A Study on Ground Water Fluctuation at Barind Area, Rajshahi

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ABSTRACT

Water is vital to life and development in all parts of world. The uncontrolled exploration of limited found water resource may cause environmental degradation. The groundwater crisis of the project area is highlighted now a day. Ground water condition of an area is mainly depending on geology, hydrologic parameter, soil properties, recharge & discharge and hydraulic characteristic of aquifer. An important component of water balance equation is ground water recharge, estimation of recharge volume is very important in forecasting ground water condition in present stage and its effect on future stage. The yearly variation of maximum and minimum groundwater level fluctuation and recharge is shown in graph. In which at Gopalpur mouza, the water level varies from 7.17 ft to 61.59 ft. Maximum level occurs 61.59 ft in year 2001 (March) and minimum level occur 7.17 ft in year 1995 (August) and 1996 (August). At Sontospur mouza of Paba upazilla available data for period 1995-2009 have been analyzed. The water level varies from 5.25 ft to 38.00 ft. Maximum level occurs 38.00 ft in year 2007 (April) and minimum level occur 5.25 ft in year 1996 (October). Most of the groundwater abstractions take place in the dry months starting from January and continues up to May also June in some dry season. The water table decline sharply and reaches to maximum depth in March/April/May. The water table starts moving upward and reaches to minimum depth from the land surface is September or October.

Keywords – Water table, Ground water, Fluctuation, Aquifer, Barind area.

I. INTRODUCTION

Water resources in any part of the world are subject to change due to meteorological and climatological impact all the year long. Impact of these factors on water resources has been extensively studied [1],[2],[3],[4]. Ground water, the rest portion of water during percolating into the soil and after meeting the necessary soil moisture deficiency, occurs at various locations below the earth's surface depending on the physical properties of various formations that exist. Such as aquifer, unconfined aquifer, confined aquifer aquiclude, aquitard, aquifuge etc. Groundwater fluctuations appear to be intimately related to spatial and temporal variations in evapotrans - piration and to the duration, magnitude, and timing of precipitation, especially in the wet meadow [5]. Ground water is widely distributed under the ground. It is the largest source of fresh water in the earth and unlike other mineral resources. The world's total water resources are at 1.37×10^8 million ha-m. Of these global water resources about 97.2% is saltwater mainly in oceans and only 2.8% is available as fresh water. Out of this 2.8%, about 2.2% is available as surface water and 0.6% as ground surface. Even out of this 2.2% of surface water, 2.15% is fresh water in glaciers and icecaps and only of the order 0.01% (1.36×10^4 ha-m) is available in lakes and reservoir and 0.0001% in streams; the remaining being in the forms 0.001% as water vapor in atmosphere 0.002% as soil moisture. Out of 0.6% of stored ground, only about 0.3% (41.1×10^4 million ha-m) can be economically extracted with the present drilling technology.

Ground water is widely distributed under the ground which is the largest source of fresh water in Bangladesh that is occurs in saturated zone of variable thickness and depth, below the earth surface. In Bangladesh most of the local or urban area, people, center and headquarter depends on the ground water.

Bangladesh is the land of river, a number of rivers crossed over it but the sources of surface water is not sufficient to requirement. Agriculture in Bangladesh is dependent on irrigation during the dry eight months from mid-October to mid-June when rainfall is minimum Groundwater supplies about 75% of dry season irrigation and almost all municipal water supplies. Ground water is the major source of water that is use for municipal water supply and irrigation purposes. The Barind area in Rajshahi zone North West of Bangladesh obviously depends on ground water for irrigation and other municipal water requirement.

