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Nandi D, Sahu P.C and Mondal S

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RESEARCH ARTICLE

GROUND WATER POTENTIAL STUDIES USING GEO-SPATIAL TECHNIQUE A CASE STUDY IN KARANJIA BLOCK OF ODISHA, INDIA

Nandi D[1] Sahu P.C[2] and Mondal S[3]

[1] Department of Remote Sensing &GIS, North Orissa University
[2] Department of Geology M.P.C Auto. College, Baripada, Odisha
[3] Remote sensing & GIS, North Orissa University

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ABSTRACT

The present study has been conducted to analyse the ground water potential zones in Karanjia Block of Mayurbhanj district, Odisha. Identify the ground water potential studies of Nine parameters have been considered for the study such as drainage density, elevation, geology, geomorphology, land use and land cover, lineaments, slope and soil texture. The selected parameters have been prepared and classified in GIS. Weightage for each parameter and its classes have been assigned, then weighted overlay analysis tool in ArcGIS used to find out the result. The result of study has been compared with the collected sample data to assess the accuracy of result. The comparison of study's result has given 95 per cent accuracy.

INTRODUCTION

The study of groundwater is vital source for drinking, irrigation and industrial use all over the human race. Groundwater is an important natural resource in present day, but of limited use due to frequent failures in monsoon, unstable surface water. India is heading towards a Fresh Water Crisis. Groundwater studies have been carried out by several researchers relating to the physical and chemical properties of groundwater to find out the quality of it (Ranjana2009, Yadav2012) and groundwater level fluctuation have been found using temporal water depth data (Vijaya Kumar 2006,) while some have studied potential groundwater zones (PGZ) using Geographical Information Systems and Remote Sensing techniques (Bera, 2012, Javed2009).Identification of potential zone ever remains a mystery. Remote Sensing from Air-craft & Satellite has recently become valuable tools for understanding the Ground water conditions. The Remotely Sensed data of Soil, Drainage, Slope, Geomorphology, Landuse-Landcover and other related characteristic of an area can be integrated and Ground Water Potential Zone can be delineated. The Geographic Information System (GIS) has emerged as a powerful tool in integration and analysis of multi thematic layers in delineating ground water prospect and deficit zones (Carver, 1991; Hoogendoorn Goyal, *et al*., 1993; Saraf and Chaudhuray, 1998; Goyal, *et al*., 1999; Rokade, *et al*., 2007, Thushan Chandrasiri Ekneligoda and HerbertHenkel, 2010). Analysis of remotely sensed data along with Survey of India Topographical and collateral information from the base line information for ground water targeting. In the present study, a part of the Karanjia Block, Mayurbhanj district, Odisha has been selected for demarcation of ground water potential zones using remotely sensed data. Criterion tables were generated considering the importance of different themes and necessary ranks and suitable weightages were given to all the categories in each theme. The groundwater recharge potential map has been prepared and classified into five general categories e.g. excellent, very good, good, moderate and poor.

Study area

The present study has been carried out in the Baitarani watershed of Mayurbhanj District, Orissa which falls in the

Corresponding author:* **Nandi D
Department of Remote Sensing &GIS, North Orissa University

Survey of India Toposheet (73K/1, 73K/2, 73K/6, 73G/13). Annual rainfall in study area at about 1246.2 mm. The total geographical area of the block is 314.76 sq.km having 154 no. of villages. (fig.1)

