The Ground Water Condition In Saraskana Block of Mayurbhanj District ,Odisha, Mayurbhanj

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Abstract*- Ground water potential zone mapping is the most important aspect of planning and management of aquifers. The present study focuse the uses of remote sensing and GIS to evaluate ground water potential zone in the hard rock terrain of Saraskana block of Odisha (India). In this study, Survey of India toposheets (SOI) and Resource Sat LISS-III satellite imageries which download from Bhuvan,ISRO are used to prepare various thematic layers. Five influence groundwater parameters such as drainage density, elevation, geomorphology, land use and land cover, lineaments, and slope have been considered for this study to delineate groundwater potential zones. The thematic vector layers are converted to raster using the feature to raster converter tool in ArcGIS (10.2.1) and then weightage for each parameter and its classes have been assigned. Weighted overlay analysis tool in ArcGIS software has been used to find out the ground water potential zones. The final ground water potential map is shown in four zones such as very good, good, moderate, low. The resulted groundwater potential zone map can be used for sustainable development and management and planning of ground water in this hard rock terrain*.

Keywords- Ground water potential, remote sensing, GIS, weight overlay analysis

I. INTRODUCTION

Groundwater is the most important natural resource with respect to its utilization towards the overall socio-economic development of a region. The potential of groundwater in a particular aquifer is dependent on parameters like rainfall, lithology, structure, slope, geomorphology and soil characteristics of the terrain and in order to prepare a groundwater potential zone map the spatial dynamics of these parameters over that region must be developed. However, the traditional survey methods to prepare these layers for a region are very time consuming and costly. In contrast to that Remote Sensing with its high-resolution satellite images are increasingly use in groundwater exploration because of their utility in identifying various ground features those may serve as direct indicators of presence of ground water. Groundwater prospective zones have been studied by several researchers based on remote sensing and G.I.S techniques (Nandi, et al. (2017), Nandi, et al. (2015), Nandi, et al. (2014), Nandi, et al. (2015) Saraf and Choudhury 1998; Jaiswal et al., 2003; Acharya et al ., 2017; Sener et al., 2005; Chowdhury et al., 2009; Jha et al., 2010;Sahu 2017). Some have studied potential groundwater zones(PGZ) using Geographical Information Systems and Remote Sensing techniques (Goyal, et al., 1999; Rokade, et al., 2007, Nandi et al. 2015). The groundwater recharge potential map is effectively prepared by them and classified into the following categories, excellent, good, very good, moderate, poor and very poor.

Spatio-temporal dynamics of ground water table vis-à-vis changes in land use/land cover can be effectively modelled using this technique.The approach of remote sensing and GIS for identification of groundwater potential zones and exploration of groundwater with locating the artificial recharge sites. The groundwater level fluctuation has also been found using temporal water depth data.

II. STUDY AREA

The study area belongs to the hard rock terrain of the Similipal Biosphere Reserve and is a part of the Baitarani watershed of Mayurbhanj District, Orissa, India. It lies between north latitudes 22º 08´ and 22º 22´ and east longitudes 86º 24´ and 86º 44´. The annual rainfall in the study area is about 1699.5 mm. It is a block covering an area of 360 sq.km and the population is nearly 100000. The study area is presented in the (fig.1)

