CHAPTER 1

INTRODUCTION

1.1 GENERAL

Groundwater is widely used for domestic, industrial and agricultural purposes in most parts of the world. Increasing demand and quest for groundwater due to ever increasing population has thrown light on the unscientific techniques to quench these precious resources. If groundwater is to continue to play an important role in the development of the human civilisation, then it has to be protected from the increasing threat of contamination. Further, groundwater always contains some dissolved ions and concentrations of these ions change along the flow path due to various geochemical reactions that mainly control the groundwater chemistry. It is important to identify and understand these geochemical reactions that are taking place in an aquifer system in order to assess the distribution of major ion chemistry of groundwater of a region. Few researchers have attempted to identify the geochemical processes controlling the hydrochemical evolution of groundwater (Fisher and Mullican 1997, Janskoswki et al 1998). Some studies have gone further by attempting to model the geochemical reactions taking place along the flow paths (Martinez and Bocangra 2002, Larsen et al 2003).

Hydrogeological/groundwater modelling is a powerful management tool which can serve multiple purposes such as providing a framework for
organising hydrologic data, quantifying the properties and behaviour of the systems and allowing quantitative prediction of the responses of those systems to externally applied stresses (Corbet and Bethke 1992, Storm and Mallory 1995, Gomboso et al 1996, Strom 1998, Gnanasundar and Elango 2000, Corbet 2000 and Selroos et al 2002). However, no attempt has been made so far to carry out groundwater/hydrogeological modelling by characterising the subsurface in combination with hydrochemical studies of the aquifer system. From the available literature it is seen that no research has coupled geochemical characterization and hydrogeological modelling. Thus, it is perceived that identification of geochemical reactions and management of groundwater through hydrogeological modelling techniques have to work hand in glove for any beneficial and sustainable management of groundwater resources. Such research may initiate increased understanding and provide proper and effective techniques to get an insight into the hydrogeological aspects of a region. Hence, such a hydrogeological and hydrogeochemical study aided by numerical modelling technique was carried out in the lower Palar River basin located in Southern India (Figure 1.1) as part of this research.

1.2 NEED FOR THE PRESENT STUDY

Groundwater is major source of water in the lower Palar River basin for domestic, agricultural and industrial requirements. The Palar River, which is one of the major rivers of the state of Tamil Nadu, used to flow generally during the monsoon period (November to January). However, over the last few years, the river has hardly flown even for about ten days in a year. Since 1998, due to failure of monsoons no major flow has been recorded in the river. Hence, groundwater has been extensively used to meet the ever-increasing demand for domestic, irrigational and industrial purposes. Major abstraction is for agricultural and industrial including pumping for Madras Atomic Power
Figure 1.1 Lower Palar River basin, southern India
Station (MAPS) located outside the northeastern boundary of this area. Due to over dependence on groundwater for all these purposes, the quantity and quality of the groundwater may decline and deteriorate over a period of time. Groundwater abstraction is expected to increase to meet the requirements of Prototype Fast Breeder Reactor (PFBR), which is coming up near MAPS. Though government agencies carry out routine monitoring of groundwater quality in a few selected wells of this area, no work has been carried out on the hydrogeochemical processes controlling the groundwater chemistry and hydrogeological modeling of this aquifer system. Hence, it is necessary to characterize this aquifer and to develop a regional hydrogeological model for effective management of the system.

1.3 OBJECTIVES OF THE STUDY

The objectives of the present study carried out in the lower Palar River Basin, Southern India are

(i) to determine the response of the system to variations in rainfall,
(ii) to determine the hydrogeochemical characteristics of groundwater and the geochemical processes,
(iii) to develop a three-dimensional mathematical model to simulate the regional groundwater flow and solute concentration and
(iv) to assess the behaviour of the aquifer system under different hydrogeological stresses.
1.4 STRUCTURE OF THE THESIS

The thesis is constituted of nine chapters as follows:

Chapter 1 introduces the need for the study and objectives of the study. Review of some of the recent research work on hydrogeology, hydrogeochemistry, and groundwater simulation are presented in chapter 2. Chapter 3 describes the study area and the methodology adopted in this study. The hydrogeology of the study area is explained in chapter 4. Major ion chemistry of groundwater of the study area is described in chapter 5. The geochemical processes and results obtained from reaction modelling are explained in chapter 6. The model development, simulation of the regional groundwater flow and solute transport are discussed in chapter 7. The behaviour of his aquifer system to variations in hydrological stresses is described in chapter 8. Finally, chapter 9 deals with the conclusions arrived from this study.