INTRODUCTION

Rapid urbanisation has led to a plethora of environmental problems offsetting the benefits of modernisation and development. Air and water pollution, solid waste management, industrial waste, sewage water, vehicular exhaust, water scarcity etc. are some of the major threats faced by large cities in developing countries. Health and sanitation top the list of development goals set by the concerned authorities and water-borne diseases stand first (more than sixty percent) among infective diseases afflicting man and animals. The important cause of water contamination is improper disposal of waste water from domestic sector. As major epidemics of gastro-enteritis break out every summer, contamination of drinking water with sewage has been found to be the main source of pollution necessitating intense investigation in this sector. The severity and extent of contamination, the economic and environmental implications vary from region to region. In this back drop the economics and ecological impacts of sewerage system in Tiruchirapalli Corporation has been studied.

Information from central pollution board envisages that more than seventy percent of water supplied to domestic sector comes out as waste water, of which only twenty five percent receives treatment before being discharged into any medium. Hence the major chunk of untreated sewage discharged into the water bodies leads to a host of health problems like gastro-enteritis, cholera, jaundice, typhoid, amoebic dysentery etc. In any urban set-up most of the households have individual septic tanks which render the household sewerage harmless before discharge. However the proper functioning and maintenance of such septic tanks need to be questioned. In many cities the public underground sewage systems do not cover all the households and wherever provided fail to function properly due to poor maintenance leading to blocked drains and seepage of sewage into drinking water pipes. Another major concern is the operation of sewage treatment plants set up in outer areas of the cities, where lack of skilled man power and inadequate maintenance lead to malfunctioning.
Urban and industrial cities of developing countries like India are facing many problems due to regular immigration of people from rural to urban area for their survival. Rapid growth of population leads to sensitive problems related to urban facilities like housing, transportation, water supply and drainage. This in turn leads to pollution problems paving the way for deterioration of health status of community.

Urbanization and industrialization have emerged as the major issues due to the rapid growth of population and civilization. It is estimated that the per capita water consumption is 180 liters for uses like toilet flushing, bathing, and washing of clothes and kitchen activity. All this contributes to domestic sewage comprising 99.9 percent of used water and just 0.1 percent of organic matter. Organic waste contains oxygen-hungry bacteria which in the right conditions proliferate, by consuming dissolved oxygen in the water (Ram Chandra et. al, 2003) leading to anaerobic conditions and the associated health and environmental problems.

In India there are 644 cities/towns which grow rapidly and generate enormous quantity of wastewater of about 18312.1 MLD; with the help of sewage treatment plants (STP) only about 4098.7 MLD (22.4 %) is treated before being drained into water bodies like river, lake, land etc. (CPCB 2000); this ultimately impairs the soil fertility and directly or indirectly affects the health of man and other living organisms.

Water is the most precious natural resource in our planet which is vital for the survival of living organism; it becomes scarce day by day in most part of the world especially in developing countries. For instance in India the scarcity of drinking water has become a major problem in all urban areas. Fresh water constitutes just 1 percent of the total water resources of which only about 4 percent is available for beneficial use. India has about 1850 km$^3$ of the total water resources and Tamil Nadu has only 3 percent is potable. Water quality is closely connected with the water use and to the state of economic development. Subsequently, the precious water resources are slowly harmed through domestic and industrial processes which discharge wastewater. Indeed water intensive industries like dying, distilleries, and tanneries consumes large volume of water and it discharging the waste water into near by water streams like river, lake

1 State of Environment Report Tamil Nadu-2005
etc., which in turn affect the quality of water resources and land fertility. Besides indiscriminate tapping of fresh water for industrial and domestic use from river, lake, aquifers and other water streams decreases not only the availability but also leads to deterioration of drinking water quality in urban areas. In this regard domestic and Industry sectors consume less quantity of water when compared to agriculture sector; but higher loads of pollutants which originate from domestic and industrial sectors are discharged into the water sources affecting the water quality. At the same time all these three sectors together play a significant role in contaminating the quality of water in water bodies.

In India domestic wastewater is the main source of water pollution in surface water comprising 80 percent of the total water pollution; this is the major source of pathogens that not only lead to water borne diseases but also the anaerobic bacteria which reduce the dissolved oxygen level in water bodies. Agriculture run-off and industrial effluents mixed with sewage would contribute huge amount of nutrient load into the watercourse that leads to eutrophication.