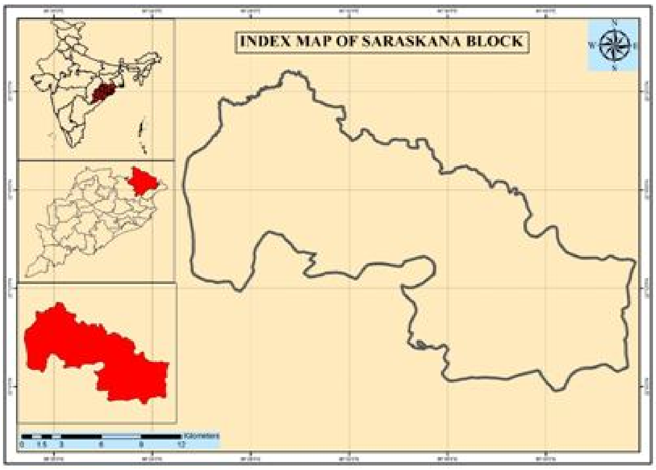

Figure 1: Location map of Saraskana

III. METHODOLOGY

The Survey of India (SOI) topographic sheets no. (73J/11, 73J/12, 73J/6, 73J/08) were used for generating parameters like lithology, geomorphology, slope, geology, drainage of base map etc. through digitization in ArcGIS 10.2.1 software. Satellite images from IRS-P6, LISS- IV sensor with the spatial resolution of 5.8m have been used for delineation of thematic layer such as land-use/ land-cover. Inverse Distance Weightage (IDW) in ArcGIS is used for interpolation of discrete data. The slope map was prepared from SRTM DEM data in ArcGIS Spatial Analyst module. The drainage density map was prepared using the line density analysis tool in ArcGIS. The thematic layers that are in vector format are converted into raster format and loaded into GIS environment. The final ground water potential zone was prepared by weighted overlay analysis by assigning appropriate ranks (Table 1) for each different factor (Shaban et al., 2006).

Table 1: Ranks assigned to different parameters used for overlay

Parameters	Classes	Groundwater Prospects	Weight	Rank
Geomorphology	Pediment-Pedi plain complex	Very good	30	5
	Anthropogenic terrain	Good		4
	Water body	Good		4
	Low dissected plateau	Poor		1
	Moderately dissected plateau	Very poor		1
Slope classes	Nearly level (00-10)	Very good	20	5
	Very gently sloping (10-30)	Good		4
	Gently sloping (30-50)	Moderate		3
	Moderately sloping (50-100)	Poor		2
	Strong sloping (100-150)	Very poor		1
Drainage density (Km/Km^2)	0-1.2	Very good	15	5
	1.2-2.4	Good		4
	2.4-3.6	Moderate		3
	3.6-4.8	Poor		2
	4.8-6	Very poor		1
Lineament density (Km/Km^2)	0-0.34	Very poor	15	1
	0.34-0.99	Poor		2
	0.99-1.57	Moderate		3
	1.57-2.11	Good		4
	2.11-2.69	Very good		5
Land use /land cover	Crop Land	Very good	15	5
	Water body	Good		4
	Fallow Land	Moderate		3
	Scrub Land	Moderate		2
	Settlement	Poor		1
	Barren Land	Very poor		1
Geology	Limestone, Sand stone, clay	Very good	5	5
	Schist	Good		4
	Granite, grand, pegmatite	Good		3
	Laterite	Poor		2
	Gabbro, Anthracite	Very poor		1
Soil	Clay, Clay loam	Very Good	5	6
	Sandy Clay	Good		5
	SiCl	Moderate		4
	Sandy loam	Moderate		3
	Laterite	Low		2
	Sand	Very Low		1

IV.RESULTS AND DISCUSSION

1) Land use / Land Cover-

Remote sensing data and GIS technique provide reliable and accurate baseline information for land use land cover mapping which plays a vital role in determining land use pattern changes therein on different times. The major land use/land cover types of our study area are scrub land, agricultural land, forest, urban areas, water body, waste land. These classes are identified from LISS-III data and field verification with overall accuracy above 85%. By extraction of various classes of land use land cover, a thematic map was generated as per covered study area (Fig 2).

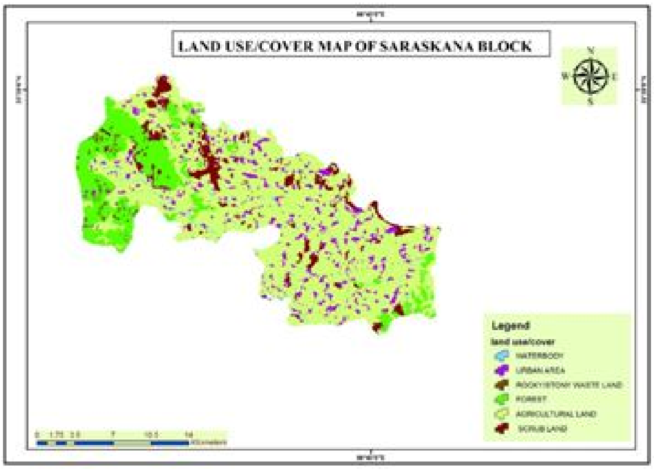

Figure 2: Land use/cover map of Saraskana Block

2) Geology-

The study area is characterized by presence of Gabro, Limestone, Mica schist, Granophyre and Granite of Precambrian age. The main rock types are granite and Granophyre. These rocks lack Primary porosity. Ground water occurrence is restricted to a weathered and fractured zone. Ground water occurs in unconfined and semi confined aquifer condition. The Geology map is given in the figure 3.