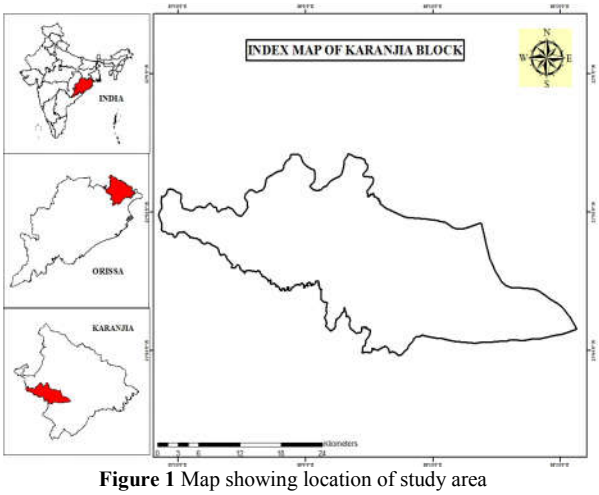

Figure 1 Map showing location of study area

METHODOLOGY

The occurrence of groundwater depends upon factors like lithology, geomorphology, slope, geology, drainage etc. The thematic layers in respect of both surface and subsurface parameters are converted into vectors using ArcGIS 10.2 software. Weightages were assigned to individual themes (Wt) and for each features within the theme, ranks were given (WI) based on their significance to groundwater studies. The drainage density map was prepared using the line density analysis tool in ArcGIS. Satellite images from IRS-p6, LISS-IV sensor with the spatial resolution of 5.3m have been used for description of thematic layer such as land-use/ land-cover. The thematic layers that are in vector format are converted into raster format in GIS conversion. Ground water potential zones were identified by overlaying all the thematic maps in terms of weighted overlay methods using the spatial analysis tool in ArcGIS 10.2. During weighted overlay analysis, the ranking was given for each different factor of each thematic map (Shaban *et al*., 2006). (Fig:-2)

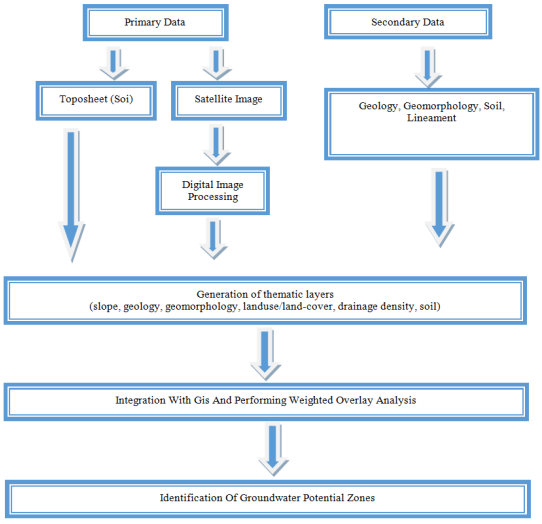

Figure 2 Flow chart showing methodology for this study

Table 1 Classification Of Weighted Factors Influencing The Potential Zones

Parameter	Classes	Groundwater Prospect	Weight (%)	Rank
Geomorphology	Pediment-pediplain 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(0^0-1^0)	Very good	20	5
	Very gently sloping(1^0-3^0)	Good		4
	Gently sloping(3^0-5^0)	Moderate		3
	Moderately sloping(5^0-10^0)	Poor		2
	Strong sloping(10^0-15^0)	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
Landuse/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

Thematic layers

Groundwater recharge potential depends upon watershed characteristics like Land use, Soil type, Geology and Geomorphology. These maps were collected from Institute of Remote Sensing & GIS, North Orissa University. The following maps were scanned, georeferenced and digitized by using ArcGIS 10.2software.

land use & land cover

Land use/land cover is one of the important parameter for the geo-hydrological study because the land use pattern of any terrain is a thinking of the complex physical processes acting with the surface of the earth. The major land use/land cover type of the study area are crop land, agriculture land, forest, water body, Westland. These classes are identified from IRS-p6, LISS-IV satellite data and field verification. Forest area covers 4383Ha, Land use covers 2323Ha, Baron land covers 657Ha, and Westland covers 1877Ha in covered study area. (Fig.-3)

Geomorphology

Climate and geomorphological characteristics of an area influence by Ground water. There are five different types of landforms present in the study area. It involves the identification and classification of various landforms and structural features. Many of these features are promising for groundwater and are classified in terms of groundwater potentiality. The study area has various landforms such as Denudational hills, Plateau, Pediplains, Structural hills and Water body. The geomorphological map is shown the below Fig.4.

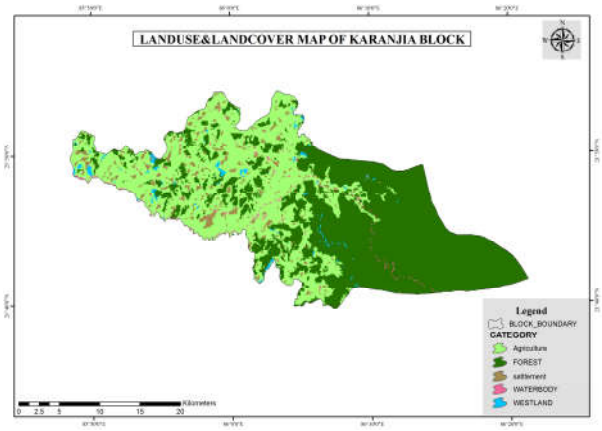

Figure 3 Land use / Land cover Map of Study Area

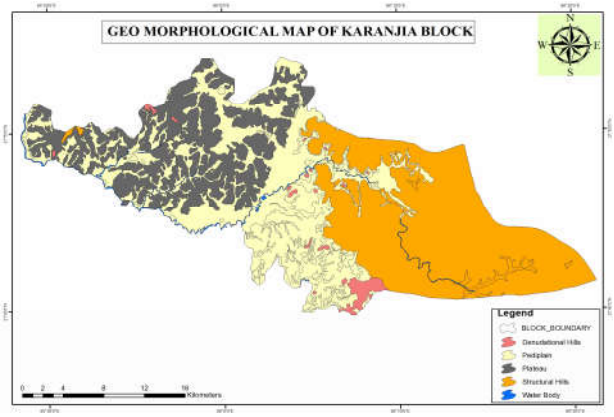

Figure 4 Geomorphology Map of Study Area.

