Ground Water Scarcity Mapping in Jhalda II Block of Purulia District, West Bengal

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Abstract

Jhalda II is one of the community development blocks under Purulia district in the state of West Bengal. Geographically it is situated in the eastern Chotanagpur plateau fringe. The area receives moderate to low rainfall in every monsoon season. Incidents of droughts exert its harsh effect on the socio economy of the selected areas people in almost every summer. To get rid of the situation, ground water uplift policy has been adopted which itself aggravating the state of ground water storage. Seasonal fluctuation of ground water depth mapping is an aspect which provides a clear idea about the dynamic state of ground water storage of an area. In order to support future planning present study incorporates a noble effort to mapping the ground water resource of the block as well as to find out the ground water scarcity zone.

Keywords: ground water scarcity, fluctuation, pre monsoon, post monsoon, GIS

I. INTRODUCTION

Water has been one of the most important reasons behind the origin and subsistence of life in the unique planet, our earth. The available surface water resources are inadequate to meet all the water requirements for all purpose, so the demand of groundwater has increased over year (Sarup, Tiwari and Khatediya, 2011). Among all the sources of water supply, ground water has become an important and most reliable source due to its several inherent qualities e.g. widespread and continuous availability, excellent natural quality, limited vulnerability, low development cost, drought reliability etc. (Todd and Mays, 2005). The assessment of quality and quantity of groundwater is essential to keep pace with additional demand of water set by rapid development activities of the society.

Groundwater distribution is not uniform all over the place. Prevalence of ground water is determined by several factors such as topography, lithology, geological structures, soil, drainage pattern, landforms, land-use/land- cover, climatic conditions and interrelationship between these factor (Saraf and Choudhury 1998). There are several methodologies to locate and map the occurrence and distribution of groundwater. Extensive field data collections are often requisite to systematically understand groundwater conditions. Collected data can be represented on the basis of two parameters i.e., pre monsoon and post monsoon ground water depth which is indeed helpful to delineate the scarcity in terms of ground water availability.

Recurrent droughts are very common in the Purulia district of West Bengal. Water have certainly great influence in people's life as its scarcity is illustrated in numerous folksongs i.e. Tusu,Vadu, Jhumur etc. (Gangopadhaya, 2003).In order to mitigate the water problem of the district, several works have done after independence. Excavation of wells, tube wells under supervision of Gram-Panchayet and Jilla-Parishad was taken up to improve the condition of water availability. Yet, in summer most of the well dried up and the tube wells go out of order due to massive decrease of ground water level (Adhikari, 2003).

In the recent years, a modern technology like Geographic Information System (GIS) is being used for various purposes such as groundwater investigations and many authors (Shahid and Nath 2002). GIS techniques enables integration and analysis of large volumes of data, collected from field studies. Datasets over a large inaccessible area can be easily handled and analyzed under GIS set up (Sener et al. 2005; Solomon and Quiel 2006). Over the last 2 decades, GIS have been widely used for the preparation of different types of thematic layers and inte¬grating them for different purposes (Saraf and Choudhury 1998; Jha and Peiffer 2006)

Present study is primarily mean to mapping ground water scarcity in Jhalda II block of Purulia district. The study also explored seasonal distribution of ground water resource in terms of pre monsoon and post monsoon scenario. Mapping of ground water with such intension helps in effective planning of such scarce resource. It is expected that not only the study will provide a pain picture of areas ground water status in terms of availability and scarcity but also it will be helpful to find out the limitation set by nature beyond which man have nothing to do.

II. STUDY AREA

Jhalda II community development block is located in north western part of Purulia district, West Bengal. In the pre historic era the area was under the rules of Vajra Bhumi Kingdom. Presently it is situated around the source of Kangsabati River in the eastern fringe of Chotanagpur plateau and nearly 37 Km away from the district headquarter. The area is bounded by $22^{o}44$ / N to

22^o74 / N latitude and 88^o08 / E to 88^o13 / E longitude. It covers a geographical area of 284.90 Km^2 which is administratively divided into 131 census villages.

