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Identification of Water Resource Potential Zones of Baghmundi Block in Purulia District, West Bengal

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***Abstract:** Remote sensing and GIS techniques have been broadly used to determine the water resource potentiality for the development and management of water resources. It is an important natural resource in our daily life and is used for domestic purposes. It's amount varies from place to place and season to season. It is scarce during the dry season, but in the rainy season, it is plenty. Assessment of water resource potentiality is very important for the management of surface/groundwater resources. Water resource potential zones are delineated with the help of RS & GIS. In this paper, standard methodology has been used to delineate the water resource potential zones using Rs & GIS techniques. Different parameters have been considered for identifying the water resource such as drainage frequency, drainage density, geology, groundwater level, slope, soil, surface water bodies, and land use/land cover have been generated satellite data and Survey of India (SoI) toposheet of a scale 1:50,000. Suitable ranks are assigned to these parameters. Various thematic maps of each parameter have been prepared by using the 'Ordered Weighted Averaging' technique. Finally, the composite map is generated by assigning all the parameters to demarcate the water resource potential zones. The study area has been classified into five categories: very poor, poor, moderate, good and excellent. This suggested methodology has been used to achieve the goal of the objective of the study area. This paper will be helpful for the identification of suitable locations for agriculture and domestic use of surface and underground water resources.*

***Keywords:** Water Resource, RS&GIS, Overlay Analysis, Thematic, Potential Zone*

I. INTRODUCTION

Underground and surface water are helpful for human beings in agriculture, industrial, household, creational and environmental activities. Precipitation is the primary source of water on the earth's surface. Water is drained out quickly through surface runoff after precipitation due to slopping ground. Some portion of rainwater is stored as underground water. It depends on voids within geological systems and the formation of the earth's crust, which act as conduits for transmission as reservoirs for storing water.

Some portion of water is stagnant on the earth's surface, like streams, ponds, khals and canals, etc., can act as recharge zones [1][17][18][19]. Rapid growth of population and unscientific exploitation of water is creating a water stress condition. At present, rainfall is gradually decreasing, uncertain and uneven spatially. This alarming situation is a cost and time-effective technique for proper evaluation of water resources and management planning. Various parameters are important for generating a water resource model of the study area. Baghmundi Block of Purulia District covers part of the Subarnarekha River basin and Kangsabati River basin. Ajoydha Hill acts as a water divider between the Subarnarekha and Kangsabati river basins. Catchment and watershed are widely used to denote the hydrological units [2]. A watershed is a natural hydrological entity that covers a specific areal space on the earth's surface from which the rainfall runoff flows through a drain, channel, gully and stream or river at any particular point. Considering various opinions, an attempt has been made to locate water resource potential zones for assessment of water availability in the present study area using remote sensing and GIS techniques.

Remote Sensing (RS) and Geographical Information System (GIS) techniques are broadly used in the field of hydrology and water development. Satellite (Remote Sensing) information is helpful for solving water resource uses. RS and GIS play a significant role in the present day for multi-criteria analysis in water resource evaluation and hydro-geomorphological mapping for water resource management. Geology, Geomorphology, slope, and land use/land cover have been extracted from satellite image and Survey of India toposheet. The GIS platform has been used for the integration of various themes. Water resource potential zones indicate that the water resource occurrence is controlled by indicators for the structures, slopes, and landforms. Assessment of the groundwater's possible recharge processes is an essential indicator for the management of water resources and protection of water quality [3]. Drainage, slope, soil, lithology and geomorphic features of the study area have been extracted and suggested appropriate methods for water resource potential studies.

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II. OBJECTIVES

The study area is located in the western part of Purulia District, West Bengal, and it is surrounded by Jharkhand state in the south and southwestern part, Jhalda and Arsha block of Purulia District, West Bengal in the north, and Balarampur in the block in the east. Baghmundi Block is a part of the Subarnarekha River and Kangsabati River basin, and the Ajoydha Hill range act as water divider between the two basins. The area of study receives water from rain in the rainy season, but in summer, it is dried up. During the dry season, people suffer from water due to a lack of water in the river, pond, khal, surface well and proper management. The study area has a subtropical climate characterized by high evaporation and low precipitation. Average rainfall varies between 1100 mm and 1500 mm. The relative humidity is high in the monsoon season, 75 to 80 per cent. But in summer, it comes down to 25 to 35 per cent. Keeping this in mind, this study attempts to demarcate the potential water resource zones in the Baghmundi Block of the Purulia District. This potential map will help a proper understanding of the sustainable use of water resources in the study area. Geographically, Baghmundi Block is extended 23^{0} $05^{/}$ $0.96^{//}$ N to 23^{0} $17^{/}$ $56.4^{//}$ N latitude and 85^{0} $11^{/}$ $55.68^{//}$ E to 85^{0} $52^{/}$ $0.48^{//}$ E longitude, covering an area of 450 square kilometers, and perimeter is 123 km. The maximum and minimum heights of this block are 677m and 190m, respectively. Rainwater is rapidly washed out from the ground surface due to steep slopes without recharging the groundwater. Agriculture activity is the major source of the economy of the people living in this block. Surface and groundwater are used for drinking and irrigation purposes. Proper water resource management is needed for local people and for irrigation and domestic purposes. Figure 1 shows the location of the study area.

