
Investigation of ground water table in the South-East (Chittagong) part of Bangladesh

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Abstract: Ground water forms the major portion of earth's fresh water source and it is almost safe to drink. Depletion of ground water table due to continuous pumping causing scarcity of water in the city area of Bangladesh. So information about ground water table is required for future recommendation of ground water supply to general people. For the investigation purpose, depth of water table has been determined in three seasons with respect to mean sea level. Among 41 wards of Chittagong City, 18 wards have been selected for this purpose where depth of water table is measured from the shallow tube well. The present investigation includes field investigation for locating of tube well in Chittagong City Corporation area with the aim of measuring water level from ground surface. Seasonal variation of the water level has also been determined with respect to man sea level. Water collected from the well has been evaluated in the laboratory for determining quality of water. From the investigation, it has been established that, water table with respect to mean sea level is different at different wards. Seasonal variation has been observed due to lowering of water table and it has been found that water table is minimum at drought season.

Keywords: Ground Water, Depletion of Ground Water, Sea Level, Seasonal Variation, Quality Water, Drought

1. Introduction

Ground water forms the major portion of earth's fresh water supply. About 97% of the earth's fresh water supply is stored in the underground formation with the increase in population, the demand for water system is essential to meet the increasing demand for water is also increasing throughout the world. Effective management of ground water system in essential to meet the increasing demand for water. Ground water can be used as a reliable source of water supply irrespective of the climate. In the monsoon areas of South-East Asia, ground water way becomes an important source of supply especially for irrigation purposes in the dry months. 94% of all the water-works use ground water and they supply 77% of the total water consumed. Ground water is a vital source of water supply, especially in area where dry summers or extended droughts cause stream flow to stop water from the surface streams is the main source of recharge for the ground water (Aziz, 1975).

1.1. Ground Water

Ground water is water located beneath the ground surface in soil pore spaces and in the fractures of rock formations. A unit of rock or an unconsolidated deposit is called an aquifer when it can yield a usable quantity of water. The depth at which soil pore spaces or fractures and voids in rock become completely saturated with water is called the water table. Groundwater is recharged from and eventually flows to the surface naturally, natural discharge often occurs at springs and seeps, a can form oases or wetlands. Ground water is also often withdrawn for agricultural, municipal & industrial use by constructing & operating extraction wells. The study of the distribution and movement of ground water is hydrogeology, also called ground water hydrology.

1.2. Ground Water Situation in Bangladesh

Ground water is a vital source of water supply for Bangladesh. Bangladesh is almost entirely underlain by water-bearing formations at depths varying from zero to 20 m below ground surface. The soil is mostly stratified and formed by alluvial deposits of sand and silt, having

occasional limes of clay. The main constituent of the aquifer materials is the medium grained sand deposited at the lower reach by the mighty rivers the Ganges, the Brahmaputra and the Meghna with their tributaries. (Aziz, 1975). Ground water in Bangladesh, except in some places, is available at a shallow depth. Ground water levels are at or near ground level during the period August-October and lowest in April-May. Ground water rises as a result of recharge during April-May and usually reaches its highest in late July in each year. Between July and October ground water level are constant and maintain a balance between surface water levels and the fully recharged aquifers. There are several areas of Bangladesh where ground water withdrawals are causing a large decrease in ground water level during dry seasons. The ground water withdrawal and recharge characteristics suggest that the actual recharge can be increased approaching the potential limits by creating addition storage through increased abstraction during the dry season. According to MPO (1991) estimates, out of 42543 Mm³ total useable recharge, 40% is available through shallow tube wells. A study shows that 349 Upazila can adequately allow ground water development by hand pump tube wells of which 197 Upazila having ground water level within 4.5 m of the surface in dry season allows groundwater abstraction by suction mode No. 6 pump. In 60 Upazila, the groundwater level lies within 4.5 m to 6.5 m, the marginal range for forced mode Tara Pump. In 92 Upazilas the water level falls below the limit of suction mode pumps in the later part of dry season.

