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Geologic and Geomorphologic Investigation of Vaippar Rivers Basin, Tamilnadu, India

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Abstract **Original Research Article**

The present study area (Vaippar river basin) lies located between Latitude 9° 0' to 9° 45' and east longitude 77 ° 20' to 78° 20' north latitude covered Virudhunagar, Tirunelveli district in Tamilnadu. The basin area is demarcated from the survey of India Topographical maps and covers an area about 4900Sqkm .The problem of the present study is a representative case of over exploitation of ground water resources, leading to the continuous exhaustion of the grained as well as the groundwater aquifers. The application of the increasingly and internationally accepted method of artificial recharge on the ground water aquifer was decided to be the most effective for the restoration of balance of the hydro geological system. The details of Hydrological conditions of the area is necessary for the success of the method, whose planning has to be made based on the principles of environmental protection and sustainable development. Use of state-of-the-art technology and estimation of all the parameters involved, which are necessary, have been taken into account. Geological, geomorphological, landuse etc., investigation of the study area, which is necessary for groundwater resources evaluation, has been digested well in this paper.

Keywords: Geomorphology, Geology, Groundwater, Remote sensing, GIS, Vaippar river basin.

INTRODUCTION

Ground water is one of the most valuable natural resources, which supports human health, economic development and ecological diversity. Because of its several inherent qualities (e.g., consistent temperature, widespread and continuous availability, excellent natural quality, limited vulnerability, low development cost, drought reliability, etc.), it has become an immensely important and dependable source of water supplies in all climatic regions including both urban and rural areas of developed and developing countries. Particularly, groundwater is emerging as a formidable poverty-alleviation tool, which can be delivered direct to poor community far more cheaply, quickly and easily than canal water. Of the 37Mkm3 of fresh water estimated to be present on the earth, about 50 % exists as ground water, which constitutes about 97 % of all liquid freshwater potentially available for human use. Unfortunately, the excessive use and continued mismanagement of water resources to supply ever-increasing water demands to profligate users have led to water shortages, increasing pollution of freshwater resources and degraded ecosystems worldwide.

Remote sensing and GIS are playing a rapidly increasing role in the field of hydrology and water resources development. For decades, geospatial technology has been used successfully for the mapping and extraction of surface structures and therefore represent an integral part of applied geomorphology [1-5]. Concerning extensive studies like the detection of landforms, the analysis of feature distribution or land cover investigations, visual interpretation of aerial photos has proved to be very effective, and its advantages for surveying are well documented [6, 7, 3, 8, 9, 10]. The high spatial resolution of airborne photographs provides a valuable data source, particularly for detecting smaller landforms (meters to decameters). Remote sensing provides multi-spectral, multi-temporal and multi-sensor data of the earth's surface. One of the greatest advantages of using remote sensing data for hydrological investigations and monitoring is its ability to generate information in spatial and temporal domain, which is very crucial for successful analysis, prediction and validation.

In general, water resources in India are very unevenly distributed both spatially and temporally, Idiosyncrasies of monsoon and diverse physiographic conditions give rise to unequal distribution of water.

Over the years, increasing population, urbanization and expansion in agriculture has accentuated the situation. The aftermath of unscientific exploitation of groundwater is that we are moving towards water stress condition. Even now, some parts of the country are facing acute water crisis. Despite being a very important part of the nation's growth, water resources analysis has been fragmentary. An integrated study covering the aspect of groundwater recharge is a crucial requirement of the present day. The present work in an attempt towards this direction. The study focuses on development of remote sensing and GIS based analysis and methodology in groundwater recharge studies in hard rock terrains. In order to demonstrate the integrated remote sensing and GIS based methodology, an area which forms Silai watershed situated in the state of West Bengal (India) has been taken.

According to conserve to next generation people to consider going the present work is an attempt towards this direction. The study area focuses on development of remote sensing and GIS based analysis and methodology in ground water recharge studies in river basin. In order to demonstrate the role of remote sensing and GIS based methodology, the basin of Vaippar river Virudhunagar, Thirunelveli.