Ground water condition of an area are mainly depends on abstraction, recharge, soil properties, hydrological characteristic of aquifer, storage capacity etc. However, MacDonald (1977) reported that permeability/ conductivity value range from 0.40×10^{-3} ft/s to 1.2×10^{-3}, transmissivity value is in the range of 0.1 ft^2/s to 0.17 ft^2 and specific yield ranges from 8% to 20% in the northwest part of Bangladesh. Again after that, MacDonald (1978) studied that that transmissivity values of the aquifer ranges from 1000 m^2/day to 2000 m^2 /day but it less than 1000 m^2/day in Paba upazilla and average storage coefficient value was estimated 0.01. Annual potential recharge was estimated varying from about 600 mm to 800 mm but actual recharge would be less by 20% to 30% of the potential recharge. It is very important increase of ground water for agricultural, municipal and industrial needs. The increase of ground water can be achieved by infiltration of rainfall, recharge by seepage, surface flow etc.

With the increasing use of ground water for agricultural, municipal, industrial needs, the annual extraction of groundwater are far in excess of net average recharge from natural sources. Consequently ground water is being withdrawn from storage and water levels are declining resulting in crop failure adverse salt balance, sea waters intrusion in costal aquifers and subsidence in areas where draft esulting compaction of sediment. Even in high rainfall areas of the state, water scarcity is experienced in summer months [6]. Hard rocks derive its status as an aquifer on the basis of secondary porosity that gets developed due to decomposive and weathering processes over a period of time [7],[8]. Consequently, groundwater occurs largely in the secondary porosity of weathered mantle limited to a shallow depth [9].

In order to maintain ground water supplies indefinitely the hydrological equilibrium must exist between all water entering and leaving the basin. The management of ground water is essential to obtain desired economic benefits. Maximum economic and beneficial use can be obtained by coordinating ground water and surface water resource. The proper management of ground water resources requires an adequate knowledge of the extent of the storage, the rate of discharge, the rate of recharge to ground water body and the use of economical of extraction. Sometimes it may be necessary to apply the artificial recharging to the reservoir so that it many supplements the natural recharge. Groundwater is stored in the ground in materials like gravel or sand. It's kind of like the earth is a big sponge holding all that water. Water can also move through rock formations like sandstone or through cracks in rocks.

II. STUDY AREA

The Barind Integrated Area Development Project (BIADP) is located in the Barind tract situated in the northern portion of Bangladesh. The part of greater Rajshahi, Nawabgonj, Dinajpur, Rangpur, Jaipurhat, Gaibanda and Bogra district of Bangladesh and the lndian territorial Maldah district of West Bengal is geographically identified as Barind tract. Paba is one of thana of Rajshahi district which is situated north side. The hard red soil of this area is varying significant in comparison with respect to the other part of the country. The Rajshahi Barind tract is located in between $24^{0}23'$ to $25^{0}15'$N latitude and $88^{0}2'$ to $88^{0}57'$E longitude. Map of the study area in Barind tract is shown in **Fig. 1**.

Paba is one of the thana of Rajshahi district. Paba thana, now an upazilla was established in 1971. It consists of 9 union parishad, 195 mouzas and 261 villages. Its total area of this thana is 161.85 square kilometers. Paba is bounded by Mohanpur and Tanore upazilla on the north, West Bengal of India and Charghat upazilla on the south, Puthia and Durgapur (Rajshahi) upazilla on the east, Godagari upazilla on the west is shown in **Fig. 2**.

Fig. 1 Map of the study area in Barind Track

Fig.2 Map of Paba Upazilla

III. ENVIRONMENTAL IMPACT DUE TO GROUND

Due to rapid lowering of static water level, several problems may be arised. The natural supply of ground water is usually limited with regard to time and place. In recent years, the use of this limited supply has grown enormously. Due to this excessive stress upon the ground water resource, the yield capacity is being reduced and the need to conserve them is now generally recognized. It is clear to require for sound development wise use and protection of this resource.

The investigated area is a semi-arid zone which is situated in the North-Western Part of Bangladesh where ground water is the only source of fresh water. Although it is not an easy task to provide a quantitative assessment of ground water reservoirs with reference to their potentialities and limitations for development, an attempt has been made to evaluate the ground water potentialities of the study area with available data. Furthermore it is seen that the water table also at higher elevation which gave rise to ground water divide.

