A study on Geo spatial based Approach for Delineation of Ground Water Potential Zones

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Abstract

A case study was conducted to find out the groundwater potential zones in Virudhunagar district, Tamil Nadu, India with an aerial extent of 4243.23 sq.kms. The thematic maps such as geology, geomorphology, soil hydrological group, land use / land cover and drainage map were prepared for the study area. Worldwide rapid growth of population, industries and agricultural activities brought about a steep increase in water demands which have to be met from available surface and ground water resources. Ground water has gained prime importance during the past decades. This has been mainly on account of its dependability throughout the year and in particular during the periods of scanty rainfall and drought condition. The Geospatial technology has proved very efficient in assessing the ground water potential of any area. This paper aims Delineating the groundwater potential zones of a location by utilizing the existing data obtained through geological and soil surveys. The capabilities of GIS and Remote sensing has been harnessed to map the areas with potential ground water sources which could be used to easily identify and recharge the areas for future uses. This GIS based output result was validated by conducting field survey by randomly selecting wells in different villages using GPS instruments. The coordinates of each well location were obtained by GPS and plotted in the GIS platform and it was clearly shown that the well coordinates were exactly seated with the classified zones.

Keywords- ArcGIS, Groundwater Weighted Overlay, Thematic Maps, Groundwater Recharge

I. INTRODUCTION

The Remote sensing and GIS technology have opened new paths in groundwater studies. The concept of integrated remote sensing and GIS has proved to be an efficient tool in integrating urban planning and ground water studies. (Krishnamurthy et al., 1996; Saraf and Chaudhary 1998; Khan & Mohrana, 2002). Hydrogeomorphological studies coupled with hydro geological and structural/lineament have proved to be very effective tool to discern ground water potential zones in the watershed (Bahuguna et al., 2003). Based on lineament density hydro geological, geomorphological and drainage conditions, the landforms such as Pedi plain deep, Pedi plain moderate and shallow Pedi plain Bajadazone are identified as potential zones. (P.Jagadeeswara Rao et al., 2004). Assigning weightages for different thematic map based on importance of ground water (V.B.Rekha, H.Vijith. 2003).

A. Study Area

The ground water potential zone mapping is tried for location where the need for the ground water is very high. Hence, Virudhunagar district of southern Tamilnadu. India was chosen for the study, because it is suffering from scarcity of water supply due declining of water table and ground water pollution due to disposal of untreated effluent from tanneries and other industries. The area of Virudhunagar district is 4243.23 sq.kms. It includes 7 taluks and 11 blocks, comprising of 600 villages. The district falls within latitude 90º20’, 90º72’N and longitude 77º20’, 78º70’E. The Vaippar, Arjunanadi and Gundar constitute the river network of the district. It does not have any perennial rivers. The Mandiri odai and Girudhamal nadi flow in to the Gundar, which irrigates the northeastern region of the district.

B. Data used

SOI Toposheet, Thematic maps.

II. METHODOLOGY

1) In order to demarcate the groundwater potential zones of study area different thematic maps on 1:50000 scale prepared from Remote sensing data, topographic maps, depth to the water level data.
2) Drainage map was prepared from SOI top sheet and satellite data
3) Contour map and spot elevation map were prepared from SOI topo sheets
4) All primary input (hydro geomorphology , lineament , contour & spot elevation , drainage ,well location) were digitized using Arc GIS 9.3 software and slope map was prepared from Digital elevation model

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5) The different polygons in the thematic layers were labeled separately and then they were registered. In the final thematic layer initially each one of the polygons were qualitatively visualized into one of the categories like (i) very good (ii) good to very good (iii) good (iv)moderate and (v) poor in terms of their importance with respect to the groundwater occurrence and suitable weights have been assigned.

III. ANALYSIS & DISCUSSION

A. Hydro Geomorphology

Hydrogeomorphological map was prepared from remotely sensed data. On the basis of specified relief and characteristic nature of the geomorphological features present in the study area were classified in to (i) Bazada zone (ii) Buried pediment (iii) Exhumed pediment (iv) Ridge An Valley Complex (v) Dissected Pediment (vi) Peri Pediment (vii) Buried Pediment (viii) Younger Flood Plain Based on the Geomorphological units .