Study Area

The river Vaippar originates at an attitude of 1644m in Vasudevanallur reserve forest on the eastern slopes of Western Ghats in Tirunelveli District and run eastward for a distance of 112 km and finally debouches into Gulf of Mannar near Vembar village, and 18 km from Vilathikulam town of Thoothukudi district. The Vaippar river basin is located between Latitude 9° 0' to 9° 45' and east longitude 77 ° 20' to 78° 20' , having on area of 4900 sq.km and is surrounded by Thamiabarani on the South, western Ghats and Vaigai basin on the west, Gundar basin on the north and Bay of Bengal on the East. In this study area covered within survey of India (SOI) topographic sheet numbers 58G/ 5, 6, 7, 8, 10, 11, 12, 14, 15, 16 58K/ 3, 4, 8 scale, 1;50,000 (Fig.1)

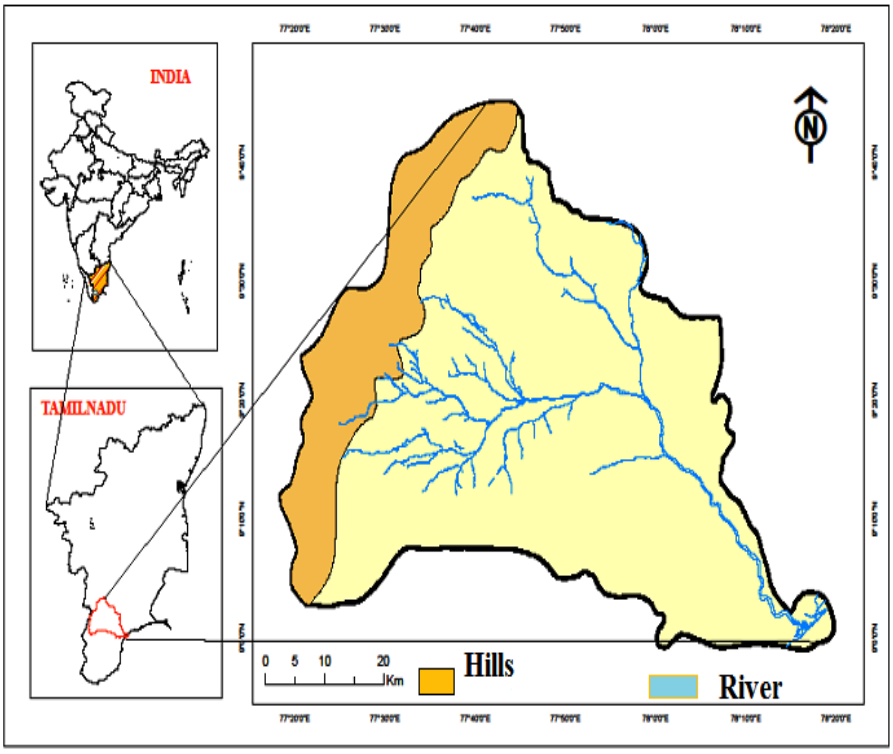

Fig-1: Study area map of Vaippar River Basin

METHODOLOGY

The most commonly used real time data is the remotely sensed satellite date. These are popular for their better spatial and spectral resolutions. Data used in this study were the geocoded data product of the IRS IB, LISS II Dispositive of path 23,24 & Row – 60 of the year 1994 by zooming with procem – II in 1:50.000 scale and topographical sheets with numbers 58G/5,6,7,8,1,11,12,15,16,58k/3,4,8 1:50,000 scale were used for the study. Visual interpretation of geocoded data product of IRS –lb LISS II data on the scale of 1:50,000.

Drainage study through the survey of India top sheets at the scale of 1:50,000. The land use map and geomorphic map giving the surface configuration and zones of probable ground water occurrence were prepared from satellite data, keeping geomorphological and lithological units mind. Similarly maps showing

drainage, lineaments, soil and land use and land cover respectively were prepared from the topo sheets.

Geology

The geology of study area is covered by the Ultra basic rock, Charnockites, Granites and Syanites and Granitic Gneisses formations, Figure 2

