Spatial Disparity of Groundwater Depletion in Dhaka City

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Abstract

[Groundwater is of course a valuable natural resource for the people of Dhaka City as surface water such as lake, river, reservoir etc. are not accessible to them sufficiently. People of Dhaka City depend on groundwater specially to meet their urgent daily needs. But the present conditions of groundwater in the city are not favorable for its population. In many parts of the city there is scarcity of pure water. This study shows that the groundwater in Dhaka city is declining at an alarming rate. The continuous over withdrawal of ground water and irregular and insufficient recharge causes depletion of groundwater. Rapid growing urbanization in the past 30 years also contributed to the present condition of Dhaka City. Recently, it is found out that the declining trend of groundwater in Dhaka City is 3 meters per year. Moreover, predictions show that the demand is increasing day by day and no chances of improving the situation is there. The volume of groundwater in storage is decreasing in many areas of the Dhaka City due to permanent over pumping. Thus, it has become obligatory to find out solutions for improvement. Therefore, scientific research on groundwater depletion in Dhaka City is very crucial to bring out fruitful solutions.]

Keywords : Spatial disparity, Ground water, Depletion, Dhaka City,

Introduction

In the past few decades the groundwater of many parts of Bangladesh has declined to a large extent. Many areas of the capital Dhaka showed similar outcomes. Indeed, most densely populated areas of the country faces relatively more depletion of groundwater than others. But still people are unaware of this acute condition. One of the reasons of this unawareness is lack of availability of information to the public domain. Many research works have been done with the same issue, but very few books and articles are written on this particular issue of groundwater decline in Dhaka City. Moreover, every day the condition of groundwater is changing. Therefore, updated study is required on the topic since it's being one of the vital problems of the country which is likely to become a threat to the survival of the future Dhaka as well as of the future Bangladesh.

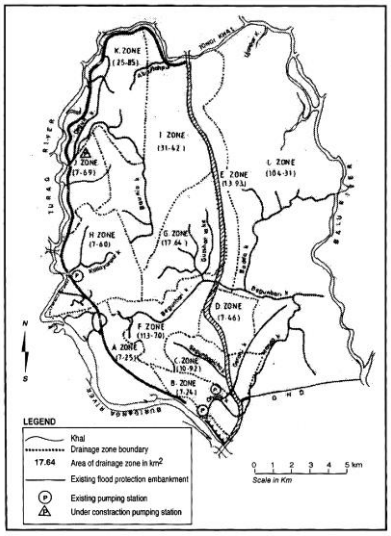
Background of the study

The heart of Bangladesh, Dhaka City has been noticed with threatening decline of groundwater last two decades. The main reasons lie under overconsumption and lack of recharge due to urbanization. Almost 82 % of the supply of water in Dhaka City is depended on groundwater. To fulfill this huge demand of water, groundwater level is declining by 2-3 meters each year (Anwar Zahid, 2011). Considering the existing depletion rate, the study predicts that the groundwater table will go down to about 110 to 115 meters by 2050 if any preventive measure would not be taken. The Ground water Hydrology (GWH) department of Bangladesh Water Development Board (BWDB) has placed 1250 piezometers throughout the country to monitor the depth of the groundwater level. All the piezometers placed in Dhaka City shows the declining trend of water table. In the past, the underground vacuum in Dhaka used to be recharged by the water flowing from the north aquifer of Gazipur district and its adjoining areas. But now these areas also suffer from severe depletion of groundwater level. For such reasons the present study has been taken as of a great importance to show the trend in groundwater decline in Dhaka City.

