CHAPTER 7
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SUMMARY AND CONCLUSIONS

Water is a precious asset of humanity. A well managed society is one that knows how to treat its water with care, prudence and respect. Groundwater is the largest available source of fresh water lying beneath the ground. Water, one of the most essential resources in our day today life is depleting faster in rural as well as urban areas mainly because of increase in agricultural and domestic demands respectively. In water resources planning, groundwater is attracting an ever-increasing interest due to scarcity of good quality subsurface water and growing need of water for domestic, agricultural, and industrial uses. It has become crucial not only for targeting of groundwater potential zones, but also monitoring and conserving this important resource. Besides targeting groundwater potential zones it is also important to identify suitable sites for artificial recharge usage cycle. When the natural recharge rate cannot meet the demand for water, the balance is disturbed and hence calls for artificial recharge on a country wise basis. In hard rock terrains, availability of groundwater is of limited extent. Occurrence of groundwater in such rocks is essentially confined to fractured and weathered horizons. Efficient management and planning of groundwater in these areas is of the utmost importance.

Remote Sensing with its advantages of spatial, spectral and temporal availability of data covering large and inaccessible areas within short time has become a very handy tool in assessing, monitoring and conserving groundwater resources. Satellite data provides quick and useful baseline information on the parameters like geology, geomorphology, land use/land cover, lineaments etc. controlling the occurrence and movement of groundwater. Thematic layers generated using remote
sensing data like geology, geomorphology, land use/land cover, lineaments etc., can be integrated in a Geographic Information System (GIS) framework and analyzed using a model developed with logical conditions to derive groundwater recharge zones. In the present study, attempt have been made to identify the Artificial recharge zones in Heggadadevanakote (H.D.Kote) taluk, Mysore district, Karnataka, India, using remote sensing and GIS techniques.

The study area H.D.Kote taluk is the southern part of Mysore district. The area is located between $11^\circ44'$ to $12^\circ08'$ north latitude and $76^\circ08'$ to $76^\circ33'$ with the geographical areal extent of 1618 sq kms covering 200 villages coming under the survey of India toposheet No. 7D/7, 57D/11, 57D/4, 57D/8, 57D/12, 58A/1, 58A/5 and 58A/6 on a scale of 1:50,000. This area falls into the western block of Proterozoic basins of Southern Karnataka and comes under semi arid type with gneisses occupying the total area.

Geologically the area is mainly comprised of gneisses, granodiorite, tonalite and migmatitic gneisses, which constitute about 99%. And the remaining small area is occupied by other rock types like amphibolites, ultramafics and dykes. They are part of the high grade terrain of the southern Karnataka. Younger dolerite dykes occur as intrusive. The aquifer characteristics of the study area, are thus, controlled by the above mentioned rock types. Structural domains like fractured, faulted, and sheared areas and lithological contacts between different rocks types have been found to be moderate to good groundwater potential zones. Fairly dense distribution of lineaments have been mapped and validated with field checks. The total numbers of lineaments mapped in the area are 137. It has been found that most drainage line are controlled by lineaments, besides the fractures and joints present in the bed rocks have been found to be good conduits for ground water movement. Thus potential zones of ground water are
coinciding with denser areas of lineaments especially the ones which are tectonogenic in origin. The mapped lineaments trend in N-S, E-W, NW-SE, NE-SW, NNE-SSW and NNW-SSE directions.

Mapping and classifications of soils have been carried out using LISS III plus PAN merged imageries. Five sub groups namely Sandy loam, Red sandy loam, Black and mixed loam, Red loam have been identified. These soils are considered to be residual concentrations derived by the weathering of parent rocks represented by gneisses of the basement complex. These soils are highly porous and having high degree of infiltration and water holding capacity.

Hydrometeorological parameters like temperature, relative humidity, wind speed, rainfall and its distribution have been analyzed. The study indicates that the average of maximum temperature of 39.40°C is recorded in the month of April and the average of minimum temperature of 13.50°C is recorded in the month of January. The relative humidity (RH) for normal years in the study area increases from April and reaches maximum in August and gradually decreases and reaches minimum in the month of March. The mean of RH varies from 30-78%. The average rainfall of the study area for the period 2001 to 2010 is 862.7mm.

Geomorphological units and associated features were identified and mapped in the study area through the visual interpretation of satellite data. Hydrogeomorphologically the H.D,Kote taluk is classified into different zones covered by Structural hills, Residual hills, Pediplain Moderately Weathered, Pediplain Shallow Weathered and Pediment have been identified. Residual hills are resulted from the end product of peniplaination which reduces the original mountains into a series of scat-treed knolls standing on the pediplains (Thornbury, 1990). These units
are considered as poor potential zones, as they have unfractured rock material, low infiltration and behave largely as runoff zone. Structural hills are the linear or acute hills exhibiting definite trend lines and mostly act as runoff zones. Piedmont plain has low relief and surface water remains for considerable time before meeting major rivers. It provides good scope for infiltration and recharge of groundwater. Consequently they pose good potential for groundwater occurrence.

