1.1 General Introduction

Nowadays groundwater is one of the most important and indispensable resources to human life. Unlike other mineral resources, it gets replenished from the meteoric precipitation. From time immemorial, man has started using the groundwater and acquired the knowledge of getting it. In recent years, this knowledge acquired greater importance since the domestic, industrial and agricultural need of groundwater has been increased. Hence the assessment of groundwater has attained sovereign importance in the evaluation of natural resources.

In the earlier days, in India, the investigations for groundwater were confined to mostly sedimentary terrains, both consolidated and unconsolidated. But now a days more emphasis is being paid towards the exploration of groundwater even in hard rock areas, which occupy nearly 65 percent of the sub continent.
The scope and objectives of the present study are listed hereunder.

1.2 Scope and objectives of the present study

The present work aims at generation and amalgamation of various studies to evaluate the water resources of the Ayyar basin aquifers comprising predominantly of the crystalline rocks. The main objectives of the proposed study are:

1. to understand the physiographic, meteorological and geological characteristics of the area which have bearing on the occurrence and movement of groundwater.

2. to evaluate the geomorphic features by analysing the drainage and morphometric characteristics and demarcate the different geomorphic units by the Digital image processing techniques.

3. to evaluate the aquifer parameters and yield characteristics through dug well pump tests.

4. to demarcate potential groundwater zones using geoelectric measurements and results.
5. to determine the quality parameters of groundwater and to evaluate their suitability for use, to identifying the hydrogeochemical patterns and to develop hydrogeochemical models.

6. to develop a two dimensional digital simulation model of the aquifer system and evaluate the recharge - discharge potentials and

7. to quantify the available groundwater resources through conventional water balance methods.

1.3 Previous work

Geology of Tiruchirapalli district was described by King and Foote (1864). Geohydrological studies with reference to the sedimentary areas of parts of Tiruchirapalli districts were carried out by Srinivasan (1959 - 1960). The causes of salinity in the water of Marudiyar river and declines in the yields and head of flowing wells in Udayarpalayam taluk were also studied by Srinivasan (1960 - 61, 62-63). Abbi, Gupta and Sharma (1971) made a mesoscale study of groundwater fluctuation of Delhi in relation to rainfall. Sharma, Seghal and Gulati (1979) brought out techniques and methods for development and assessment of groundwater resources both for surface and subsurface level investigations.
A spatial analysis of groundwater potential of Tamilnadu with special reference to major landforms, has been made by Panchanathan (1981). Sharma et al (1983) carried out an investigation towards evaluating the feasibility of using aerial and satellite remote sensing for groundwater studies on the test site in Tirupati area in Andhra Pradesh. Sahai et al (1983) studied multi dated LANDSAT images covering the Saurashtra peninsula in order to demarcate potential groundwater areas for further exploration and exploitation. Pumping test results at most of the sites were found to be encouraging. Abbi, Gosami and Narayanan (1985) made an attempt to study the water balance of Dandavathi a tributary of Tungabadra river in Karnataka by applying the sacrament model which is a deterministic conceptual model. Manivel (1985) has described the quality parameters and aquifer characteristics of the district. Sathyamoorthy (1991) has dealt with various aspects of groundwater in and around Tiruchirapalli, Tamilnadu. Srinivasan (1992) has determined the quality and quantity of groundwater in Mamundiyar river -basin by an integrated approach.
1.4 General features of river

1.4.1 Location and Extent of the study area

The Ayyar river basin spreads over an area of 1171.00 sq. km. between 10° 55' to 11° 25' N latitudes and 78° 8'16" to 78° 41'E longitudes (Fig. 1.1). It forms a part of the survey of India Toposheets 58 I/7, 8, 11 & 12 and this sub basin forms a part of the major Cauvery river basin that includes mostly Musiri and Thuraiyur taluks of Tiruchirapalli district. A small coverage of area fall on the northern side of Salem District.

The river originates in Kollimalal hills (1358 m above MSL), confluences the river Cauvery in the Mukkamboo Upper Anikat, 15 km west of Tiruchirapalli town. The study area is surrounded by the main stream of river Cauvery in the south, Kollimalai and Pachamalai in the north, Salem district in the west and Perambalur taluk centre in the east.