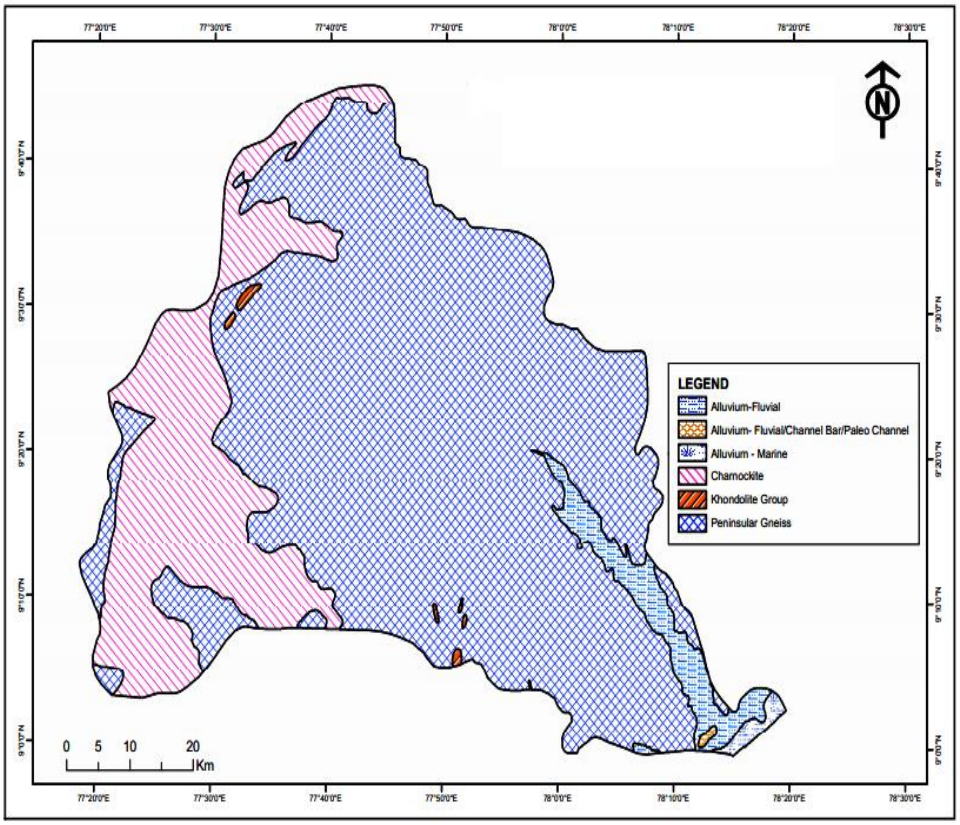

Fig-2: Geologymap of Vaippar River Basin

Soil

Soil types of the area are more important, since it is the main criteria in the agricultural production and in the recharge of ground water. Different type of soils is derived from a wide range of geological formations (Figure 3). Knowledge about the types of soils, its extent and occurrence is of primary importance for agricultural planning to maximize production and for the groundwater recharge.

