IOSR Journal of Engineering (IOSRJEN) **www.iosrjen.org**
ISSN (e): 2250-3021, ISSN (p): 2278-8719
Vol. 10, Issue 12, December 2020, ||Series -II|| PP 47-52

Groundwater Potentiality Identification in the South-eastern Side of Rajshahi Division, Bangladesh.

Md. Saiful Islam[1], Md. Omar Faruk[2]
[1]*Department of Electrical Electronic and Communication Engineering, Pabna University of Science and Technology, Bangladesh*
[2]*Department of Information and Communication Engineering, Pabna University of Science and Technology, Bangladesh*
Corresponding Author: Md. Omar Faruk
Received 30 December 2020; Accepted 12 January2021

Abstract: In this research 467 borehole litho logic data and 85 static water level data have been collected from relevant organizations as the secondary data to estimate various parameters of aquifer material. Elevation, latitude and longitude data have been collected through direct field investigations. Then all the data were processed, analyzed and interpreted to detect the potential zone of the study area comprising 18 upazillas of Pabna and Sirajgonj districts under Rajshahi division. Actually, the yield potential index, the specific yield and the transmissivity are the helping parameters to identify the groundwater potential zone in the area. This yield potential index map has been generated with the help of total formation and the total sand of the area investigated. It is basically the ratio of total sand to the total clay formation. Specific yield is used to identify the storage of the aquifer and it determines whether or not the water saturated zone is a source of groundwater and the natural characteristics of the water bearing formations. The transmissivity represents its average water transmitting property which depends mainly on the number and diameter of the pores present and determines the effectiveness of groundwater reservoir.
Keywords: Groundwater, potential, abstraction, yield, lithology.

I. INTRODUCTION

Water is found as solid, liquid and vapor. The main source of water is sea and ocean. Due to its salinity this type of water is not acceptable always. The source of mild water is surface and groundwater [1]. Groundwater is a hidden treasure which is not directly visible from the earth's surface. The amount of groundwater in any area depends on the character of the underlying aquifer, its extent and the frequency of discharge. Groundwater is a precious and the most widely distributed resource of the earth and is replenishable resource unlike any other mineral resources. It is the largest source of fresh water on the planet excluding the polar icecaps and glaciers [2]. Bangladesh's dependence on groundwater is very great. About 95% of domestic water supplies and about 70% of irrigation water is supplied from groundwater sources [3]. Groundwater is a valuable natural resource and its importance knows no bound. But large scale abstraction of groundwater creates various problems. These problems have become particularly severe for the developing countries, adversely affecting their agriculture, fisheries, navigation, drinking water supply and sanitation.

Groundwater is the only source of water supply for drinking and main source of irrigation in the studied area. Water scarcity is found in the proposed area during the irrigation period due to increasing population and development activities. The increasing population has suddenly increased the demand for consumption of water and stimulated investigations oriented towards quantifications of this resource. The large scale abstraction of groundwater for irrigation without proper planning and management has caused much environmental degradation. So, a detailed study is now essential for the conservation of this important resource in the area.

Aquifer parameter of subsurface formations plays an important role for groundwater occurrence, distribution and reservation. These parameters can be classified into two categories. One of them is formation parameter and the other is hydrogeological parameter. Formation parameters are very important for groundwater investigation and detection of its condition. Detection of effective groundwater reservoir, measurement of the rate of propagation of groundwater, selection of suitable well-sites etc. are important for groundwater development.

Hydraulic conductivity, transmissivity, hydraulic diffusivity and radius of influence are the measuring instruments for the identification and estimation of the hydro-geologic parameters. Considering the yield potential index, specific yield and transmissivity of the area studied, the groundwater potential zones are identified. Those parameters have been estimated and presented in the form of shaded contour maps. So, the estimation of various types of aquifer parameter would identify the actual feature of groundwater potential zones in the study area.

II. MATERIALS AND METHODS

Any effective and fruitful research does not depend not only on the availability and quality of requisite data but also on the proper methodology. The subsurface formation is not visible; it resides under the earth surface. So it not possible to identify the subsurface formations through direct visual measurement and its properties are not be identified and estimated. The present research work has been conducted and completed through appropriate data acquisition. The data used in this purpose have been collected from various relevant organizations. About 467 lithological borehole data and static water level data of 85 locations during the period of 1994-2014 have been collected for the purpose of aquifer parameter measurements. Borehole litho log data would provide valuable information of subsurface water bearing formations and help to estimate the different types of aquifer parameter of the area studied. The study area map, the lithological map and the static water level map were generated with the help of computer program.