IV. SOIL FORMATION

The Barind tract is nearly level over most of the extent, but is hilly and dissent by narrow vallents (bodes) in the west. Major soils are mixed yellowish brown and grayishloam to clay loam. The total cultivated area being 1.44 million acres, out of which 34% is loamy, 10% sandy, 49% clayey, and 7% others.

V. TOPOGRAPHY

The landscape comprises mainly in the Eastern part, dissected and undulating in western part. Dissection and valley occur both at short and long distances. In the dissected areas top to the landscapes, that is the summits are level, the slopes and valley sides are terraced locally rounded dome shaped summit occurs due to closer dissection. The land is classified as follows: High land (H.L): Land above normal flood level. Medium high land (M.H.L): Land flooded up to a depth of 7.62 cm during monsoon season but water level in the fields in normally 15.24 or less by the end of August. Medium Land (M.L): Land flooded from 0.92 m - 1.83 m depth during the monsoon season. Low land (L.L): Land flooded above 1.83 m depth during the monsoon season.

VI. CLIMATE

There are two main season, separated by transition season. The monsoon season lasts from May/June until September and shows the typical monsoon characteristic of heavy rain and high humidity. The dry season from November to February is sunny and relatively cool, with only occasional scattered. The climate of the project area is more and less the average for the country as a whole characterized by the two distinct seasons– the wet season from June to September and the dry season during rest of the year.

The average temperature of the project area varies between 8^0C to 44^0C. January and February are the coolest month, when temperature falls below 8^0C. Summer starts abruptly in March and is characterized by a hot north westerly wind and a rapid increase in mean daily relative humidity from 60% to 85%. Temperature as high as 43^0C is experienced for some time during summer season. The monthly distribution of rainfall in the project follows the usual pattern of monsoon with heavy rains starting in May and ending in September and very little of no rainfall during the rest of the year. Rainfall area varies from about 1500 to 2000 mm.

VII. SPECIFIC YIELD

The volume of water, expressed as percentage of the total volume of the saturated aquifer, that can be drained by gravity is called the specific yield. The specific yield of an aquifer is the ratio of the volume of water which will drain freely from the material to the volume of formation.

VIII. RESULT AND DISCUSSION

In the study area most of the groundwater abstractions take place in the dry months starting from January and continues up to May also June in some dry season. During this period the recharge is almost nil, the rate of evaporation and evapotranspiration is high and most of the river flow is derived from groundwater reservoir as base flow. As a result of all these natural and artificial withdrawal, the water table decline sharply and reaches to maximum depth in March/April/May. Rain starts in the pre-monsoon period and at the same time begins to recharge to the underground storage. The major artificial abstraction of ground water is also stopped by this time and high relative humidity in the atmospheric reduces the rate of evaporation and evapotranspiration. All these cause a gradual increase in ground water reservoir which is reflected by the change of the water table. The water table starts moving upward and reaches to minimum depth from the land surface is September or October.

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The fluctuation of ground water level (monthwise) for the two unions (Naohata, Haripur) of Paba.

Fluctuation of ground water level is different in magnitude depending on the extraction and recharge for different location. For this study groundwater level of Barind area of Rajshahi have been analyzed. All available data of Paba of Barind area of Rajshahi have been considered for preparing hydrographs. Ground water level fluctuation of different region of different year is shown in figure 4.3.1 to 4.3.30.

At Gopalpur mouza union of Paba upazilla available data for or period 1994-2008 have been analyzed. The water level varies from 7.17 ft to 61.59 ft. Maximum level occur 61.59 ft in year 2001 (March) and minimum level occurs 7.17 ft in year 1995 (August) and 1996 (August). At Sontospur mouza of Paba upazilla available data for period 1995-2009 have been analyzed. The water level varies from 5.25 ft to 38.00 ft. Maximum level occur 38.00 ft in year 2007 (April) and minimum level occur 5.25 ft in year 1996 (October).