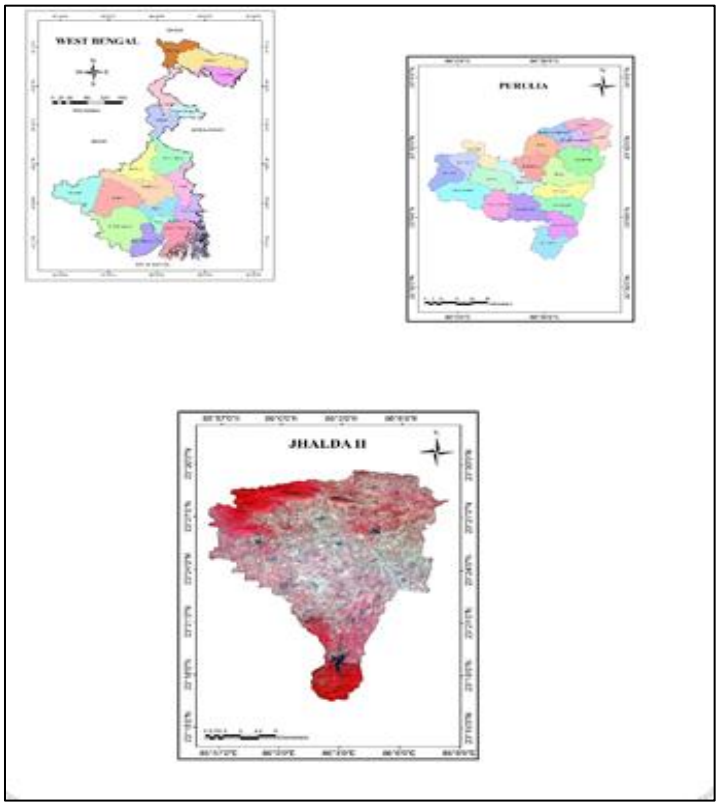

Fig. 1: Location of the study area

It is the land of scattered hills and undulated topography accompanied by dense coverage of tropical deciduous forest mainly, Sal and Mahua. In spite of several natural positives, the area has long history of water scarcity. With the passage of time, increasing level of economic activity and lack of management policy has widened the gap between demand and supply more prominently. Now days the block has been came under noticed due to its increasing water scarcity in summer season.

III. DATA COLLECTION AND SAMPLING

This study has been carried out based on quantitative data collected from primary sources. It has been acquired through observation of water depth in the same well twice in a year, i.e., once in the month of May and others in the month of October for the year 2013. Depth of water was measured in MKS system by the help of chain. For increasing the accuracy each measurement was taken twice and the average value was accepted.

Data has been collected using random sampling technique. Out of 145 census villages, observations were conducted for 129 census villages. While collecting the data 16 census villages were not taken into consideration as they represent uninhabited category by Census of India 2011.One well in each selected census villages were observed under the present study.

IV. SOFTWARE USED

1) Image Processing
   Erdas Imagine 9.2 has been used for digitization and boundary generation of the selected area II. Classification accuracy and relation assessment:
2) GIS based data processing
3) Thematic maps were prepared by the help of ARC GIS 10.1
4) Other doings

Google Earth, MS-Excel and MS-Word were also successfully used for different purpose.

V. METHODOLOGY

Geographical Information system based data analysis approach has been adopted as the basis of the present study. Various apparatuses of the selected methodology are:

A. Construction of Ground Water Depth Layers

In the present study, spatial layers of ground water depth for both pre and monsoon seasons were constructed using GIS techniques. In order to build the layers, a multi-parametric dataset comprising data of ground water depth in terms of seasonal water stress and other conventional maps including Survey of India (SOI) top-sheets were used. Using Erdas imagine software, the census villages were digitized and center point have been generated. Seasonal depth data table have been created using the acquired database from the field observation. In the process two thematic layers, viz., pre monsoon and post ground water depth layers were finally developed under the Arc GIS environments. Finally these layers were reclassified into five categories in terms of ground water depth.

B. Construction of Ground Water Fluctuation Layers

In this study, ground water fluctuation layers have been also developed to trace the severity of available ground water resource. Such layer was also prepared using Arc GIS raster calculator tool. For the preparation of spatial layer on ground water fluctuation (FL), following equation has been used:

$$FL = [Pomd – Prmd]$$

(Where, Pomd = Post monsoonal ground water depth layer, Prmd = Pre monsoonal ground water depth layer.)

C. Identification of Water Scarcity Zone

The ground water fluctuation map was reclassified into three categories on the basis of natural jerks in the range of data. In the map the degree of water scarcity increases with the increasing amount of fluctuation in water depth. The Zones where the values are high were considered as Zone with ground water scarcity.