Details of the study area

Dhaka City is situated in the middle of Bangladesh. Being the capital of the country Dhaka is facing more problems due to groundwater depletion. The groundwater level of main commercial and residential areas of Dhaka City is studied. Seven important points as Mirpur, Motijheel, Mohammadpur, Gulshan, Sutrapur, Lalbagh and Dhanmondi have been taken into consideration are intensely studied. Findings of the study showed a drastic fall in groundwater level since 1980. Geographically Dhaka City is located within the Latitude 23.71 and Longitude 90.41 bounded by Gazipur at the North, Narayanganj at the east, Savar at the North-West, Keraniganj at the South-West. The river Buriganga flows through South-West end of the city, Turag flows from the North-West end and Shitalaxya (Tongi Khal) at the South-eastern part of the city. The city is situated on the southern part of the Pleistocene alluvial terrace, Madhupur Tract. Most part of the Dhaka city is dominated by Holocene deposits and have developed as low-lying flood plains. The elevation of the city ranges from 2 to 13 meters above sea level. The subsurface of Dhaka is composed of 10 meters thick compact upper clay which hinders rainwater to penetrate down into the soil surface (GSB, 2013). With a few exceptions, Dhaka has a **tropical monsoon climate** characterized by wide seasonal variations in rainfall, high temperatures, and high humidity.

Figure 01 : Study area



Source : BCAS, 1999

Data Source and Identification

It was very important to have clear understanding on the topic and present situation of the Dhaka aquifers to adhere to the expert community. Interviews regarding causes and consequences of groundwater declining in Dhaka were made and the declining trend was analyzed. Many experts were approached from the Department of Geography and Environment, and Geology, University of Dhaka, Institute of Water Modeling (IWM), DWASA, BWDB to present their important experiences. The interviews were non-structured, only consists of open ended questions. In conducting the interview a "Cold Calling" process was applied.

The prime source of information was secondary data collection. Secondary data on level of groundwater from 1970 to 2010 were collected from Ground Water Circle II (GWC II) under Groundwater Hydrology section of BWDB. Groundwater level data from more than10 piezometers around Dhaka city were collected at regular intervals. Data on depth of water in different parts of Dhaka city in various times were collected from Water & Hydrology Department of DWASA. Ground water assessment and demand management data were collected from IWM, Dhaka. Besides this, relevant data and information were collected from the Department of Geology, University of Dhaka.

Findings and analysis

Ground water level

Declining of groundwater level has become one of the main problems of Dhaka City. Therefore, to understand the present condition of water level and to work for its stability it is very important to research on the issue. It is high time that practical steps should be taken to stop the depletion of groundwater and use it in a sustainable manner. The piezometric survey made by the Bangladesh Water Development Board (BWDB) represent the data of seven important points of Dhaka city obtained by a survey in 2010 given below.

Table 1: Location and recorded groundwater level of selected piezometers in Dhaka City

Well ID	Location	Thana	Latitude	Longitude	Groundwater Level in meters (2010)
GT2608001	Joar Shahara	Cantonment	23.83	90.42	27.81
GT2668019	Khilgaon	Sabujbag	23.73	90.42	54.4
GT2642900	Palashi	Lalbagh	23.72	90.41	44.77
GT2648010	Monipur	Mirpur	23.79	90.37	65.97
GT2650011	PC Culture	Mohammadpur	23.75	90.37	31.24
GT2616012	Sultanganj	Dhanmondi	23.74	90.37	66.32
GT2988021	Gandaria	Sutrapur	23.70	90.42	21.1

Source: Bangladesh Water Development Board (BWDB), 2014

Groundwater declining scenario

The reduction of groundwater table in 30 years from 1980 to 2010 showing continuous declining scenario. It is clear that the trend of depletion or reduction of groundwater is alarming and urgently needed to take necessary action to reduce the depletion as well as to save the city people from severe natural disaster. Comparative study of ground water level between the years 1980 and 1990 shows that water table decline were almost similar in Mirpur, Mohammadpur, Dhanmondi, Gulshan. In 1990, Sabujbagh along with Lalbagh showed extreme decline. By 2010 Dhanmondi and Mirpur seemed to have highest depth of groundwater table (figure 16). But in the period of 2000 to 2010 the highest depletion rate found in Mirpur and Dhanmondi area. Declining trends of different thanas (administrative unit) mentioned in table 1 described below:

