CHAPTER 8
SUMMARY AND CONCLUSION

The important findings of the present study are recounted below to provide a holistic picture of the study area.

1. The study area lies mainly over the Archaean crystallines and the groundwater occurs under unconfined conditions in the weathered and fractured zones of the hard rock aquifers. The average annual rainfall of the study area has been computed to be around 1046.87 mm. So, the significant rise of water table observed during December and January was mainly due to northeast monsoon.

2. The perusal of the drainage map of the study area has revealed that the Gadilam is a consequent river. Its tributaries flow irregularly in E-W, N-S, S-W and NW-SE orientations giving rise to dendritic, trellis and circular drainage patterns reflecting the heterogeneous character of the sub-surface geology. Following Strahler's system of stream ordering, the main tributary of Gadilam, Seshanadhi is a IV order stream and after its confluence Gadilam becomes a V order river.

3. The annual water table fluctuation varies between 2.2 and 11.8 m, which follows the general trend with reference to sub-surface topography of the study area. The study of well hydrographs for a period of twenty years from 1975 has revealed that there was not much difference between rainfall and water level as they follow the same trend and rhythmic. Grid deviation water level map delineates the areas of recharge and discharge zones.

4. Drawdown and recovery data of 28 dug well pumping tests have been analysed to evaluate the aquifer parameters and yield characteristics. It was found that zones of high transmissivity are falling adjacent to lineament intersections and buried pediments whereas the low transmissivity horizons were observed over pediments and shallow pediment regions. Time required for full recovery in the dug wells of the study area is very low in the areas of high transmissivity and optimum yield of aquifers.

5. The Vertical Electrical Soundings (VES) carried out in 39 locations up to a depth of 100 m have been analysed and the geoelectrical parameters were determined. These
results have been translated into subsurface geological details. It could be seen that (i) the aquifer consists of dry top soil of high resistivity as the first layer; moderately water saturated weathered layer of low resistivity as the second layer; and compact hard rock of very high resistivity as the last layer.

6. An Iso-apparent resistivity contour map has been drawn to delineate the subsurface lithological and hydrogeological conditions. It has been propounded that water is found in jointed formations, where the resistivity is approximately > 500 ohm m.

7. From the results of resistivity survey, thickness of the aquifer and depth to water table, a groundwater development map was prepared to delineate areas favourable for good yield dug wells and dug-cum bore wells. The maximum saturated aquifer thickness encountered in the study area being rather low, it is not advisable to go in for bore wells. However, further geophysical studies pertaining to depth of more than 100 m may bring to light the presence of certain fissured horizons that could be developed through deep bore wells.

8. Water samples collected for summer and winter seasons have been analysed for their major ion concentrations. The groundwater has been analysed for their major ion concentrations. The groundwater has been classified using the criteria of Handa, Piper, Stuyfzand, U.S.S.L., Schoeller and Gibbs schemes. A set of spatial variation maps depicting for summer and winter season are (i) total dissolved solids (ii) groundwater hardness (iii) salinity and sodium hazard (iv) index of base exchange (v) groundwater types (vi) corrosivity ratio and (vii) CaCO₃ saturation index of groundwater have been prepared to project the regional quality behaviour of groundwater. Groundwater in the study area is characterised by both temporary and permanent hardness. The Schoeller's chloride dominated water types and high CaCO₃ saturation indices of most of the water samples reflect a greater residence time of the groundwater in the aquifers. The chief mechanism controlling the chemistry of groundwater in the study area is due to the chemistry of rock types and the water infiltrated from precipitation. Nearly 80 percent of the water samples fall in C₁ S₁, C₂ S₁, C₁ S₁ and C₃ S₂ classes of the U.S.S.L. diagram and may be voted for safe to marginal for irrigation use, C₃ S₃, C₄ S₂ and C₄ S₃ can be used for raising salt tolerance crop. Though C₅ S₂, C₅ S₃ and C₅ S₄ classes, which were of poor quality and unsuitable for irrigation can be used for developing industrial activity.
9. First four principal components contributing to the chemistry of the groundwater have been identified. The first principal component is weighed on the group Na+K, Cl, SO₄, Ca, Mg for summer season and Cl, SO₄, Ca, Na+K, Mg for winter season. This contributes for nearly 57 and 58 percent of the variance. The dominance of sodium and potassium in the summer is attributed to the primary source of weathering of feldspathic minerals. The dominance of chloride in winter is indicative of the longer residence time of groundwater in the aquifer. With the help of the positive scores made by the individual samples with reference to the principal components, the hydrogeochemical model of the study area has been developed for summer and winter seasons. The component 2 of summer is represented by nitrate ions with the variants of 13.71% and component 3 of winter are represented by carbonate and nitrate with 9.2% of the total variants. In the study area nitrate pollution is found to be more than 100 ppm. in around the village Nathamur during summer and Thoneganandal during winter. These villages are found to be endangered due to the possible attempts of Methamoglobin anaemia disease. The high amount of nitrate above 45 ppm. is found in and around the villages of Kattusellur, Tottikunjaram and Kuchipalayam during summer and Parikal during winter. In the above four locations, nitrate has crossed the maximum permissible limit of ISI (1983) and WHO (1971). The high amount of nitrates in and around the above locations was due to usage of nitrate fertilisers and natural manure used for agricultural activities. Apart from this high cattle population and sewage wastes in and around the above-inhabited areas may also have significantly contributed to the high levels of nitrate concentration. This was the observation found during fieldwork. Magnesium ion concentration of groundwater samples has exceeded the tolerance limit of 100 ppm. for drinking purposes in and around village Tottikunjaram during summer and Elanthirai mettukuppam and Parikal during winter. As an ill effect of Magnesium contamination, encrustation in water supply structure will occur.

