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DYNAMIC GROUNDWATER MAP OF KALAHANDI DISTRICT, ODISHA USING REMOTE SENSING AND GIS TECHNIQUES

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ABSTRACT

Groundwater has for a long time been a source of drinking water to urban and rural populations for both the developed and developing countries, therefore the understanding of the nature of this important resource, its potential zones, how much there is available, how long it may last in different places at current rates of extraction, is very important. With the use Geographic Information System (GIS) and remote sensing and technologies, groundwater potential zones mapping has become a less tedious procedure from the recent past, as the use of these techniques has offered a new avenue for groundwater availability assessment and identification of potential zones. For this present study, an attempt is made to identify groundwater potential zones in Kalahandi district, Odisha, India using remote sensing and GIS techniques at Dept of Soil and water conservation and Engineering, CAET, OUAT, Bhubaneswar during 2018-19. Flood plains which are considered as good groundwater prospect as much as the water bodies only cover slight patches of the total area of the study area, and also visible in patches are the ground water zones of Kandhamal district of Odisha. The dynamic groundwater levels of the study area vary from 1.2-4.1 m, with 1.2m being the lowest variation and 4.2m the highest variation.

Key words-Dynamic ground water map remote sensing GIS

INTRODUCTION

Groundwater is without a doubt a precious resource especially in the arid and semi-arid areas and areas where there is limited availability of surface water. The global demand for water has seen a significant increase over the past years which mainly came as a result of industrialization, population growth and changing consumption patterns among other factors, and this dramatic increase is expected to continue to grow significantly over the foreseeable future with the outright scarcity becoming all but invertible. Climate change has also impacted the recharge and supply of the water resources putting more pressure in the available limited groundwater resources in many countries.

Concept of Occurrence and Movement of Groundwater

Hydrologists use the term groundwater to represent water in the zone of saturation; it is explained as the water found in the subsurface in fractures of rock formations and soil pore spaces. (Subramanya, 2013) defines it as the water from precipitation that has found its way to infiltrate the earth surface, recharge from streams and other natural bodies and artificial recharge due to the action of man. Groundwater is extracted from either consolidated rock formations or unconsolidated loose sediments and occurrence in both the rock formation is strikingly different. Two main properties of the rock; porosity and permeability are considered to control the occurrence of groundwater in a geological formation, its flow rate and its scope for exploitation (Lakshmi and Reddy 2018).

Remote sensing and GIS in groundwater studies

Assessment and potential zoning of groundwater using field observation are expensive and time-consuming, but with the use of remote sensing and Geographic Information System (GIS) technologies, the groundwater potential zones mapping within each geological unit has become less tedious and time-consuming (AL-Ruzouq *et, al.* 2015). From the recent past, the use of these techniques has offered a new advanced way for groundwater availability assessment and for the identification of potential zones. A number of studies have been carried out and others are on-going for the investigation of groundwater potential zones using the integration of remote sensing and GIS techniques which provides quite accurate results and indirectly provides ways of analysis of the role of some directly observable surface parameters like geomorphic features, geological structures and their hydrologic character for groundwater availability, (Pothiraj and Rajagopalan 2011), (Sahoo *et, al.* 2015).

Remote Sensing and GIS in Groundwater Studies

Remote sensing and Geographic Information System (GIS) are rapid and effective techniques as large information especially in inaccessible areas can be provided within short period of time for monitoring, assessing and management, Ramamoorthy *et, al.* (2014), remote sensing and GIS also aid groundwater studies in areas where there is few hydro geological data and limited previous investigations, Solomon and Quiel (2005). The work carried out by Preeja *et, al.* (2011) made more noticeable or prominent the expediency of geographic information system (GIS) and remote sensing applications in groundwater studies, as they used these techniques in Ithikkara River Basin (IRB), Kerala, India to identify of groundwater potential zones.