Lineament Density

Lineaments are the irregular earth features that can easily identified on the ground. Higher the Lineament density, higher will be the rate of penetration where as low density leads to more run off (Kumar, *et al*., 1999). Such features may represent on the deep seated faults, fractures and joints sets of 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.

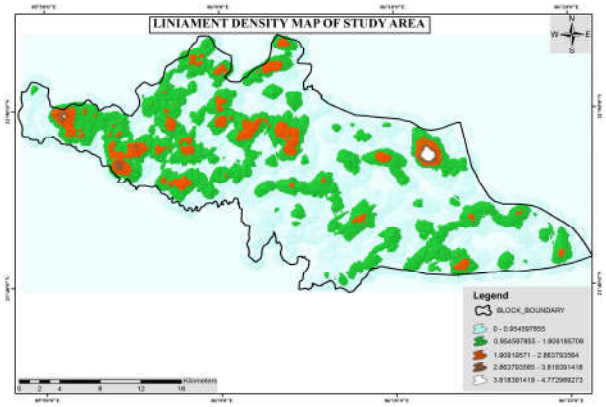

Figure 5 Lineament Density map of study area.

On the basis of groundwater potentiality they were grouped into five classes as very poor (0-0.34km), poor (0.34-0.99km), Moderate (0.99-1.57km), good (1.57-2.11km) and very good (2.11-2.69km).

Drainage Density

Drainage density is defined as the closeness of spacing of stream channels. It is a measure of the total length of the stream segment of all orders per unit area. The drainage density map is shown in the below Fig.-6.On basis of groundwater potentiality they were regrouped into five classes

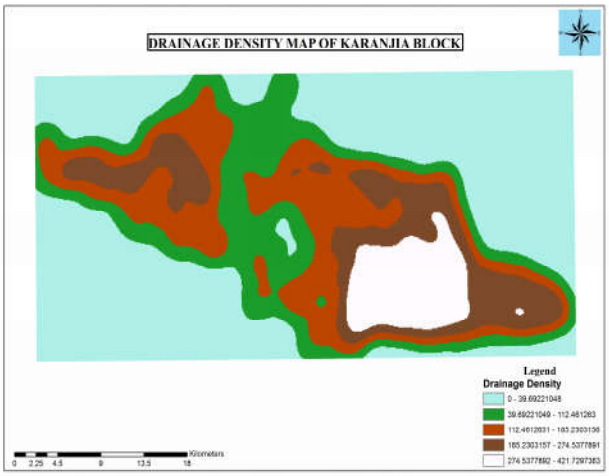

Figure 6 Drainage Density map of study area

Slope Map

Slope is an important factor for the identification of groundwater potential zones. The slope map of the study area was prepared by SRTM data using the spatial analysis tool in ArcInfo 10.2. A high sloping region based on more runoff and less infiltration and thus has poor groundwater prospects compared to the low slope region. The study area can be divided into five classes based on slope. (Fig.7).

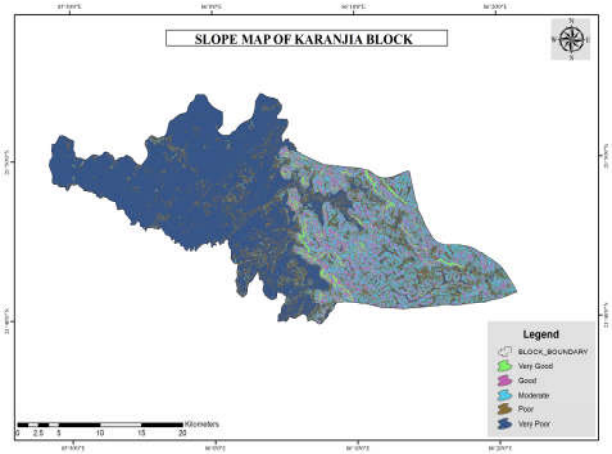

Figure 7 slope Map of study area

Soil Map

Soil is one of the primary factor which determines the amount of groundwater. The study of soil helps to find out the types and its properties. The movement of ground water and penetration of surface water into ground is based on the porosity and absorbency of soil. Therefore the study of soil is important for determine the amount of ground water of any place. The result of soil classification indicates that, the study area has six types of major soils such as, Laterite Soil, Sandy Loam, Sandy Clay, Clay, Clay Loam and Sticky Clay.(Fig:-8)