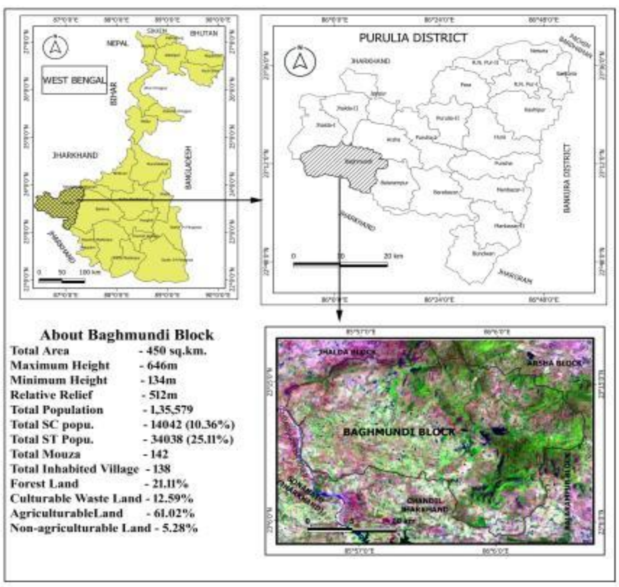

Fig. 1. Location Map of the Study Area

III. MATERIALS/DATA USED

Different types of data have been used to achieve fulfillig the objective of the study area. Landsat 8 data has been used to determine the different geomorphic features. Topographical maps of a scale 1: 50,000 (No. 73E/15, 73E/16, 73I/3 and 73I/4) Survey of India also have been used. The elevation of the study area has been determined using SRTM data (Cartosat-I). Geological map (GSI) and groundwater level data from Central Ground Water Board (GoI) have been used for identification and delineation of water resource potential zones in Baghmundi Block, Purulia district.

IV. METHODOLOGY

The proposed methodology of study comprises of the preparation of base maps, land use/ land cover and geological maps, digitizing and image processing techniques using GIS software and interpretation of outputs. The administrative boundary has been digitized and divided into one square kilometer grid (Figure 2). Various parameters related to water resources, such as average slope, drainage frequency, and drainage density, have been extracted from each grid and classified into several classes and assigned scores for each class. The soil texture of the study area is categorized on the basis of water content, and a score has been assigned correspondingly. Other parameters, in this way, like land use/ land cover, geology of rocks, groundwater and surface water bodies, are used to demarcate the water resource potentiality. SRTM data (Cartosat-I) is used to prepare slope and drainage maps by extracting elevation in RS&GIS software. This methodology is widely used for the availability of water resource maps for small to medium ranges of hydrological units. All the above thematic information have been analyzed, and weight is given to evaluate suitable water potential available zones. In the present study, average slope, drainage density and frequency, soil texture, groundwater, surface water bodies, geology and land use/land cover etc., are considered for the identification of water resource potentiality in Baghmundi Block. All these thematic layers are weighted sum raster overlay analysis using Qgis and Saga. The proposed methodology of the study is given below diagrammatically (Figure 3).

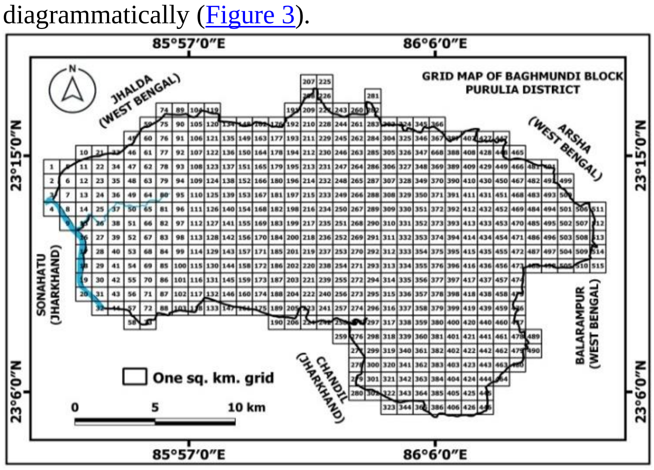

Fig. 2. Grid Layout of the Study Area

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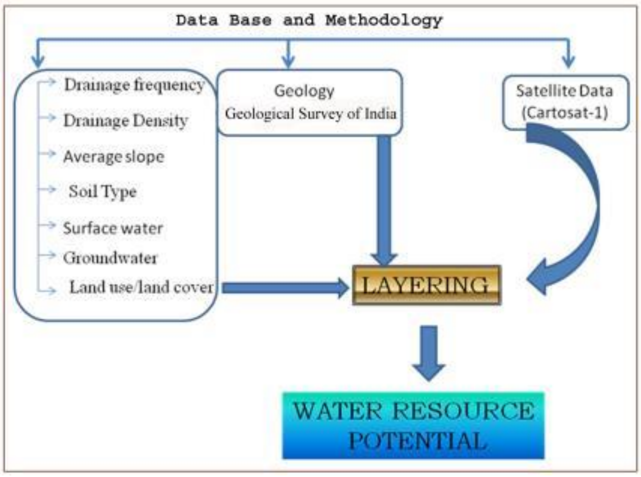