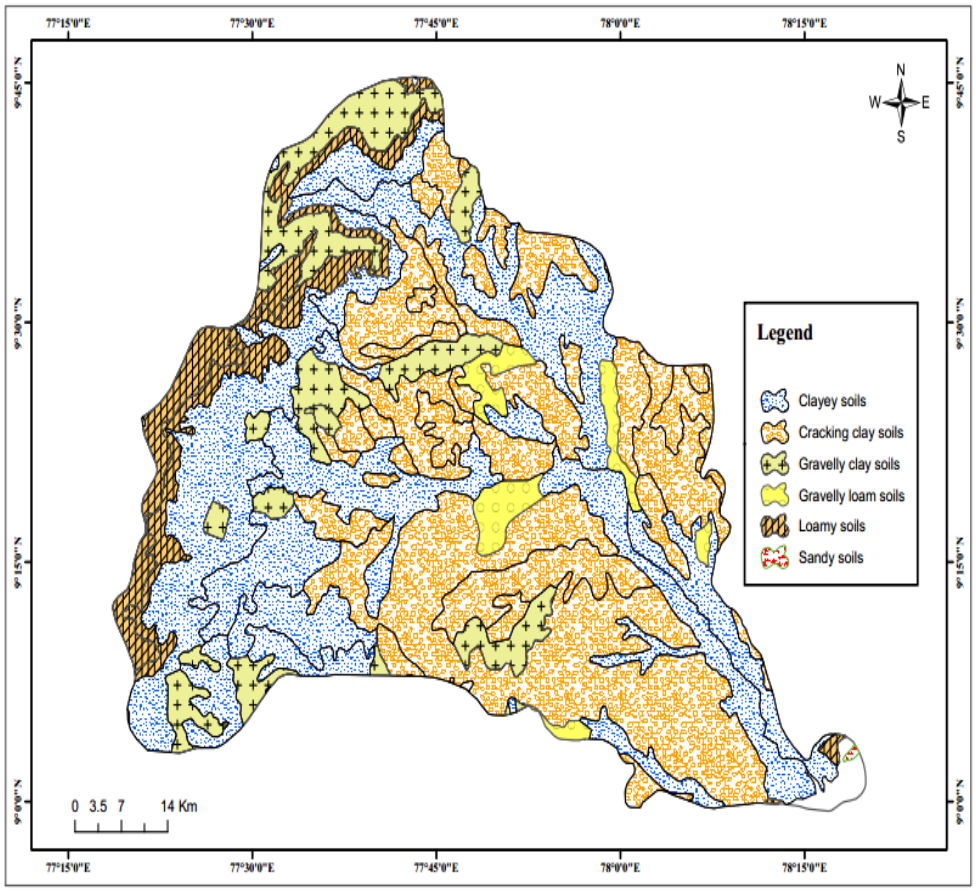

Fig-3: Soil map of Vaippar River Basin

Geomorphology

On the basis specific relief in three dimensions under Mirror Stereoscope; shape, texture and geotechnical element, geomorphic feature of the study area can be categorized into buried pediments, pediment, and shallow pediments, to complex, inselbergs and relief hill, figure 4.

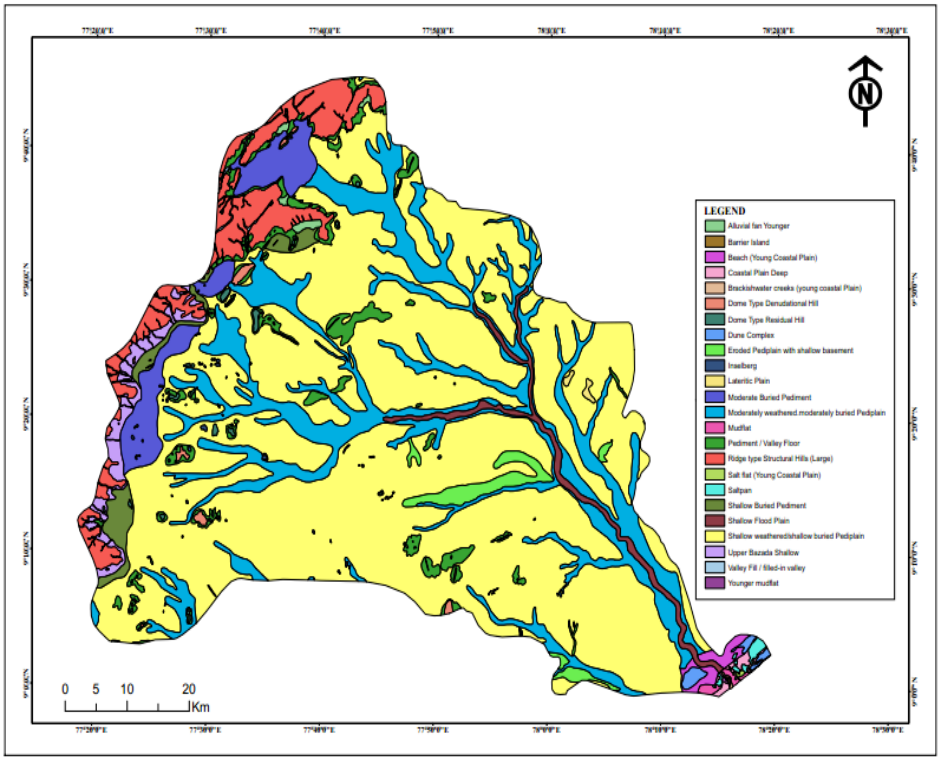

Fig-4: Geomorphologymap of Vaippar River Basin

Landuse

The landuse map for the study area (figure.5) was prepared with the help of image interpretation keys such as tone, texture, drainages, structure fabric and relief, using both top sheets as well as geocoded data. Further, demarcated areas were confirmed through ground truth data. The various landuse found in the study area and their map overlay technique is a concept of GIS. Here it involves the superimposition of all the thematic maps and generation of all the possible combination and further grouping all the combinations into four class's namely poor, moderate, good and very good. All the thematic maps were reduced and the final map.