III. DESCRIPTION OF THE STUDY AREA

The study area is composed with Pabna and Sirajgongonj districts in Fig.1. The study area is the east-southern most part of Rajshahi division. The total area of the study area is 4869.42sq.km and it is situated in between 23°48´ and 24°47´N latitudes and 89°00´ and 89°59´E longitudes. It contains 18 upazilas which has been presented in Fig.2. The area is bounded by Padma river, Kusthia and Rajbari districts on the south; Jamuna river, Jamalpur, Tangail and Manikganj districts on the east; Natore district on the west and Bogra district on the north. The river Padma flows in the extreme boundary of the southern side and the river Jamuna flows in the extreme boundary of the eastern side of the area. These two major rivers meet with each other in the south-eastern corner of the study area and are sustaining the environmental balance and socio-economic development of the area. Numerous swamps have been developed in the study area.

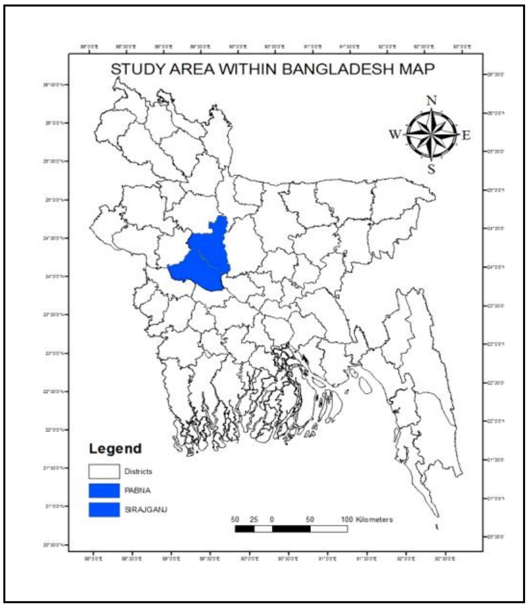

Figure1: Study area within Bangladesh map.

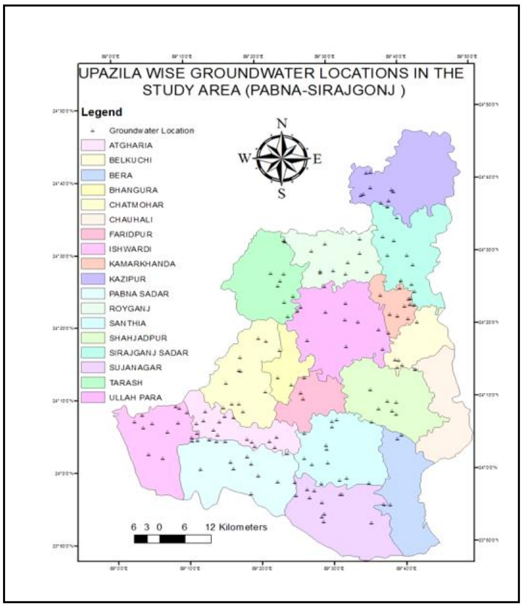

Figure2: Study area with upazilla boundary.

There exists many beels of various shapes and sizes. The largest Chalan beel is also situated in this area which constitutes the largest swamp of the Rajshahi division covering several hundred square miles. Chalan beel is a wet land in Bangladesh. It is a large inland depression, marshy in character, with rich flora and fauna. Forty seven rivers and other waterways flow into the Chalan beel. As silt builds up in the beel, its size is being reduced. The study area is located in the flood plains of the Ganges, the Brahmaputta and the Meghna river systems [4].