Fig. 3. Data Base and Methodology

V. RESULT AND DISCUSSION

A. Drainage Frequency

Drainage is an important parameter for the availability of water resources. The drainage pattern of the study area is controlled by the regional rock structure and geomorphology. Remote sensing information and Geographical Information System (GIS) have been used to generate data and to know the spatial drainage deviation characteristics, thus providing an insight into hydrological conditions necessary for developing watershed management strategies [4]. The drainage pattern of the block Baghmundi is the dendritic type, and generally, streams flow north to south direction. This drainage pattern indicates the homogeneity in texture and lack of structural control and helps in understanding various terrain parameters such as natural bedrock, infiltration capacity, etc. [5]. A number of streams have been extracted from each grid (one square kilometer) for the preparation of a drainage frequency map. It has been classified into very high (> 8 streams per sq. km.), high (6 to 8 streams per sq. km.), moderate (4 to 6 streams per sq. km.), low (2 to 4 stream per sq. km.) and very low (< 2 stream per sq. km.) drainage frequency zone. A very high drainage frequency zone covers an area of 1.04 per cent of the study. High, moderate and low drainage frequency zones cover 16.02, 27.84 and 36.74 per cent areas, respectively, and 15.36 per cent areas lie under very low drainage frequency zones. Table 1 shows the different drainage frequency zones and their score on the basis of water availability in the study area.

Table-I: Drainage Frequency Zones and Score Assigned

S. No.	No. of Stream/Sq. km.	Water Resource Prospects	Area Covered in Sq. Km.	Area Covered in %	Score
1	< 2	Very Low	69.1	15.36	1
2	2 to 4	Low	165.33	36.74	2
3	4 to 6	Moderate	125.28	27.84	3
4	6 to 8	High	72.09	16.02	4
5	>8	Very High	18.2	4.04	5

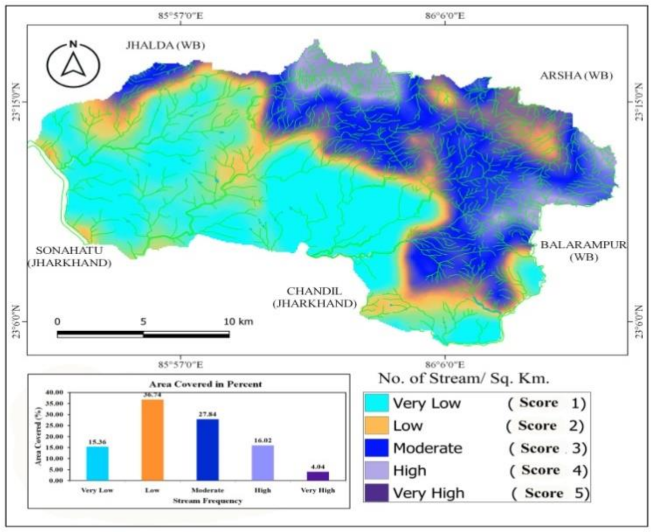

Fig. 4. Weighted Score of Drainage Frequency Map Based on Water Prosperity

Source: SRTM 2015 & author's compilation

B. Drainage Density

According to Strahler [6][21], drainage density is shown by Dd=L/A , Where L is stream length, and A is unit area. Figure 5 and Table 2 show the various drainage density zones and assigned scores of the study area. The drainage density map has been categorized into very high (> 4 km stream length per sq. km.), high (3 to 4 km. stream length per sq. km.), moderate (2 to 3 km. stream length per sq. km), low (1 to 2 km. stream length per sq. km.) and very low (< 1 km. stream length per sq. km.) drainage density zones and assigned score on the basis of drainage density of the study. Very high drainage density zone covers 0.44 per cent area and. High moderate and low drainage density zones cover an area of 14.24 per cent, 34.61 per cent and 44.47 per cent area, respectively, of the study. 6.24 per cent of the area of the study lies under a very low drainage density zone. Low drainage density area indicates a poorly drained area with a slow hydrological response from an area; making it highly susceptible to flooding, gully erosion, etc. [7]. A high drainage density zone indicates a quick hydrological response to rainfall events. Besides, high drainage density area is indicated by impermeable subsoil material, sparse vegetation and high relief [8].

Table-II: Drainage Density Zones and Score Assigned

S. No.	Stream Length in km./Sq. km.	Water Resource Prospects	Area Covered in Sq. Km.	Area Covered in %	Score
1	< 1	Very Low	28.06	6.24	1
2	1 to 2	Low	200.11	44.47	2
3	2 to 3	Moderate	155.74	34.61	3
4	3 to 4	High	64.09	14.24	4
5	> 4	Very High	2.00	0.44	5

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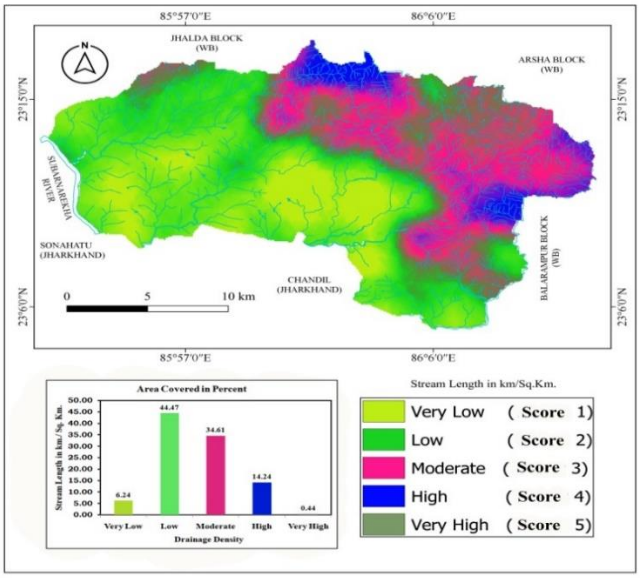

