each parameter was developed between the ground data and digital data in order to alternate high cost effective procedure for mapping water quality.

Archer, H, Croswell, P.L. et al., (1991), described the various methodologies and approaches using Geographical Information System (GIS) and basis of the type of the requirement of the user. The various presentation techniques had also been described in detail.

Bennett, E.C and Curtis, L.F (1992), described about the modes of radar signals, spectral signature variations across the electromagnetic spectrum on the basis of case studies and application for different aspects in the fields of environment. The book not only discusses about the remote sensing but the related computers and Geographical Information System (GIS) methodologies.

Cooper, Alan and Wilcock, David (1993), estimated the land cover of the ecological resources and land use categories in the Antrim coast and Glens, in Northern Ireland using Landsat MSS imagery, which was processed using ERDAS software applying spatial modeler.

Cherill, A.J. Lane, A and Fuller, R.M (1994), used Landsat Thematic Mapping Imageries to analyze the character of the landscape in England, the spectral signature variation analysis portrayed the difference in nature and composition of the landscape in the different parts.

Collins, WG, Adinaryana, J and Flach, J.D (1994), analyzed the data sources like the topography, irrigation, forest cover information from the Landsat imagery, for creation of suitability identification of database for agriculture, land use, urban settlement, waste land classification etc.

Osborne, L. Lewis (1998), empirically analyzed the relationship between land use / cover and stream water quality. The study used aerial photographs and GIS software ARC - INFO for creating buffer constructed polygons in the outer boundary of the network stream.
Anion (1999), is a guide through the various steps in the usage of ERDAS software. The various methods of image enhancement, classification, map composition is described. The technique to build spatial model and the creation of knowledge base for easy classification is also clearly portrayed.

Minami, Micheal, Sakala, Michelle and Wrightsell, Jenniffer (1999), discussed about the basics of using ARC - MAP and described in detail the creation of maps, labeling the map and preparation of layout for printing out the maps. The book also discussed about using the Editor and creation of the database and writing of queries for the retrieval of the data from the database.

West, Robert (1999), described the role and uses of a shared geographic database in a multi-user Geographic Information System (GIS). The book provides an overview of Arc - SDE, describing the capabilities and the general choices available when implementing Arc - SDE. The aspects like geo-databases, data storage and Arc - SDE architecture and coverage are also discussed.

Espedal, H.A and Johannessen, O.M (2000), studied the use of Synthetic Aperture Radar (SAR) in the detection of oil spills near offshore installations. The SEASAT data was used to analyze the spread and the effects of oil spillage on the fragile marine and coastal ecosystem.

The review of literature of the environmental studies reveal predominantly compartmentalized in particular aspects of environment, with very few studies analyzing all the environmental problems and impacts. When it comes to a comparative study the areas nearby have only been considered for comparison; a comparative study on the environmental problems and impact in the cities of the developed and developing countries have not been analyzed. This study aims at analyzing the problems and impact of development on the environment in a city in developed and developing countries.

1.4 Crux of the Study

The pivotal part of the study lies in analyzing the change and impact on natural resources like air, groundwater, river, geology and marine resources. The urban development generated problems like noise and solid waste generation have
FIG 1.5 LOCATION OF STUDY AREAS

WORLD

UNITED KINGDOM

INDIA

PLYMOUTH

CHENNAI

National Aeronautical Space Agency (NASA), U.S.A.
Geo-referenced
also been studied. The changes due to urban development on the ecosystem like the hydrology, geology, climate change etc and its impact on urban environment, human beings, flora and fauna are analyzed. The sustainability of the urban ecosystem and the measures to be adopted to maintain and improve the fragile balance is suggested.

The environment scenario at Chennai, a city in the Tropical Zone and Plymouth a city in the Temperate Zone are analyzed. Admittedly, while Chennai is located in a developing country, Plymouth is situated in a developed country; a comparative study will help to arrive at an explicit and holistic conclusion of the problems faced by both the cities.