10. The seasonal groundwater chemistry when compared with aforesaid interpretation has revealed that the hydrogeochemical facies of the region change with reference to seasons.

11. After the analysis of trace metals from the selected groundwater samples of post monsoon season, it was noticed that the study area is subjected to the pollution of Sb,
Pb, Se, Cd, Mo, Hg, As and Sr as these elements have crossed the tolerance limit when compared with WHO, ISI, U.S. EPA and FAO standards. The above may be due to the chemical weathering. It is found that the study area is subjected to contamination of Se, Sb and Hg, which may not only due to rock weathering but also from pollution discharging source away from the study area. Due to the contamination of selenium in groundwater it is inferred to be toxic and there is every possibility for the occurrence of disease Nausea, dermatitis and pathological changes in the nails. Antimony is hazardous and so, not suitable for consumption. Mercury contamination in water may result to neurological and renal disturbances in addition to general toxic effect it produces gonodotoxic, mutagenic effect and disturbs cholesterol metabolism.

12. Based on the analysis of remotely sensed data the areas highly suitable for groundwater explorations are in the regions of buried pediments, suitable in pediments, moderately favourable in shallow pediments and water bodies. While the areas in and around relief hills, inselbergs and tor complexes are less favourable. Lineament map shows extensional, shear and release fractures and has helped in locating suitable sites for dug wells and dug-cum bore wells.

13. Groundwater potential zone map prepared by integrating geology, geomorphology, Iso-apparent resistivity, drainage density and lineament density shows that very higher potential zones are found adjacent to the river and drainage courses. This zone is sandwiched all along by high potential zones and low potential zones which were mainly found mostly along the southern part of the study area comprising hard lithology like relief hills, tor complexes, inselbergs and shallow pediment. Moderate potential zone is found along the periphery and in rest of the region in the study area which also contain above mentioned harder lithology. The very high and high potential zones are found to have the influence of geomorphology, Iso-apparent resistivity and lineament density than the other variables even after five combinations (final integration).

14. The groundwater potential zone model developed from GIS was validated with the optimum dug well yield data which shows that very good potential zones in the villages of Maranodai and Kalamarudur gives the value of 62.9 m$^{3}$/day and 42.3 m$^{3}$/day respectively. The villages around Thimmalai and Pusaripalayam shows 2.4
m$^3$/day respectively under poor groundwater prospective zones. Thus the model is in agreement with the pumping test data collected in the field.

So, the implications of the findings are as follows,

1. Artificial recharge methods such as construction of percolation ponds, check dams and desilting of the irrigation tanks should be attempted in the western and southern to southeastern parts of the study area where opportunities for such recharge are found. Grid deviation map prepared will be of added advantage if it is also considered to find the locations of artificial recharge zones.

2. Encroachment of few tanks in the northern and eastern parts of the study area should be removed and reclaimed to enrich the storage capacity of the surface water in the tanks and also to improve the groundwater recuperation.

3. Special salinity and sodium hazard management practices should be adopted to improve the quality of water in parts of south-central, eastern and more importantly in the southern part during summer. It comprises the villages like Thimmalai, Tottikunjaram, Neivanai, Kuchipalayam, Nathamur and Kattuidaiyar. On the other hand, salt tolerant crops like lemon, chilly, cotton, tobacco, date, sugarcane, onion and cucumber and trees like palm can be cultivated and grown in the areas of salt enrichment. Sodium hazard can be improved by adding gypsum and other amendments increases the crustal conductive properties of soil, it causes base ionic exchange in the soil, creating flocculation and more permeability in the soil texture and thereby improves the drainability as well.

4. With high intensity of agriculture practice and also due to the considerable use of fertilisers in northcentral and in the region adjacent to river courses, it becomes the areas of high deterioration and sickness in the soils. Use of organic manure and vermicompost must be used to improve the quality of the soil and redress the deterioration.

The methodology adopted, computer programmes used and the results obtained with suitable recommendation and remedial measures suggested for the study could be used as a positive, predictive and preventive tool for further developmental schemes by the planners and governmental or co-operative entrepreneurs of the study area.