1.4.2 Accessibility

Thuraiyur is a major town situated at the heart of the basin. The area is characterised by a network of good roads. The state highways connect Thuraiyur with the important adjacent towns like
Tiruchirapalli, Salem, Perambalur and Lalgudi. The nearest Railway Junction and the International Airport are at Tiruchirapalli.

1.4.3 Climate

(The area experiences a hot and dry climate in general. It falls under As' type according to Koppen's classification.) Shanbag (1956) includes the study area under the semiarid and dry province under megathermal group. Gaussen et al (1961) classify the climate of the district as tropical accentuated bioclimate (t < 20°C Rf 500 to 1000 mm with 7 or 8 dry months) and tropical moderate bioeric bioclimate (t > 20°C 500 < Rf < 1000 with 5 or 6 months). (The basin has an average annual rainfall of 722 mm/annum.) Most of the precipitation received by the basin is from the NE monsoon between October and December.

1.4.4 Physiography

The physiography of the area is very subdued due to prolonged sub tropical weathering. It is represented by an undulating plain flanked by hills. The hills are encountered in the northern part of the basin. The Pachamalai hills and the southern extension of Kollimalai hills are prominent. They
represent the much denuded remnants of the Eastern Ghat and some of their peaks rise to heights of over 1,000 metres. From the hills, the terrain slopes gently towards south and form a stretch of plain. The gently undulating plain is characterised by the floodplain of the Ayyar river. The plain along the foot of the Pachamalai and the Kollimalai are characterised in some places with outcrops of rocks and they comprise the pediments. The relief of the area is shown in figure 1.2.

1.4.5 Vegetation

In the northern hilly region, there is the predominance of Colueus Aromatics, Asystasia Cormandeliana, Sarcostemma intermedia and Mundalea suberosa. The plains are characterised by Manikara Chloroxylon - semi evergreen series. It varies from the close thorny thicket to the discontinuous low thorny thicket. Albizzia amera is generally present and chloroxylon swietenia is one of the most dominant species. The most frequent fruit trees of the region are Tamarind and Coconut. In the hilly tracts of the basin are found the fruit trees of Jack and Orange. The timber producing varieties found in the hilly
region are Teak, Vanni Malai Vemboo, Manja Kadamboo and Pillai Marudoo. Bamboos are extensively grown in the Pachamalai hills.

1.5. Research methodology

Topographic sheets of Survey Of India, Aerial photographs, Satellite imagery and base line informations from various sources are the basic sources for this study. By using topographic sheets, the watershed of the Ayyar river has been delineated and the availability of surface water resources were determined by using depth value given for each and every one of the tanks. By using topographic sheets with the addition of limited field checks and thin section studies the geological map of the area has been prepared. Documentary sources like rainfall, temperature from meteorological department, water level, water quality data from the Public Works Department were collected and from that monthly average rainfall of every stations, annual average rainfall of the area, demarcation of dry and wet months, Grid-deviation water table map, water level fluctuation map and well hydrograph have been prepared. Water quality data for twenty years have been used to find, whether the seasonal changes in quality are present or not.
From the topographic sheets, the drainage morphometry analysis is done by using rotometer and predict the areal, linear and relief characteristics of the basin. The correlation of morphometric results with the groundwater potential zones is highlighted. Satellite data have been used to predict the geomorphology, landuse and landcover of the area. The satellite data further used and principle component analyses have been done and it is correlated with morphometric structure. Further linear enhancement technique is used to compare the processed lineaments to the lineaments which are prepared from the aerial photos.

1.5.1 Field sources:

Post and Premonsoon waterlevel (year 1991 and 1992 respectively) for 79 wells have been monitored and the waterlevel maps with reference to MSL were prepared to study the status of water level. Pumptests have been conducted for 35 dug wells distributed all over the area, to evaluate the aquifer characteristics of the basin. To demarcate the groundwater potential zones, the Vertical Electrical Sounding (VES) for 85 locations have also been conducted. From the results, the depthwise behavior of resistivity and groundwater development maps were prepared which are greatly useful
to the formers. Water samples were collected from 50 dug wells in order to study the water quality of the area and to develop the geochemical pattern.