According to Bhuvaneswaran *et, al*. (2015) the collective use of GIS and remote sensing based potential zone analysis has brought a new path in this field. Thus, the combination of these two techniques has proved to be a powerful tool in understanding the groundwater behavior in any Therefore taking into consideration the enormous vitality of groundwater and the advantages of GIS and remote sensing in identifying groundwater potential zones, a study was carried out to identify groundwater potential zones in Kalahandi district, Odisha, India using remote sensing and GIS techniques with the following objectives:

Objectives of the study:

The study is to be accomplished with the following objectives:

1. To develop hydrogeological thematic maps of the study area
2. To identify and delineate groundwater potential zones using GIS technique
   area.

MATERIALS AND METHODS

Study area

Kalahandi district occupies the South-Western portion of Orissa and lies between North latitudes 19°03’ and 20°45’ and East longitudes 82°18’ and 83°48’. On the north the district is bounded by bounded of Balangir and Nawapara districts, on the south is bounded by Rayagada district, Nawarangpur and Raipur (Chhatisgarh) districts on the west and on the east lie Rayagada and Boudh districts. The district extends over an area of 7920 Sq. Km and has its headquarters at Bhawanipatna town which stands almost to the Eastern border. Shown below is the map of the study area in Fig 1.

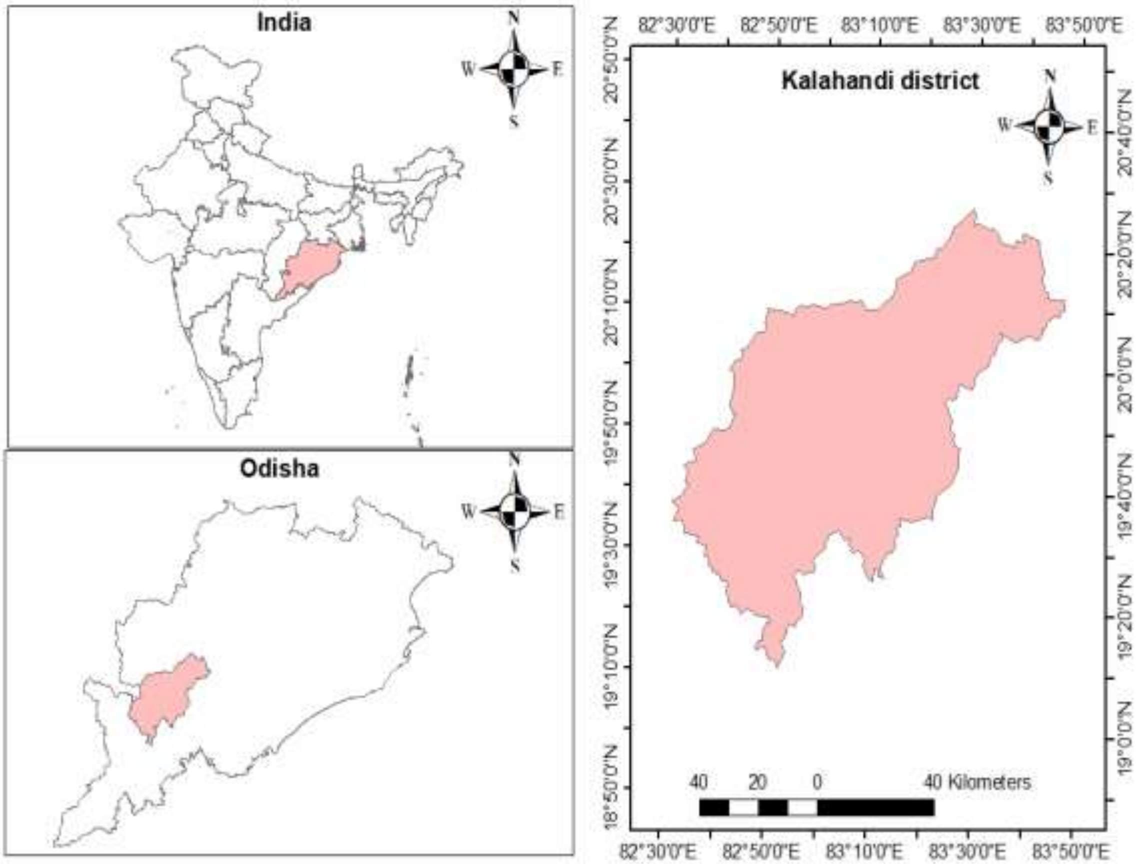

Fig 1 Location of the study area

Topography

The District can be classified into two distinct physiographic regions, which are the plain lands and the hilly tracts. The plain lands region run southward up to Bhawanipatna and then Westward through Junagarh and Dharmgarh and then further up to the boundary of the District, covering about 59 percent of the total area of the district. South Western part of Bhawanipatna subdivision is mostly covered by the hilly tracts, and some of the hilly tracts are covered with dense forest.