1.5 Study Area

A comparative analysis of the coastal urban ecosystems of Chennai formerly known as Madras located 13 degrees North latitude, 80 degrees 11 minutes East longitude, is in Tamil Nadu state located in the South India, on the eastern coast of India, facing Bay of Bengal and Plymouth is located at 50 degrees North latitude, 4 degrees West longitude, in Devon County located in South - West of United Kingdom facing the English Channel. Both the study areas are located in the Northern Hemisphere. Chennai is a city set in a developing country, whereas Plymouth city in a developed country (Fig 1 5)

1.6 Objectives

The increase in industrial and urban activities due to technological progress has brought along the bane of pollution, which has greatly affected the environment. The study analyzes the magnitude of environmental changes and impact due to urban development in the cities of Chennai and Plymouth. The following are the objectives of this study:

To analyze the effects of various pollutants on the natural resources of environment and impact on human beings, flora and fauna using statistical techniques and Geographical Information System (GIS).

To study the changes in air, water and noise quality based on its composition due to urban development by using Geographical Information System (GIS).
To analyze the growth, characteristics, disposal and impact of solid waste generation on the environment.

To study the changes in climate, geology, hydrology and the impact of changes due to urban development using Remote Sensing and Geographical Information System (GIS).

To put forth measures for Sustainable Development of the Urban Environment in Chennai and Plymouth.

1.7 Data Sources

The methodology used is an integrated methodology, where the traditional data collection and processing is integrated with the modern technical and technological advancements using Geographical Information System (GIS) and Remote Sensing data products. The data for the cities of Chennai and Plymouth are collected.

The climatic data are collected from Regional Meteorological Center, Nungambakkam, Hadley Center, United Kingdom and Intergovernmental Panel of Climate Change (IPCC) Data Distribution Center.

The surface water quality from Tamil Nadu Pollution Control Board (TNPCB) and Environment Agency, United Kingdom; the ground water data were collected from Center for Water Resources, Taramani, Chennai.

The data regarding air and noise quality are collected from Tamil Nadu Pollution Control Board (TNPCB), Chennai and Plymouth City Council.

The solid waste data are collected from Chennai Metropolitan Development Authority (CMDA) and Environmental Agency, United Kingdom.

The seawater quality data are collected from National Institute of Ocean Technology (NIOT), Pallikarnai, Chennai and Environmental Agency, Exeter.

The data pertaining to flora are collected from Commissioner Museum, Government of Tamil Nadu, Madras Naturalistic Society and English Nature, United Kingdom.
The data regarding faunal species in rivers and marine environment are collected from Zoological Survey of India, Office of the Fisheries, Chennai, English Nature, United Kingdom and Tamar Development Authority, Devon.

The land use data are collected from Chennai Metropolitan Development Authority (CMDA) and the Plymouth City Council.

The population data are collected from the Department of Census Operations, India and United Kingdom.

The satellite data regarding climate, sea level changes, pollution, sea water concentration and land use are collected from NASA, Goddard Centre, U.S.A, SeaWifs, Climate Prediction Centre, U.S.A, Remote Sensing Data Analysis Service, Plymouth (RSDAS), Dundee Satellite Station, United Kingdom, National Resources Space Authority (NRSA), Hyderabad and Institute of Remote Sensing and Institute of Ocean Management, Anna University, Chennai.

The transport data are collected from the Directorate of Transport, Egnore, Chennai and Department of Environment, Transport and the Regions (DETR), United Kingdom.

1.8 Methodology

In order to analyze the data collected from various sources the Statistical, Cartographic, Digital Image Processing, Mathematical Modeling and Geographical Information Systems (GIS) techniques is adopted. The data collected are processed using Microsoft Works and SPSS are used for statistical analysis. The Map Info software are used for the creation of thematic map analysis; the ARC - INFO software is used for single theme and overlay analysis. The ARC-VIEW software and its extensions SPATIAL ANALYST are used for spatial representation. The ERDAS Imagine is used for processing the digital data and classification. The SURFER software for analyzing and building three dimensional models. The data processed with all the above software is presented with the help of ARC - VIEW, Corel 8 and Adobe Photoshop.
The air quality is analyzed using Air Quality Index (AQI). The trend and seasonal variations in the pollutant concentration are statistically analyzed using World Health Organization (WHO) permissible standards. The Spatial Modeling of Air Quality is prepared with Kriging and represented using SURFER software. The influence of climatic parameters for air pollutant concentration and dispersion is analyzed and the vehicular emission is calculated using Vehicular Pollution Index (VPI).

