CHAPTER 7

RESULTS AND DISCUSSION

7.1 GENERAL

The present study of Gadilam river basin is an attempt to demonstrate the concept of organizing a systematic database of spatial data and non-spatial data in a GIS environment. A systematic database for the Gadilam river sub basin has been organized using the spatial data collected from remote sensing technology. Several cartographic and statistical methods of analysis have been made to determine the spatial pattern and to prepare the thematic maps.

The following maps were generated from satellite imagery IRS 1D LISS III of Gadilam river lower sub basin using

1. Geomorphology map
2. Landuse / Land cover map
3. Soil map and
4. Wasteland map

In addition to these maps, the base map and the drainage map have been prepared from the topographic maps and taluk maps (1:50000), Geology map is prepared from the resource map of Geological Survey of India. In addition to the above derived maps, the maps such as water quality maps, rainfall contour maps, Average ground water level contour maps etc were also prepared.
7.2 RESULTS

The results obtained from the above study are discussed below.

7.2.1 Groundwater Potential Zone

ArcInfo and ArcView GIS software were used to create database for spatial and non spatial data for the sub basin. GIS query system under spatial and non spatial analysis modules are used for raster and vector overlay analysis and the final output map of groundwater potential map was generated by integrating the various thematic layers such as Geomorphology, Geology, Rainfall, Pre-Monsoon Water Level, Aquifer thickness, Soil, Landuse, relief and drainage by giving appropriate weightages to the different themes and are shown in the Figure 7.1.

The ground water potential, recharge and discharge are also arrived for the periods of 1992 and 1998. The ground water availability during the year 1992 is calculated as 34.20 and during the year 1998 it was 27.55 Mcum.
Figure 7.1  Ground Water Potential map
7.2.2 Evaluation of the Aquifer Parameters and Yield Characteristics

- From the geophysical survey, it is inferred that in the north of the river Gadilam (Alluviam), resistivity value ranges from 10-20 ohm-m indicates clay, 20 – 50 ohm-m indicates sand and more than 50 ohm.m indicates sandstone. Similarly in the south of the river (Tertiary), resistivity value around 10 ohm indicates clay, 81 – 273 ohm- m indicates sandstone and 278 – 773 ohm-m indicates laterite.

- From the well logging interpretation it is inferred that in the north of the river Gadilam, the resistivity value ranges from 5 – 10 ohm-m indicates clay and 15 – 40 ohm-m indicates sand. In the south of the river, the resistivity value ranges from 15 – 20 ohm-m indicates clay, 90 – 120 ohm-m indicates sand and 220 – 350 ohm-m indicates sandstone.

- The aquifer parameters are estimated by conducting pumping tests in the deeper aquifer. The discharge (Q) ranges from 2532 to 8016 lpm and transmissibility (T) are ranges from 1800 to 7860.10 m²/day in the locations such as Kadampuliyur, Chavadi and Naduveerapattu and in the locations such as Anguchettipalayam, Pannaikuchipalayam, Periyapurangani, Sathipattu, Pathirkuppam, Poongunam, Meliruppu and Marungur which are having shallow aquifer, showing the discharge ranges from 164 to 981 lpm and transmissibility ranges from 190 to 1321.50 m²/day.

- The storage coefficient (S) of Kadampuliyur and Chavadi is 2.975x10’5 and 9.583x10’5 and other locations showing the
values ranges from 0.001 to 0.41 except Naduveerapattu. The specific capacity of Kadampuliyur is calculated as 3193.62 (l/m of dd) and in other bore wells it varies from 115.20 to 863.15 (lpm/m of dd) except Anguchettipalayam, Pannaikuchipalaiyam and Poongunam it varies from 34.05 to 92.37 (lpm/m of dd). The maximum draw down observed in the Chavadi, Anguchettipalayam, Pannaikuchipalayam and Poongunam ranges from 6.77 to 10.62 m.

- The bore well lithology collected from 31 villages from PWD and 7 from CGWB clearly revealed that in the alluvial formation consisting of sand, clay etc and in the tertiary part consisting of sand, clay, laterite, sandstone etc. And also the aquifer zones seen to be sloping towards eastern direction.

- The bore well lithology and geophysical data furnish adequate information over subsurface hydrogeological condition, depth of penetration and thickness of aquifer zones of the study area.

