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Research Paper

Spatio-temporal Analysis of Groundwater Resource using GIS: A Case Study of Murshidabad District, West Bengal, India

Debabrata Mondal
Assistant Teacher,
Manindranagar High School (HS), Cossimbazar,
Murshidabad, West Bengal.

ABSTRACT

In modern time, Geographic Information System (GIS) has been considered as a powerful tool in mapping of ground water resources. The study area Murshidabad district has experienced a remarkable change in ground water table throughout the decades. The present paper is an attempt to evaluate the decadal trend of ground water fluctuation in several blocks of the district along with their possible causes by using the data from secondary sources and processed them through GIS software.

Key words: GIS, Ground water table, Ground water resource.

INTRODUCTION

Groundwater is the only reliable water resource for domestic, as well as for agriculture practice in those countries where rainfall is erratic. Since the country of India has its economic base lying on agricultural sector, a major emphasis has been given to accelerate the agricultural production without concerning the environmental issues for feeding its huge population. From the last few decades gradual depletion of groundwater supplies as a consequence of continued population growth and initiation of Boro cultivation over the Gangetic moribund delta has now been considered as an emerging problem. Now a day's Murshidabad district is also facing this invisible hazard of groundwater depletion. In this regard monitoring, analyzing of groundwater is necessary for assessing its quantity.

Ground water fluctuation map is an important tool for analyzing the temporal as well as spatial changing pattern of groundwater resources. In this regard Geographic Information System (GIS) plays a crucial role for analyzing, model building and interpreting the groundwater data. In order to obtain long term groundwater information, GIS has been used in this study to visually and spatially analyze groundwater data.

ABOUT THE STUDY AREA

The present study area Murshidabad district is situated in the lower part of the Ganga basin in the hearth of West Bengal. The district can be delimited by 23º 43' to 24º 52' north latitude and 87º 49' to 88º 44' east longitudes covering an area of 5324 Sq Km. It consists of 26 blocks and 255 Gram Panchayat with 2210 villages.

Geology:

The west of the Bhagirathi river i.e. Rarh area has been formed by the depositional work of Ajoy-Damodar-Mayurakhi river system constituting older alluvium of Pleistocene age. It consists of stiff and plastic like clay and calcareous materials which are susceptible to laterization process at the surface area. The east of the Bhagirathi river is characterized by recent to subrecent alluvium deposits of the Ganga river system.

Soil:

The soil found in the Rarh area is of lateritic clay and calcareous nodules of the Sub-Vindhayan region whereas the Bagri region is characterized by light alluvial fertile soil.

Hydrogeological set up:

Murshidabad district belongs to hot and humid climatic type driven by south-west monsoon wind. The maximum rainfall occurs at the later half of June. In addition, pre-monsoon rain is received during the month of March-April. The annual rainfall ranges from about 1100mm to 1500mm. May is the hottest month during which the maximum temperature fluctuates between 40º-43ºC. January, the coldest month experiences a huge fall in temperature up to 8ºC. A systematic hydrogeological survey conducted by CGWB, 1994 has revealed that the eastern part of Bhagirathi river is constituted by unconfined aquifer and occurred down to 90-350 mbgl. Ground water occurs in the western part of Bhagirathi river under semi confined condition within the deeper horizon of sand and gravel having different texture where the main aquifers are found at greater than 150mbgl.

OBJECTIVES

Ø To build a model that will create a contoured water table surface map.
Ø To create groundwater fluctuation maps.
Ø To evaluate groundwater fluctuation in different decades.
Ø To assess the reasons behind such fluctuation in Murshidabad district.

METHODOLOGY

I. The study of decadal (1980, 1990, 2000, and 2010) condition of ground water was conducted based on secondary data of 114 network stations in different blocks of the study area supplied by Senior Geologist, SWID, Berhampore, Murshidabad.
II. The ground water data of different stations has been integrated in GIS environment as point vector layer, and then ground water contour map has been generated for the consecutive periods.
III. With the help of 'Feature Info Tool' in Global Mapper 10 software, the maximum and minimum depth of

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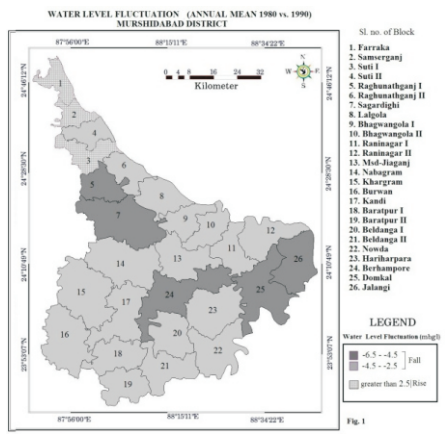
water level has been procured for different years.

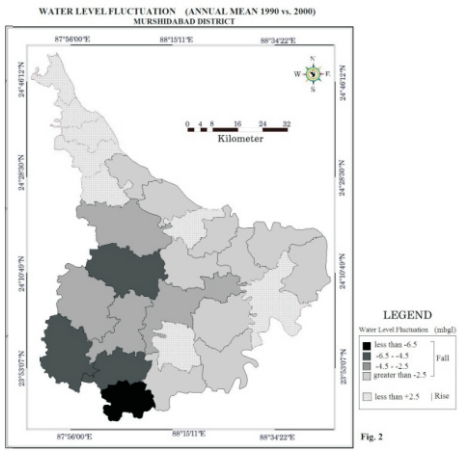
IV. Groundwater fluctuation maps were developed by overlaying two individual groundwater contour maps and the rise-fall patches were generated by subtracting the most recent values from older one for the all blocks. This process is accomplished by the Overlay Analysis Operation in PCI Geomatica 10.1.