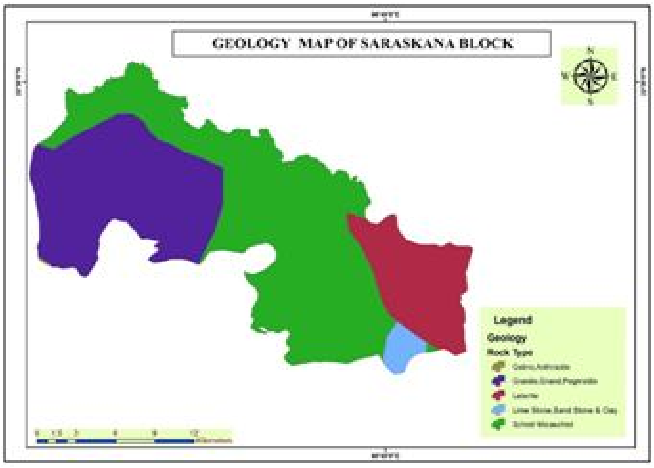

Figure 3: Geology map of Saraskana Block

3) Geomorphology-

The identification and characterization of various landforms and structural features in the study area was very important from the geomorphological study point of view. Climate and geomorphological characteristics of an area affect its response to a significant level. There are five different types of landforms present in the study area. The image characteristics such as tone, texture, shape, color and association was used to identify these features and by overlapping the base map over the geocoded FCC image, the geomorphologic units and landforms, the structural information and structural trend lines are perfected. Many of these features are promising for the amount of groundwater and are classified in terms of groundwater potentiality. The study area has various landforms such as Alluvial plains, Pedi plains, Plateaus and Structural hills. The ranks were assigned to the individual landform, according to its respective influence on groundwater occurrence, holding and recharge, as per the GSI references. The geomorphological map is shown in fig 4.

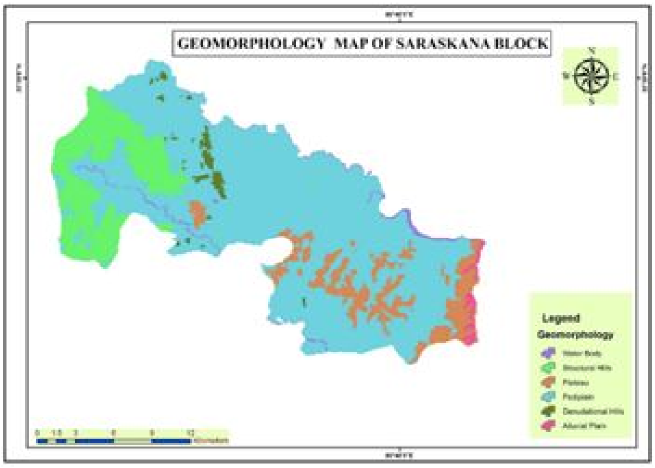

Figure 4: Geomorphology of the Sarskana Block

4) Lineament Density-

Lineaments are linear geomorphic features that are the surface expression of zones of weakness or structural displacement in the crust of the earth. In hard rock terrain lineaments and fractures act as master conduits in movement and storage of groundwater. Such features may represent deep seated faults, fractures and joints sets, drainage lines and boundary lines of different rock formations. All these linear features are interpreted from the satellite data and the lineament map is prepared for the study area (Fig 5). For the groundwater potentiality, they were regrouped into five classes as very poor (0-0.77km), poor (0.77-1.54km), Moderate (1.54-2.31km), good (2.31-3.08km) and very good (3.08-3.85km).