VI. RESULT AND DISCUSSION

A. Pre Monsoon Ground Water Depth

Analysis of spatial layers on Pre monsoon ground water depth as shown in Figure 2 revealed that during the year 2013, ground water depth in the study area was found maximum in the northern and southern portion of the selected block containing a zonal range of value from 52.79 to 65.03 meter. Depth of ground water was found minimum in the middle segment of the study area having a value of 27.00 to 34.17 meter. The map further showed that the depth of ground water was increase from center to north and south gradually.

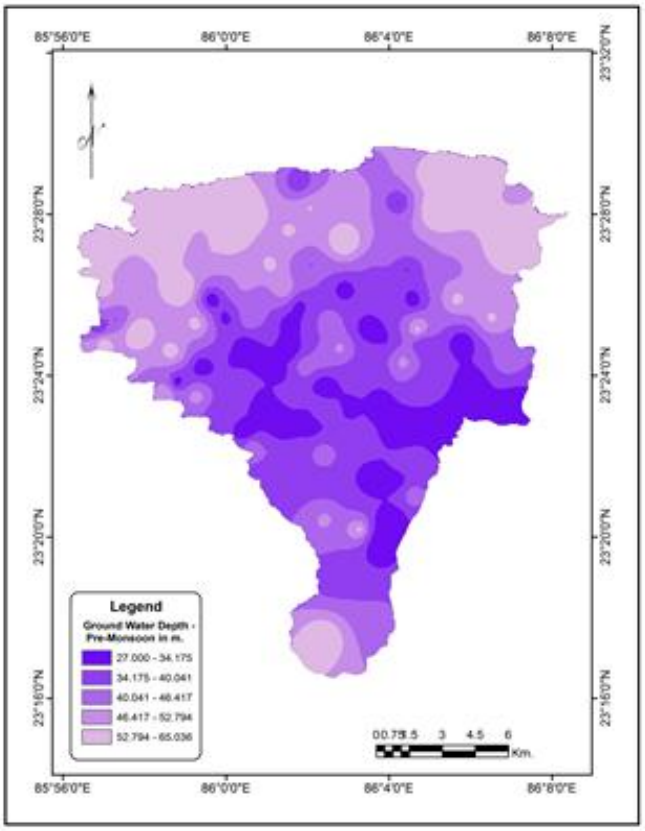

Fig. 2: Pre monsoon ground water depth

B. Post Monsoon Ground Water Depth

Analysis of spatial layers on Post monsoon ground water depth as shown in Figure 3 also explored that during the year 2013, ground water depth in the study area was found maximum towards northern and southern portion of the selected block and in many discrete parts containing a zonal range of value from 26.66 to 32.07 meter. Depth of ground water was found minimum in the central north and south eastern parts of the block having value of 12.00 to 16.97 meter. Comparing the two maps it can be said that depth of ground water was far low in post monsoon than pre monsoon.

