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Seasonal variation of salinity of ground water at Patenga area of Chittagong district in Bangladesh

A Hoque, MA Hossen, MF Islam, MIU Mahmud

Department of Civil Engineering, Chittagong University of Engineering & Technology, Bangladesh.

Abstract

Availability of safe drinking water is scarce in the coastal areas of Bangladesh due to saltwater intrusion in fresh water aquifer. Patenga, a densely populated coastal area within Chittagong city corporation area, is not under the municipal water supply coverage. The groundwater of Patenga is contaminated by higher concentration of chloride and total dissolved solid. This study aims to investigate the water quality of the tube well based on its distance from flood protection embankment to observed saltwater intrusion in fresh water aquifer. Water sample were collected several times from different tube wells at patenga area based on tube well's distance from embankment from February 2017 to August 2017 to observe the seasonal variation of water quality. It was found that chloride concentration, electric conductivity, total dissolved solids etc. are very high compared to the standard value for drinking purpose in Bangladesh. The chloride concentration also decreased as the distance of the tube-wells from embankment increased, which implies that tube well near to coast line has higher chloride concentration. It was also observed that chloride concentration in tube well water also increased during dry season. In this study, the location of the tubewells were considered only along a single alignment in the perpendicular direction of the coastal bank. The study can be further extended for more offsets both in the parallel and the perpendicular direction of the coastal bank for better understanding of the groundwater salinity intrusion.

Key words: Coastal area, chloride, total dissolve solid, seasonal salinity variation

***Corresponding Author:** asiful135@yahoo.com

Introduction

Groundwater is a salient source of water supply in many parts of the world. As groundwater use has increased, issues associated with the quality of groundwater resources have likewise grown in importance. About one third of world's population lives in water shortage areas and of them about 1.1 billion people lives without access to safe drinking water (Shaw & Thaitakoo, 2010). There is an affluence of water in Bangladesh, but scarcity of safe drinking water is the real situation now. The coastal region covers almost 29000 km^2 or about 20% of the country and about 53% of the coastal areas are affected by salinity (Sohela & Karim, 2014). About 15 million people already are forced to drink saline water and 30 million people are unable to collect potable drinking water due to a lack of available safe water sources (Hoque, 2009).

The coast of Bangladesh consists of 19 districts, covers 32% of the country and accommodates more than 35 million people (Huq and Rabbani, 2011) Increasing salinity is a crucial issue to the people of the coastal region of Bangladesh. Due to increasing salinity in the water and soil, the people of the region are suffering from scarcity of safe drinking water, irrigation, agriculture and other uses. Ecology of the coastal region especially in the southwest region is greatly concerned with salinity. A recent study indicates that the salinity affected area has increased from 8330 square km in 1973 to 10560 square km in 2009 (Soil Resource Development Institute, 2010).

Patenga is located in the south-east zone under Bandar Upazila of Chittagong district. Here, the problem with drinking water is salinity. Many natural calamities in the form of cyclones and tidal surge frequently occur in coastal zones and sea level rise is an outcome of these natural hazards (Abedin & Shaw, 2013). This sea level rise has various impacts on the coastal areas, such as land erosion, salinity-intrusion and loss of bio diversity (Azad et al., 2009). Due to the relatively low lying land formation of Bangladesh, a small increase in sea level will cause salinity intrusion to a much longer distance in inland (Sarwar & Khan, 2007). By drinking saline water, people are suffering from various kinds of health problem, such as highblood pressure, diahorea, cholera and others (Pereira et al., 2009). People are also getting saline through various food grains more than they required (Khan & Aneire, 2011). Structures, exposed to salinity, may deteriorate as a result of combined effects of chemical action of saline water.

In this context, the study is intended to explore the level of salinity in ground water at Patenga in Chittagong. Previous literatures mainly focused on the south-western part of the county for studying the salinity intrusion. There is a lack of study in the southern coastal areas of Bangladesh to address the issue. So a detailed study on the salinity condition of the area will provide a clear view of the problems associated with drinking water and sub-surface irrigation which will help the government and policy makers to formulate action plan in saline prone areas like this. Using the database, authority will be able to take necessary steps, based on severity of salinity, to determine remedial actions against drinking water problems.

Materials and Methods

A literature review and preliminary survey was done through Chittagong city to explore extend of saline degraded drinking water. Patenga was selected as a study area because it is fairly close to seashore and there is no water supply facility from WASA.

The housing colony area which is situated in the ward no. 40 was selected for the study. Then, ten tubewells have been selected for detailed investigation. To determine the existing water quality parameters related to salinity (Conductivity, total dissolved solids, salinity and Concentration of chloride ions), water samples from those ten tube wells are collected at different time of the year. In the laboratory, pH, alkalinity, chloride concentration, color, turbidity, hardness, electric conductivity and TDS were tested immediately after collecting the sample. Table 1 represents about details of the tubewell from where water were collected. Age and depth of well are presented according to information supplied by the owner of tubewell.