From the study ground water recharge is maximum 6 ft during 1994 to 1996 and minimum 1.6 ft during 2008 at Gopalpur and ground water recharge is maximum 3.8 ft during 2007 and minimum 1.4 ft during 2003 at Sontospur. The results of this study have been intended to illustrate the effect of deep tube wells on groundwater table in the Barind tract Paba.

A declined water table is a characteristic of the region that has used its water resources not wisely and is taking more from its groundwater reservoir than is replenished naturally.

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TABLE 1

ESTIMATION OF GROUND WATER LEVEL FLUCTUATION AT GOPALPUR

Year	Maximum water level (ft)		Minimum water level (ft)		Variation of water level (ft)	
	first test	Second test	first test	Second test	first test	Second test
1994	53.08	53.67	14.67	18.00	38.41	35.67
1995	52.25	52.75	9.33	7.17	42.92	45.58
1996	52.25	52.75	9.33	7.17	42.92	45.58
1997	51.59	51.25	20.50	20.33	31.09	30.92
1998	47.59	48.00	17.17	15.00	30.42	33.00
1999	57.33	56.59	18.33	20.50	39.00	36.09
2000	45.59	52.50	23.00	19.50	22.59	33.00
2001	60.00	61.59	23.00	21.33	37.00	40.26
2002	53.08	53.67	14.67	18.00	38.41	35.67
2003	36.92	38.08	21.42	21.33	15.50	16.75
2004	55.25	55.42	36.00	35.42	19.25	20.00
2005	38.00	38.17	20.00	20.08	18.00	18.09
2006	33.42	34.84	18.50	18.50	14.92	16.34
2007	40.00	39.50	17.17	16.75	22.83	22.75
2008	41.08	40.00	26.25	29.75	14.83	10.25

TABLE 2

ESTIMATION OF GROUND WATER LEVEL FLUCTUATION AT SONTOSPUR

Year	Maximum water level (ft)		Minimum water level (ft)		Variation of water level (ft)	
	first test	Second test	first test	Second test	first test	Second test
1995	30.42	31.17	6.50	6.33	23.92	24.84
1996	26.08	26.25	5.33	5.25	20.75	21.00
1997	23.08	23.00	8.42	8.92	14.66	14.08
1998	28.33	29.08	12.59	12.00	15.74	17.08
1999	32.42	32.00	6.17	7.42	26.25	24.58
2000	27.33	29.17	9.50	7.42	17.83	21.75
2001	31.59	33.67	10.25	11.42	21.34	22.25
2002	33.50	33.33	11.50	11.50	22.00	21.83
2003	21.67	22.08	12.17	11.50	9.50	10.58
2004	31.50	33.33	19.00	19.42	12.50	13.91
2005	28.50	30.17	18.25	18.84	10.25	11.33
2006	29.33	31.67	18.50	18.50	10.83	13.17
2007	36.00	38.00	9.00	8.17	27.00	29.83
2008	33.92	34.84	9.17	10.00	24.75	24.84
2009	32.33	33.67	16.17	14.50	16.16	19.17

