

INTERACTION BETWEEN GROUNDWATER AND RIVER WATER ADJACENT TO THE MEGHNA BRIDGE

Bala S. K.*, Hoque M. M., Ahmed S. M. U. and Haque A.

Institute of Flood Control & Drainage Research, BUET, Dhaka-1000

Abstract To investigate the behaviour of groundwater level and its relation with the Meghna river water level close to bank in the vicinity of the Meghna Bridge was studied. Three groundwater observation wells were installed in a line perpendicular to the direction of the river flow near the Meghna Bridge, where bank erosion was severe. Accordingly, three groundwater wells were installed near Baidder Bazar, where also severe bank erosion exists. An analysis of the primary data, collected from the wells to see the dependency of the groundwater on the Meghna river water level has been performed. The analysis shows that during the dry period, the groundwater level remains higher than that of the river water level. In the rainy season, the opposite is occurred. There is a high degree of correlation between groundwater and river water. In the study area, r^2 varies from 0.724 to 0.937. The correlation also shows that the groundwater level is more strongly affected by the river water during recession period that may serve a cause of bank destabilization resulting in bank erosion.

Keywords: Behaviour, correlation, erosion

INTRODUCTION

There is an inherent correlation between groundwater table and river water level. Both of them are interdependent. The high stage in the river gives recharge in groundwater level from the river part, while the low flow in the river is nothing but the base flow from the part of groundwater. It was felt that interaction of groundwater and river water during rising and falling stage of a flood event play a role in bank instability that contributes to the bank erosion process. So to investigate the groundwater and river water level interactive correlation, two severe erosion prone areas – one at the Meghna Bridge Site and other at Baidder Bazar were selected for carrying out the research studies. The study area includes 1 km downstream of the Meghna Bridge to 12 km upstream of the Upper Meghna River (Fig. 1). The results of the study are presented in the paper.

INSTALLATION OF GROUNDWATER WELLS

In order to investigate the behaviour of groundwater and its relations with the Meghna water levels, seven groundwater observation wells were installed near the river banks during the Japan Bangladesh Joint Study Project, Phase-I (Hoque et al., 1997). Wells P1, P2 and P3 were installed in a line perpendicular to the direction of the river flow near the Meghna Bridge, where erosion was severe. Accordingly, groundwater wells PB1, PB2

and PB3 were installed near Baidder Bazar. The seventh well, which has been eroded away, was installed at right bank near a staff gauge (R4). The depth of each well is about 30m. A typical schematic diagram of the position, location and layout of the wells is shown in Fig. 2.

PRESENT SITUATION OF THE WELLS

The present status of the installed wells has been changed. Substantial construction works have been accomplished near the Meghna Bridge after the installation of the wells. As a result, most of the wells have been affected. The construction of newly Concord Industrial Complex damaged the well P1. The basement of well P2 was partly damaged due to washing out of soil underneath the basement by heavy rainfall and was repaired. Similarly, the well PB1 was not responding to the electronic water level checker. The well PB1 is also threatened by bank erosion. The well near R4 has been also damaged due to severe bank erosion at staff gauge R4. The old electronic water level checker was not also functioning well.

METHODOLOGY AND DATA COLLECTION

The groundwater level was measured with the help of electronic water level checker from top of the wells after removing their caps. The elevations of top of wells are leveled with nearby B. M. values of PWD so that groundwater levels can be correlated with the Meghna water levels. The elevations of top of the wells are shown in Table 1.