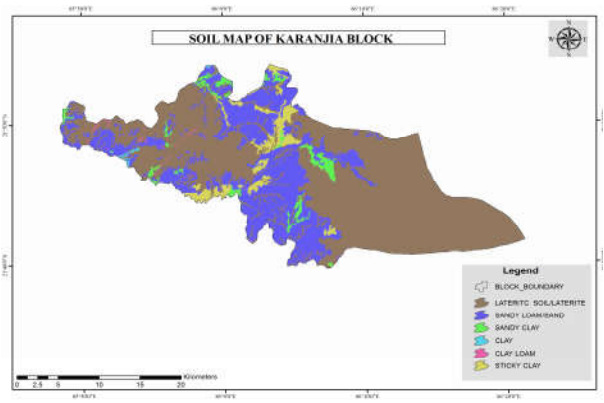

Figure 8 Soil Map of study area

Geology

Geology is one of the major factor which plays an important role in the occurrence and Distribution of groundwater. The study area is composed of Epidiorite, Gabbro, Granite, Pegmatite, Quarizite, and Schist. (Fig.-9)

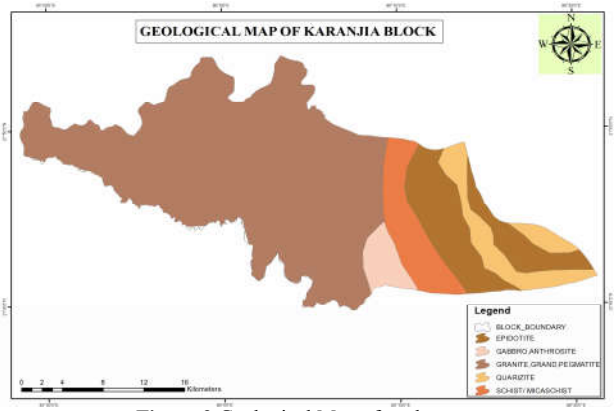

Figure 9 Geological Map of study area

Weighted overlay

This study analyzed the hydrologic and geographic attributes of the watershed in study area and identified six major factors influencing groundwater recharge potential, viz. Slope (%), geomorphology, soil, land use land cover, drainage density and lineament density. Each factor was examined and assigned an appropriate weightage. Each recharge of potential factor may influence to the groundwater recharge process to a different degree. Overlay analysis is carried out, using weighted overlay analysis tool provided in the ArcGIS software, to integrate various 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 an important role in the study for groundwater recharge potential zones of study area. The various thematic maps were assigned with different weightages of numerical value to derive the groundwater recharge potential zones. 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 potential zones is obtained. (fig.10). This map has been categorized into five classes viz. "Very Poor" "Poor" "Moderate" "Good" "Very Good" from Groundwater Potentialities point of view.

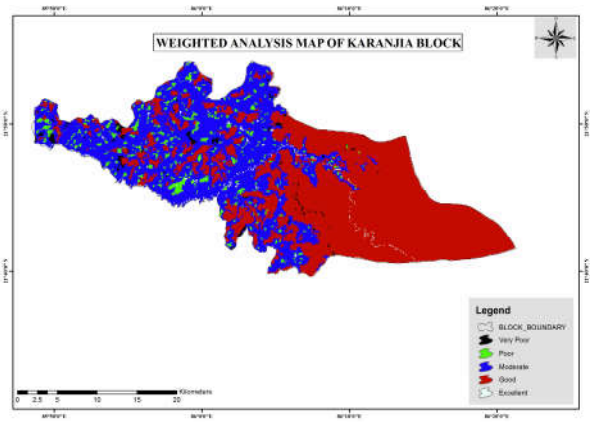

Figure 10 Weighted analysis map of study area

CONCLUSIONS

The study of identifies of ground water potential zone in Karanjia Block, Orissa. The thematic layers such as Land use& Land cover, Soil type, Drainage density, Lineament density, Slope, Geology and Geomorphology were integrated through weighted overlay analysis and final output map of groundwater potential zone was generated. The groundwater recharge potential zone generated is into five different zones such as Excellent, good, moderate, poor, very poor.

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