ZIBELINE INTERNATIONAL PUBLISHING

Journal of Water Resources (JWR)

DOI: *http://doi.org/10.7508/jwr.02.2019.01.04*

ISSN: 2327-7262 (Print)
ISSN: 2327-7688 (Online)
CODEN : JWROB9

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MAR TECHNOLOGY IMPROVES THE DOWNWARD TREND OF GROUNDWATER LEVEL IN BARIND DISTRICT IN NORTHWESTERN BANGLADESH

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ARTICLE DETAILS

Article History:

Received 19 October 2019
Accepted 13 November 2019
Available online 16 December 2019

ABSTRACT

Permanent decline of groundwater table was observed in some area due to over extraction of groundwater and least natural recharge. Management of groundwater is needed for sustainable use of water for irrigation, drinking and other purposes. The paper aims to assess the trend of rainfall and groundwater level and recommend the groundwater level management option. Rainfall and Groundwater level data have been collected from the Barind Multipurpose Development Authority (BMDA). The data are checked for quality and consistency and then processed in the required format. After checking and analyzing the data, hydrographs are drawn and found the trend. Results show that annual average rainfall is lower than the country average; gradual decreasing trend in groundwater level; MAR technique increases the GWL reducing the declining trend. Though BMDA has taken so many initiatives to reduce the stress on groundwater through surface water augmentation and devising efficient irrigation management system, groundwater table is going down day by day due to the excessive exploitation of groundwater. MAR technique is a suitable option to reverse the declining trend of groundwater level. So, research and study are necessary to design and modify MAR structure for sustainable management of groundwater table in Barind area.

KEYWORDS

Groundwater, water management, MAR, groundwater level, rainfall.

1. INTRODUCTION

Water is a precious natural resource. Groundwater is the most essential and valuable resource for agriculture, domestic and industrial purposes. It is an integral part of the water cycle. The cycle starts with precipitation falling on the surface. Runoff from precipitation goes directly into lakes and streams. Some of the water which seeps into the ground is used by plants for transpiration. The remaining water drains down through the soil to the saturated zone, where water fills all the spaces between soil particles and rocks, called groundwater. Groundwater is the subsurface water that occurs beneath the water table in the soils and geologic formations that are fully saturated. Safe groundwater abstraction and proper groundwater management are important for sustainability of the resources[1]. A recent study shows that groundwater level in some areas falls between 5 m-10 m in dry season and most of the tube wells fail to lift sufficient water. Researchers and policymakers are advocating sustainable development as the best approach to today's and future water problems. With groundwater development, fluctuations will amplify; but as long as rainfall is managed to recharge aquifers, and proactive water saving strategies are put in place, a steady and sustainable state can be achieved. In mainstream irrigation thinking, groundwater recharge is considered as a by-product of flow irrigation, but in today's world, groundwater recharge needs to be understood on its first emergency for making groundwater sustainable integrating all possible options[2]. Various places around the world are currently or potentially experiencing the problem of water shortage due to rapid population growth, water contamination, groundwater exhaustion, and unbalanced allocation of water resources caused by geographical and seasonal variations. Different studies have documented that groundwater level declined substantially during the last decade causing a threat to the sustainability of water use for irrigation in this region and impacting upon other sectors, too. Due to lack of proper knowledge, indiscriminate installation of pumps and non-availability of modern technologies, farmers lift water without thinking future use which causes the declining of groundwater table alarmingly in many areas of Bangladesh. Although the groundwater dominates the total irrigated area, its sustainability is at risk in terms of quantity in the northwest region[3]. Frequent shortage of water in the region has had impacts that can be ranged as economic, social and environmental. Groundwater plays an important role in sustaining Bangladesh's economy, environment, and standard of living. The benefits of utilizing groundwater in developing countries have been clearly demonstrated; aquifers providing a store of groundwater, which, if are utilized and managed effectively, can play a vital role in increased yield resulting reliable irrigation. Presently groundwater-based irrigation is adapted to cultivate high-yielding rice variety during dry season in South Asia especially in Bangladesh-the fourth biggest rice-producing country in the world. Here agriculture contributes nearly 15% of the GDP as rice crops cover 75% of the cropped areas and contribute over 95% to the total food grain production[4]. The significant growth in the country's irrigated agriculture has happened in the past decade which resulted ever increasing demand of finally leads to water shortage. Like other natural calamities and disasters such as floods or cyclones in coastal and most part of the country. its northwestern part is affected more severely by drought when monsoon ends.