- The groundwater level data were collected for 10 years from 1994 to 2003 for water level fluctuation study. This study reveals that during the post monsoon period for 10 years from 1994 to 2003 the water level lowered from 0.40 to 7.65 m in the observation wells located at Semakottai and Anguchettipalayam whereas during pre monsoon the level goes down from 2.20 to 8.25 m. But in the observation wells such as Alagappasamudhram, Naduveerapattu and Ramapuram, the water level fluctuation ranges from 1.05 – 22.90 m during post monsoon period and level goes down in pre monsoon season from 2.35 – 30.10 m.
• By studying the water level in the observation wells for the period of 5 years (1999 – 2003) it is indicated that the ground water level varies from 2.20 m to 5.70 m at Thiruvamur, Cuddalore, Semakottai, Anguchettipalayam, Panruti and Nellikuppam and rest of the locations show the declining trend value ranges from 10.40 m to 18.10 m.

7.2.3 Landuse Change Detection Analysis

• The overlay analysis was carried out to detect the landuse changes in the Gadilam river lower Sub basin. Using the ArcGIS software 9.2, the individual landuse categories and variations in the aerial extent and its percentage were estimated. Analysis of the landuse maps of 1997 and 2003 revealed the changes in aerial extent of landuse categories.

• The changes in various categories of landuse maps between 1997 and 2003 indicate that the dry crop land, land with or without scrub, plantation, wet crop etc are drastically reduced in the year 2003. But other categories like forest plantation and settlements are slightly increased.

• The dry cropland is reduced considerably in the area (about 64.44%). Plantation is increased considerably in area to the tune of about 68.41% and wet crops reduced to 2327.88 ha (about 51.58%). There is considerable increase in the settlements (about 122.45%). The changes in the wasteland categories have been identified for the period 1997 to 2003.
7.2.4 Wasteland Analysis

- The wasteland categories identified in the study area are sandy soil, gullied land deep, barren land etc. These are the examples of the villages covering the wasteland. Kondur, covering sandy soil of about 1.79 acres, Nadukuppam covering the gullied land deep of about 6.25 acres and Thirumanikuzhi is covering barren land of about 3.92 acres.

7.2.5 Groundwater Quality

- Groundwater samples were collected from 25 locations covering the entire study area for 1997 and 2005 and were analyzed. The contour maps were generated for Total Dissolved Soilds, Electrical Conductivity, Total Hardness, pH and Chloride for the same period. By observing the water quality for the year 1997, out of 25 locations five locations shows the EC values ranging from 1045 – 4020 microhms/cm. The rest of the villages shows the EC values ranging from 99 – 810 microhms/cm whereas the TDS values in seven locations shows less than 100 mg/l and rest of the locations ranging from 100 - 440 mg/l except Nellikuppam and Cuddalore showing 952 mg/l and 2814 mg/l respectively. The chloride observed at Cuddalore was 1024 mg/l.

- Similarly during the year 2005, 8 locations showsthe EC values ranging from 1140 - 1910 microhms/cm and the rest of the villages shows 105 – 910 microhms/cm except two locations such as Natham and Cuddalore shows 2310 and 3450 microhms/cm which is attributed to local pollution
whereas the TDS values in 4 villages show less than 100 mg/l, other 3 locations shows 1005 to 1617 mg/l and rest of the villages shows 126 to 879mg/l except one location having TDS value of 2815 mg/L. The chloride value observed in Cuddalore was 750 mg/l.

- From the water quality analysis, it is learnt that the quality of water is generally good in the study area. But in these two periods in the locations Nellikuppam and Cuddalore, the quality of water is not satisfactory for drinking. The TDS contour map clearly shows that the quality of water near the coast shows the higher salinity.

### 7.2.6 Groundwater Modeling

- The pump test data, borewell lithology, water level fluctuations are used to develop the groundwater model to estimate the head in the lower Gadilam river basin for a period of 15 years (1995-2010) for better understanding of the aquifer system. The simulated results indicate that this aquifer system is stable under the present groundwater exploitation and utilization condition. The model developed was also used to forecast the groundwater condition for the year 2010.

- By correlating the groundwater model, rainfall data for 35 years and land use changes for the period 1997 and 2003, the following inferences were drawn.

- The average rainfall in the year 1997 is 1491.70 mm and in the year 2003 it was found as 1148.00 mm. The reduction in rainfall for the period 1997 and 2003 is found to be 23%.
The groundwater model simulated for 1997 and 2003 also confirmed that the reduction of rainfall leads to reduction in the groundwater head. From the model, the groundwater head computed for the year 1997 was 29.29 m whereas for the year 2003 it was 25.45 m. This difference in the groundwater head is 3.84 m, which clearly confirmed the effect due to reduction in rainfall.