Table 1. Tubewells details

Tube well no./ Sample ID	Owner's Name	Age of tube well (Years)	Depth of tube well (ft.)
01	Mahatab	1	30
02	Md. Farooq	15	50
03	Abdul Gani	4	70
04	Khairul Bashar	16	50
05	Nazrul Contractor	7	70-80
06	Shiraz Ali	5	70-80
07	Abu Bakkar Siddique	8	40-50
08	Mamunur Rahman	11	40
09	Jahidul Islam	4	30-40
10	Kamrul Islam	9	40

The location of the tube-wells and their distance from costal embankment is shown bellow in Figure 1 & Figure 2.

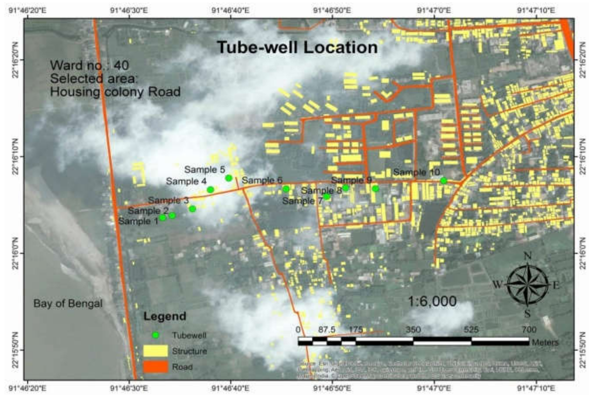

Figure 1. Location of the tube-wells

Figure 2. Distance of the tube-wells from each other and from Patenga beribadh (Coastal embankment).

Results and Discussion

The water samples from 10 different locations were collected and tested in the laboratory. Though the present study emphasizes on the salinity intrusion in groundwater, 8 different physical parameters (pH, turbidity, color, total dissolved solids, electrical conductivity, chloride, alkalinity, hardness) have been assessed in order to understand the general groundwater quality. The average value of different water quality parameters are showing in the Table 2.

The pH of the groundwater did not differ significantly at all the 10 locations (7.16-7.94) and were within the range of drinking water standard (6.5-8.5). The color and turbidity of groundwater were found higher close to the coastal bank and decreased with the increase in distance from coastal bank. The TDS and EC varied significantly from 1220 to 8650 mg/L and from 1009 to 11030 µS/cm respectively. The chloride concentration of groundwater was found highest at the tubewell closest to the sea and decresead towards the inland since the depth of all tube wells are not same as the variation was not linear (Figure 3). Alkalinity and hardness of groundwater varied arbitrarily at different locations and ranged from 207.44-266.78 mg/L and 109.5-316 mg/L respectively.

Table 2. Average value of different water quality parameters of selected samples.

Sample Id./location	Water Quality Parameters							
	pH	Color (PCU)	Turbidity (NTU)	TDS (mg/L)	Electro-Conductivity (µS/cm)	Chloride Concentration (mg/L)	Alkalinity (mg/L)	Hardness (mg/L)
01	7.49	>100	176.50	7181	9150	3264	238.55	311
02	7.47	>100	167	5709	11030	2375	264.78	304
03	7.52	>100	65.06	6498	7640	3037	239.88	302
04	7.23	42	25.97	3329	5300	1227	211	141
05	7.16	57	33.48	3250	5900	1445	238.67	173
06	7.27	5	2.38	1220	1009	2768	223.5	316
07	7.41	40	22.67	8650	8650	2596	259.44	260
08	7.36	78	39.21	3321	4890	987	266.78	109.5
09	7.73	66	31.39	3294	5530	768	207.44	126.7
10	7.94	72	39.26	4598	6050	1092	235	152

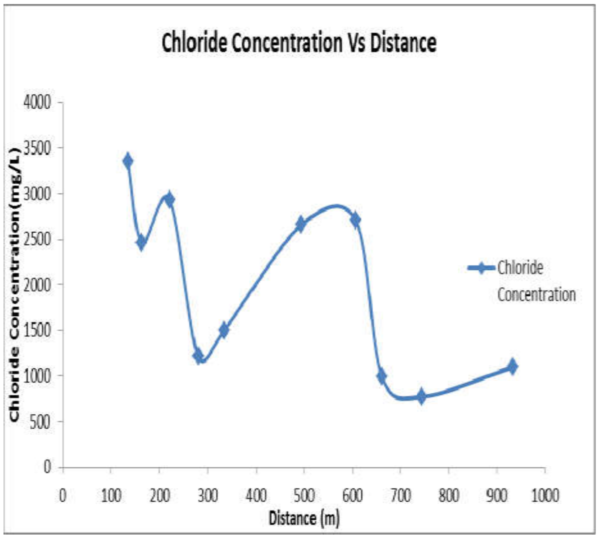

Figure 3. Variation of chloride concentration with distance

From the Figure 4, it was observed that the salinity decreased as the rain increase in wet season. This may happen as the rainwater recharged the ground water table and reduced the salinity. But there were some exceptions in salinity at particular locations which might be due to aquifer variations and change in groundwater flow which were not considered for this study. The amount of salt in water is often expressed as concentration in milligrams of chloride per liter of water (mg Cl-/l) or in its equivalent; parts per million (ppm). Another standard way of measuring salinity is milligrams TDS per liter,where TDS is Total Dissolved Solids. It can also be expressed using the ElectricalConductivity (in reference to 25^{0} Celcius) often expressed either in milliSiemens percentimeter (mS/cm) or microSiemens per centimeter (μS/cm). The maximum, minimum and the average value of chloride concentration of different samples at different locations are showing in Table 3.