Mirpur

The declining trend is quite high at Mirpur area. From 1980s to 1990s the water table lowered from 8 meters to 15 meters. But from 1990s it declined in double rate in every decade. Within the span of 10 years from 1990 to 2000 groundwater level decreased from 15 to 35 meters. The worst situation found between 2000 and 2005 when water level dropped as much as 28 meters in only 5 years. Since then a relatively stable condition is observed in the height of the water table. No specific causes identified behind this depletion. But it is said by the local people that, this time (2000 to 2005) the number of resident population and number of building rapidly increased at Mirpur area.

Mohammadpur

The level of groundwater at Mohammadpur area found lowered maximum between 1990 to 1995 by 6 meters and 2000 to 2005 by 12 meters. The current depth (2014) of groundwater is 31 meters which is relatively lower than other parts of the city. It is assumed that due to the goodness of situation of some nearby lakes and stream, the groundwater in this area still can be found within 30 meters below whereas in many other parts of the city it has

gone under 60 meters. In the period 2000 to 2005 the depletion rate of the ground water of this area was rapid than other times from 1980 to 2010.

Dhanmondi

Ground water level at Dhanmondi area shows gradual declining trend from 1990 to present. Within the period of 10 years from 2000 to 2010, depth of groundwater table increased about 26 meters. Due to rapid increasing urbanization followed by population growth, the area observed scarcity of fresh water. The present depth of the water table is around 66 meters below the ground surface. The water table dropped from 15 to 60 meters with average declining trend of 3 meters per year within 15 years from 1990 to 2005.

Lalbagh

In the Lalbagh area, the declining trend is relatively low compared to the other areas of the Dhaka city. Within the time span of 5 years from 1981 to 1986 groundwater table declined about15 meters with an annual rate of 3 meters. Major gradual declining trend was noticed between1995 to 2001 and was sbout 17 meters. During this time, the yearly declining rate was 2.8 meters per year. In the period of 1986 to 1995 the declining rate of groundwater in Lalbag area was very slow. Only four to five meters fall of water level noticed within this period.

Sutrapur

Sutrapur area experiences one of the lowest trend areas of ground water depletion in the entire Dhaka city with an average declining rate less than 1 meter per year. This rate was more or less constant in last 30 years. From the year 1980 to 1990 the declining rate found quite slow. But in the period of 1990 to 2000 the trend of decline found comparatively high. In this period ground water level declined from 11 to 20 meters. It is the highest declining rate in this area for about 30 years long. After 2000 the declining trend is almost stable and more or less constant till now.

Sabujbag

Since 1980 the area Sabujbag experienced continuous declining trend in its water table as shown in the figure below. From the year 1990 to 1998 the declining rate was high. From 1999 to 2002 the same trend found gradual running down. In 2001, it was 3.5 meters per year and in 2002, it increased to 5.58 meters per annum. Thus the rate of groundwater depletion is becoming higher in short time intervals. After 2002, 2003 noticed no more decrease in water table height.

Gulshan

Gradual decline of groundwater has been observed at Gulshan area from 1998 to 2003. The annual rate of declining water table was 2.5meters. But still compared to the other areas of Dhaka city, at relatively low depth water can be found due to the presence of Gulshan Lake. In the period of 1990 to 1998, rapid declining trend of groundwater found in this area. After this period till 2003 the running down rate of groundwater level found slow and gradual.

Spatial Disparity in Groundwater Depletion from 1980 to 2010

Throughout the Dhaka City, depletion of groundwater level is observed. There are variations in current groundwater level and in the rate of its decline in different areas of the city. Due to difference in topography, geology, environment, population and other factors this disparity is observed. The areas which are more populated show high depth of water table than that of the less populated areas. Rapid and alarming depletion of water table found in the Mirpur and Dhanmondi are where the depletion goes accordingly 65.97 from 8.36 and from 10.12 to 66.32 meters in the this period (1980 to 2010). Second highest depletion found in the Sabujbag area from 3.13 to 54.4 meters. Sutrapur, Cantonment and Mohammadpur area found comparatively less depletion rate. The depletion rate of the selection eight points of the Dhaka city given below (table 2).