IV. YIELD POTENTIAL INDEX

The yield potential index of any area is defined as the ratio of the total thickness of sandy formation to the total thickness of clayey formation. It indicates the proportion of sand thickness and the clay thickness. The area possesses the highest proportion indicates the aquifer dominated area and vice versa. The aquifer dominated area indicates the good regions for groundwater reservation and abstraction. On the other hand, the lowest value of proportion indicates the bad potentiality. This measure is very much effective for the site selection of well construction. The yield index map of the area has been prepared by considering the combined thickness of sands and the thickness of the top clay–silt. Therefore, the distribution of total aquifer yield index has been processed in Fig.3

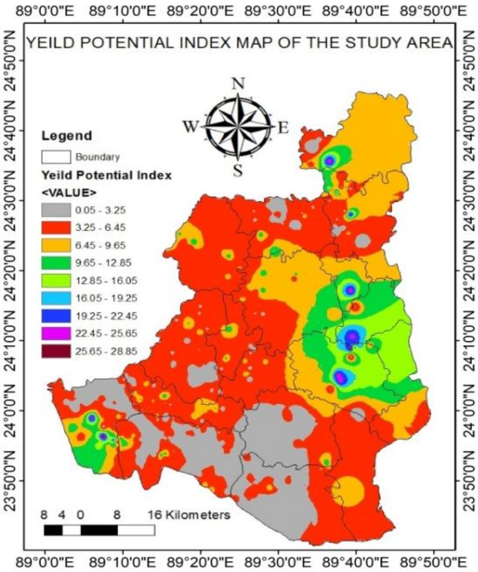

Figure 3: Distribution of yield potential index.

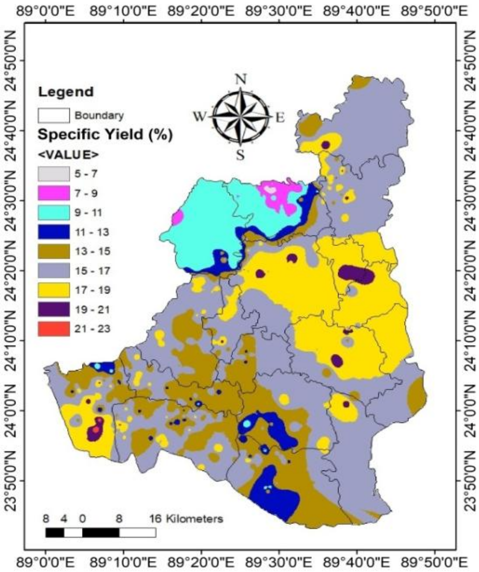

Figure 4: Distribution of specific yield**.**

The aquifer dominated high groundwater potential yield zone having values of 9.65-25.65 and above occupy around 15% region in the study area. The aquitard dominated zones (almost 80 % area) with yield potential index of 0.05-9.65 distributed across the study area indicate a bad potentiality. The higher groundwater potential zone of yield index of 9.65- 25.65 is distributed in the middle of the eastern side of the study area. From the map it is observed that the major portion of the study area having the values of 3.25-6.45 indicates the moderate yield index. This portion is found from the southeastern side to the middle-western side of the area investigated. There is another trend of lowest values of yield index which extends from the southern part to the western corner of the study area. This area indicates the lowest potentiality for groundwater abstraction. From the observation it is obvious that the upper part of the eastern side and a small region in the south-western corner have the satisfactory potential yield of the study area. These portions are favorable for selecting of well sites. This yield potential index map is widely used for selecting the location of well sites.

V. SPECIFIC YIELD

The term yield is applied to the maximum amount of water which can be obtained indefinitely from a well whereas production is the amount obtained from a limited time. The specific yield (S_y) is defined as the volume of water released by the downward movement of a unit distance. The portion that can be pumped out of a well and are that part of the water that would drain under the influence of gravity is measured by specific yield. Specific yield is also the storage capacity of a unit volume of material [2]. The specific yield of an aquifer is the ratio of the volume water which will drain freely from the material to the volume of the formation [5].

Specific yield is related to texture classes and within classes, depending upon the composition; the more sand in the sediments the higher the specific yield. The higher the clay content, lower the specific yield. The water bearing sand deposits of the study area has been encountered just below the upper clay layer. The specific yield of the study area has been estimated from the borehole and static water level data and a shaded contour map (Fig.4) of it has been prepared at an interval of 2%. From the contour map it is observed that the specific yield values change from 5% to 23%. The specific yield of 15% to 17% is found in the maximum portion of the study area. The specific yield values of 17% to 19% are observed in the middle-eastern side of the study area. There are some pockets of the range of 17% to 19% are identified in the south-western corner of the area. There is a trend of specific yield of 13%-15% which stars from the south-eastern side and ends to the western side of the area. A small portion having specific yield of 9% -11% is found in the north-western side of the area. Besides, there are some ranges of specific yield those are not evolved significantly. The analysis based on the lithology gives good estimates of specific yield and the overall values of specific yield of the study area is suitable and satisfactory for groundwater potentiality.