Fig. 5. Weighted Score of Drainage Density Map According to Water Prosperity

Source: SRTM 2015 & author's compilation

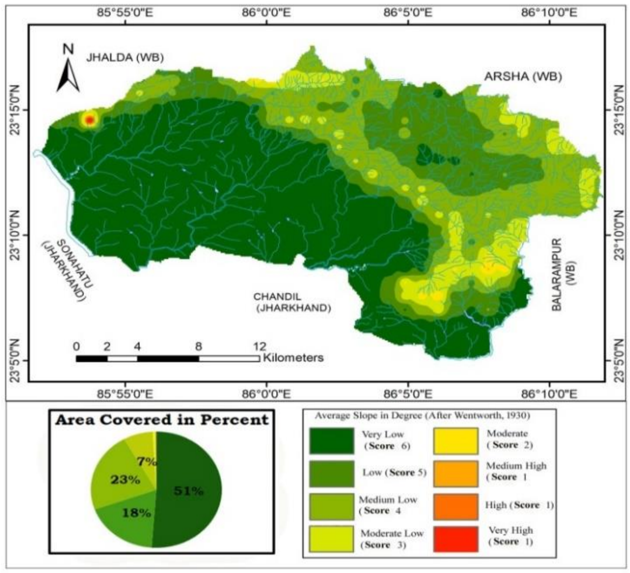

Fig. 6. Weighted Score of Average Slope Map as Per Water Holding Capacity

Source: Toposheet no. 73E/15, E/16, 73I/3, I/4 (SoI) & author's compilation

C. Average Slope

Slope is an element of earth's terrestrial and submarine surfaces; it is, therefore, simply an element of the interface between the lithosphere and atmosphere [9]. According to Wentworth 1930 [10], average slope is defined by using the formula: $\theta=\tan^{-1}$ (N x i/K), where N is the number of contour crossing per kilometer, and i is the contour interval, and K is constant (636.6 for the kilometer grid). The average slope of the Baghmundi Block has been categorized into very high (> 35 degrees), high (30 to 35 degrees), medium high (25^0 to 30^0), moderate (20^0 to 25^0), moderately low (15^0 to 20^0), medium low (10^0 to 15^0), low (5^0 to 10^0) and very low (< 5^0) and assigned score of each zone of the basis of water prosperity. It is an important parameter for the availability of surface as well as sub-surface water. It also controls the infiltration and surface runoff, which affects the water resource availability. 0.87 per cent of the area is under the above 20^0 slope of the study area, and 47.96 per cent of the area is between 5^0 and 20^0 slope of the study. 57.16 per cent of the area lies under below 5^0 slopes. Figure 6 and Table 3 depict the score of the average slope zone on the basis of water resource prosperity.

Table-III: Average Slope Zones and Assigned Score

Sl. No.	Slope in Degree	Water Resource Prospects	Area Covered in Sq. Km.	Area Covered in %	Score
1	< 5	Very Low	230.24	51.16	7
2	5 to 10	Low	82.43	18.32	6
3	10 to 15	Medium Low	100.53	22.34	5
4	15 to 20	Moderate Low	32.87	7.30	4
5	20 to 25	Moderate	2.82	0.63	3
6	25 to 30	Medium High	0.4	0.09	2
7	30 to 35	High	0.37	0.08	1
8	>35	Very High	0.34	0.08	1

D. Soil

The water retention capacity of the soil is mainly dependent on the particle size of the soil. The water holding capacity of the soil is higher in the finer texture soil due to the cohesive nature of the soil. The pore space in the soil indicates the voids between soil particles and is occupied by air or water. Soil texture, bulk density and structures of the soil determine the quantity and size of pore space [11]. Soil texture controls the water percolation through the soil, which in turn recharges the groundwater. The soil of the study area is classified into a fine texture, fine loamy, coarse loamy, fine loamy and gravelly loam loam, and each category has been assigned a score on the basis of water holding capacity. Figure 7 and Table 4 show the soil characteristics score of the study area. Fine soil texture covers 33.02 per cent of the study area. 33.65 percent of the study area lies under fine loamy coarse loamy soil. Fine loamy and gravelly loam loam soil cover 12.40, 20.93 per cent of the area of the Baghmundi Block, respectively.

Table-IV: Soil Texture Characteristics and Assigned Score

Sl. No.	Soil Type	Water Resource Prospects	Area Covered in Sq. Km.	Area Covered in %	Score
1	Fine Texture	High	148.58	33.02	4
2	Fine Lomy Coarse Loamy	Medium	151.41	33.65	3
3	Fine Loamy	Low	55.82	12.4	2
4	Gravally Loam Loam	Very Low	94.19	20.93	1