Morphometric analysis of the H.D.Kote taluk and its sub basin level has been carried out taking the hydrological boundary into consideration. The area has been divided into three sub-basins. Kabini river is found to be fifth order, the stream length ratio of the sub basin and its watersheds are changing haphazardly which is attributed due to differences in slope and topographic conditions of the study area. The bifurcation ratio varies from one order to its next order. These irregularities are dependent upon the geological and lithological conditions of the drainage basin. The lower values are characteristics of the taluk, which have suffered less structural disturbances, and the higher values indicate strong structural control on the drainage pattern. Drainage density values of the sub-basin and the watersheds are all indicative of very coarse to coarse drainage texture which is having highly permeable subsoil, dense vegetative cover and low relief.

All the three shape parameters viz., elongation ratio, circularity ratio and form factor are suggestive of an elongated shape for the basin, in turn has an effect on the discharge characteristic of the basin. The higher values of relief ratio and relative relief values are indicative of basin located in the south-western part of the sub-basin having steeper slope and high relief compare the remaining watersheds having lower to gentle slope values. Finally, it can be suggested that remote sensing and GIS techniques have proved to be an efficient tool in drainage delineation and their
updation. These updated drainages have been used for the morphometric analysis. The morphometric analysis is carried out through measurement of linear, areal and relief aspects of basins.

In the present study Remote Sensing and GIS techniques were used to carry out the study on artificial recharge zones of H.D.Kote taluk. In the view of this IRS-ID LISS-III image was interpreted to prepare various themes which mainly include Lithology, Geomorphology, Slope, Landuse/Landcover, lineament, soil map, drainage map, groundwater prospect and etc. The SOI topographical maps and other maps were used for preparation of base maps. The thematic maps so prepared by interpretation were digitized in ArcMap10 platform.

The land use/land cover maps were prepared using satellite images on 1:50,000 scale and topographic maps were used as reference on the same scale. The methodology adopted according to the NRIS Node design and standards for classification of various land use/land cover classes. The different land use/land cover classes like settlements, crop land, fallow and agricultural plantations, scrub degraded forest, forest plantations, land with scrub, land without scrub, barren rock/stony waste, rivers, streams and tanks were delineated based on the double cropped area and agricultural plantations are mainly noticed along valleys and tank command areas. Similarly waste lands like stone waste and scrub lands are found in the uplands and along the fringes of the forest area.

Slope analysis reveals that most of the study area comes under nearly level, gentle slope and very gentle slope class. Low degree of slope in the terrain is indicative of nearly level to gently sloping. The slopes have been classified into seven categories i.e. nearly level (0-1%) very gentle (1-3%) Gentle (3-5%) Moderate (5-
Most of the northern half of the study area occupies slope category of 0-1% and is favourable from groundwater potential point of view. On the other hand, high degree of inclination represents steeply sloping land. Steeper the slope, higher is the run-off and erosion. In general, lower is the slope, less is the run-off and vice-versa.

Identification of groundwater potential zone is great in demand due to the increasing population and urbanization. It has been reported that there is a good interrelationship among the geomorphic units, geological characteristics, lineaments, drainage and their density and groundwater conditions in an area. It has also been noticed, the drainage density has negative correlation with the groundwater conditions in an aquifer (Pratap et al., 2000; Obi Reddy et al., 2000; Srivastava and Bhattacharya, 2000) in the study area also, the geomorphology, Lineaments, intersection of lineaments, drainage density, type of lithology and surface water bodies are directly influencing the pattern of groundwater table. The drainage density in the area is relatively low in the valley region, moderate in plains and high in hills and pediments. Remotely sensed data and field investigations have clearly shown, the groundwater conditions in VSF and PPM is very good to good, in PPS; good to moderate, in pediments; moderate to poor and in hills; very poor. It could be attributed due to low drainage density and also most of the lineaments are confined to the valley regions and these lineaments are acting as pathways for groundwater movements. Hence the groundwater level in the area, along and in the regions near to lineaments at shallow depths and yield is relatively high. It is also noticed that the groundwater table increases considerably during the monsoon season.

Vertical electric sounding (VES) data of 42 locations in the H.D.Kote taluk, which was collected with the help of CRM-20 (Computerized Resistivity Meter). The
survey lines were located along existing roads, paths and open fields avoiding physical obstacles like buildings and fences. These locations of the VES points are given in the Map 3.1. The maximum electrode separation (AB/2) in VES was kept as 100 m. The data was analyzed and determined the upper soil strata, weathered rock and bedrock details. The high resistivity values are found in the southern part of the study area indicates the hard and massive bedrock at shallow depths and show poor aquifer conditions. The remaining parts of the study basin having moderate to low apparent resistivity and these areas indicate promising zones for groundwater.

According to the recharge zone map (Map 6.4), H.D.kote taluk is divided into three different zones, namely ‘Good,’ ‘Moderate’ and ‘Poor.’ About 45% of the total area falls under the Good recharge zone, (36%) falls under ‘moderate groundwater recharge zone, and 19% of the study area falls under poor recharge zone. The artificial recharge zone map of the area was prepared by integrating different thematic layers like geomorphology, geology, Slope, landuse/landcover, lineament density, Drainage Density, Aquifer thickness and apparent respectively in ArcMap 10 software. The study has shown that preparation of integrated groundwater recharge map using remote sensing, GIS and resistivity survey leads to precise identification and may help in planning for optimum utilization of water resources especially in hard rock area.