CHAPTER 1

INTRODUCTION

1.1 GENERAL

Water is the prime need for the survival of all living things, whether it belongs to flora kingdom or fauna kingdom and industrial developments. The demand on water for domestic, commercial, industrial and agricultural purposes is increasing significantly in the recent past. The situation is exacerbated by the growing urbanisation. Many cities have fully exploited the readily available water resources and are now obliged to develop and treat sources of lower quality or reach long distances to develop new supplies, both expensive options. The need to conserve potable water supply has thus become an increasingly important part of urban and regional planning.

As per the United Nations Habitat (2004) report, at least 1.01 B people may not even have access to safe drinking water and 2.4 B may not have adequate sanitation facilities. Increasing population and expanding development would further increase the demands for water. It is estimated that by 2024, two – thirds of the world population would be suffering from acute water shortage.

1.2 URBAN PERSPECTIVE OF WATER AND WASTEWATER

Urbanisation taking place throughout the developing world is at unprecedented rates. It is projected that 88% of one Billion growths in global
population by 2015 will take place in cities. Essentially, all of it may be in developing countries after 2015 (UNDP 1998). All worldwide growth in population is expected to decline by 6% by 2050, while the global rural population should plateau at approximately 3.2 B. The result is that after 2015 all the worldwide growth in population will take place in cities of developing countries.

The Millennium development goals call for halving the proportion of people without access to improved sanitation or water by 2015. As a result, an additional 1.6 B people will require access to water supplies, 1.018 B in urban areas and 581 M in rural areas (WHO and UNICEF 2000). On the other hand, wastewater discharged into water courses are polluting them to unacceptable levels. If the water quality in streams is to be maintained for the designated use, wastewater requires adequate treatment prior to disposal to prevent water quality degradation and to protect public health. Effective management of water resources and control of pollution are thus essential elements in sustainable development and human welfare.

With people, throughout the world, approaching or reaching the limits of their available water supplies, water reclamation and reuse have become an attractive option for conserving and extending available water supplies to meet the current and future demands.

1.3 IMPROPER DISPOSAL OF SEWAGE AND WATER POLLUTION

One of the serious challenges posed by urbanisation is pollution. Both domestic and industrial uses of water result in large quantities of wastewater, which have to be disposed. When there is inadequate collection and treatment, the receiving water bodies like tanks, rivers, etc., get polluted,
which in turn could be detrimental to health, to ecosystems and in a variety of other ways. Water quality management thus becomes a key component of managing water resources. Institutions have been created to address these issues. Unfortunately, there is very little coordination between the agencies responsible for water allocation and for water quality resulting in problems in many parts of the Country as well as in the State. Wastewater systems in most cities and towns are at very primitive levels. Substantial investments are needed, which require financing of the capital costs and levying of user charges for cost recovery. There is a gradual realisation that the neglect of the wastewater side of the equation has very grim consequences in terms of public health, river water quality, tank degradation etc. The National River Action Plan has designated funding for wastewater system of cities and towns along major rivers. Water quality concerns remain outside the ambit of most of these institutions. Large municipal authorities, who operate sewerage systems, only have the technical and managerial capacity to deal with wastewater. In many areas, septic tanks and open drainage systems for sullage are commonly used resulting in pollution of waterways and water bodies.

The neglect of disposal of wastewater and solid wastes often results in the contamination of water. Water borne diseases such as cholera, gastroenteritis, hepatitis, etc., as well as vector borne diseases such as malaria, filarial and dengue fever are endemic in many cities and towns. The social costs in terms of treatment, absenteeism, reduced productivity, etc., can be very large. In India, water contamination alone accounted for more than 60% of all the damages caused by pollution and environmental degradation. Discharges of sewage into water bodies such as rivers, lakes and tanks have also caused serious ecological problems, for example Ooty, Kodaikanal and Madurai lakes as well as many tanks and water bodies. Thus, the quality of urban environments can be affected by discharges of wastewater or by over extraction of ground water (CWR 2004).
1.4 SIMPLE SOLUTION BY WASTEWATER IRRIGATION

Wastewater reuse for agriculture presents not only a low cost appropriate disposal method but also an opportunity to manage wastes with minimum adverse environmental effects, as the treatment requirements prior to land application are less rigid than those for disposal into water bodies.

The overriding consideration in developing a wastewater reuse system is the compatibility of the reclaimed water with its intended usage. Higher level uses, such as irrigation of public access lands or vegetables to be consumed without processing, require a higher level of wastewater treatment prior to reuse than lower level uses such as pasture irrigation. When untreated wastewater is used for agriculture and aquaculture, health impacts on farm workers as also bioaccumulation of heavy metals may lead to health hazards. Excessive hydraulic and nutrient loading poses the problem of water logging, salinisation and excessive nitrate in ground water. One of the best ways to dispose this wastewater is to recycle and reuse. Although various treatment options are available before reuse, the money involved in the treatment of wastewater is huge, which cannot be affordable by the developing countries like India. However, the reuse of wastewater for agricultural purposes requires minimum treatment or no treatment, which depends upon the quality of wastewater and type of crop to be cultivated.