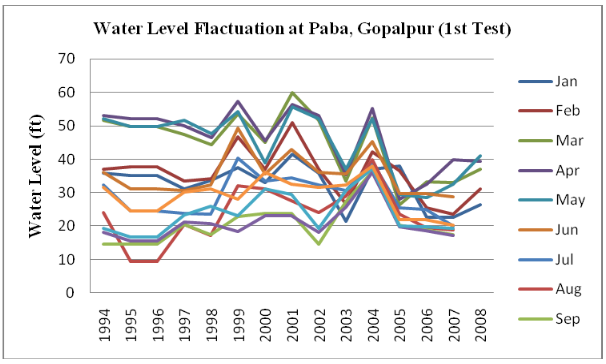
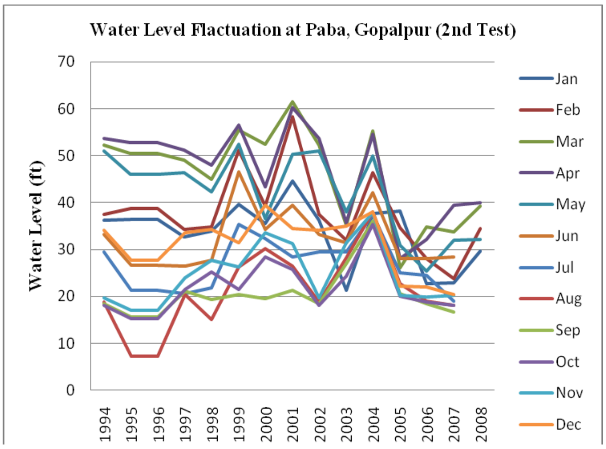


Fig. 3 Water Level Flactuation at Paba, Golappur (1st Test)



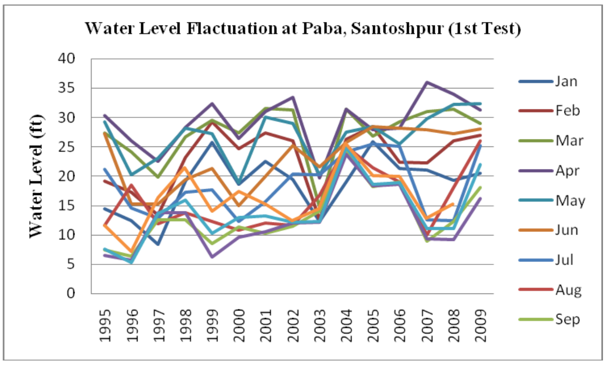


Fig. 5 Water Level Flactuation at Paba, Santoshpur (1st Test)

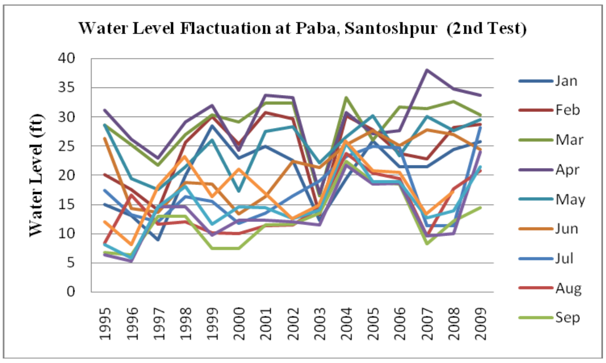


Fig. 6 Water Level Flactuation at Paba, Santoshpur (2nd Test)

IX. CONCLUSION

Ground water level shows a seasonal pattern of fluctuation. The magnitude of fluctuation depends upon the qualities of water recharge and discharge. The ground water level in Barind area rise and falls continuously with the advance of wet and dry season. Analysis the records of ground water level in observation well of Paba have indicated the level rises to its peak in the month of August to September even to October in some place. During October, November and December when the intensity of rainfall decreases ground water level starts depleting rapidly. At that time water level remain much higher than of stream level. The ground water table at that time remains only a few below or nearly the ground surface.

In the Barind area it is seen that the amount of ground water extraction is caused by irrigation. The amount of extraction is increased day by day. Due to increase of population need to increase production of crops to meet the desire demand. Irrigation is a parameter to increase production of crops. So the amount of extraction of ground water is increase.

There is no rainfall occur equally all the month in a year of our country. In the Barind area rainfall is so little. But that are only rainy season. In the Barind area soil is normally hard clay or clay type which is less permeable to infiltration. As a result a little amount of rain water is infiltrated into the ground.

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