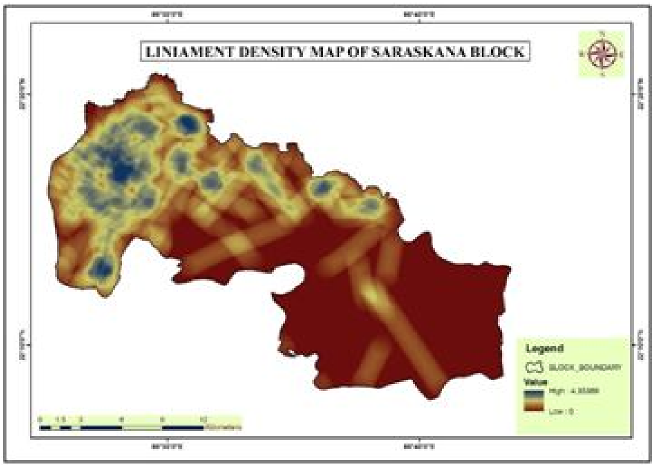

Figure 5: Lineament Density map of Saraskana Block

5) Drainage density-

The Drainage density indicates the closeness or spacing of stream channels. It is a measure of the total length of the stream segment of all orders per unit area. Wherever the density is high then surface runoff will be more on contrary in low density areas infiltration will be more. In order to normalize the data, contours were generated using ArcGIS Software. The drainage density map is shown in fig 6.

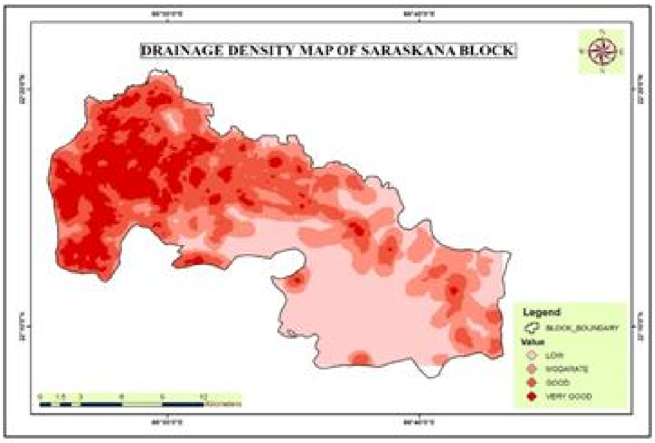

Figure 6: Drainage Density map of Saraskana Block

Slope Map-

Slope is an important factor for the identification of groundwater potential zones. The precipitous terrain causes rapid runoff and does not store water easily. In the gentle slope area, the surface runoff is slow allowing more time for rainwater to percolate whereas steep slope area facilitates high runoff allowing less residence time for rainwater to percolate and hence comparatively less infiltration. The slope map of the study area was prepared based on SRTM data using the spatial analysis tool in Arc Info 10.2. The slope map of the study area is derived from ASTER DEM 30 m and slope of the study area is classified into five classes, Despite of this very gentle slope, a slope map has been prepared according to the following class interval map is shown in fig 7.

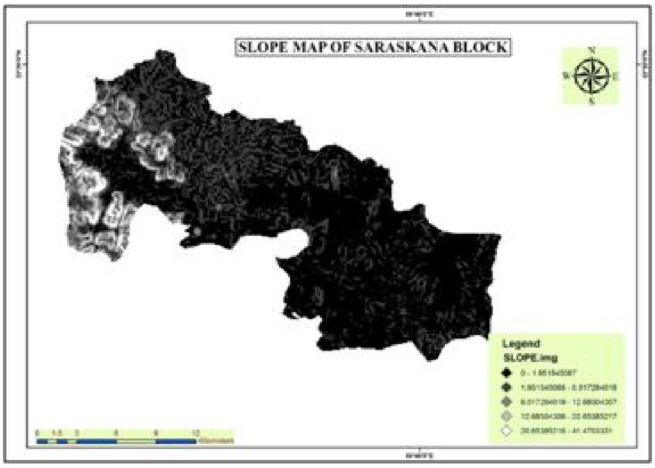

Figure 6: Slope map of Saraskana Block

Soil Map-

Soil is a one of the key influence factor for searching ground water probable zone. The soil act as a natural filter and penetration of surface water into an aquifer system and directly related to rates of infiltration, percolation and permeability. The movement and penetration of surface water into ground is based on the porosity and absorbency of soil. The result of soil classification found that, the study area has six types of soils such as, Laterite Soil, Sandy Loam, Sandy Clay, Clay,Clay Loam and Sticky Clay. In the study area soils, such as Clay and Sandy Clay Loam, have poor water-holding capacity and have been given a low weightage. The soil map of Saraskana block is given in figure 7.