Sewage water becomes a major problem, when released in great quantities. When small amount of sewage is discharged from few households, it often breaks down and biodegrades without being a dangerous source of contamination, but when population increases the not only there is a corresponding increase in the per capita water consumption but also due to enhanced quality of life; as a result the quantity of waste increases. When directly discharged into water bodies, it mixes with fresh water with the feces and rapidly becomes a toxic pollutant. When these elements eventually exceed the ecosystems' natural carrying capacity of digestion it causes problems like eutrophication.

Globally sewage wastewater contaminates potable water supply and affects about 3.5 million people every year; indeed more than 9000 people including many children under the age group of 5 die daily²

² www.wastewatergardens.com
1.1 STATEMENT OF THE PROBLEM

Development depends on the environment which constitutes the major input for the development process. This ultimately results in the disorder of eco-system. However, though the environment has a tremendous carrying capacity for recycling the undesired resources it has its own tolerance limits. When such limits exceed, a pollution crisis would set in. sewage pollution continues to be a major factor causing the degradation of the environment, affecting the quality of water we use, the air we breathe and the soil we live on. Thus pollution (water, air, so on) is the major threat to the entire eco-system adversely affecting the living and nonliving components directly or indirectly.

The character and quality of the wastewater from different sectors vary, depending on the usage of water by the domestic and other sectors. The overall impacts of such wastewater are influenced by the nature of the watercourse and its surroundings. Some people would argue that open drainage will cause health problems, while others say that underground drainage will cause more practical problems while constructing sewerage. The entire idea is not to develop a prior impression on domestic, but to focus the potential damage that the domestic sector could cause.

The major Research Questions posed are: a) How to characterize the sewage water disposal as an environmental issue? b) At corporation level what would be the magnitude of the sewage water disposal from domestic sector and treatment processes thereof? c) The cost implications of Sewage Water Treatment Plants in the study area. d) Whether or not improper disposal of sewage water caused hazards to human health. e) What is the best environmental management practice towards sewage water disposal?

Tiruchirapalli is one among the seven municipal corporations of Tamil Nadu, with a population of 8.5 lakhs covering 146 sq. km. area. The quantum of sewage generated by households has been reported as 21 MLD (Million Litres per Day) within the corporation limit, which is about 80-85 LPCD. Out of this, only 9.4 percent of the total ML passes through underground sewerage and get treated in sewage treatment plant set-up at Panjapur. The remaining gets partially treated by individual household
septic tanks or without any treatment reaches the water bodies and channels crises crossing the city; finally all *in toto* gets drained into river Cauvery, the main source of drinking water supply for the city. Frequent outbreak of gastro-enteritis and other water-borne diseases in the city has led to need for the research investigation to ascertain the magnitude of sewage pollution in river Cauvery. The river Cauvery also receives effluents from industries, agriculture and domestic waste water but the sewage contamination is the unique cause of drinking water pollution.

The study aims to focus on the points of maximum pollution and the remedial measures to be carried out to redress the problem of water contamination. The economic aspect of underground sewerage system was also studied by collecting data regarding the cost of laying, setting up, operation and maintenance of sewage treatment plant (STP). Revenue generation and allocation would be a major constraint faced by the corporation authorities in maintaining the facility on a sustainable basis; extension of the service to unavailable areas in the outskirts of the city to cover the whole city would be another challenging problem. The major agenda of the governing authorities is to set-up a new sewage treatment plant with a higher capacity with most recent technology. The proposed study would suggest a viable tax structure with which recovery of expenditure can be achieved from the stakeholders.

### 1.2 OBJECTIVES OF THE STUDY

- To estimate the quantum of sewage generation from the domestic sector in Tiruchirappalli City Corporation of Tamil Nadu.
- To examine the measures undertaken by the municipal corporation and to analyze the cost of operation and maintenance of sewage treatment plants in the study area.
- To analyse the pollution load from the domestic sector to river Cauvery in Tiruchirappalli region.
- To discern the impact of untreated sewage on the health of human beings and the social cost involved in it.
- To suggest changes in the existing policy framework in the light of the empirical study.
1.3 HYPOTHESIS

i. Toilet facilities available in the house, family size, water used for washing and bathing in liters per day, water allotted for toilet in liters per day and water used for drinking & cooking purpose are the key determinants of per capita sewage water disposal.

ii. There is relationship between the incidence of water borne disease in the household sector and domestic sewage.

iii. There is difference between the zones in terms of incidence of water borne diseases in the family members, cost of medical treatment for one per year and man day loss due to health.