The landuse change detection analysis was made between 1997 and 2003. The analysis of data indicates that plantation area has been increased by 7935.50 ha. The analysis of groundwater model indicates that 23% reduction in rainfall leads to the declining of groundwater head of 3.84 m (from the groundwater flow model). The reduction of both the rainfall and groundwater head leads to landuse change in the wet crop into plantation.

The results obtained from the groundwater model indicates that the decrease of groundwater level from 25.45m to 21.10 m (i.e.) 4.35 m in depth between 2003 and 2010.

Due to the decrease of groundwater head by 4.35 m the wet crop or dry crop area can be converted into plantation depending upon the existing ground water condition.

It is clear that during the last few years in the anicuts zero runoff was recorded. But during the year 2005 October, November and December runoff was recorded in the anicuts as 1.73 TMC, since there was a heavy rainfall during the year 2005.
7.2.7 **Groundwater Recharge Zone**

Arc-Info and Arc-GIS software are used to generate various thematic maps. By integrating all the themes and overlaying under GIS platform, it is inferred that the geomorphic units like flood plains, buried river coarse, alluvial deposits and tertiary deposits are favourable for recharge. The recharge zone map was generated using geomorphology, geology, landuse, rainfall, water level, Aquifer thickness and wasteland maps by assigning suitable weightages to the individual themes and is presented in the Figure 7.2. The recharge zones their aerial extent is given in Table 7.1.

**Table 7.1  Recharge Zone and Their Aerial Extent**

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Description</th>
<th>Area in ha.</th>
<th>Area in Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Highly favorable for recharge</td>
<td>8243.09</td>
<td>26.18</td>
</tr>
<tr>
<td>2</td>
<td>Moderately favorable for recharge</td>
<td>23179.20</td>
<td>73.60</td>
</tr>
<tr>
<td>3</td>
<td>Less favorable for recharge</td>
<td>70.59</td>
<td>0.22</td>
</tr>
<tr>
<td><strong>Total Area</strong></td>
<td></td>
<td><strong>31492.88</strong></td>
<td><strong>100.00</strong></td>
</tr>
</tbody>
</table>
Figure 7.2 Recharge Zonation map
7.2.8 Artificial Recharge Structure

- The analysis of landuse 2003 indicates that 303.75 ha of land with or without scrub falling under the high and moderate zones of recharge which can be improved by constructing artificial recharge structures.

- Suitable locations are identified for constructing artificial structures by remote sensing and GIS technology. Check dams, percolation ponds are recommended in the highly favorable recharge zones, recharge pits and recharge shafts are suggested for moderately favorable recharge zones and surface ponds, nullahbund are recommended for poorly rechargeable zones. The artificial recharge structure map is shown in the Figure 7.3.
Figure 7.3  Artificial Recharge Structure map
7.2.9 Salinity Impact

The bore well lithology and logging details were collected from Central Ground water Board to know the salinity impact of the study area. The depth of bore well drilled at Cuddalore was 300m and at Chavadi was 665.86m. The logging data of Chavadi shows that the saline water is identified from 0-80 m and fresh water from 100-300m. The depth from 300 to 420m shows brackish water and below this formation the quality of water shows salinity. This is confirmed by the water quality result. The EC value was 296 and Cl was 215 mg/l. The TKS value was calculated as 7860, 76.3 and 9.583x10^-4. Representation of Lithology and E.Log of Chavadi is presented in the Figure 7.4. Sangolikuppam and Alappakkam are not comes under the study area.

Figure 7.4 Lithology and E.Log of Chavadi
Three zones were identified in the bore well at Cuddalore. The top zone up to the depth of 100m shows saline water. It is confirmed by EC value is 1200 and Cl is 1300 mg/l. The middle zone starts from 100m to 160m and indicates brackish water. The EC value is 970 and the Chloride value is 113. The depth between 130 to 140m shows the lignite seems. Below the depth of 160m indicates saline water. Representation of Lithology and E.Log of Cuddalore is presented in the Figure 7.5.

Figure 7.5  Lithology well Design and E.Log of Observation Well at Cuddalore
Saline water is underline by fresh water in general below 400 to 450 mbgl at Chavadi. Lenses of saline water pockets in shallow aquifers between 30 to 99 mbgl all along Chavadi and Cuddalore area have also been observed. Quality of ground water improves downwards and becomes fresh below 200 through a transition zone of brackish from 99 to 200 mbgl at Cuddalore. Thickness of fresh water aquifers reduces towards coast. Ground water occurring from 200-300 mbgl is highly saline (30,000 mg/l below 200 mbgl) at Cuddalore. This map indicates the water quality at various depth of the well.