A considerable fluctuation of salinity is observed at different sampling locations based on the data of dry season and wet season salinity. The reason responsible for groundwater salinity reduction at the time of wet season may be due to the rainwater infiltration and subsequent groundwater dilution.

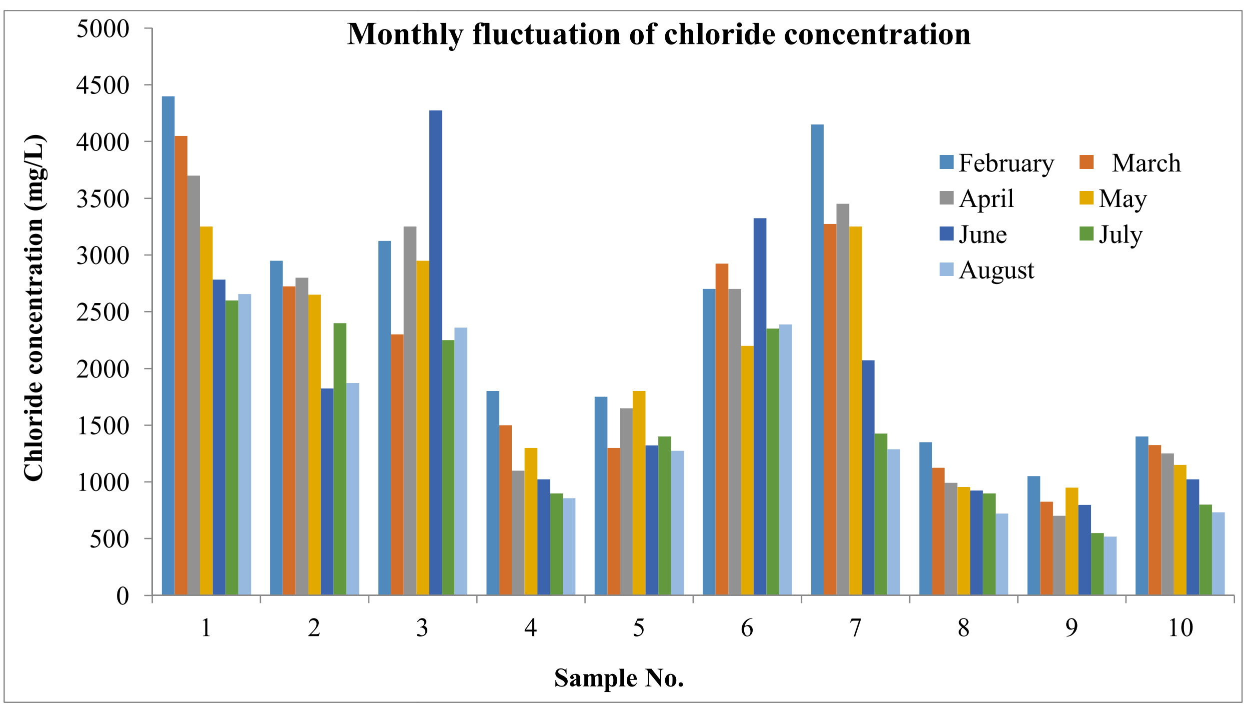

Figure 4. Seasonal variation of chloride concentration.

Table 3. Minimum, maximum & average value of salinity.

Sample Id./location	Dry season (Feb- May) Salinity (mg/L)			Wet season (Jun-Aug) Salinity (mg/L)		
	Minimum	Maximum	Average	Minimum	Maximum	Average
01	4875	6600	5835	3581	4425	3957
02	3900	4425	4155	2475	3600	2970
03	2925	4688	4178	3375	6975	4935
04	1575	2925	2160	1286	1800	1521
05	1725	2700	2340	1725	2243	1995
06	3300	4950	4035	3525	5250	4269
07	4050	6225	5760	1931	3740	2570
08	1434	2175	1664	1082	1496	1299
09	1050	1575	1305	776	1421	999
10	1725	2100	1935	1100	1650	1341

Conclusion

Salinity intrusion is an alarming issue in the coastal regions of Bangladesh. Although, Patenga is one of coastal areas under Chittagong City Corporation area, there is no coverage of city water supply in this area. So, ground water is the only option for dirinking, cooking and other purpose. The water quality of Potenga is not suitable for both drinking and cooking purpose. It was found that the salinity of the groundwater in the inland from the sea-shore decreases with the distance from the coastal belt, except some nearby the coast line which indicates the possibility of the perched aquifer. It was also found that chloride concentration in tube well water also increased in dry season.

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