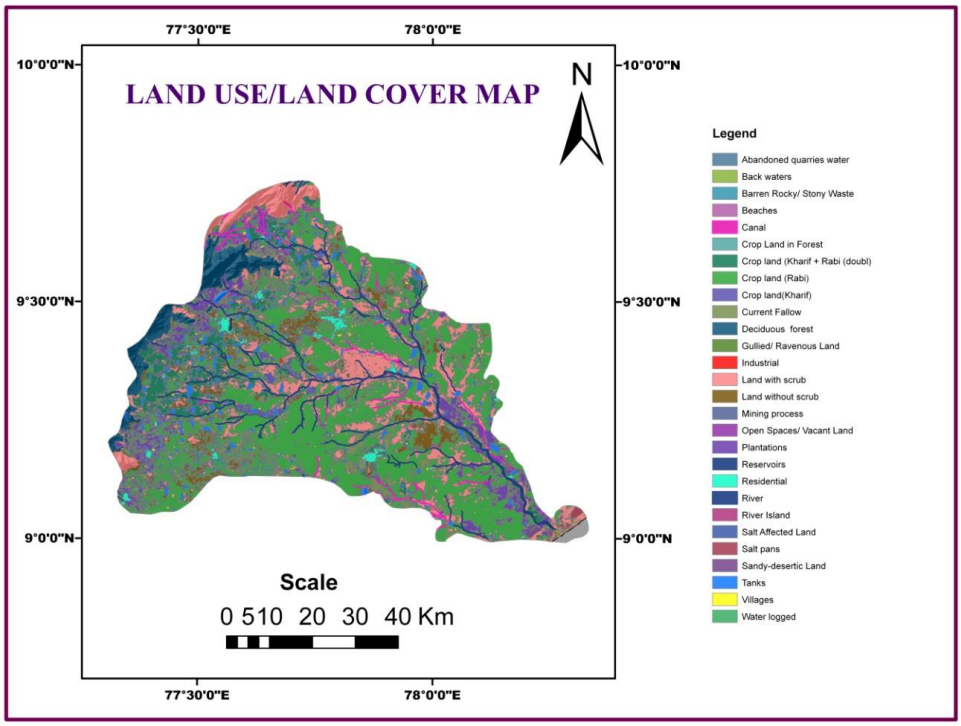

Fig-5: Landuse map of Vaippar River Basin

Ground water Condition

In the hard rock areas in the Vaippar river basin, ground water occurs in an unconfined condition within the fractured hard rocks and its weathered mantle. The potential aquifer in this part comprises of a weathered residuum that is 10 to 20 m thick and the underlying fractured hard rock's with secondary porosity that extends up to 50 m from the surface. In the laterite and the alluvial areas ground water is in unconfined state in shallow aquifers and in confined state below a blanket of clay of varying thickness in deeper aquifers.

Although, the annual rainfall in the watershed is relatively moderate, the availability of ground water is problematic because of the following reasons:

- Low recharge rate.
- Generally high run off mainly
- Unsuitable aquifer conditions over the parts of hard rock areas.
- Long and hot dry season
- Excess withdrawals of ground water in parts of the eastern alluvial tract, for irrigation purposes have caused continuous lowering of the groundwater table over the years.

Groundwater Resource Evaluation

Quantitative assessment of groundwater recharge is an important issue in groundwater development. Estimation of ground water recharge requires proper understanding of the recharge and discharge prices and interrelationship with geological, geomorphological, soil and landuse. There are various methods in use for the quantitative evaluation of groundwater recharge e.g. (a) Ground water level fluctuation and specific yield method (b) Rainfall infiltration method and (c) Soil moisture balance method. In the present study, the ground water level fluctuation and specific yield method is used for the quantitative estimate of ground water recharge in the Vaippar river basin.

The conventional approach for groundwater recharge assessment has some limitations in spite of its simplicity and wide applicability in varied hydro geological setup. Ground water movement is controlled by natural boundaries like valleys and ridges. Hence, vaippar river basin is the most appropriate unit for groundwater recharge estimation.

In the case of conventional methods like rainfall infiltration method or water level fluctuation method average values of rainfall or water fluctuation is taken for a part of the land. In this study we are taking the average of 10 years (2000 - 2009) to describe in the annual fluctuation of water level. The spatial variability in the components of recharge is not considered. In case of remote sensing and GIS based method spatial distribution of the variables are taken into account, thus preparing an information is required for estimation of recharge.