Barind Tract is a physiographic unit located in north-western part of Bangladesh having gross area of 7727 km^2. The elevations vary from 47 m in its central part to 11 m in the southeast and 9 m in the northeast. Barind is a drought prone water stressed area. Surface water sources are very limited here. Most of the rivers, pond and other water bodies get dried up during dry season in this area. So, groundwater is the main source which is used for irrigation, drinking and other purposes[5]. A Typical dry climate with comparatively high temperature prevails in Barind area except for the wet season beginning from mid-June to October and temperature ranges from 4°C to 44°C. Annual rainfall is very less and varies from 1250 mm to 2000 mm and the average annual rainfall is 1418 mm. Groundwater recharging in Bangladesh mainly occurs by monsoon rainfall and flooding but it is a severely drought prone area as well as the area is under flood free zone. More than 15,000 Deep Tube wells (DTWs) have installed to withdraw groundwater for irrigation. with a total number of nearly 23,000 including private owners for drinking and irrigation purposes and this excessive withdrawal of groundwater causes the declining of groundwater table and put threat on its resource sustainability[6].

Permanent decline of groundwater table was observed in some area due to over extraction of groundwater and least natural recharge. Management of groundwater is needed for sustainable use of water for irrigation, drinking and other purposes[7]. So, the present study aims to assess the trend of rainfall and groundwater level and recommend the groundwater level management option.

2. STUDY AREA

The study area is mainly Barind located at Godagari and Mohonpur Upazila under Rajshahi District and Niamatpur Upazila under Naogaon district (Upazila and district are the second and third tiers of administrative units in Bangladesh). Topography of the area varies from 10.5 m PWD to 44.3 m PWD[8]. The landscape comprises mainly plain in the eastern part, dissected and undulating in the western part. Middle part of the study area is relatively high and uneven. Most of the area is flood free making it suitable for the year-round cultivation. The location map of the study area is shown in Figure 1.

Figure 1: Location map of the study area.

3. DATA AND METHOD

Rainfall and Groundwater level data have been collected from the Barind Multipurpose Development Authority (BMDA). The data are checked for quality and consistency and then processed in the required format. After checking and analyzing the data, hydrographs are drawn and found the trend.

4. OBSERVATIONS

4.1 Rainfall

Rainfall data are collected from permanent rain gauge stations of Godagari, Niamatpur and Mohonpur Upazila office of BMDA for the period of 2002 to 2015. The annual rainfall and the monthly average rainfall are shown in Figure 2 and Figure 3. Figure 2 shows that maximum annual rainfall of Godagari Upazila is 2452 mm and the minimum annual rainfall is 848 mm and yearly average rainfall is 1240 mm[9]. For Niamatpur Upazila maximum and minimum annual rainfall are 2295.00 mm and 886 mm respectively and yearly average rainfall is 1298 mm. Maximum and minimum annual rainfalls for Mohonpur Upazila are 1400 mm and 773 mm and yearly average rainfall is 1088 mm. Figure 3 shows that monthly average maximum rainfall for those three Upazila is 248 mm, 269 mm and 217 mm respectively. Decreasing trend in rainfall is observed for both the Godagari and Mohonpur Upazila whereas increasing trend in rainfall is observed for Niamatpur Upazila. If average annual rainfall of these three Upazila is seen (Figure 4), mild increasing trend is observed for the study area. Overall average annual rainfall of the study area is about 1209 mm which is less than the annual average (2500 mm) of the country.

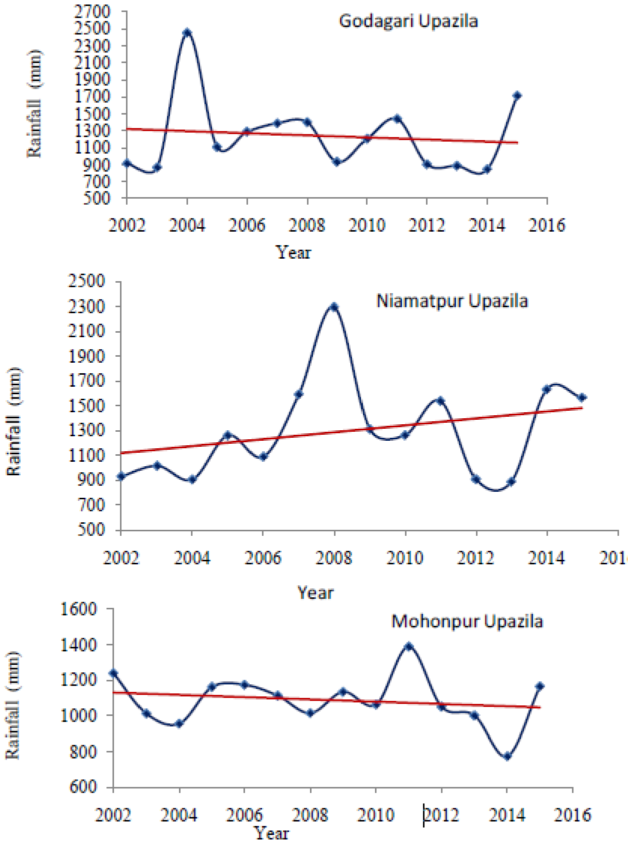

Figure 2: Annual rainfall status of the study area.