1.5.2. Statistical Analysis and Simulation Modeling

Factor analysis has been used to find out the inter-relationship among the individual parameters in different aspects like morphometry and groundwater chemistry. A spatial model have been developed for both the aspects and it will give a clear picture for further development.

A composite computer program - APE - in BASIC has been used to analyse pumping and recovery test, to evaluate the aquifer parameters of the area. Another BASIC program HYCM was developed by A. Balasubramanian (1985) has been used to analyse the chemical parameters to determine the chemical characteristics of groundwater in the area.

The program BACKDIF which can perform the computation of the backward difference(Implicit) formulation from finite-difference method, is used to study the recharge and discharge condition of the area.
1.6 Surface Water Facilities

Locating surface water bodies and determining their depth along with storage and distribution and evaluation of waters are the processes involved in surface water inventory. From the Geological Survey of India Toposheets, the area of water bodies are measured with the help of a square grid and the volume measured with the help of a depth value given in the topographic sheet. The Figure 1.3 shows the areas of water bodies, and Table 1.1 shows the number of tanks, their area of water spread and water holding capacity. In the Ayyar river basin there are 63 major and minor tanks with an area of 27,136.41 m² and the total water holding capacity of the tanks are about 1,09,578.00 m³. Hence the surface water availability in the area is not very appreciable and most of the farmers depend on the groundwater resources for their irrigation needs. It must be emphasised that the surface and groundwater components of the total water resources are interdependent. Changes in one component can have far reaching effect on the other. By properly coordinating the surface and groundwater supplies, optimum regional water resources development may be assured.
TABLE 1.1

SURFACE WATER AVAILABILITY IN TANKS OF THE AYYAR RIVER BASIN

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<th>Tank No.</th>
<th>Area (M)</th>
<th>Water Holding Capacity (N)</th>
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TOTAL 27136.41 109578.00
1.7 Organisation of thesis

The thesis has been divided into nine chapters as outlined below. The Introductory Chapter I deals with

(i) the objectives and scope of the present work
(ii) review of previous investigations in the field and
(iii) an outline of the contents of various aspects of the study covered in this work.

In Chapter II the geological, soil characteristics and climate of the area are described. Geology, subsurface geology, structure and climate are the important features elaborately discussed here.

In Chapter III the morphometric analyses of the basin have been attempted. The areal, linear and relief parameters of the basin morphometry have been evaluated. The hydrologic significance of some of these parameters has been highlighted and potential areas for detailed groundwater investigations delineated. The hydrogeomorphical features are identified by satellite data with the help of digital image processing.
Hydrogeology, which forms the most important part of the present investigation, is dealt within Chapter IV. The various aspects considered are:

(i) the identification of aquifer parameters and description of groundwater situation in the area of study.

(ii) evaluation of aquifer transmissivity, storage co-efficient, specific capacity indices, recuperation time for full recovery of open wells and optimum yield of wells.

In Chapter V, entitled “Geophysical analysis” the result of vertical electrical soundings have been analysed and interpreted and potential area for groundwater development have been delineated.

Chapter VI, deals with the chemical characteristics of the groundwater in the basin. This study includes (i) the presentation of major ion characteristics of representative groundwater samples from the basin (ii) the mapping of spatial variation showing water quality characteristics and identification of geochemical patterns. (iii) the assessment of water quality for domestic and
agricultural uses and (iv) development of hydrochemical model using numerical methods.

In Chapter VII, using a few selected conventional water balance methods, the annual groundwater recharge and groundwater storages have been estimated.

Chapter VIII has been devoted for modeling the groundwater system. A two dimensional digital simulation model of the aquifer system has been formulated by finite difference methods. The model is used as a deterministic tool for evaluating the groundwater storage in the aquifer system.

Chapter IX, summarises the findings and discusses the conclusions arrived at this work. Documentation of the analytical work has been carried out with suitable maps, figures, flowcharts, tables and charts. There is the bibliography at the end of the thesis. The computer programs used for processing the data relating to the various parameters of the study are appended to the thesis as well.