Figure 02: Spatial Disparity in groundwater decline in 1980 & 1990 in Dhaka City

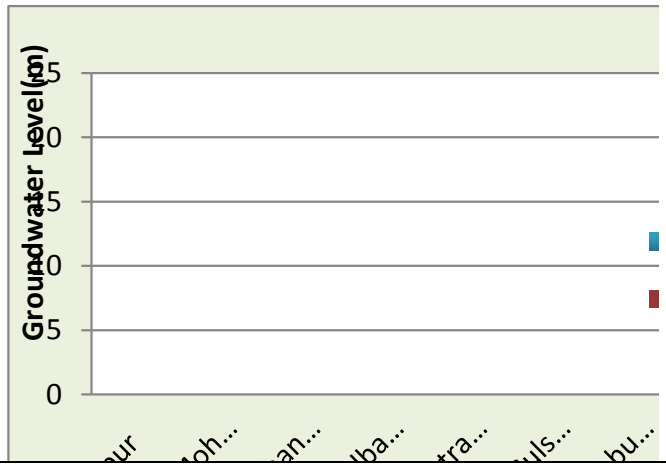
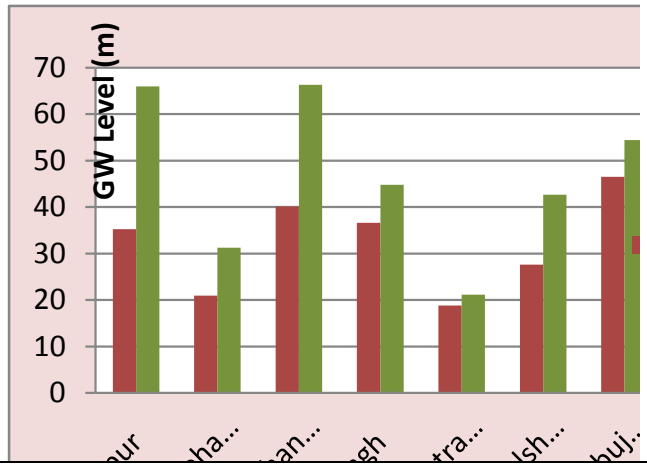


Figure 03: Spatial Disparity in groundwater decline in 2000 & 2010 in Dhaka City



Source: Bangladesh Water Development Board (BWDB), 2014

Table 2 : Depth of Groundwater Table in different areas of Dhaka City in different year (1980-2010)

Year	Mirpur	Mohammadpur	Dhanmondi	Gulshan	Cantonment	Lalbag	Sabujbag	Sutrapur
1980	8.36	9.3	10.12	9.91	-	1.67	3.13	5.88
1985	13.57	13.5	12.76	9.95	-	16.06	13.63	8.93
1990	15.3	14.52	15.4	10	-	17.71	21.49	11.08
1995	20.76	20.48	24.27	24.25	18.46	19.78	26.43	15.67
2000	35.2	20.87	40.12	27.59	27.88	36.57	46.45	18.79
2005	63	32.21	60.85	37.3	27.8	44.77	54.4	20.12
2010	65.97	31.24	66.32	42.66	27.81	44.77	54.4	21.1