4.2 Groundwater Level

Groundwater level fluctuation data are collected from the observation wells (OW) of BMDA Godagari, Niamatpur and Mohonpur Zonal office. For Godagari and Mohonpur Upazila data were available for the period of 1995 to 2015 but for Niamatpur Upazila, data were available for the period of 2005 to 2015[10]. Data are analyzed and presented as the hydrograph. Groundwater depth hydrographs of the entire three Upazilas are shown in Figure 5.

Gradual declining trend in GWL is observed (Figure 5) for all the three Upazilas. Figure 5 shows GWL decreased by about 8 m and 7 m in 21 years for Godagari and Mohonpur Upazila respectively. For Niamatpur Upazila GWL decreased by about 2.4 m in 11 years.

4.3 Groundwater Level Management

1) Recharge Well as Managed Aquifer Recharged (MAR) technique

In 2013 a Recharge Well (RW) was installed at the bed of re-excavated Sarmangla canal under Godagari Upazila and modified for continuous operation in 2016 and observed the trend of GWL. Water level fluctuation data for the RW are collected and analyzed. The groundwater level hydrograph is shown in Figure 6.

Figure 6 shows that after submergence of the RW and due to recharge of groundwater, GWL level rises and gradual increase in GWL is observed. So, MAR technique as groundwater management option is suitable to reverse the declining trend of groundwater level.

2) Surface water augmentation and efficient irrigation management to reduce the stress on groundwater

Re-excavation of derelict pond, canal and other water bodies for surface water augmentation as well as rainwater conservation has reduced the pressure on withdrawing groundwater for irrigation and introduction of buried pipe irrigation and prepaid meter irrigation system has reduced the irrigation water loss.

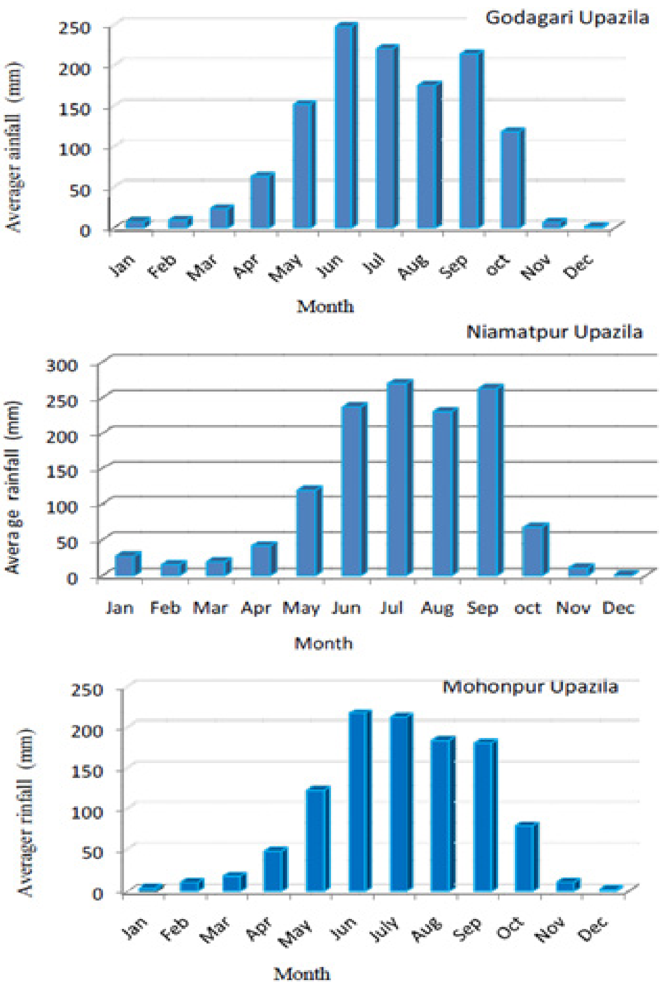

Figure 3: Monthly average rainfall status of the study area.

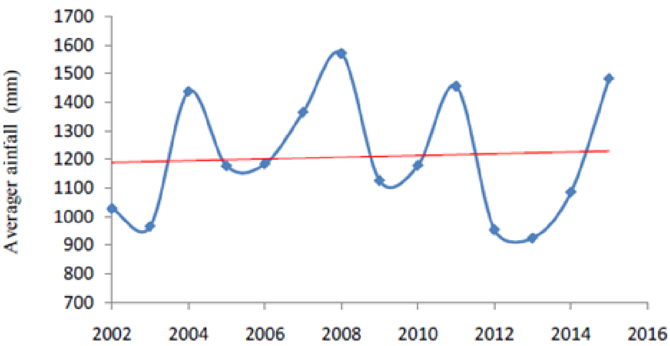

Figure 4: Annual average rainfall trend of the study area.