*Email:bala@ifcdr.buet.edu

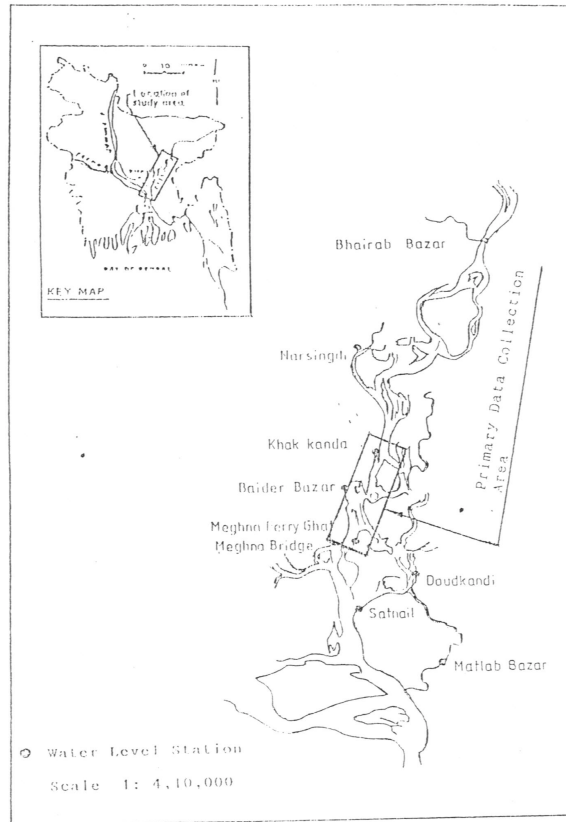


Fig. 1 Study area around Meghna Bridge Site

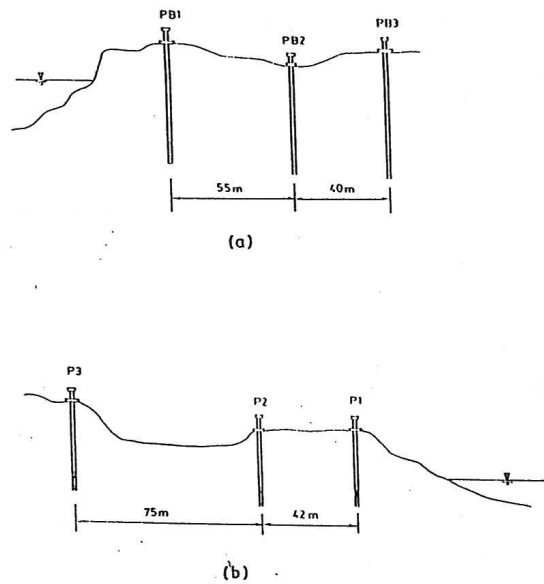


Fig. 2 A schematic diagram of layout and location of the wells a) Baider Bazar, b) Meghna Bridge Site

Weekly groundwater levels were measured in the wells for 8 weeks. The first set of data was collected on 19th April 1998. Additionally, 3 sets of continuous groundwater level data measured at 1hour interval for 12 hours were collected from the wells. Simultaneous river water levels were measured at the staff gauges and the automatic water level gauges.

DATA ANALYSIS AND DISCUSSION

In order to analyze the tidal influence upon groundwater level, the continuous groundwater level data of the wells P2 and P3 for the dry period in April 1999 are plotted with simultaneous river water level at Meghna Bridge Site in Fig. 3. Simple plotting has been made for the wells P1, P2 and P3 for June 1998, which are shown in Fig. 4. These figures show that there is a time lag between the peaks of the river water level and groundwater level. This difference of time is the time required for groundwater to respond to the tidal fluctuation of the river water level.

Table 1B: M. values at top of groundwater wells

Serial No.	Name of the wells	Elevation (m PWD)	Remarks
1	P1	5.377	Damaged
2	P2	5.048	
3	P3	6.05	
4	PB1	5.192	
5	PB2	5.055	
6	PB3	5.51	

It is also seen from the Fig. 3 that during dry period in the month of April the groundwater level remains higher than that of river water level, which means that the river water is fed by base flow of groundwater. Similarly, it is seen from the Fig. 4 that during rainy season in the month of June, the river water level remains higher than that of groundwater level, which means that the groundwater level is fed by river water. The monthly variation of groundwater levels of wells P2 and P3 at Meghna Bridge Site and PB1, PB2 and PB3 at Baiddar Bazar for July 1999 are plotted in Fig. 5. It is seen from the figure that groundwater level variation follows a definite trend, which is influenced by spring and neap tides of the Meghna.

In order to find out the correlation between the groundwater levels and the river water levels, corresponding data at Meghna Bridge Site are plotted in Fig. 6 and 7. It is seen that the correlation curves form an anti-clockwise loop and rising limb is lower than the falling limb. This is because groundwater responses later after the rising of the river water and response of groundwater during rising period is slower than that during falling stage. The falling stage of river water influences the groundwater quickly, which may be seen from the slope of the curve. Moreover, the influence of river water upon groundwater well nearer to the river is

more dominant, as the loop of well P2 is steeper than the P3. As the groundwater well P2 is closer to the river, the curve is more affected by the river and has a steep loop, while P3 has a flatter curve, which means the groundwater is less affected by river water. The correlation between groundwater level and river water level is strong enough. The correlation coefficient shows that during falling period correlation is stronger than rising period. This again supports that the groundwater level is more strongly affected by river water during recession of water. The values of ‘r’ are shown in Table 2. The regression analysis of correlation of river water level and groundwater level of well P1, P2 and P3 also shows the high degree of correlation. For the well P1, correlation between river water level and groundwater level for rising and falling stage may be expressed by following relations 1 and 2 respectively:

$$Y_{IR} = 1.0049 * X_1 - 0.323 \quad (r^2 = 0.724) \quad (1)$$

$$Y_{IF} = 1.529 * X_1 - 1.503 \quad (r^2 = 0.894) \quad (2)$$

Similarly, for the well P2, correlation between river water level and groundwater level for rising and falling stage may be expressed by following relations 3 and 4 respectively:

$$Y_{2R} = 1.082 * X_2 - 0.528 \quad (r^2 = 0.788) \quad (3)$$

$$Y_{2F} = 1.378 * X_2 - 1.171 \quad (r^2 = 0.916) \quad (4)$$

Table 2 Correlation coefficients etweengroundwater level and river water level

Name Of the wells	P2	P3	P1	P2	P3
Coefficient of correlation	r	r	r	r	r
Rising	0.712	0.391	0.851	0.887	0.968
Falling	0.952	0.941	0.945	0.957	0.917

Accordingly, for the well P3, correlation between river water level and groundwater level for rising and falling stage may be expressed by following relations 5 and 6 respectively:

$$Y_{3R} = 0.911 * X_3 - 0.528 \quad (r^2 = 0.937) \quad (5)$$

$$Y_{3F} = 1.064 * X_3 - 0.460 \quad (r^2 = 0.842) \quad (6)$$

Without considering rising and falling stages, the correlation is expressed between river water level and groundwater level for the wells P1, P2 and P3 by the following equations respectively:

$$Y = 1.154 * X - 0.649 \quad (7)$$

$$Y = 1.161 * X - 0.685 \quad (8)$$

$$Y = 0.981 * X - 0.284 \quad (9)$$

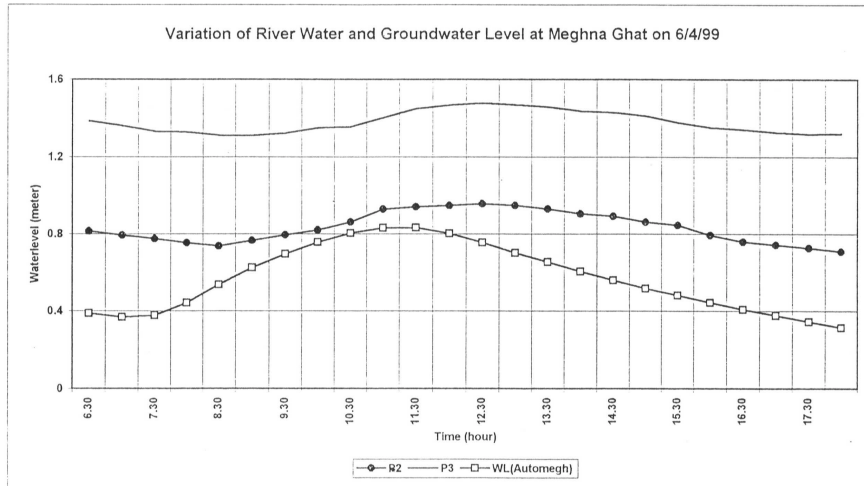


Fig. 3 Variation of river water level and groundwater level at Meghna Bridge site (Date: 06/04/1999)

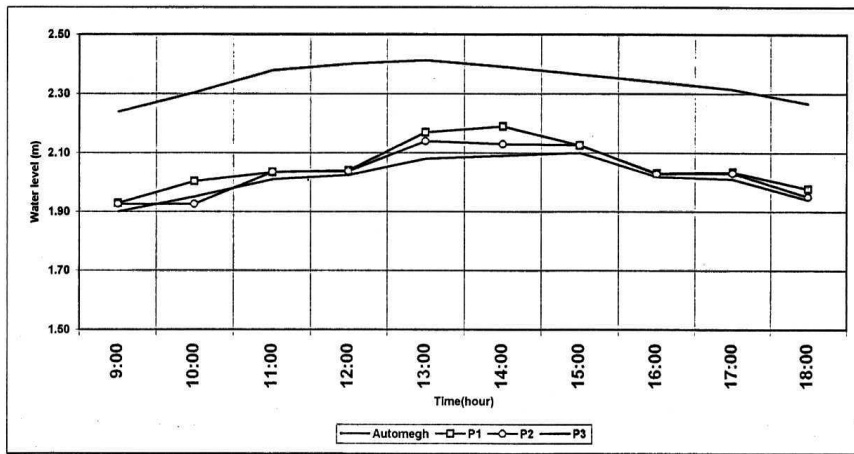


Fig. 4 Variation of river water level and groundwater level at Meghna Bridge site (Date: 19/06/1998)

