CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

6.1 GENERAL

The present study was carried out to extract the physical characteristics of Alanthurai watershed, to assess the surface runoff potential of the watershed, to delineate favourable zones in the study area for implementing suitable artificial recharge structures in order to augment groundwater, to assess soil erosion status and groundwater quality mapping using GIS and statistical modeling. It is found that the data integration, management and visualization in GIS environment were relatively efficient for this work. Therefore, GIS based approach is used for the study in order to develop, characterize and support numerical model for the Alanthurai watershed system. The modeling study is used to identify the present status of the Alanthurai watershed and to make a decision for the further development and planning of the Alanthurai watershed.

In order to conserve the existing water bodies and to avoid the water scarcity problem of an area, the available water resources must be managed properly. By keeping these in mind to study the characteristics of watershed, to avoid fast decline in groundwater levels, to safe use of surface runoff, to avoid the further erosion of soil and to improve the groundwater quality, the present study has been undertaken for the conservation and management of Alanthurai watershed located near the western ghats of
Coimbatore district in Tamil Nadu. The conclusions of the present study are presented in this chapter.

6.2 CONCLUSIONS AND RECOMMENDATIONS FROM THE STUDY

By studying the existing scenario of Alanthurai watershed through the spatial analysis of watershed characteristics, surface runoff, groundwater flow pattern, soil erosion status and groundwater quality using statistical, software packages and Geographical information system tools, following conclusions are drawn.

1. The base map of Alanthurai watershed is successfully delineated from the survey of India (SOI) topographic map using the Map Info software package and it could be used for manipulation and modeling of any parameter related to watershed and runoff characteristics.

2. From the watershed characteristics study, it has been concluded that the Alanthurai watershed covered an area of 161.275 km$^2$ and the study area is elongated roughly in triangular shape with gently undulating terrain having hills and forest area in the western side of high physiographic and sloping towards eastern direction. The drainage basin is coming under the sub-watershed classification and the stream density is good on one side and less dense on the other side due to high land. The slope value of the watershed is high since the watershed surrounded by western ghats in one region.
3. The drainage pattern of Alanthurai watershed is deduced from the survey of India toposheet using Map Info and Arc View 3.2 a software packages and it is found to be of sub-dendritic pattern. The drainage pattern provides a guideline for locating the vulnerable areas, which are in need of soil and water conservation measures, to install.

4. The stream order and network for the Alanthurai watershed is prepared by means of Strahler’s ordering scheme. The concept of stream order is used to compute the other indicators of drainage character. Based on the Horton’s bifurcation law of stream numbers, the number of streams in the watershed of each order is measured and the stream density of the study area is also measured.

5. The average permeability value of the collected surface soil samples throughout the catchment area showed that moderately rapid permeability. From the field study it is concluded that the watershed is falls into the average catchment class according to Strange’s table. The annual percentage of surface runoff values of the watershed is calculated by means of Strange’s table based on the average catchment class.

6. From the rainfall records of the catchment area for the years 1985 to 2007, it is found that the maximum successive rainfall events occurred during the years 1994, 1998, 2004, 2005 and 2006. The maximum annual rainfall value for the above period is measured as 973.5 mm during the year 2005 and the minimum value of annual rainfall recorded as 465.7 mm during the year 1986. From the rainfall records, it is
concluded that the catchment has received maximum rainfall during North-East monsoon period.

7. The surface runoff value of the sub-watershed was assessed through the Strange’s table method. The statistical linear regression of surface runoff modeling were developed between the observed rainfall data and the computed runoff values using Excel software package with the square of correlation co-efficient is $r^2 = 0.99$. The results proved that the basin posses a perfectly positive correlation and it can be considered for the implementation of irrigation schemes in the catchment area.

8. In order to compare the surface runoff values calculated from the Strange’s table, the Artificial Neural Network (ANN) software is used. The comparative study shows that the prediction of surface runoff by ANN is perfectly matched with the Strange’s table method. From the study, it is concluded that the analysis of rainfall data by ANN approach is holds good and easier prediction for the future findings. The correlation co-efficient ($r^2$) value between the above two method is 0.999.

9. The soil erosion status of the Alanthurai watershed region is assessed by Universal Soil Loss Equation (USLE). The estimated soil loss values are presented pictorially using Arc View 3.2a version of GIS software. From the study, it is found that the western parts of the watershed covered a forest area, which intercepts raindrops before falling to the ground surface, therefore the soil erosion loss is comparatively low in that area.
10. Also it is identified that some parts of western region and the gauging point of eastern region are subjected to low erosion because of good vegetative covers and relatively lesser land slopes. It is estimated that around 25% of the land areas along the watershed are subjected to high and very high erosion. This is identified that the areas are covering lesser crop cover, comparatively sloping land and more transporting power of the water in streams.

11. From the soil erosion study, it has been suggested to adopt a suitable agronomical and engineering measure in order to arrest the further erosion of soil along the watershed region. The only way suggested for soil conservation is participation of farmers with low cost technology such as ploughing, furrowing, trenching, bunding and vegetative hedging along contours. They control runoff, erosion, improve subsurface drainage for favourable aeration, workability of soil in root zone and conserve soil moisture.