In many countries, use of untreated wastewater is being practised over the years. Continuous usage of this wastewater causes both soil and ground water degradations. The rate and degree of contamination of this depend upon the quality of wastewater reused, type and profile of soil, type of crop, climatic conditions and method of irrigation.
1.5 NEED FOR PRESENT STUDY

Some experts view sewage as a means of wastewater disposal, others view it as a resource to facilitate economic development, while a few view it as a source of pollution. Though the concept of sewage irrigation seems promising, the real success can be fully realised only if there is no adverse impact on environment. The benefits of sewage irrigation can be offset by environmental problems if it is improperly practised. There have been apprehensions about the long-term sustainability of effluent irrigation. The continuous use of effluents over extended period can accumulate toxic elements detrimental to the environment (Srinivasachari et al 2000). This is a matter of serious concern because of the associated health hazards to mankind through food chain. The concern for environment is the major constraint for further acceptance, adoption and advocacy of this technology. The extent to which sewage irrigation is responsible for environmental problems such as water logging, salinisation of soil, deterioration of surface and ground waters is not estimated in a holistic manner. Long term field studies are very few and hence it is difficult to predict the environmental impact over decades. Evaluation of sewage irrigation systems for long-term sustainability and to incorporate monitoring measures to sustain the sewage irrigation is of prime importance to the wastewater users and general public.

Hence, the present study has been taken up to assess the environmental impacts of sewage irrigation, both on the positive and negative sides. Sewage irrigation, especially near to the urban areas, provides people livelihood options for the urban poor in terms of agriculture and also it generates plenty of agricultural products like, greens and vegetables. On the other side, surface and ground waters and soil pollution are the major negative impacts.

One such condition is prevailing in Madurai city, which is in the state of Tamil Nadu in the Southern part of India. The city has a well
established water supply and sewerage network since 1924 and it is reusing its wastewater since that time with a systematic arrangement. But the rate at which the population is growing, is not matched with the sewerage development. So, the River Vaigai is at the receiving end of the wastewater generated in the city. Apart from that plenty of sewage is discharged in the nearby channels and then it is utilised for the irrigation. The study presented here focuses on the environmental impacts of the sewage irrigation particularly with respect to surface and ground waters, soil, plant and socio and economic conditions with the objectives as presented below.

1.6 OBJECTIVES OF STUDY

The major objective of the present study is to investigate the possibility of using urban wastewater for irrigation and also to investigate its impact on environment and socio and economic conditions. However, the specific objectives are:

(i) to assess the present status of soil and ground water degradation due to the continuous usage of untreated urban wastewater for irrigation;

(ii) to develop a water quality forecasting model for the area surrounding a sewage farm using Artificial Neural Network;

(iii) to predict the movement of contaminants using Visual MODFLOW; and

(iv) to understand the socio-economic status of the wastewater users.

1.7 ORGANISATION OF THESIS

Chapter 1, Introduction, gives a general introduction to the study. The objectives and need of the study are clearly spelled out in this chapter.
In Chapter 2 Literature Review, extensive literature survey is made on urbanisation and its impacts. Wastewater management and reuse around the world and in India, land treatment and pytoremediation, environmental impacts due to urban sewage on soil, ground water and health aspects and ground water modeling techniques are all reviewed. The way in which the present study differs from others is also highlighted.

Chapter 3 Study Area: Madurai and Avaniyapuram Sewage Farm as well as details about the study area are explained in this chapter in a detailed manner and the need for the present study is emphasised.

Chapter 4, Methodology, presents the primary and secondary data used for the analysis, background behind the sample locations and procedures adopted in the contaminant movement prediction by Visual MODFLOW.

In Chapter 5, Impact of Wastewater Irrigation on Land and Water, quantum of sewage inflow into the farm, its quality and its impact on the soil by studying the vertical profile inside as well as outside the farm are presented. The ground water results obtained from observation wells are analysed using Vertical Mapper and then modelling of ground water using Visual MODFLOW and Artificial Neural Network are also presented.

Chapter 6, Socio- Economic Impact of Wastewater Irrigation, presents the results and discussions relating to the socio-economic study of wastewater irrigation including the health aspects.

Chapter 7, Summary and Conclusions, comprises of the summary of the work and conclusions derived from this study and future course of actions and research with respect to wastewater irrigation and its impact.