B. Lineament

Generally Lineaments are weaker zones which have been formed due to movement of the earth crust. . Lineament occurs as linear lines and is identified in satellite imageries for preparation of small scale lineament map for regional study. Lineaments may be in the form of fault or geological contacts or shear or major points. Lineaments are proven secondary aquifer in hard rock region. Ground water occurrence is confined to fractured aquifer and is stored in the deeper zones. After exploiting the shallow aquifers for agricultural and domestic purposes, targeting of ground water is concentrated towards the investigation of heterogenic hydro fractures zones. In virudhunagar district there are four sets of lineaments which are (i)E-W rending Lineament (ii)N-S trending Lineament (iii)NE-SW trending Lineament (iv)NW-SE trending Lineament

C. Drainage Pattern

Drainage in the study area is Dendritic pattern.The Arjuna Nadi and Sevalaperi River flowers across Srivilliputhur and Sattur taluks and join Vaipar in Sattur taluk and then enters the Tirunelveli district, east of Sattur. The Mudangiar is a drainage channel in Srivilliputtur taluk and Uppodai is a drainage channel in Sattur taluk. The Vijaya Nadi and Mannarkottai Nadi are the two affluent of the Arjuna Nadi in Sattur taluk. The Gundar originates in the eastern slopes of the Varushanadu and Andipatty ranges above Watrap flows through Aruppukkottai and empties into theGulf of Mannar. The Kanal Odai is a drainage channel in Aruppukkottai taluk.

D. Slope Map

The western part of the district is covered by hilly track part of varushanad hills while the eastern part is by Aruppukottai plain. The elevation of the plain ranges from 25.80 to 156 m above M.S.L. The hill ranges in the west rises from 200m to 1000 m level in general and isolated peaks are present. The highest peak is pemalai having an elevation of 1694 m above M.S.L. The slope map can be prepared from elevation of the virdhunagar district. The slope is very high in the Western part of the district (slope range 20-30%). In the region Aruppukottai, Narikudi, Kariyapatti, the land is flat area,(slope range 0-5%)

E. Geology Map

Geologically the entire virudhunagar district can be broadly classified into hard rock and sedimentary formation of Alluvium and Tertiary. The geological features in virudhunagar district are classified as Alluvium, Pink granite, Charnockite, Quartizite , Calc.gnesis, Tertiaries, Feldapathic gnesis. From the map we identified, Major part of the districts covered by gneissic groups of rocks which include Feldapathic gnesis. Charnocite occurs in the western part of district around Srivilliputur. Joint, fracture and its development is much less when compared to gneissic formation. Ground water potential is very less in this region compared to gneissic formation. The Pink granite occurs south of watrap and around mangalam. Eastern part of district is covered by alluvial formation of recent age occurring in Narikudi block and southeast of Thiruchuli block. Tertiary Formation occupies eastern part of district covering part of Narikudi, Thiruchulli ad Kariyapatti block. In Alluvial and Tertiary formation, Ground water occurs under semi-confined conditions. These formations are highly porous, permeable. Ground water potential is very high in this region. Ground water potential of quartzite is very much less in this region.

F. Soil Map

Soil map has been prepared based on the types of soil present in the study area. The district has two naturally district regions viz. (i) Eastern slopes of the Western Ghats in the Srivilliputtur taluk and (ii) the plains of the Sattur, and Aruppukkottai. Tea and coffee estates have sprung up on the slopes of the Ghats, where spices are also grown. Teak is also grown in some parts. The plain of Sattur and Aruppukkottai taluks mostly has black cotton soil, locally known as `Karisal'. This soil is mostly used for growing cotton and cultivation of dry crops. Black Soil is the predominant Soil type in this district accounting for about 39.23 %. Ground water potential was based on infiltration rate of various type of soil. Infiltration rate is very high in case deep loamy soil (4-5.8 cm/hr). Soil can be classified based on the infiltration rate.

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IV. OVERLAY ANALYSIS

The process of superimposing two or more maps through registration to a common co-ordinate system, such that the resultant maps contain the data from both maps for selected features. Overlay analysis can be done which is used to determine the ground water potential zone for virudhunagar district.

A. Weighted Overlay Analysis

Weighted overlay is a technique for applying a common scale of values to diverse and dissimilar input in order to create an integrated analysis. Weighted Overlay only accepts integer rasters as input, such as a raster of Geomorphology, Soil, Geology, Slope, Aquifer thickness. Rasters must be reclassified to integer before they can be used. Generally, the values of continuous raster are grouped. Each range must be assigned a single value before it can be used in the Weighted Overlay tool. The Reclassify tool allows for such rasters to be reclassified. Weightage Scale should be given based on occurrence of groundwater. Weightage Scale can be taken as 1-25.