12. In the present study, the Visual MODFLOW (VMF), a three dimensional groundwater flow modeling software is used. It is a dynamic compartment modeling system that can be used for analysis of variety of groundwater flow problems. Aquifer characteristics such as co-efficient of storage and transmissivity are calculated by the Jacob’s and Chow’s method, using the pump test data, for the purpose of model generation.

13. The model created by the MODFLOW software is run by steady state and transient state methods. From the steady state calibration, it was observed that there is a good agreement between the calculated and observed water levels
in most of the wells. The correlation co-efficient obtained in this calibration is 0.796, which is near to 80%. The computed groundwater level contour map, for the watershed region shows that higher water level in the western parts. It is identified that the presence of tanks in the foothill of the ghats.

14. In transient state calibration, the parameters which are arrived through the steady state model calibration were used as the initial condition. From the transient (dynamic) state calibration, it was observed that there is a very good agreement between the calculated and observed water levels in most of the wells. The correlation co-efficient value obtained in this calibration is 0.844, which is more than 80%. It has been resulted that the groundwater model developed in this region has good correlation with the observed field values. The computed well hydrographs for the boreholes shows a fairly good agreement with the field values. Therefore the developed groundwater model for the Alanthurai watershed is mainly used for the purpose of providing a management tool for present planning and future decision-making.

15. In the present study, the optimal locations for constructing the artificial recharge structures were identified through the overlay analysis of thematic maps such as landuse, soil map, geology, geomorphology and lineament maps using GIS. The identified recharge area is further classified as priority area I, II and III according to the coincidence of the maps.

16. The artificial recharge structures were also recommended for the following conditions. The areas having null slopes, then
the areas are suggested to use spreading method such as flooding and furrowing. If the areas are covered by tanks, then the tanks should be desilted to increase the recharge. The percolation ponds were suggested for the areas having less than 5% slope. The areas having maximum zones of drainage density, then the area is suggested to go for pitting techniques for artificial recharge. The induced recharge method is suggested where the zones of coincidence of drainage density is minimum and the water level is minimum.

17. Finally the groundwater quality mapping study for the Alanthurai watershed region is generated using Arc GIS software package. From the groundwater quality analysis study, it was observed that except total dissolved solids and electrical conductivity all the physico-chemical constituents tested were within the prescribed limit for irrigation standards. From the study it is concluded that the well waters in the Alanthurai watershed region are suitable for irrigation purposes.

6.3 SUGGESTIONS FOR THE DEVELOPMENT OF ALANTHURAI WATERSHED

Briefly water conservation means putting the water resources of the country for the best beneficial use with all the technologies at our command that is to make water use sustainable. For the development of watershed, it is important that, a detail soil survey of the area must be carried out before the implementation of any developmental programme. The watershed management emplies the judicious use of all the resources such as land,
vegetation and water of the watershed to achieve maximum production with minimum hazard to the natural resources and for the well being of people. The following suggestions were made from the study.

1. The three key activities that are essential for the development of a watershed area is irrigation management, catchment management and drainage basin monitoring and management. For these activities planners need information about the physical characteristics of the watershed. Hence the present work was concentrated firstly on the estimation of physical characteristics of the Alanthurai watershed.

2. Water conservation measures comprises of creation of reservoirs, prevention of losses, improving water use efficiency and recycling and reuse of wastewater. Surface water potential of the Alanthurai watershed region is good due to the river Noyyal, therefore economical use of water together with conjunctive use of surface and groundwater resources are essential in the watershed area to augment the surface and groundwater.

3. Harvesting of rainwater through a grid of farm ponds and reservoirs are needed in the watershed for the conservation of surface and groundwater. Artificial recharge methods suggested are to be implemented for the conservation purposes and improving the quality of groundwater.

4. Through the analysis of soil erosion study, it is clear that about 25 percent of area is subjected to high and very high erosion. In future it may leads to sedimentation and other consequential problems to the watershed. It could be
controlled by suitable agronomical and engineering soil conservation measures.

5. Farmers must be educated and instructed them, to avoid the over irrigation of crop. Further, new wells should be banned particularly in over-exploited areas in the watershed and the free electricity policy should be redefined. Training the farmers in selection of suitable number of crops and cropping pattern for the particular period of cultivation.

6.4 RECOMMENDATIONS FOR FURTHER RESEARCH

1. The present study deals with the estimation of watershed characteristics for Alanthurai watershed only, it could be extended to near by or any other watershed and it may correlate the watershed characteristics between them.

2. The estimation of surface runoff for the study area is done by the Strange’s table method; the study may also be extended to find the impact of watershed characteristics on the surface runoff of the watershed using software packages.

3. The present groundwater model is developed to understand the complex dynamic behaviour of the multi layer aquifer system in the Alanthurai watershed by using the limited observed data. For better accuracy it can be extended to more number of years.

4. The available water level data and pumping test data are limited number of wells only. In order to improve the accuracy of the model more number of field observed values can be included. The aquifer parameters arrived from
pumping test results are cross verified by conducting pumping test on more number of wells.

5. The proposed location of artificial recharge structures should be verified from the field observation.

6. The effect of soil and water conservation measures on the development of watershed to be studied by the extensive field survey.