VI. TRANSMISSIVITY

Transmissivity is the product of mean aquifer thickness and mean aquifer permeability. Decreasing aquifer thickness will cause a decrease in transmissvity for the same type of sand and lowered mean permeability caused by train towards fine or poorly sorted sands will have the same effect. Steep gradients on the transmissivity map are generally a combination of both aquifer thickness and lithological changes. The coefficient of transmissivity (T) is the discharge through unit width of aquifer for the fully saturated depth under a unit hydraulic gradient and is usually expressed as m2/day. It is the product of permeability(K) and saturated thickness (b) of the aquifer.

$$T = K.b$$

The value of transmissivity depends on the type and thickness of the aquifer. It is usually evaluated from the pumping test [5].

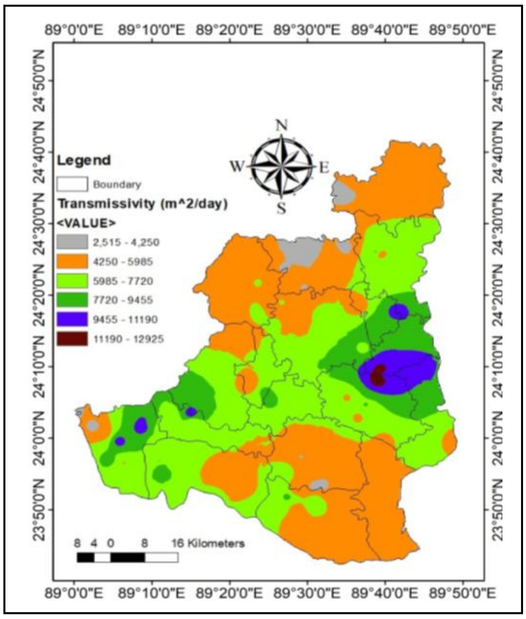

Figure 5: Distribution of transmissivity in the area.

The value of transmissivity in the study area has been estimated from the borehole information. In the present study, transmissivity of water in the saturated formation i.e., below the water table only has been taken into account considering the thickness of the layer of different grain size and the corresponding hydraulic conductivity in different layers have been calculated. Then the transmissivity of the geologic formation of the area have been estimated. The transmissivity value in the study area has been estimated and presented in the form of a shaded contour map at an interval of 1735m^2/day as shown in Fig.5. The figure illustrates a high contrast of tranmissivity over the area, which ranges from 2515m^2/day to 12925m^2/day. In most of the areas, the value of transmissivity covers 5985m^2/day to 7720m^2/day. From the contour map it is observed that the mid-eastern region of the study area have the highest value of transmissivity of 9455m^2/day to 12925m^2/day. The area having the transmissivity of 7720m^2/day to 9455 m^2/day is found around the highest value of transmissivity. Besides, there are some pockets of the highest value of transmissivity are also found in the area studied. The values of transmissivity show that the studied area is suitable for groundwater exploration.

VII. GROUNDWATER POTENTIAL ZONE

The principal aim of the interpretation of borehole data and the preparation of different aquifer properties maps are to provide input information to the groundwater potential map [6] of an area. Three distinct types of yield potential zone have been demarcated in the study area.

Groundwater potential map can be prepared from the geometric properties of aquifer. A thick layer of coarse sand represents higher potential and a thin layer of fine sand with slit represents low potential. Therefore, groundwater potential of an area depends on the aquifer thickness and aquifer composition material. The existence of groundwater does not mean that it can be exploited for bulk production. It is well known that groundwater head gradient plays an important role in exploration of groundwater. An area with high gradient of groundwater head means low conductivity and hence it is not suitable for bulk extraction. Therefore, suitable location for water-wells is the place, which is potential for groundwater and have low groundwater head gradient. A location is marked as suitable for water-wells if the location is potential for groundwater and has a good hydraulic permeability. A high gradient of groundwater head represents less permeability and a low gradient means high permeability.