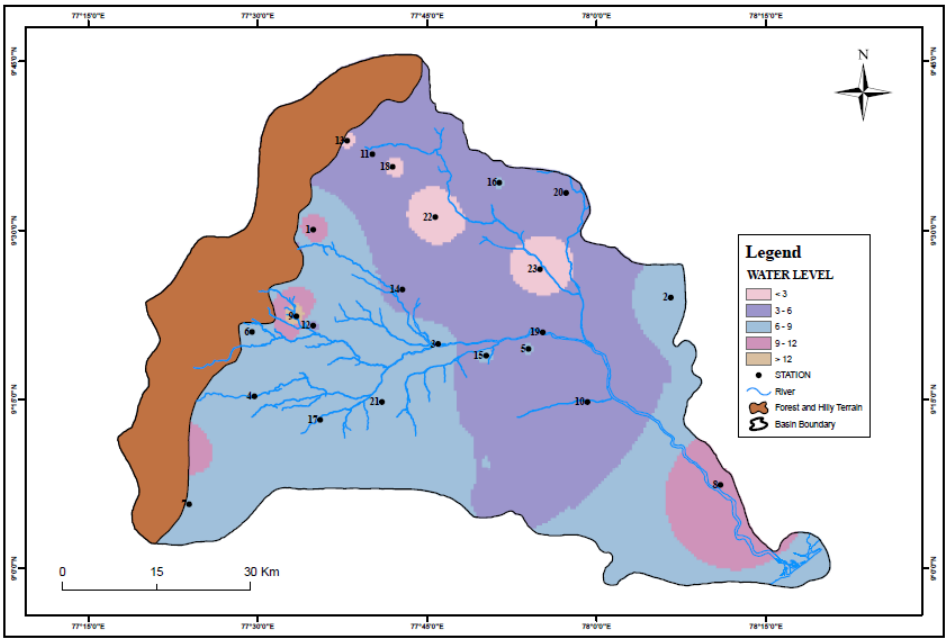

Fig-6: Water levelmap of Vaippar River Basin

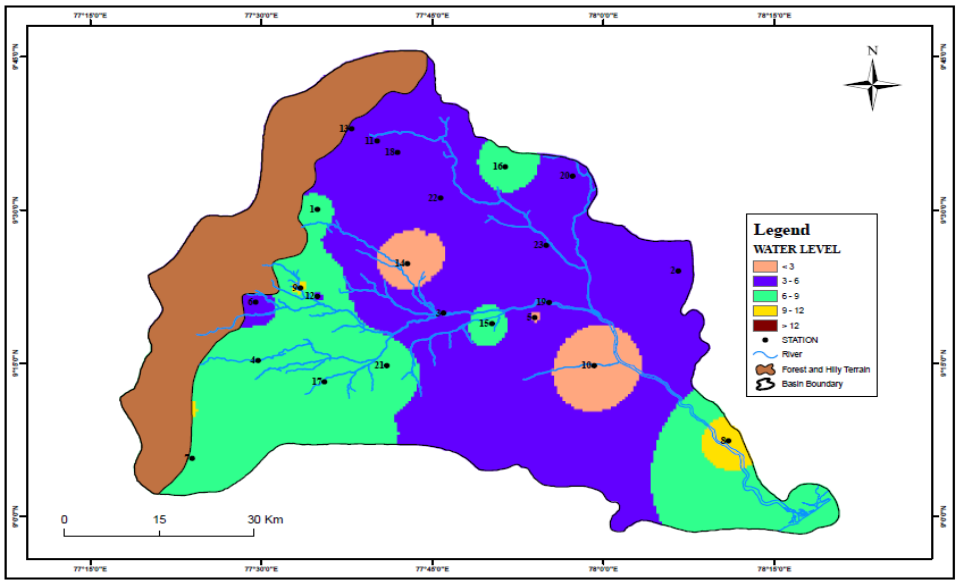

Fig-7: Water levelmap of Vaippar River Basin

CONCLUSION

Groundwater is a precious resource of finite extent. Over the years, increasing population, urbanization and expansion in agriculture has lead to the unscientific exploitation of ground water creating a water stress condition. This alarming situation calls for a cost and time-effective technique for proper evaluation of groundwater resources and management planning. Groundwater development program needs a large volume of data from various sources. As demonstrated successfully in this study that integrated remote sensing and GIS can provide the appropriate platform for convergent analysis of large volume of multi-disciplinary data and decision making for groundwater studies.

The following conclusions are drawn from the above study

- In the present study an integrated remote sensing and GIS based methodology has been developed and demonstrated for evaluation of ground water resources.
- Change in landuse is mainly due to the hydrological factors as is clear from the change image derived by subtraction of the landuse maps.
- Moderately high-resolution remote sensing data provide details of the terrain as well as a synoptic overview, to visualize the general ground water condition indirectly.
- The methodology developed may be applied to similar terrain conditions with some local conservations and modifications. Further, incorporation of geophysical data can enrich the interpretation.

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