1.3. The Study Area

Chittagong city is the second largest city of Bangladesh, considered the heart of all commercial and business activity. At present, the city's land area occupies around 157 km² inhabited by about 4 million people (2001 census). Chittagong Water Supply and Sewerage Authority (CWASA) which is the authority for water supply and sewerage only supply water to one-third of city dwellers. Rest of people depends on the shallow tube well and deep tube well. Location of ground water table in Chittagong City Corporation area has been shown in study area map of Figure 1. For the investigation purpose specific problem has been identified and through which important information can be found.

1.4. Ground Water Table in Chittagong City According to CWASA

Ground water table in Chittagong City is at present in a position from where it is tough to pump ground water by shallow tube well. Deep tube well is required almost in every position to find the fresh water from ground. According to Chittagong WASA they have 89 deep tube well permanently in all city area. Location & depth of all the deep tube well has not been found as the authority of CWASA provides location and depth of some deep tube well. Location and depth of some deep tube well of CWASA are shown in Table 1.

Table 1. Location & depth of deep tube well of CWASA.

Location	Depth (m)	Depth (ft.)
1. Head of Kaptai Road (13)	165.7 m	543.5 ft
2. Asian Housing Society (22)	175 m	574 ft
3. Moulabi Pukur Par (08)	141.7 m	464.1 ft
4. Agrabad Al Nahian, CDA	296.62 m	973 ft
5. Haliashahar Housing & Settlement School, L Block	298.12 m	977.8 ft
6. Bishaw Colony, D Block	196.62 m	645 ft
7. Khawaja Road (3)	134.83 m	442.2 ft
8. Dewanhat CSD Gudam	208.90 m	685.2 ft
9. Salimpur Housing Society, Foujderhat	111.81 m	366.7 ft
10. Mojaffar Nagar, Polytechnic	190.32 m	624.2 ft

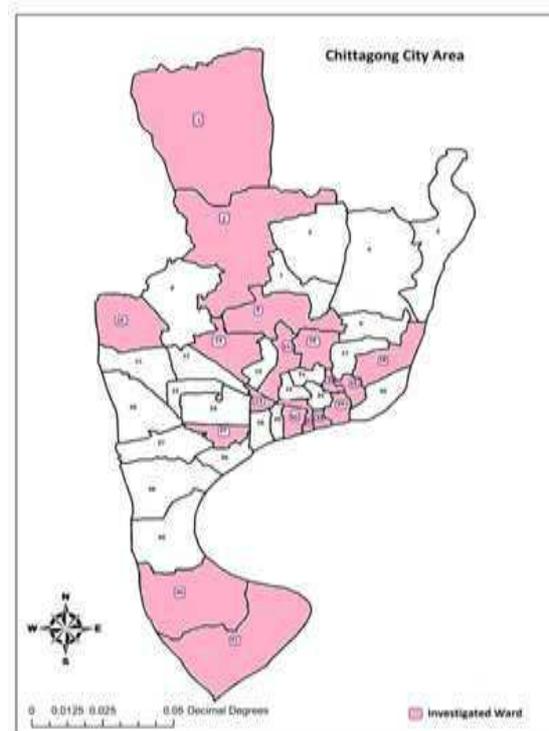


Figure 1. Study area map of Chittagong City Corporation.

2. Methodology

Investigation of ground water table in Chittagong City is overall a tough task. Although the water level in Chittagong City is in a critical state, an investigation has been done with great consciousness.

2.1. Field Investigation for Shallow Well

At the beginning of the investigation first task is to find out the shallow tube well in the 41 ward's City Corporation School. For this school list has been taken from City Corporation. Following the list to school, location of shallow tube well is found. Maps of Chittagong district has been shown in Figure 2.

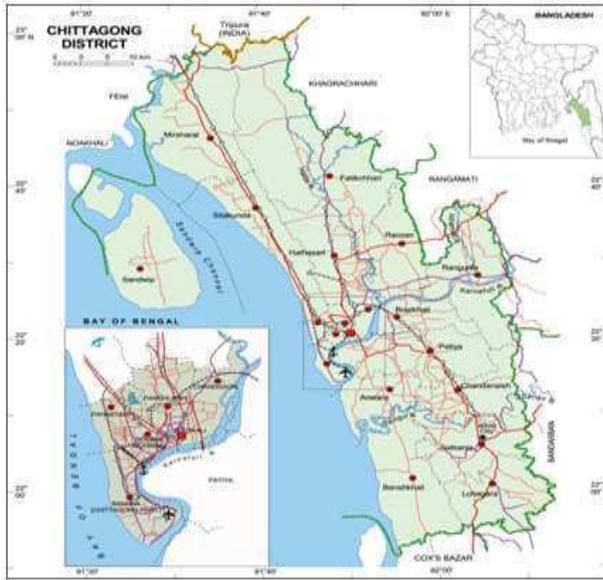


Figure 2. Maps of Chittagong district.