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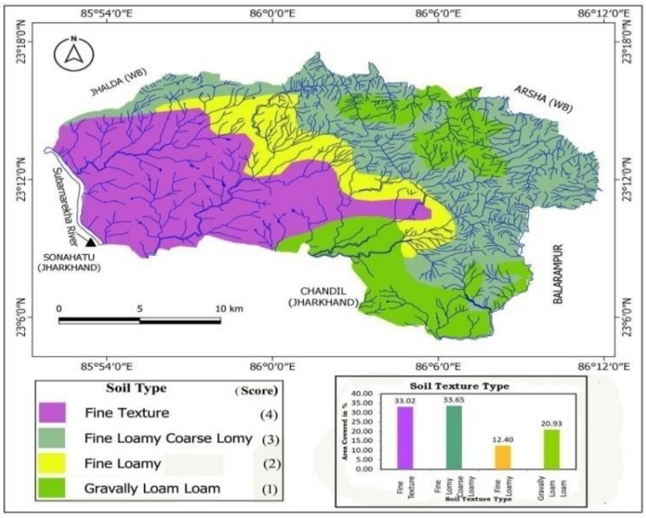

Fig. 7. Weighted Score of Soil Texture Map on the Basis of Water Holding Capacity

Source: NBSI, Regional Centre, Kolkata & author's compilation

E. Surface Water

Surface water has been important not only to humans but to all life forms on the earth ever since life began. Plants and animals grow congregate around waterways simply because water is essential to life. It might seem that river happens to run through many cities in the world, but it is not that the rivers go through the city but rather that the city was built and grew around the river [12][22]. Most of the surface water comes from rainfall, and it is runoff surrounding the catchment area. Of course, not all water ends up in rivers; some evaporates, some is used by vegetation, and part of it soaks into the ground for recharging our groundwater systems, some of which can seep back into the river beds. Various forms of surface water on the earth's surface, like water in streams, rivers, lakes, wetlands, reservoirs, creeks, etc., are the indicators of water availability on the earth's surface. The basis of the area under surface water has been classified and assigned a score for each zone (Figure 8 & Table 5). The high surface water zone (Above 4% water) covers 4.92 per cent of the area of the study. Medium (2.0 to 4.0% surface water) and low (0.5 to 2.0% surface water) surface water zone covers 9.80 and 39.90 per cent of the total area of the study. A very low surface water zone (below 0.5% surface water) covers an area of 40.12 per cent area of Baghmundi Block.

Table-V: Zones of Surface Water Bodies and Assigned Score

S. No.	% of Surface Water Bodies to the total area of the village	Water Resource Prospects	Area Covered in sq. km.	Area Covered in %	Score
1	Above 4.0	High	22.16	4.92	4
2	2.0 to 4.0	Medium	44.12	9.80	3
3	0.5 to 2.0	Low	179.54	39.90	2
4	Below 0.5	Very Low	180.52	40.12	1
5	Matha Protected Forest	Low	23.66	5.264	2

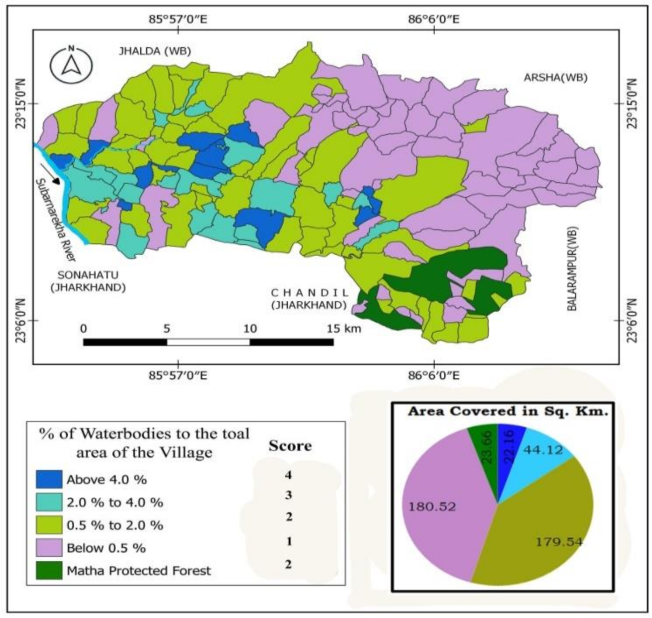

Fig. 8. Surface Water Map as Per Weighted Score

Source: Google Earth, 2022 & author's compilation

F. Groundwater

Soils and rocks of an upper-level surface of underground water are permanently saturated with water [13]. Different kinds of ecosystems depend on groundwater: aquatic (wetlands, rivers and lakes receiving groundwater), terrestrial (with phreatophyte vegetation, either shallow-rooted in alluvial settings or deep-rooted in arid zones) and even subterranean (in limestone formations with karstic caverns). Groundwater is an important part of an ecosystem-based adaption measure, green infrastructure, or nature-based solution [14]. Groundwater level has been measured from the ground surface. In this study area, 11.33 per cent area of the study is a high (0.80 to 4.05 mbgl) water resource prospects zone. Medium (4.05 to 4.77 mbgl) water resource prospects zone covers 65.56 per cent of the area of the study, and 23.11 per cent of the area lies in the low water prospects zone (4.77 to 5.38 mbgl) (Figure 9). According to a meter below ground level, a score has been assigned to each zone to understand the variability of groundwater resources of the study area. Table 6 shows the groundwater level (mbgl) zone and assigned score.