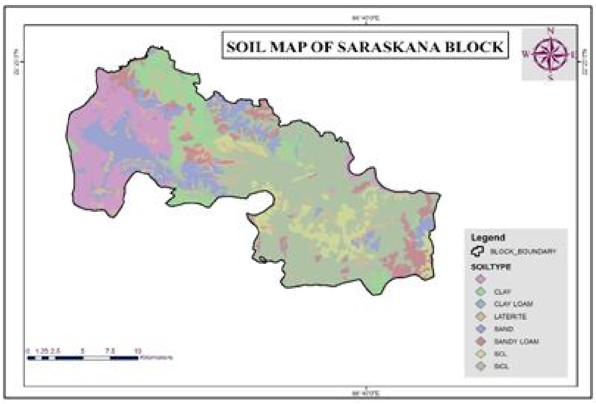

Figure 7: Soil map of Saraskana Block

6) V.WEIGHTED OVERLAY ANALYSIS

Taking into consideration the relative importance of the parameters and the classes belonging to each parameter, this study analyzed the hydrologic and geographic attributes of the watershed in study area by the use of identified five major factors influencing groundwater recharge potential. For overlay purpose criteria for the analysis are defined and each parameter is assigned importance (Mondel et al. 2006). Overlay analysis is carried out, using weighted overlay analysis tool provided in the ArcGIS software to integrate the thematic maps viz. Geomorphology map, soil map, slope (%) map, land use land cover map, drainage density map and lineament density map, which are being very informative and play important role in the study for groundwater recharge potential zones of study area. Average Score S is defined by,

$$S = \sum_{i}^{n} S_{ij} \times W_i$$

Where, S is weighted score for an area object (polygon, pixel)

Wi = weight for the ith input map
Sij = Score for the jth class of the ith map

On the basis of weightage assigned to these maps and bringing them into the function of spatial analyst for integration of these thematic maps, a map indicating groundwater recharge potential zones is obtained. The output range of weighted score values been categorized into five classes' viz. "Very Poor" "Poor" "Moderate" "Good" "Very Good" from Groundwater Potential Zone of view. The weighted overlay map is shown in fig 8.

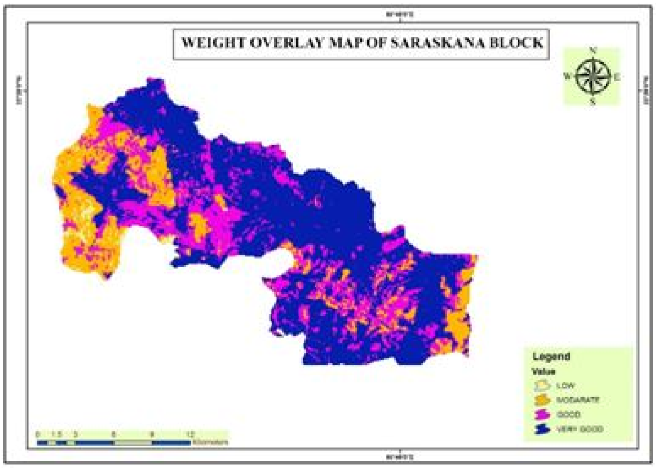

Figure 8: Weight overlay map of Saraskana Block

VI. CONCLUSION

The present study attempts to demarcate groundwater recharge potential zones of the Saraskana watershed of Mayurbhanj District, using GIS techniques. The thematic layers such as Land use & Land cover pattern, Geomorphology, Lineament density, Drainage density and Slope map were integrated with one another through weighted overlay analysis and final output map of groundwater potential zone was generated with areas of excellent groundwater potential zone. However, determination of weightage of each class is the most crucial in integrated analysis as the output is largely dependent on the assignment of appropriate weightage. The groundwater recharge potential zones such as very good, good, moderate, poor, very poor can serve the planning and management of the aquifer.

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