Soils

Different soil type's distribution in the district depends mainly on its physiographic and lithological variations. Based on the physical and chemical characteristics, mode of origin and occurrence, soils of the district may be classified into two groups namely Alfisols and Vertisols. Generally, the major soil type found in Kalahandi district is black soil with more clay content (Vertisols), matured unaltered soils with coarse parent materials (Entisols), red & lateritic soil (Alfisols) mixed grey soil (Inceptisols) unclassified soil(like mud flats).

Climate and rainfall

The climate of the district is sub-tropical with hot and dry summer and pleasant winter. The summer season extends from March to the middle of June followed by the rainy season from June to September; the winter season extends from November till the end of February. There are large varieties of day and night temperature. Humidity is high during the middle of June and it's less in the post-monsoon period, the average relative humidity in the district varies from 27% to 80% throughout the year. It is dry except during monsoon and the south-west monsoon is the principal source of rainfall in the district. The average annual rainfall of the district is 1378.2 mm. About 80 to 85% of the total rainfall is received during the period from June-September. The variation in the rainfall from year to year is not large. 90% of the rainfall received from June to September. Drought is a normal feature of this district.

Groundwater scenario

The hydrogeological framework of the district is mainly controlled by the geological setup, rainfall distribution and the degree of secondary and primary porosities in the geological formations for storage and movement of groundwater. Since major parts of the district are underlain by hard rocks of diverse lithological composition and structure, the water-bearing properties of the formations also vary to a great extent. A hydrogeological survey in the district reveals the lithological characteristics and the role of tectonic deformation on the occurrence and distribution of groundwater reservoirs and their water-bearing and water-yielding properties. Lineaments formed due to tensile deformation were picked up from remote sensing studies. The structural elements mainly control the occurrence and movement of groundwater in the typical fractured crystalline basement terrain. The major hydrogeologic units in the district are, areas underlain by fractured, fissured and consolidated basement rock formations and areas underlain by recent unconsolidated alluvial formations.

Concept and methodology

In order to identify groundwater potential zones for Kalahandi district, remote sensing (RS), geographic information system (GIS) and multi-criteria decision making (MCDM) techniques using analytical hierarchy process (AHP) were used. The concept and methodology adapted are based on past studies on groundwater potential zoning carried out in different areas amongst them are (Maheswaran *et, al.* 2016), (Machiwal *et, al.* 2011) and (Chowdhury *et, al.* 2009).

RESULT AND DISCUSSION

Dynamic groundwater map

The dynamic groundwater map presented in fig 2 shows the difference in terms of depth of the pre-monsoon and post-monsoon groundwater depths of the area. The dynamic groundwater like other factors used for groundwater prospecting plays a major role in delineating groundwater potential areas as it directly gives the groundwater levels in terms of variation. The depth to water level mostly depends upon the hydrogeological conditions of the area as well as topography, rainfall pattern, among others (Elewa & Qaddah 2011). The rate of infiltration in the area controls the rate of recharge thereby controlling groundwater levels.

The dynamic groundwater levels of the study area vary from 1.2-4.1 m, with 1.2m being the lowest variation and 4.2m the highest variation. Low variations ranging from 1.2-1.9m can only be seen in the north part of the study area, high dynamic groundwater variations of the area ranging from 3.5-4.2 m are predominant in the central part and some parts in the east part. The rest of the study area has different good to moderate variations of ranges, 1.9-2.6 m, 2.6-3.1m and 3.1-3.5m.