2.2. Reduce Level in Well Location

It is too tough to find out reduce level of well location with respect to mean sea level. But by using Global Positioning System (GPS), Reduce level of ground surface in well location can be easily found. GPS is a space based global navigation satellite system that provides reliable location and time information in all weather & all times anywhere on or near the earth when & where there is an unobstructed line of sight to four or more GPS satellites. On the well location, switch on the GPS. Then wait for five minutes to set its location properly. Then it will give value of longitude latitude & elevation of that specific location with respect to mean sea level. Determination of reduce level in well location with GPS device has been shown in Figure 3. GPS device gives almost accurate elevation in the location. GPS device works accurately in the open area.



Figure 3. Determination of RL in well location by GPS device.

2.3. Depth of Water Table in Different Season

Depth of water table has been measured from the ground

level at well location by opening the head of well. After opening the head of the well, wait for 10-15 minutes to drop the water in the well pipe. Then using a thick wire with a small steel at its bottom, entering into the well pipe until the wire is in a state of less weight. Then by using tape, find the depth from the weir. In this process, the depth is measured three times. Once at the beginning of winter season (09.11.2010) when the water table is fully saturated, once at the drought season (07.04.2011) when the water table is in lowest position as suction of water is more and once at the beginning of rainy season (31.05.2011) after some rainfall when water table is recharged and comes up.

2.4. Water Quality Parameter Test of Sample

Different water quality parameter such as pH, Iron, Alkalinity, Arsenic, CO₂ and Salinity has been determined in the laboratory from the sample water collected from well location. After determination compare the result with Bangladesh standard and WHO standard and suggest weather the water is drinkable or not. Water quality parameter test done in the Environmental laboratory has been shown in Figure 4. Arsenic has been tested by Wagtech Arsenic kit box. In each test it takes 25 minutes to find the result by comparing the filter paper with the color chart. Test done by Wagtech Arsenic kit box which gives almost accurate values in the field. Wagtech Arsenic kit box with sample water collected from well location has been shown in Figure 5.



Figure 4. Water quality parameter test in laboratory.



Figure 5. Wagtech Arsenic kit box with sample water.

3. Ground Water Table Investigation

3.1. Field Investigation for Location of Shallow Tube Well in Chittagong City

According to the list of school from Chittagong City

Corporation, field investigation for the location of shallow tube well has been done. Location of shallow tube well and deep tube well in 41 ward's City Corporation school are given in Table 2. School well has been selected for the investigation because the well in school is permanent rather than the outside open well which may not present in future.

Table 2. Location of shallow and deep tube well in 41 wards City Corporation School.