Source: Bangladesh Water Development Board, 2014

Spatial Disparity of Groundwater Level from 1980 to 2010

The maximum depth of water table in 1980 was around 10 meter in Dhanmondi and the minimum was 1.67 meters in Lalbagh. The blue areas in the map express depth of groundwater is relatively low, the red areas indicate the depth is relatively high (figure 02). In Mirpur, Mohammadpur, Gulshan the depth was higher than Sabujbagh, Sutrapur and Lalbagh. But overall the condition of groundwater table was much better than present condition. Five years later in 1985, the depth increased in all the seven thanas. Mirpur, Mohammadpur, Dhanmondi and Sabujbagh showed similar depth. Gulshan and Sutrapur displayed lowest depth of groundwater table. In these 5 years lowest declining rate was of Gulshan area that is 0.08, whereas highest declining rate was in Lalbagh area is 16.06 meters (table 2). From the map of 1990, it is seen that in the southern part of the city the crisis of groundwater started developing quickly; mainly in Lalbagh, Sabujbagh, Ramna, Motijheel areas. Population in these areas was rising quickly and to fulfill the demand good amount of groundwater was being extracted which resulted in gradual depletion of water in these areas. While in the northern part of the city, in Cantonment, Uttara the groundwater depth was relatively low as population in these areas were still very low. By 1995, depth of groundwater in all areas increased more or less about 20 meters. Only Sutrapur, Cantonment and Lalbagh showed depth less than 20 meters. The highest depth was in Sabujbagh. From the map it is noticed that by 1995, the central and southern part of Dhaka had high depth of groundwater table, while in 1990, the central part had relatively low depth of groundwater table. The map of 2000 shows that, in Motijheel, Hazaribagh, Sabujbagh, Dhanmondi the depth of water table was high. The closely spaced contours in these areas show high fluctuation of groundwater table within very small spatial distance. Thus the depth of groundwater level in these areas decreased rapidly. In Mirpur, groundwater can be found at lower depth. In Sutrapur, the depth of water level was still low. In Gulshan, Mohammadpur the rate of decline was lower than other areas. In 2005, the condition in Mirpur became vulnerable. The depth of groundwater became 63 meters. In 5 years it increased 29.8 meters with an annual rate of 5.56 meters per year.Very high depth of groundwater table developed also in Motijheel, Sabujbagh, Ramna, Dhanmondi, touching to almost 60 meters. Mohammadpur and Sutrapur were relatively in good conditions in the southern Dhaka. The northern Dhaka also had a low water table depth. The depth of groundwater table in 2010 was similar to that of 2005. Only in Gulshan, the water table fell by 5.36 meters and in Dhanmondi by 5.47 meters. In the other areas the depth of the water table increased 1 or 2 meters.