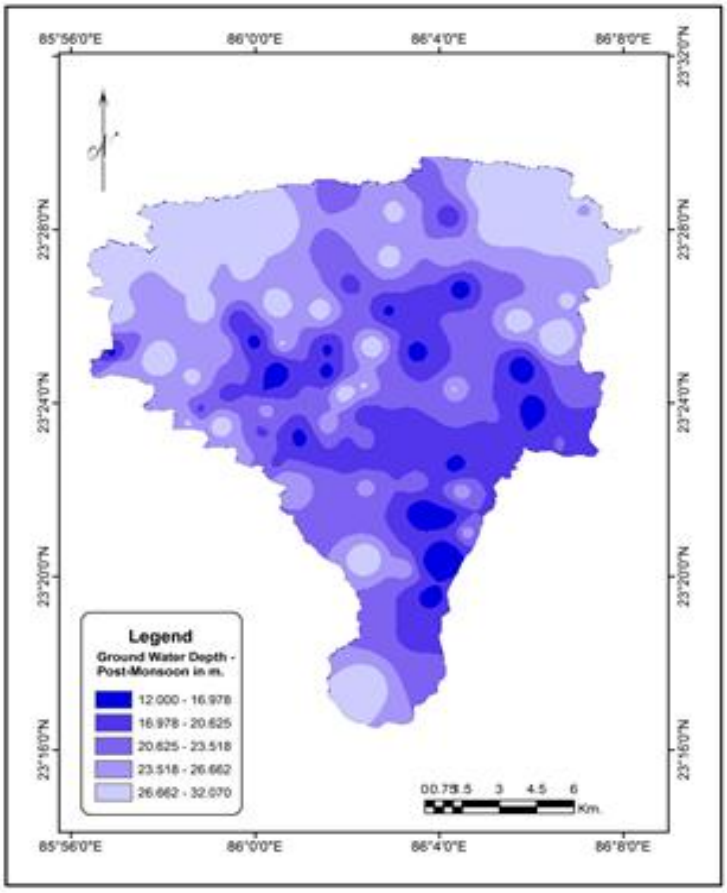

Fig. 3: Post monsoon ground water depth

C. Ground Water Fluctuation

Ground water fluctuation map derived from processing of pre and post monsoon water depth layers under GIS environment enables to understand the present status of the study areas ground water scenario. Among the five zones, fluctuation was lowest in two large zones lying at the central part of the area, whereas it increases towards north and south of the study area. Obtained statistics of area under various zones are given in table 1.

Table 1:
Different fluctuation zones

Fluctuation zone	*Fluctuation status*	*Spatial extension in percent*
Zone I	*Very low*	*16.108*
Zone II	*Low*	*29.936*
Zone III	*Medium*	*20.138*
Zone IV	*High*	*21.382*
Zone V	*Very high*	*12.433*

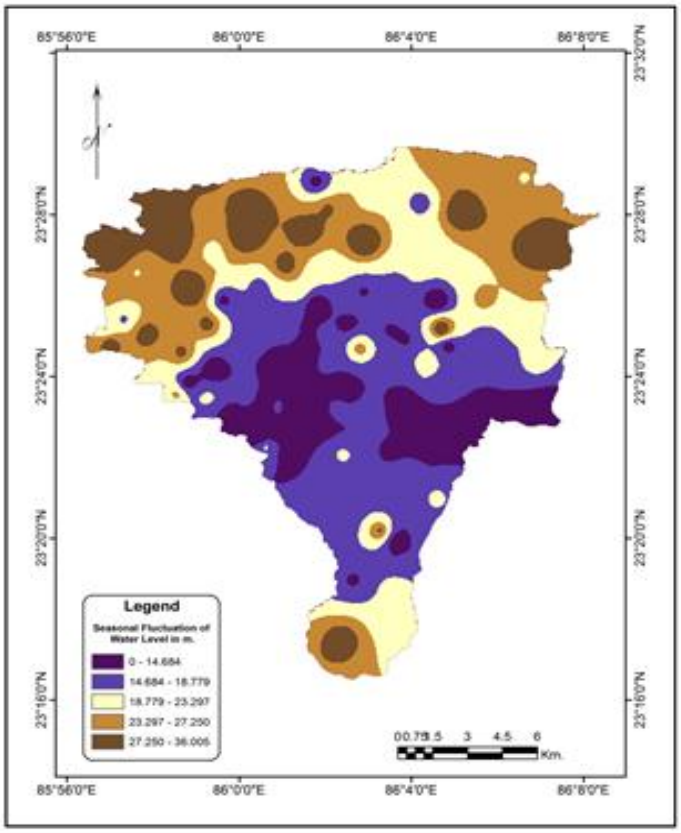

Fig. 4: Ground water fluctuation zones

D. Ground Water Scarcity Zone Identification

The zones having fluctuation value from 23.29 to 36.05 meter was identified as ground water scarcity zone of Jhalda II block. Areal extension of this category is found 96.32 Km2. It is found that there exists a high positive fluctuation value in terms of pre and post monsoon ground water depth. Existence of rugged topography along with comparatively elevated surface is possibly the reason behind this phenomenon.

E. Findings and Overall Analysis

The selected study area under Puruliya district is falls under a rain shortage area of West Bengal. Abundance of ground water is restricted in few small areas of the block. Seasonal fluctuation of water level in the aquifers is common. Aquifers in the northern and southern parts possess considerably high depth of water table, ultimately resulting into poor yielding capacity.

VII. CONCLUSION

From the above discussion it can be said that the problem of water scarcity in Jhalda II block of Puruliya district is more influenced by hydro geological constraints than human measures. Lack of proper groundwater excavation policy also causes few micro zones of serious water fluctuation. Thus the mapping of water scarcity is an effort to delineate a guideline of accessing potentiality offered by the groundwater reserve is used in sensible way so that the problem of water shortage can be sustainably alleviated.

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