Groundwater potential map has been prepared on the basis of specific yield, transmissivity and yield index values of subsurface formation of the study area as shown in Fig.6**.** Three zones are identified in the figure as high, medium and low potential. The low potential zone is found in the northwestern and the south-eastern portions of the study area. A medium potential profile is observed from the middle-eastern portion to the southeastern corner in the study area. The high potential profile is observed in the eastern side of the study area. But this type of potential zone does not cover a large area. Besides, some pockets of high potential region are also found in various parts of the study area in a scattered manner. In general, it could be said that the overall study area is favorable for groundwater exploration, but large scale abstraction of water should be avoided.

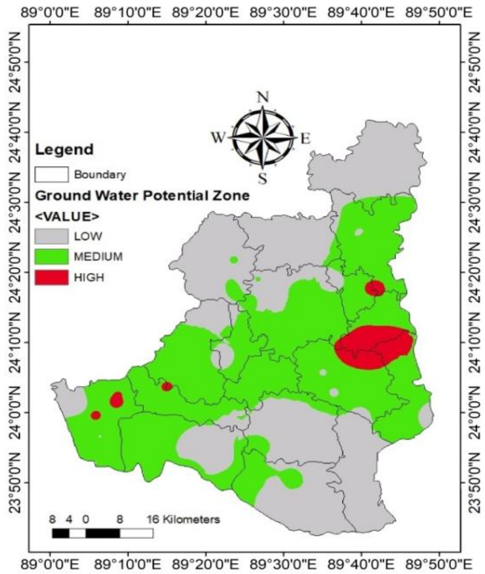

Figure 6: Distribution of groundwater potential zone.

VIII. CONCLUSION

Water is the most abundant substance on earth, the principal constituent of all living things, and a major force constantly shaping the surface of the earth. It is also a key factor in air-conditioning the earth for human existence and in influencing the progress of civilization. [7]. Lithological data have been analyzed to estimate the yield potential index, the specific yield and the transmissivity of subsurface formations of the study area and presented in the form of shaded contour maps. Finally, a map of groundwater potential zone of the study area has been prepared with the help of the combination of those parameters. From the analysis it is clearly observed that the values of various parameter stand within the recognized limits. The sandy layer formation is lying below the top clay layer and has varying thickness. No impermeable layer is found below the sandy formation in the study area. Basically, the area is unconfined in nature. The overall thickness of the composite sandy formation is suitable for groundwater potentiality. The potential zone map of the study area indicates the favorable condition for groundwater abstraction.

ACKNOWLEDGEMENT

The research work has been accomplished in the Geophysics Laboratory of the Department of Electrical and Electronic Engineering of Rajshahi University, Rajshahi, Bangladesh. The relevant organizations have given their full co-operation through supplying their valuable information. I am very much grateful to those institutions .The work has been conducted through the direct supervision of my guide who is appointed for my research work.

REFERENCES

[1]. C. Moumita, Ecological Systems and the Environment (Haque Publications, 38, Banglabazar, Dhaka-1100, 2007).
[2]. H.M. Raughunath, Ground Water (Wiley Eastern Limited, New Delhi, India, 1987).
[3]. M. Moniruzzaman, Water Resources Development in Bangladesh (Boipatra,38/4 Banglabazar,Dhaka-1100, 2003**)**.

[4]. F.H. Khan, Geology of Bangladesh (The University Press Limited, Dhaka, Bangladesh, 2001).
[5]. P. J. Reddi, A Textbook of Hydrology (Laxmi Publications (Pvt.) Ltd, New Delhi, India,1992).
[6]. J. Krishnamurthy, P. Manavalan and V. Salvasan, Application of digital enhancement techniques for groundwater exploration in a hard-rock terrain, International journal of Remote Sensing, 13(15), 1992, 2925-2942.
[7]. Ven Te Chaw, David R. Maidment, Larry W. Mays, Applied Hydrology (McGraw-Hill Book Company, New York, 1988).

Md. Saiful Islam, et. al. "Groundwater Potentiality Identification in the South-eastern Side of Rajshahi Division, Bangladesh." *IOSR Journal of Engineering (IOSRJEN),* 10(12), 2020, pp. 47-52.