Ward No.	Name of the ward	Well location	Remarks
01	South Pahartali	Fatehabad Bohumuki City Corporation Girl's High School Kulgoan City Corporation High School	Shallow tube well Shallow tube well
02	Jalabad	Imaratonnesa City Corporation Girl's High School East Nasirabad A. Jalil Govt. Primary School Panchlaish City Corporation Girl's High School	Shallow tube well Deep tube well. Deep tube well.
03	Panchlaish	Sohid Dr. Mokbul Ahmed Govt. Primary School.	Deep tube well.
04	Chandgaon	Mohammadpur Govt. Primary School	Deep tube well.
05	Mohara		
06	East Sholashahar	Kapashgola City Corporation Girl's High School Kapashgola Primary School Eklasur Rahman Govt. Primary School	Deep tube well. Deep tube well. Deep tube well.
07	West Sholashahar	Rahmania High School Hamzarbag UCEF School Mohammadpur Govt. Primary School Hossain Ahmed Chowdhury City Corporation School	Deep tube well. Deep tube well. Deep tube well. Shallow tube well
08	Sulakbahar	Ahmed Miah Primary School	Deep tube well.
09	North Pahartali		
10	North Kattali	Kattali City Corporation Girl's High School	Shallow tube well
11	South Kattali		
12	Saraipara	Saraipara City Corporation School & College.	Deep tube well
13	Pahartali	New Jawtala Primary School	Shallow tube well
14	Lalkhan Bazar	Shahid Nagar City Corporation Girl's High School Bagmoniram Abdur Rashid City Corporation Boy's High School	Deep tube well Shallow tube well
15	Bagmoniram	Bagmoniram Siraja Khatun City Corporation Girl's High School	Shallow tube well
16	Chawkbazar	Gul A Zar Begum City Corporation Girl's High School	Shallow tube well
17	West Bakalia	West Bakalia Govt. Primary School	Deep tube well
18	East Bakalia	East Bakalia City Corporation Girl's High School	Shallow tube well
19	South Bakalia	Char Chaktai City Corporation Boy's High School Boluardhigi City Corporation Girl's High School	Shallow tube well Shallow tube well
20	Dewan Bazar	Lamabazar AAS City Corporation Boy's High School Kadam Mubarak City Corporation Boy's High School	Shallow tube well Deep tube well
21	Jamal Khan	Jamal Khan Kusom Kumari City Corporation Girl's High School Saleh Jahur City Corporation High School	Deep tube well Deep tube well
22	Enahet Bazar		
23	Uttar Pahartooly	Postarpar City Corporation Boy's High School Postarpar A Khatun City Corporation Girl's High School Patantooly Khan Shaheb City Corporation Girl's High School	Shallow tube well Deep tube well Deep tube well
24	North Agrabad		
25	Rampur		
26	North Haliashahar	Haliashahar Mohabbat Ali City Corporation High School	Deep tube well
27	South Agrabad	Al Nahian Primary School Patangooly City Corporation Boy's High School.	Shallow tube well Deep tube well
28	Patantooly		
29	West Madarbari	Patantooly City Corporation Girl's High School. West Madarbari City Corporation Girl's High School. East Madarbari City Corporation Girl's High School.	Deep tube well Deep tube well Deep tube well
30	East Madarbari		
31	Alaran	Primary Techer's Institute Al-karan Nur Ahmed City Corporation Boy's High School.	Shallow tube well Shallow tube well

Ward No.	Name of the ward	Well location	Remarks
32	Anderkill	Opornacharon City Corporation Girl's High School.	Deep tube well
33	Firingi Bazar	Krishno Komari City Corporation Girl's High School.	Deep tube well
34	Patharghata	Al-karan Sultan Ahmed City Corporation Girl's High School.	Shallow tube well
35	Boxir Hat	Patharghata Menaka City Corporation Boy's High School.	Shallow tube well
36	Gosaidenga	Gosaidenga KBAN City Corporation Girl's High School.	Deep tube well
37	North Middle Halishahar		
38	South Middle Halishahar		
39	South Halishahar	Halishahar City Corporation Girl's High School.	Deep tube well
40	North Potenga	Potenga City Corporation Girl's High School.	Shallow tube well
41	South Potenga	South Potenga City Corporation High School.	Shallow tube well

3.2. Reduce Level of Ground Surface in Well Location by GPS

RL of ground surface of well location at the reference of mean sea level by GPS has been shown in Table 3.

Table 3. Longitude, Latitude & Elevation at the well location by GPS.

Serial No.	Ward No.	Longitude	Latitude	Elevation (RL of ground surface w.r. to MSL)
01	08	91°49'29.9"	22°20'08.7"	97'
02	02	91°49'09.1"	22°24'14.8"	31'
03	01	91°49'08.5"	22°26'53.1"	21'
04	18	91°51'28.4"	22°21'03.9"	18'
05	16	91°50'17.8"	22°21'05.1"	54'
06	20	91°50'34.2"	22°20'24.9"	36'
07	19	91°50'51.8"	22°20'21.6"	34'
08	34	91°50'22.2"	22°20'08.0"	54'
09	33	91°50'03.1"	22°19'54.9"	19'