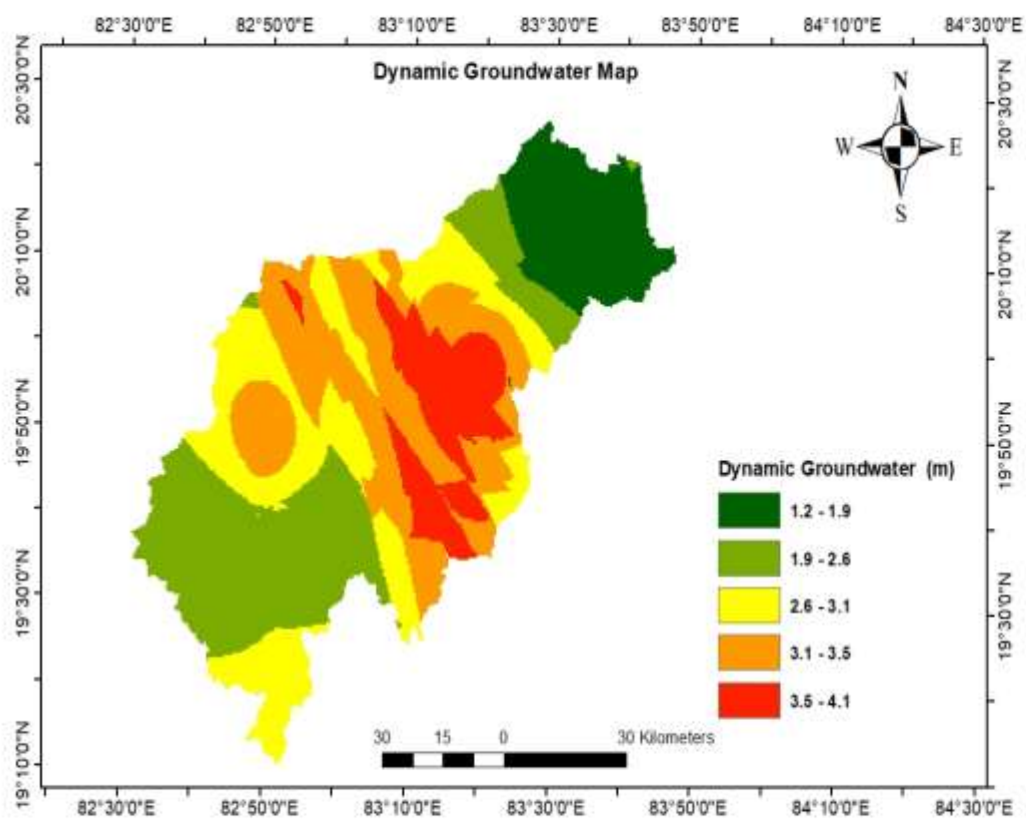

Fig 2 Dynamic Groundwater Map of the Study Area

In Table 1 the different zones of Kalahandi district of Odisha are shown in Table 1 and Fig 3 below and planning for digging LI point may be decided accordingly by any organization.

Table: 1 Potential zones area of individual blocks

SI. No	Block name	Very good (km^2)	Good (km2)	Moderate (km2)	Poor (km2)	Very poor (km2)
1	Bhawaniptana	43	296	297	243	43
2	Dharmagarh	11	6	150	164	52
3	Golamunda	34	91	303	130	83
4	Jaipatna	6	49	148	53	255
5	Junagarh	23	41	307	260	22
6	Kalampur	6	2	108	14	24
7	Karlamunda	4	5	30	3	154
8	Kesinga	48	118	88	175	40
9	Kokasara	9	25	356	97	5
10	Lanjigarh	99	434	55	390	9
11	Madanpur Rampur	19	29	323	164	331
12	Narala	144	171	90	91	30
13	Thuamul Rampur	5	252	416	423	20

CONCLUSION

1. Large areas of very poor groundwater potential zones are seen in the Karlamunda, Jaipatna and Madanpur Rampur blocks, whereas Narala block has the largest area covered by very good groundwater potential zone.

2 The dynamic groundwater levels of the study area vary from 1.2-4.1 m, with 1.2m being the lowest variation and 4.2m the highest variation.

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