Table-VI: Zones of Groundwater Level and Assigned Score

S. No,	Depth to Water Level (mbgl)	Water Resource Prospects	Area Covered in sq.km.	Area Covered in %	Score
1	0.80 to 4.05	High	51	11.33	4
2	4.05 to 4.77	Medium	295	65.56	3
3	4.77 to 5.38	Low	104	23.11	2

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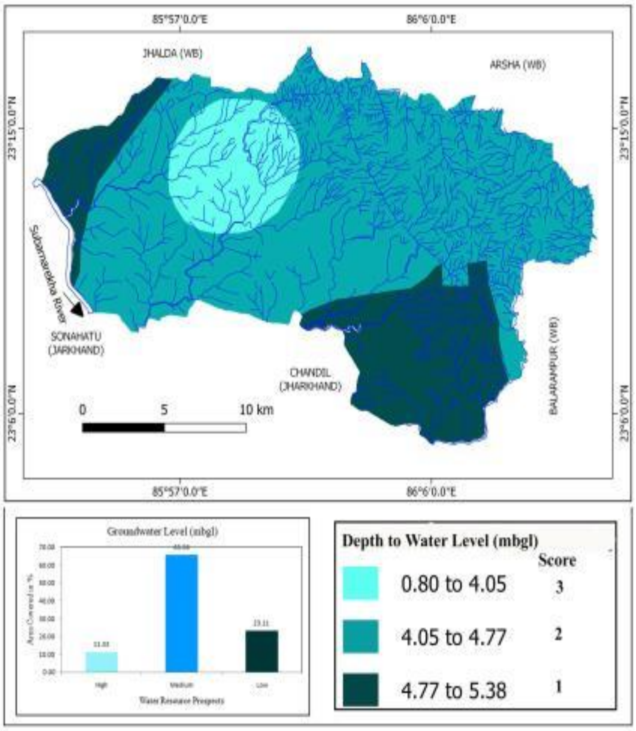

Fig. 9. Groundwater Level Prospects Map According to Weighted Score

Source: CGWB, Govt. of India & author's compilation

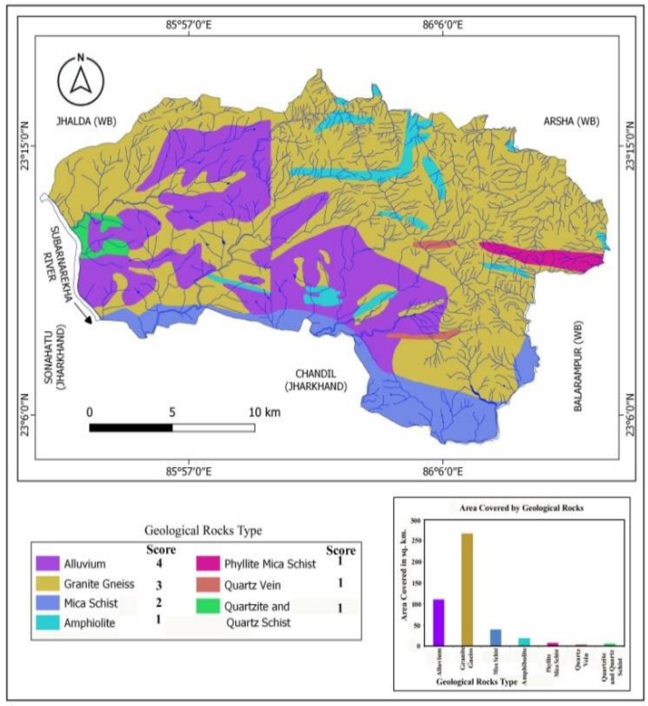

Fig. 10. Geological Characteristics Map According to Water Resource Prosperity

Source: SoI, Govt. of India & author's compilation

G. Geology

Underground geological rock characteristics are an important controlling factor for the infiltration of surface water into the subsurface, which proves to be the most crucial factor in deciding the infiltration of surface water to the subsurface level. Various types of rocks are seen in the study area, such as alluvium, granite gneiss, mica schist, amphibolites, phyllite mica schist, quartz vein and quartzite and quartz schist. Alluvium (high water resource prospects) covers 24.60 per cent of the area of the study. Granite gneiss (medium water resource prospects) covers an area of 59.45 per cent. 8.79 per cent of the area is under mica schist (low water resource prospects. Amphibolites, phyllite mica schist, quartz vein and quartzite and quartz (very low water resource prospects) cover 7.16 per cent area of the Baghmundi Block. On the basis of the groundwater recharge ability of the rocks, scores have been assigned to each rock. Figure 10 and Table 7 show the different rocks and their water potentiality.

Table-VII: Geological Characteristics of Rocks and Score Assigned

S. No.	Rocks Type	Water Resource Prospects	Area Covered in Sq. Km.	Area Covered in %	Score
1	Alluvium	High	110.69	24.60	4
2	Granite Gneiss	Medium	267.52	59.45	3
3	Mica Schist	Low	39.56	8.79	2
4	Amphibolite	Very Low	18.52	4.12	1
5	Phyllite Mica Schist	Very Low	6.52	1.45	1
6	Quartz Vein	Very Low	2.66	0.59	1
7	Quartzite and Quartz Schist	Very Low	4.53	1.01	1