1.4 METHODOLOGY

For the present study Tiruchirappalli City Corporation in the state of Tamil Nadu is chosen. The city of Trichirapalli is one among the eight Corporations in the state, comprising 4 zones. Each zone has 15 wards; all the 60 wards were taken for study. From the pilot survey we found that the contamination of water source and the associated health damage is not confined to particular areas/wards but is a common problem in all the wards of the Tiruchirappalli City Corporation. Hence all the wards constituted the universe for the study.

1.4.1 Method of sample selection

The present study has used disproportional stratified sampling viz. stratified random sample method to select the sample households. The criteria adopted to stratify the four zones selected to choose 300 households includes the following; economic status, family size, availability of water sources, underground sewerage system availability with the households, health impact due to sewage, etc. all sixty wards was taken for the sampling, in which 5 sample were chosen from each ward in the entire Tiruchirappalli City Corporation.

Zone and ward details are collected from the Tiruchirappalli City Corporation (TCC) office. The list of number of households particulars are obtained from the Tiruchirappalli City Corporation.
1.4.2 Data source

Secondary information on the status of health was obtained from Corporation office. Information related to number of underground sewerage system connection were collected from the Tamil Nadu Water supply and Drainage Board (TWAD) and Corporation office. Secondary sources include the records and documents of the municipal corporation, Central and State Pollution Control Boards' publication series, and reports from the Environmental Information Systems of State of Tamilnadu.

1.4.3 Primary household survey period

The survey was conducted with the help of detailed interview schedule during March to December 2008. The study period covered both summer as well as rainy monsoon seasons. During monsoon period there is an increase in the quantity of sewage water input in the river Cauvery water. Environmental quality of water testing was carried out in the drinking water sample. Sample was collected from the wards were the health damage was high and to find the level of Total coliform and E. coli from the potable water.

1.4.4 Tools of Analysis

Simple statistical tools such as mean, percentage, standard deviation, coefficient of variation, correlation, regression, ANOVA, ‘t’ test along with bar and pie diagrams. Correlation is used for both primary and secondary sources of information, the correlation matrices were used to drop less important variables to avoid multi-co linearity problems. Regression model was used to analyse only primary source of information. The t’ test was used to analyze both the primary and secondary sources of information, GPS was used for mapping.

Data analyses of both secondary and primary data were carried out and the obtained results are presented in third and fifth chapter. Primary household survey information was analysed through regression and Duncan’s multiple range test was used to test the stated hypothesis. Block rate pricing method was applied to estimate the wastewater tariff for household’s service connection.
1.5 CHAPTER SCHEMES

The first chapter comprise an introductory part, statement of the problem, objectives and methodology. The second chapter includes conceptualization of the problem and review of the literature. Third chapter includes the profile of the study area, existing sewage treatment plant, centralised and decentralised wastewater treatment system. National and state scenarios form part of the fourth chapter. Fifth chapter focused on river Cauvery. Sixth chapter presents the results of the household survey and the environmental dimension of domestic water and sewage generation from the residential area. Seventh chapter presents health impact survey. Eighth chapter presents policy implication. Findings, summary and conclusion form the last chapter.
1.6 LIMITATIONS OF THE STUDY

Household survey to study the practice of water usage, the mode of disposal of used water and their health impact in Tiruchirappalli City Corporation limit is a quite exhaustive one and hence the present study confines to a sample of five households from each of the 15 wards in four zones. Hence the primary data collected from the households with the help of prepared interview schedule forms the mainstay of the study. The data collected is based on the memory of the respondents only and hence bias and inaccuracy can not be ruled out. For instance at the household level they revealed the information on the quantum of wastewater disposed in based on their memory only. Approaching the Corporation office was very difficult and in household level survey the respondents were reluctant to reveal the details of quantum of water consumption at their households level especially for bathing and toilet use and its disposal. It had been a great task to enter into urban household to collect data from them. However maximum care was taken to gather information at Corporation level and from household level by educating them about the need of the study which provided solution to this problem.