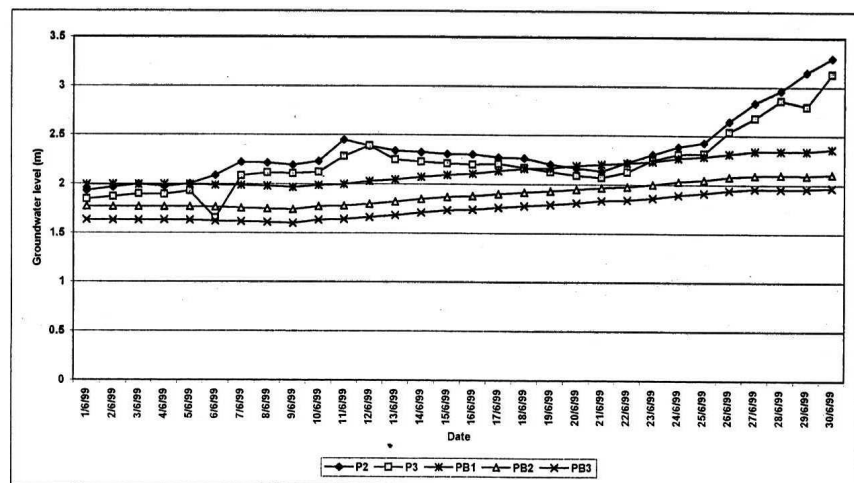


Fig. 5 Variation of groundwater level at Meghna Bridge site and Baidder Bazar in July 1999

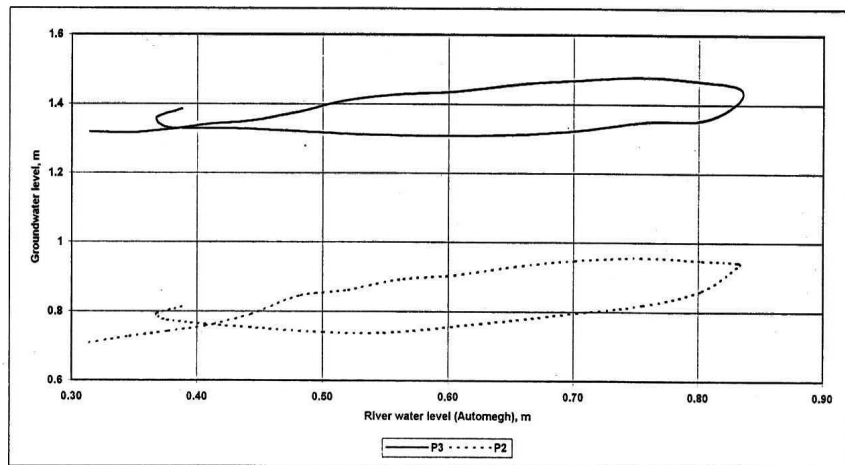


Fig. 6 Correlation between river water level and groundwater level at Meghna Bridge site (Date: 06/04/1999)

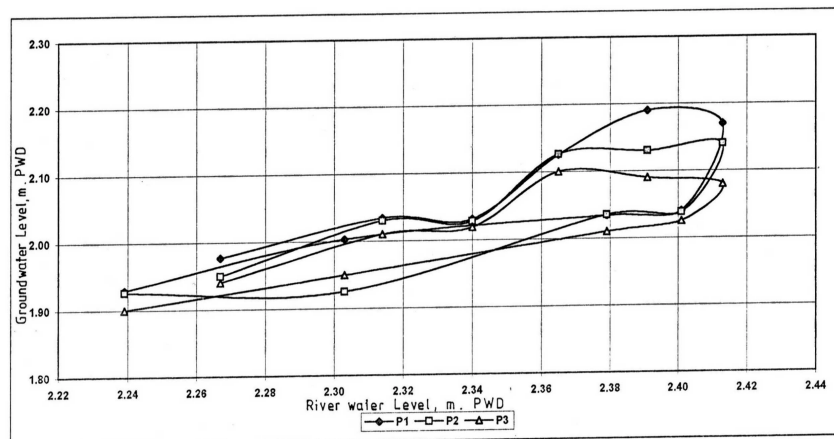


Fig. 7 Correlation between river water level and groundwater level at Meghna Bridge site (Date: 19/06/1998)

In the above equations from (1) to (9), Y stands for groundwater level and X stands for river water level in meter.

level is more strongly affected by the river water during recession period that may serve a cause of bank destabilization resulting in bank erosion.

CONCLUSION

Based on the study, the following conclusions are made:

- i. An analysis of the primary data collected from the groundwater wells with the Meghna water level has been performed. The analysis shows that during the dry period, the groundwater level remains higher than that of river water level. In the rainy season, the opposite is occurred.
- ii. There is a high degree of correlation between groundwater and river water. In the study area, r^2 varies from 0.724 to 0.937.
- iii. The correlation also shows that the groundwater

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