Serial No.	Ward No.	Longitude	Latitude	Elevation (RL of ground surface w.r. to MSL)
10	31	91°50'04.8"	22°19'9.1"	20'
11	30	91°49'37.3"	22°19'56.3"	18'
12	23	91°49'02.3"	22°20'17.2"	36'
13	41	91°47'36.7"	22°15'24.5"	44'
14	40	91°48'28.3"	22°14'16.7"	48'
15	13	91°48'31.8"	22°21'41.6"	76'
16	27	91°48'07.2"	22°19'25.9"	27'
17	15	91°49'21.6"	22°21'07.6"	61'
18	10	91°48'30.2"	22°20'18.5"	40'

3.3. Depth of Water Table in Three Different Seasons from Mean Sea Level

Depth of water table measured in three different seasons from ground level & adjustment of depth from mean sea level has been shown in Table 4.

Table 4. Depth of water table in three different seasons from mean sea level.

Ward No	Name of Ward	Well location	At the beginning of winter season	At drought season	At the beginning of rainy season
01	South Pahartali	Fatehabad Bohumuki City Corporation Girl's High School.	(21'-32') = -11'	(21'-39') = -18'	(21'-34') = -13'
02	Jalabad	Kulgaon City Corporation High School.	(31'-36') = -5'	(31'-42') = -11'	(31'-39') = -8'
08	Sulakbahar	Hossain Ahmed Chowdhury City Corporation School.	(97'-78') = 19'	(97'-82'4") = 14'8"	(97'-75'10") = 21'2"
10	North Kattali	Kattali City Corporation Girl's High School.	(40'-42'6") = -2'6"	(40'-45') = -5'	(40'-41') = -1'
13	Pahartali	New Jawtala Primary School	(76'-48") = 28'	(76'-52") = 24'	(76'-48'6") = 27'6"
15	Bagmoniram	Bagmoniram Abdur Rashid City Corporation Boy's High School.	(61'-113') = -52'	(61'-120') = -59'	(61'-108') = -47'
16	Chawk Bazar	Gul A Zar Begum City Corporation Girl's High School.	(54'-35') = 19'	(54'-41') = 13'	(54'-38') = 16'
18	East Bakalia	East Bakalia City Corporation Girl's High School.	(18'-37'6") = -19'6"	(18'-41') = -23'	(18'-31') = -13'
19	South Bakalia	Char Chaktai City Corporation Boy's High School.	(34'-29'7") = 4'5"	(34'-24'6") = 9'6"	(34'-22'6") = 11'6"
20	Dewan Bazar	Lama Bazar AA S City Corporation Boy's High School.	(36'-33') = 3'	(36'-41'6") = -5'6"	(36'-33'6") = 2'6"
23	Uttar Pahartooly	Posterpar City Corporation Boy's High School.	(36'-70') = -34'	(36'-75'6") = -39'6"	(36'-71') = -35'
27	South Agrabad	Al Nahian Primary School.	(27'-23') = 4'	(27'-27') = 0'	(27'-25'6") = 1'6"
30	East Madarbari	Primary Teacher's Institute.	(18'-12'6") = 5'6"	(18'-18') = 0'	(18'-15') = 3'
31	Alkaran	Alkaran Nur Ahmed City Corporation Boy's High School.	(20'-18'5") = 1'7"	(20'-25'9") = -5'9"	(20'-20') = 0'
33	Firingi Bazar	Alkaran Sultan Ahmed City Corporation Girl's High School.	(19'-17') = 2'	(19'-23') = -4'	(19'-20') = -1'
34	Patharghata	Patharghata Menaka City Corporation Boy's High School.	(54'-45') = 9'	(54'-52'7") = 1'5"	(54'-49'6") = 4'6"
40	North Poenta	Potenga City Corporation Girl's High School.	(48'-30') = 18'	(48'-30') = 18'	(48'-22') = 26'
41	South Poenta	South Potenga City Corporation High School.	(44'-25') = 19'	(44'-25'5") = 18'7"	(44'-21') = 23'