V. DELINEATION OF GROUND WATER POTENTIAL ZONES

Weighted Overlay can be applied to various thematic maps by applying the weightage based on the importance of ground water. The resultant ground water potential map was obtained after applying the weighted overlay tool in ARCGIS 9.2.In the resultant map, highest Weightage obtained as 25 and Lower Value as 6. It can be classified as given in the table.(1)

Table 1

SL.NO.	*CRITERIA*	*CLASSES*	*WEIGHT*
1	*Hydrogeomorphology*	*Young Flood Plain*	*23*
		Valley Fill	*21*
		Partially Exhumed Pediment	*14*
		Older Flood Plains	*25*
		Ridge	*5*
		Peri Pediment	*15*
		Bazada Zone	*19*
		Exhumed Fragment of Pediment	*15*
		Black Soil	*10*
		Dissected Pediment	*8*
		Composite Slope	*16*
		Buried Pediment	*22*
2	*Lineament*	*Present*	*24*
		Absent	*1*
3	*Drainage*	*Present*	*10*
		Absent	*1*
4	*Geology*	*Alluvium*	*25*
		Tertiaries	*22*
		Pink Granite	*10*
		Fedelpathic Gneiss	*15*
		Quartzite	*2*
		Calc Gneisss	*12*
		Charnocite	*8*
5	*Soil*	*Calcerous clayey soil*	*6*
		Deep Black Soil	*20*
		Deep Clayey Soil	*10*
		Deep Loamy Soil	*25*
	Soil	*Red Grayay Soil*	*14*
		Shallow Loamy Soil	*18*
6	*Slope*	*0-5*	*25*
		05-10.0	*18*
		10.0-20	*10*
		20-30	*7*
		>30	*1*
7	*Aquifer Thickness*	*<15*	*8*
		15.0-20	*12*
		20-30	*17*
		30-35	*21*
		>35	*25*

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VI. RESULTS AND DISCUSSION

As mentioned in the methodology the selected nine parameters have been created using GIS techniques and it has been ranked based on the weighted overlay analysis. In most part of Virudhunagar district,The map showing ground water potential was moderate and poor- moderate. Area having high ground water potential was very much less.(See fig & table 2) .This shows that ground water potential capacity was very much less in the virudhunagar district. So there is need for recharge of ground water.

Table 2

SL. NO	*GROUNDWATER CATEGORY*	*LOWER & UPPER WEIGHT VALUE*	*AREA (SQ.KM)*
1	*Very Good*	*19 - 25*	*0.20*
2	*Good to very good*	*17 - 19*	*10.8*
3	*Good*	*15 - 17*	*24.1*
4	*Moderate to good*	*13 - 15*	*67.9*
5	*Moderate*	*11 - 13*	*49.3*
6	*Poor to moderate*	*07 - 11*	*50.5*
7	*Poor*	*< 7*	*45.2*

The area having high ground water potential was very low.(See fig1) This shows that ground water potential capacity was very low in this district. So there is need for recharge of ground water.

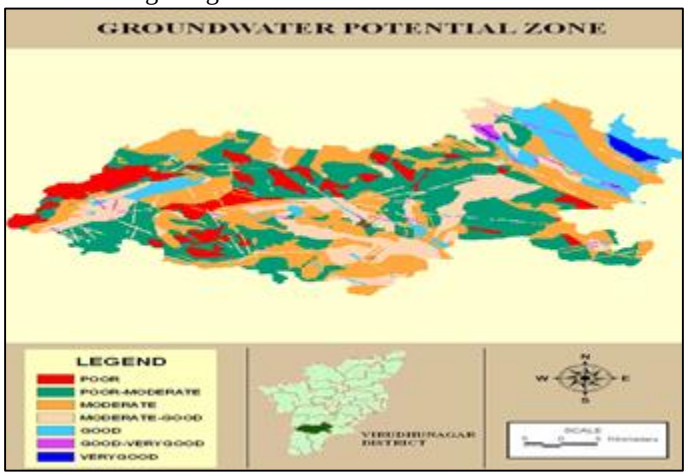

Fig. 1: Ground Water Potential Zone

VII. CONCLUSION

In order to delineate the groundwater potential zones for virudhunagar district, in general, different thematic layers viz: hydrogeomorphology, geology, lineaments, slope, drainage and acquifer thickness are used to be integrated. This provides a broad idea about the groundwater prospect of the area. Presently groundwater potential zones have been demarcated by integration of aquifer thickness. The groundwater potential zones map generated through this model was verified with the yield data to ascertain the validity of the model developed and found that it is in agreement with the bore wells yield data. This illustrates that the approach outlined has merits and can be successfully used elsewhere with appropriate modifications.

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