H. Land use/Land Cover

Land use/land cover parameter plays an important role in the water resource availability of the earth's surface. It includes agricultural land, surface water bodies (ponds, wetlands, lakes, khals streams, etc.), vegetation cover, current fallow land and bare soil/rock and built-up. Land use/ land cover plays a significant role in hydrological processes, such as the infiltration rate of surface water and surface runoff. The infiltration rate of surface water is high, and the discharge of surface water is less in forest areas. It can also modify the underlying mechanisms of transforming rainfall to water yield by altering the ecosystem's hydrological characteristics, such as infiltration, evapotranspiration and groundwater recharge capacity [15]. Figure 11 and Table 8 shows the classification of land use/ land cover and has been assigned a score on the basis of water availability of the study area. Whereas 6.36 per cent of the area is water bodies (high water resource prospects), and 47.34 per cent of the area is under vegetation cover (medium water resource prospects). Current fallow land (low water resource prospects) covers 44.26 per cent of the area and 2.04 per cent of the area is under built-up/bare rock (very low water resource prospects) of the study area (Table 8). On the basis of water holding capacity, scores have been assigned to each land use/ land cover zone, and the variation reflects the hydrological services of different land ecosystems.

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Table-VIII: Land Use/Land Cover Category and Assigned Score

S. No.	Land use	Water Resource Prospects	Area Covered in %	Score
1	Water Bodies	High	6.36	4
2	Vegetation	Medium	47.34	3
3	Current Fallow Land	Low	44.26	2
4	Built-up/Bare Rock	Very Low	2.04	1

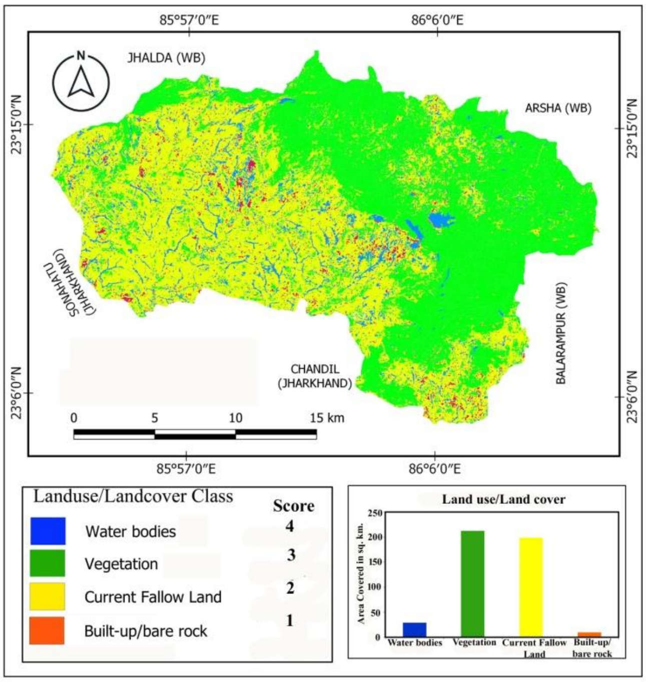

Fig. 11. Land Use/Land Cover Category as Per Water Holding Capacity

Source: Landsat 8, 2020 & author's compilation

VI. WEIGHT ASSIGNMENT

Water resource potential zones are obtained by overlying all the thematic maps, and the weighted overlay averaging method has been used in GIS software. Weight has been assigned according to the influence of water resources on each thematic map [16].

All the thematic maps are converted from vector to raster format. Surface water bodies, drainage density, drainage frequency and average slope are assigned higher weight, whereas geology, soil texture, groundwater level and land use/ land cover are assigned lower weight comparatively. Assigned weights to the different thematic maps and individual scores are given for the sub-variable. GIS has been analyzed carefully, and scores are given sub-variables [17].

The highest score is assigned to the feature with the highest potentiality, and the lowest score is given to the lowest potential features. Higher drainage frequency areas are given the highest score, and a lower score is assigned for lower drainage frequency. Higher drainage density areas are given the highest score, and a lower score is assigned for lower drainage density areas. As far as slope, higher scores are assigned for lower (gentle) pitch, and lower scores are assigned to higher (steep) slope areas. In land use/ land cover, a higher score is assigned to surface water bodies and vegetation cover areas, and a lower score is assigned to built-up, current fallow land and bare rock areas. All the assigned scores and weighted values of different thematic maps are tabulated in Table 9.

Table-IX: Assigned Score and Weight for Various Parameters of Water Resource Potential Zones

S. No.	Parameter	Classes	Water Resource Prosperity	Score	Maps Weight
1	Geology	Alluvium	High	4	0.5
		Granite Gneiss	Medium	3	
		Mica Schist	Low	2	
		Amphibolite	Very Low	1	
		Phyllite Mica Schist	Very Low	1	
		Quartz Vein	Very Low	1	
		Quartzite and Quartz Schist	Very Low	1	
2	Average slope (Degree)	< 5	Very Low	7	1
		5 to 10	Low	6	
		10 to 15	Medium Low	5	
		15 to 20	Moderate Low	4	
		20 to 25	Moderate	3	
		25 to 30	Medium High	2	
		30 to 35	High	1	
		>35	Very High	1	
3	Drainage Frequency (Number of Stream/ sq. km.)	>8	Very High	5	2
		6 to 8	High	4	
		4 to 6	Moderate	3	
		2 to 4	Low	2	
		<2	Very Low	1	
4	Drainage Density (Stream Length in km./sq. km.)	>4	Very High	5	2
		3 to 4	High	4	
		2 to 3	Moderate	3	
		1 to 2	Low	2	
		<1	Very Low	1	
5	% of Surface Waterbodies to total area of the Village	Above 4.0	High	4	3
		2.0 to 4.0	Medium	3	
		0.5 to 2.0	Low	2	
		Below 0.5	Very Low	1	
		Matha Protected Forest	Low	2	