Figure 04 : Depth of Groundwater Table in Dhaka City in 1980

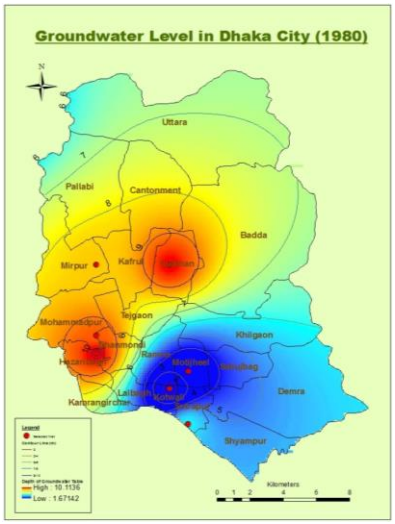


Figure 05 : Depth of Groundwater Table in Dhaka City in 1985

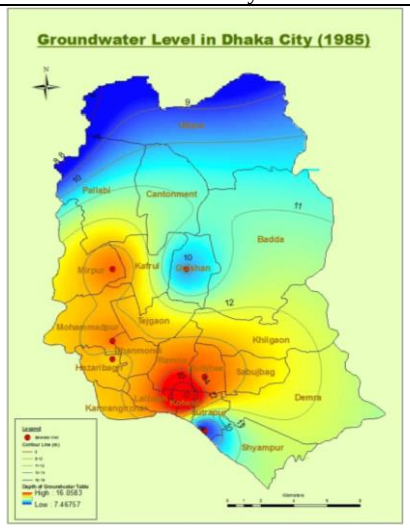


Figure 06: Depth of Groundwater Table in Dhaka City in 1990

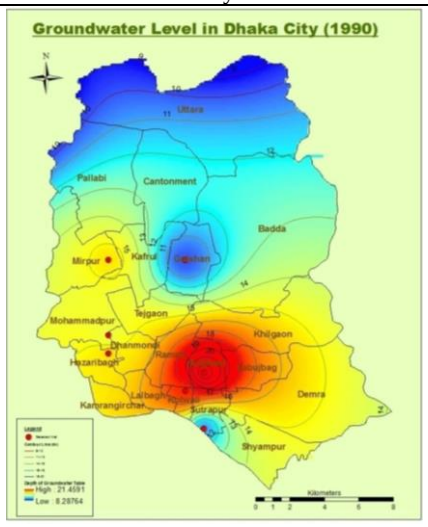


Figure 07: Depth of Groundwater Table in Dhaka City in 1995

Figure 08: Depth of Groundwater Table in Dhaka City in 2000

Figure 09: Depth of Groundwater Table in Dhaka City in 2005

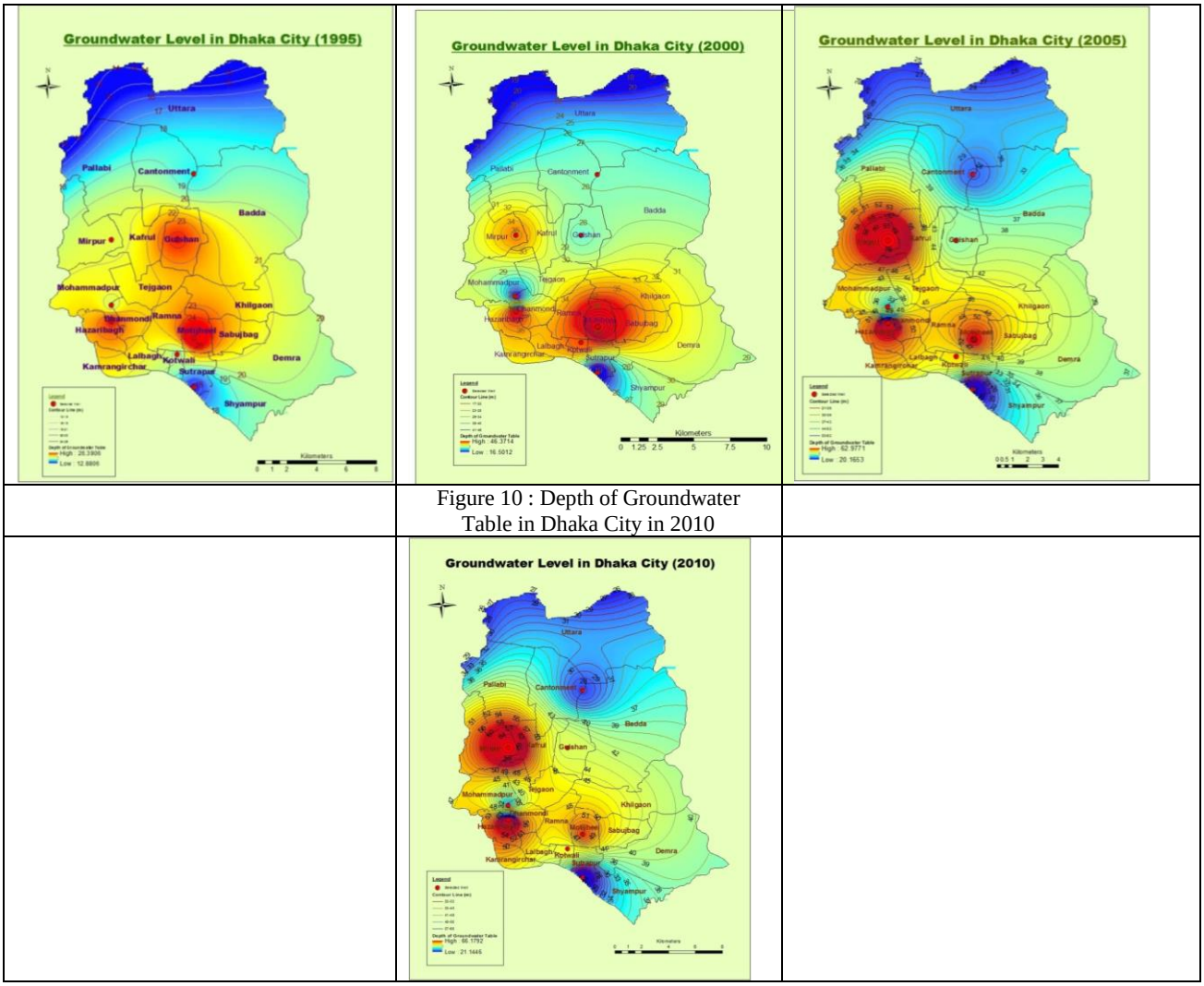


Figure 10 : Depth of Groundwater Table in Dhaka City in 2010

Source: Bangladesh Water Development Board, 2014

Causes of Spatial Disparity in Groundwater Level in Dhaka City

Throughout the recent past 30 years Dhanmondi, Motijheel, Mirpur, Hazaribagh, Ramna area showed drastic decline in groundwater table. Therefore, most of the southern part is affected by groundwater depletion because of high rate of urbanization, commercialization and increase of population in these areas. Sutrapur and Sabujbagh are the places in southern Dhaka where the depth of the water table is lower compared to other places. This is because of presence of water body and river nearby. Withdrawn of groundwater in Sutrapur area is high as the number of population is more compared to the other areas. On the other hand, the northern part of the city is relatively less populated and industrialized, thus the pressure in groundwater resources is low. As a result, the depth of the water table is relatively low. Apart from urbanization and industrialization the characteristics of soil plays an important role in water table depth. The clay content in soil is one of the most important characteristic of soil.

Summery Findings

From 1980 to present, groundwater level in different parts of Dhaka City found declined extensively. Mirpur, Sabujbagh, Motijheel, Dhanmondi, Ramna, Tejgaon, Hazaribagh show high rate of groundwater depletion. The rate is relatively low in Sutrapur, Cantonment and Uttara areas. The main reasons behind groundwater decline are