The fresh water is further divided into surface and ground water. Both are analyzed using Surface and Ground Water Quality Index and transportability of the ground water are analyzed using Corrosivity Index (CI). The seasonal variations and impact of changes in river water quality composition resulting acidification and eutrophication is studied. The groundwater spatial distribution analysis is done with Nearest Neighborhood Model. The ground water potential is calculated based on occurrence using Ground Water Potential Index (GWPI) and ground water vulnerability using DRASTIC Index. The variations in water table levels, seasonal variations and Gribbs Factorial Analysis for Ground water Geo-chemistry are used for understanding ground water dynamics.

The noise scenario is studied with noise climate. the level of noise pollution using Noise Pollution Level (NPL) and traffic noise using Traffic Noise Index (TNI). The impact of noise on human beings have also been analyzed. The noise quality is studied on the basis of noise equilibrium (L_{eq}), the stress caused due to noise with L_{np}.

The trend in solid waste generation and composition of waste is analyzed using statistical techniques. The influence of population and land use on solid waste is also studied. The Landfill Suitability Index (LSI) model is studied along with geology and leechate. The zoning of the impact of the landfill on the surrounding areas is represented with ARC-VIEW.

The seawater quality hydro-chemical and sediment concentration seasonal variations, changes in concentration due to tidal variations, bathing water quality and eutrophication are studied. The seawater profiling analysis using cartographic
techniques helps to understand the variations in the surface and bottom of the sea. The zoning of pollutants from the coast to the open sea with ERDAS highlights the spread of pollutants.

The changes in the environment both due to natural and human activity are studied using Time Series Analysis, to evaluate the changes in the climatic parameters in the study areas. The impact of development on geology, hydrology, human beings and vegetation cover are analyzed.

The methodology uses an integrated approach in handling the changes and impact of modern development on urban environment based on statistical, cartographical, spatial, and image processing techniques.

1.9 Limitations

The study having an extensive scope has some limitations, as the study area belong to different countries of two varied economic status and approach towards handling the issues also being different, resulting in non availability of some information.

The study is a one-scholar study and hence the breadth and depth of analysis is limited.

The study is based on geographical analysis and the inter-disciplinary perspective in some areas is limited.

The non-availability of groundwater quality monitoring data for Plymouth as it is below suitability levels. Therefore the data regarding the groundwater quality and water table levels is not available.

The impact of noise on human health is not available for Chennai, as psychological impact analysis is yet to catch up in India.

1.10 Chapter Organization

The chapter organization of the present study is follows :-

The chapter one starts with a brief introduction, review of global environmental scenario, review of literature for the area of study, highlighting the
crux of the study, study area, objectives, sources of date, methodology employed, limitations of the study and a brief outline of the study.

The chapter two analyses the natural resources of the study areas like Climate, Geology, and Land Use and Population.

The chapter three deals with composition of air pollutants and attempts to delineate air quality using mathematical algorithm and statistical techniques.

The chapter four studies the water quality of surface and ground water sources, analyzing the changes and suitability using statistical and modeling techniques.

The Chapter five focuses on the noise environment analyzing the noise levels, statistical methodology is adopted to examine noise climate, stress levels, traffic noise and psychological impact of noise in the urban environment.

The chapter six examines the solid waste generation, the composition of waste and the disposal techniques adopted in the study areas.

The Chapter seven deals with the hydro-chemical content of sea water quality, the influence on the marine ecosystem and the spread of pollutants.

The chapter eight deals with the impact of urban development on natural resources and the impact of changes on human beings, flora and fauna.

The chapter nine summary and conclusion, besides it suggests measures for the Sustainable Development in the cities of Chennai and Plymouth.

The next chapter examines the natural resources in the study areas.