V. Finally, the trend of ground water fluctuation has been generated in tabular format.

RESULTS AND DISCUSSION

The Green Revolution has been introduced in Murshidabad District in a massive way in the late1980s. Due to erratic character of rainfall and lack of canal irrigation agricultural sector was highly dependent upon groundwater irrigation. As a consequence of which most of the blocks of western part has experienced a mark seasonal as well as decadal lowering of groundwater level.





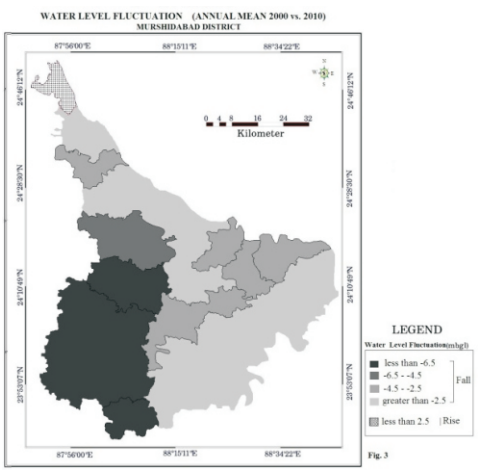


Table-1: Spatio-temporal fluctuation of groundwater resource in different blocks of Murshidabad district

Fluctuation		Sl. No. of Blocks in different periods		
		Annual Mean 1980 vs. 1990	Annual Mean 1990 vs. 2000	Annual Mean 2000 vs. 2010
Fall	Less than -6.5	-	19	15, 16, 17, 18, 19,
	-6.5 - -4.5	5, 7, 24, 25, 26	14, 16, 18	14
	-4.5 - -2.5	4, 6, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23	7, 17, 24, 15,	3, 10, 11, 12, 24
	Greater than -2.5	1, 2, 3	6, 8, 10, 11, 12, 13, 20, 21, 22, 23, 25, 26	2, 4, 5, 6, 8, 9, 22, 23, 25, 26
Rise	Less than +2.5	-	1, 2, 3, 4, 5	1
	+2.5 - +4.5	-	-	-

Source: Computed by author

The decadal trend of ground water fluctuation, processed through tabular format (Table-1.). This table reveals the following facts.

1. In the Rarh area, where the decadal fluctuation of ground water is much greater than Bagri.
2. The water level fluctuation map of 1980-90 (fig.1) has depicted few numbers of blocks with fall of water level ranges between -4.5 to -6.5, contrary to this there is higher magnitude of fluctuation in the period of 2000 to 2010 (fig. 3) due to huge pump out of ground water for irrigational practices.
3. Due to flood of 2000 the average water level has been raised, so most of the blocks suffered water logging condition.
4. The water logging condition is found in the block of Farraka, Suti-I, Suti-II and Samsergang during three consecutive decades. Where a rise has been.
5. The continuous significant decline of groundwater level in the Rarh area during three decades has revealed a clear indication of disparity between recharge and discharge.

Table-2: Depth of water level in pre and post monsoon period in different years

Year	Rarh		Bagri	
	Pre-monsoon (mbgl*)	Post-monsoon (mbgl*)	Pre-monsoon (mbgl*)	Post-monsoon (mbgl*)
1980	1.17-15.35	0.79-11.32	0.99-6.67	1.34-4.80
1990	1.64-15.82	0.87-11.46	1.44-6.64	1.06-6.56
2000	2.82-18.87	1.93-16.73	3.27-12.19	0.64-9.87
2010	5.08-21.14	4.3-22.2	4.6-11.68	3.08-10.21

*Metre Below Ground Level

Source: Computed by author

Table-2 shows the changing pattern of ground water level in different consecutive period in Rarh and Bagri region of Murshidabad. The depth to water level in pre-monsoon period in Rarh area varies from 1.17 to 15.35 mbgl while during post-monsoon it is from 0.79 to 11.32 in 1980 but this figure gradually changed in the year 2010 and representing a huge change of depth of water level whereas the picture of Bagri is quite different from that of Rarh. During post monsoon, 2010 the depth of water level, in general, ranges between 3.5 to 9.5 mbgl in major blocks of Bagri region. In the same time period Nabagram, Kandi Khargram blocks of Rarh has found deeper water level (22.2 mbgl).

CONCLUDING REMARKS

The huge quantity of ground water abstraction by means of irrigation water has laid upon a diverse effect upon ground water table of Murshidabad district. In recent times, various reports categorized the district as a highly arsenic prone area. It may be convenient to say that ground water depletion as a consequence of faulty agricultural practice and misuse of water in domestic purpose has directly or indirectly influenced the contamination of arsenic in our drinking water. The present study highly appreciates this problem and asks for kind attention of State as well as Central Government authorities to take pilot project in sustainable use of water resources by encouraging the use of surface water in irrigation and domestic purpose.

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