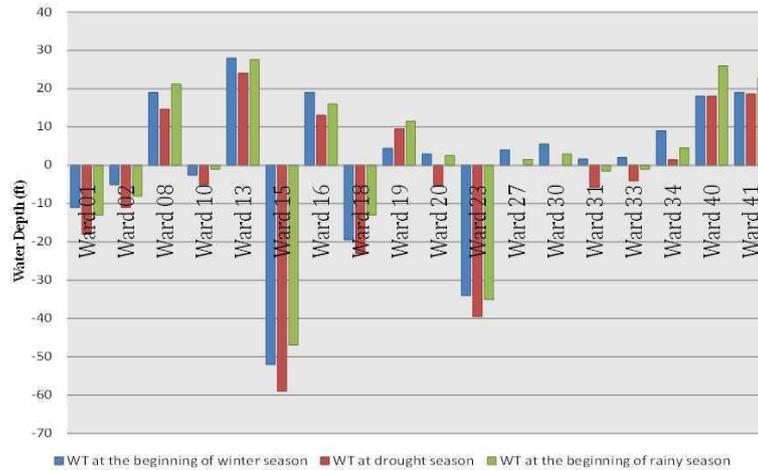


Figure 6. Graphical representation of seasonal WT variation for various wards.

4. Water Quality of Investigated Well

4.1. Test Result of Water Quality Parameter

Laboratory test has been conducted on water collected from well location. The comparison of test result with standard values has been shown in Table 5.

Table 5. Test results for different parameters.

Ward No	pH	CO ₂ (mg/l)	Iron (mg/l)	Alkalinity (mg/l)	Arsenic (mg/l)	Chloride (mg/l)
WHO	6.5-8.5	---	0.1-1.0	---	0.01	250
Bangladesh	6.5-8.5	---	0.3-1.0	200-500	0.05	200-300
01	6.97	37.5	0.1	110	Nil	7
02	6.98	32.5	0.1	120	Nil	10
08	6.88	15	0.001	30	Nil	20
10	6.99	22.5	0.1	80	Nil	15
13	7.10	20	0.001	70	Nil	5
15	7.20	37.5	0.1	110	Nil	35
16	6.86	25	0.001	50	Nil	15
18	7.02	30	0.2	130	Nil	62
19	7.09	35	0.2	130	Nil	85
20	7.19	62.5	0.1	80	Nil	40
23	7.32	25	0.001	320	Nil	950
27	7.45	22.5	0.3	350	<0.01	1000
30	6.95	20	0.001	120	Nil	30
31	7.85	72.5	0.2	290	Nil	145
33	7.11	55	0.1	230	Nil	143
34	7.08	30	0.4	280	Nil	70
40	7.38	95	0.8	420	<0.01	750
41	7.21	55	0.001	270	Nil	20

5. Conclusion and Discussions

Ground water table in Chittagong City Corporation area is in a position where day by day the water table is lowering. In this project, our aim was to find out the seasonal variation of the ground water table. For this purpose we have to select the shallow well instead of deep well by considering the limitation we have. Thus within 41 wards in Chittagong City Corporation area, the location selected is City Corporation School, where in only 18 wards shallow well was found. By considering this

limitation we investigate the ground water table in those 18 wards where there is presence of shallow tube well.

Conclusion: The concluding remarks that can be derived from the investigation have been presented below-

- Water tables are different in different wards. But nearly similar in adjacent wards.
- During field investigation, it was found that within 50 well locations in 41 wards; only 21 shallow tube well is present. As majority of the location can't pump water through shallow tube well.
- Majority of the shallow tube well that can pump water has a depth of (50'-110').

- d. The overall view shows that, in almost every ward, to find fresh water deep tube well is must as shallow tube well can't frequently pump water.
- e. Through the water quality test in the laboratory, it has been found that, majority of shallow tube well water tested having pH, CO₂, Iron, Alkalinity, Chloride concentration & Arsenic within the limit suggested by WHO and Bangladesh standard.
- f. From the investigation it is clear that, ground water table is lowering day by day and it is lower most at the drought season. At the beginning of rainy season when it started to rain the water table comes up.
- g. Ground water through shallow tube well is not sufficient to fulfill the required demand for the general people as it is becoming out of reach through shallow well day by day.
- h. Chittagong is the 2nd most important city of Bangladesh. But still the depth of water table has not been measured by any organization.
- i. Depth of water table with respect to mean sea level is quite lower in ward no-15 & 23.
- j. Depth of water table with respect to mean sea level is quite higher in ward no-08, 13, 40, & 41.

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