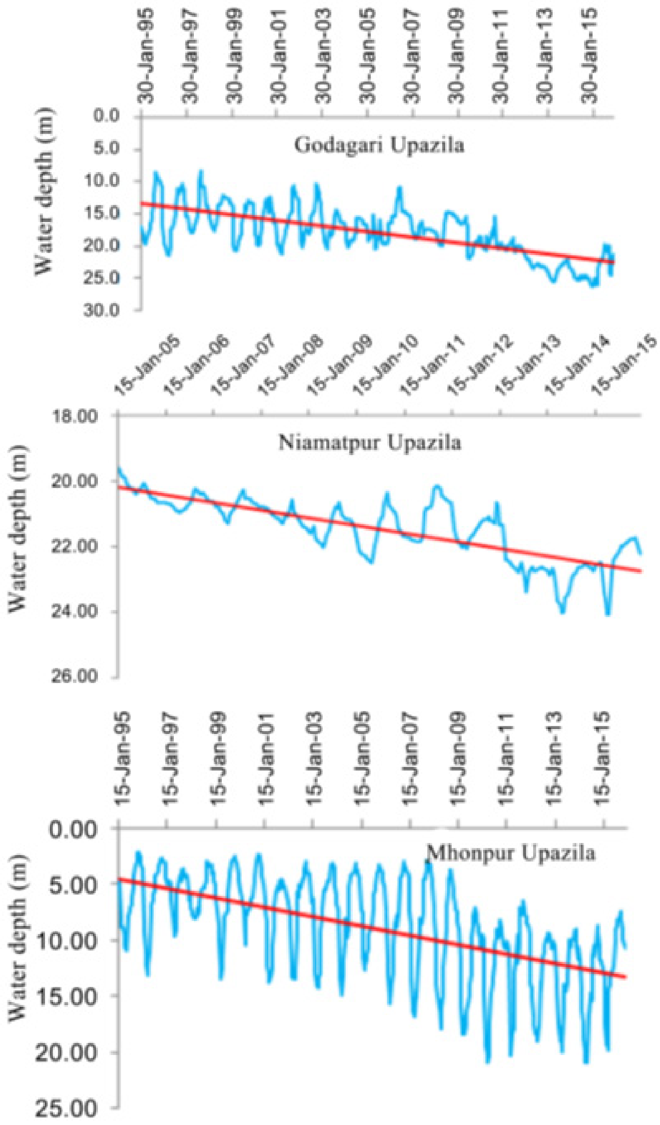

Figure 5: Groundwater level hydrograph of the study area.

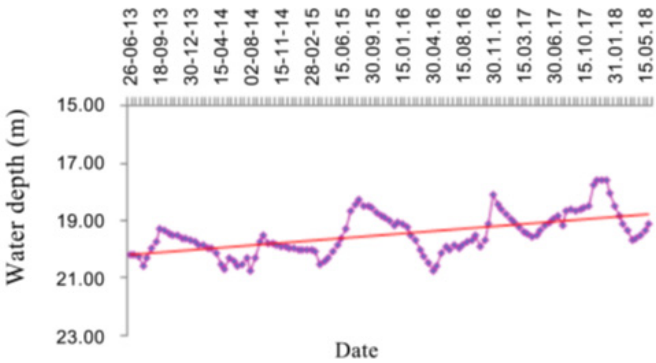

Figure 6: Groundwater level hydrograph for the RW at Godagari Upazila.

5. CONCLUSION

There is a proverb for the drought prone water stressed Barind area, "Barind is the land where Life is written in water." Less and uneven distribution of rainfall has further extended the sufferings. Poor surface water sources have made the people dependent on groundwater for irrigation, drinking and other uses. Due to thick clay layer of the top surface storm water cannot percolate easily, so natural recharge is negligible. On the other hand, continuous withdrawing of groundwater causes the declining groundwater level. However, the study results show that annual average rainfall is lower than the country average; gradual decreasing trend in groundwater level; MAR technique increases the GWL reducing the declining trend. Though BMDA has taken so many initiatives to reduce the stress on groundwater through surface water augmentation and devising efficient irrigation management system, groundwater table is going down day by day due to the excessive exploitation of groundwater. MAR technique is a suitable option to reverse the declining trend of groundwater level. So, research and study are necessary to design and modify MAR structure for sustainable management of groundwater table in Barind area.

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