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6	Soil Texture	Fine Texture	High	4	0.5
		Fine Loamy	Low	2	
		Gravally Loam Loam	Very Low	1	
7	Groundwater Level (mbgl)	0.80 to 4.05	High	4	0.5
		4.05 to 4.77	Medium	3	
		4.77 to 5.38	Low	2	
8	Land use/land cover	Water bodies	High	4	0.5
		Vegetation	Medium	3	
		Current Fallow Land	Low	2	
		Built-up/Bare Rock	Very low	1	

VII. CONCLUSION

Remote Sensing and Geographical Information System (RS&GIS) techniques are important tools to determine the water resource potentiality in the Baghmundi Block of Purulia District, West Bengal; it reveals that integration of eight thematic maps such as average slope, soil texture, drainage density, drainage frequency, groundwater level, surface water bodies, geology and land use/ land cover gives information to the local people, authorities and planners about the area suitable for water resource exploration. The study area has been classified into excellent, very good, good and poor water potential zones, which have been indicated in Figure 12. As per Table 9 & Table 10, the study area reveals that having very low drainage frequency (below 2 number of streams/ sq, km.), very high average slope (above 35^0), fine loamy and gravelly loam loam soil, very low surface water bodies (below0.5% area to total area), low groundwater resource prospects (4.77 to 5.38 mbgl), the area under granite gneiss and amphibolites, and areas covered with vegetation and bare rock/soil is poor water resource potential zone and it covers an area of 1.96 per cent of the study. It has been observed that the good water resource potential zone in the study area is considered as having the area of low and moderate drainage frequency (2 to 4 and 4 to 6 number of streams per sq. km.), low and moderate drainage density (1 to 2 and 2 to 3 stream length in km. per sq. km.) respectively). Moderate and medium high slope (20^0 to 35^0), fine loamy soil texture, the area under low water resource prospects (0.5 2.0 % surface water bodies to the total area), area of medium groundwater resource prospects (4.05 to 4.77 mbgl) from the ground surface, the area under granite gneiss rock and area covered with vegetation and bare rock/soil are observed as good water resource potential zone, and it covers an area of 27.26 per cent of the study area. The area has high drainage frequency (6 to 8 number of stream per sq. km.), high drainage density (3 to 4 stream lengths in km. per sq. km.), low and moderate low slope (5^0 to 15^0), fine loamy and coarse loamy texture soil, medium (2.0 to 4.0 %) surface water bodies, area of medium groundwater resource prospects (0.80 to 4.05 mbgl), granite gneiss rock and covered with agricultural land and scatter vegetation are observed as very good water resource potential zone and it covers an area of 67.18 per cent of the study area. Excellent water resource potential zone is noticed in the area where there are very high drainage frequency (above 8 number of streams per sq. km.), very high drainage density (above 4 km. stream length per sq. km.), very low slope (below 5^0), fine texture soil, the area under surface water bodies (above 4.0 per cent to the total area), area of high groundwater resource prospects (0.80 to 4.05 mbgl), area of alluvium soil and area covered with agricultural land are observed as excellent water resource potential zone and it covers an area of 3.59 per cent to the total area of the study. Water resource potential information of the study will help the local people or planners in the effective identification of suitable locations for proper use and management of water resources. The present methodology and work of this paper will be helpful for the researcher as a guideline for further research.

Table-X: Water Resource Potential Zones

S. No.	Water Resource Potential Zones	Area Covered (sq. km.)	Area Covered (%)
1	Poor	8.84	1.96
2	Good	122.68	27.26
3	Very Good	302.31	67.18
4	Excellent	16.17	3.59

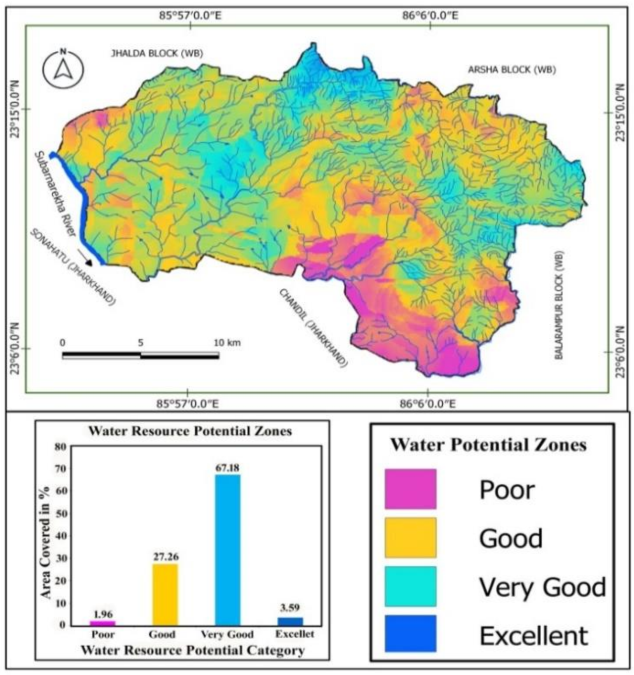

Fig. 12. Water Resource Potential Zones Map of Baghmundi Block

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