overexploitation of water, population increase, urbanization, rainfall fluctuation etc. Groundwater decline has great impact on Dhaka City. It lead to water scarcity, rise of expanses in constructing well, hamper in food production, ecological imbalance in the city, earthquake risk and many other problems. Government has taken a number of policies to control the depletion of groundwater and to meet the demand of the people. Experts have suggested to control increase population and to reduce dependency on groundwater.

Recommendations

Artificial recharging of groundwater needs to be executed so that groundwater could be recharged sufficiently.

Treatment of the pollutants and wastes must be ensured by the industries. No industry without a treatment plant for waste water should be permitted to setup.

Proper implementation of existing laws, formulation of a specific groundwater law, initiatives to stop misusing supplied water can reduce the burden on groundwater.

Reducing number of population of the city.

River dredging, the main rivers of the country: Padma, Meghna, Jamuna, Brahmaputra and others should be dredged regularly.

Practicing rain water harvesting in every building of the City should be developed as early as possible so that demand of ground water could be minimized.

Finally, Government should look into the matter seriously to reduce the risk of natural hazard like earthquake or severe shortage of ground water in future.

Conclusion

Spatial disparity prevails in different areas of Dhaka City. Some areas show high declining trend and some low, but all the areas is subjected to lowering of water table. To have a sustainable groundwater utilization system the trend of groundwater decline must be stopped. By identifying reasons behind the spatial disparity, steps can be taken to reduce in different areas and stop groundwater declining. It is believed that this study can help to understand the real scenarios of ground water decline of the city Dhaka to the policy makers for their future plan.

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