

Evaluating the Quality of Ground Water for Drinking Purpose in Jhenaidah Municipal Area

Abanti Kundu¹, Dilip Kumar Datta², Nusrat Tazeen Tonu^{3,*}, Md. Rezaul Haque⁴

Student, Chemistry Discipline, Khulna University, Khulna-9208, Bangladesh¹

Professor, Environmental Science Discipline, Khulna University, Khulna-9208, Bangladesh²

Lecturer, Chemistry Discipline, Khulna University, Khulna-9208, Bangladesh³

Professor, Chemistry Discipline, Khulna University, Khulna-9208, Bangladesh⁴

ABSTRACT: This study was conducted in order to assess the quality and suitability of groundwater for drinking purposes and the spatial variation in area of Jhenaidah Municipality, which is situated in the southwestern part in the Jhenaidah District under Khulna division of Bangladesh. Ground water samples were collected from nineteen different sampling spots, which were located on the Jhenaidah municipal area. The groundwater quality was assessed by measuring the following physico-chemical parameters pH, EC, Na⁺, K⁺, Ca²⁺, Mg²⁺, Cl⁻, SO₄²⁻, PO₄³⁻, HCO₃⁻, H₄SiO₄²⁻ and TDS (Total Dissolved Solids). The average value of parameter are pH (7.396), EC (618.894 μS/cm), TDS (598.5463 mg/L), Na⁺ (24.624 mg/L), K⁺ (2.947 mg/L), Ca²⁺ (60.335 mg/L), Mg²⁺ (28.393 mg/L), HCO₃⁻ (370.421 mg/L), Cl⁻ (35.3621 mg/L), SO₄²⁻ (0.915 mg/L), PO₄³⁻ (0.260 mg/L) and H₄SiO₄²⁻ (75.289 mg/L). The data did not show a huge range of considerable spatial variation in the concentration of major ion in the study area. Ca²⁺ and HCO₃⁻ dominate the chemical composition of the ground water. Analytical accuracy of total major cation and major anion showed an approximate balancing of total ion with little fluctuation. Compared to WHO and BDS standards majority of the samples of ground water in study area were within the permission limit and safe to drink.

KEYWORDS: Jhenaidah Municipal Area, Ground Water Quality, Chemical Parameters, WHO and BDS Standard

I. INTRODUCTION

Water is one of the most important substances on earth [1]. It is absolutely the most necessary commodity for the substance and wellbeing for mankind [2]. All plants and animals must have water to survive. Among all available sources of water, groundwater is most decentralized and dependable source of water for millions rural and urban families. So, this ground water is widely distributed, renewable and most important resources. It is the major source of drinking water in both urban and rural. Besides, it is an important source of water for the agricultural and the industrial sector [3]. Agriculture is the main source of livelihood of the population and ground water is the major source of irrigation. Groundwater is contaminated with a variety of pollutants generated from diverse sources such as agriculture, industrial and domestic [4]. In recent years the rapid growth of population, urbanization and industrialization created adverse impact on groundwater in both quantitative and qualitative aspect. Pollution of groundwater due to industrial effluents and municipal waste in water bodies is a major concern in many cities and industrial clusters in Bangladesh [1, 5]. Globally, 91% of people had access to water suitable for drinking. Nearly 4.2 billion had access to tap water while another 2.4 billion had access to wells or public taps. Still 1.8 billion people use an unsafe drinking water source that may be contaminated for various reasons. As a result, people may be affected by diarrhea, cholera and typhoid diseases [6]. According to WHO organization, about 80% of all the diseases in human beings are caused by water. Once the groundwater is contaminated, its quality cannot be restored by stopping the pollutants from the source. It therefore becomes imperative to monitor the quality of groundwater regularly and to device ways and means to protect it [5]. Besides, water quality is extremely important because constant access to good quality water is necessary for life as well as the economy. Due to inadequate supply of surface waters, most of the people in our country are depending mainly

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 10, October 2018

on groundwater resources for drinking and domestic, industrial, and irrigation uses. The quality of water is a vital concern for mankind since it is directly linked with human welfare [7]. Assessment of the water quality for drinking purpose involves the determination of the chemical composition of groundwater and the remedial measures for the restoration of the quality of water in case of its deterioration demand the identification of possible sources for the contamination of groundwater [8]. The drinking water in Jhenaidah district can be contaminated due to geographical location, huge cultivation and industrialization. For this reason, checking the quality of drinking water is very important. The term water quality is used to describe the condition of the water, including its chemical, physical and biological characteristics, usually with respect to its suitability for a particular purpose i.e., drinking, swimming or fishing. Keeping all this aspect in mind, the present study was designed to investigate drinking water quality in Jhenaidah district by measuring some important parameters like Dissolved oxygen (DO), Chemical oxygen demand (COD), Biological oxygen demand (BOD), Calcium (Ca^{2+}), pH, Salinity, Hardness [6]. Water quality standards are needed to determine whether ground water of a certain quality is suitable for its intended use [9]. The people of Jhenaidah Municipality are fully dependent on ground water for their drinking and domestic purpose. Very little number of people uses surface water for their bathing, washing, and cooking purpose. The Municipality authority contributes only 38-40% of the water demand by pipeline networking. Rest of the demand is fulfilled by different shallow tube wells and open water in the study area by the consumers. Thus, the objectives of this study are to assess the major dissolved ions chemistry of the ground water in study area, to explore the water quality of the study area for drinking purposes and to explore the spatial variation of water quality parameter in this study area.

II. LITERATURE REVIEW

Sultana et al. investigated some water quality parameters in Tangail municipality, Bangladesh and they reported there were no major differences found in pH, EC and TDS values among the studied stations and not exceeded the recommended thresholds [10]. *Akhter et al.* assessed the water quality of Dhamsona, Dhaka and they reported, among different physiochemical parameters, pH, TDS and EC were found within the range. The range of pH for all of the samples was found from 7.1 to 8.17 and 120 to 450 mg/L for TDS. The values of EC were 90 to 300 $\mu\text{S cm}^{-1}$. For pH, EC and TDS, though the ranges were within the limit [11]. *Rahman et al.* analysed the drinking water quality of tube-wells from Kushtia District, Bangladesh. Results showed variation of the investigated parameter in water samples as follows: pH 6.81 to 8.12, Electrical Conductivity (EC) 490 to 1995 $\mu\text{S/cm}$, Hardness 285 to 810 mg/L as CaCO_3 . It was seen that some physicochemical parameters were beyond drinking limit [12]. *Haque et al.* studied the major ion chemistry of the groundwater under Jhenaidah district of Bangladesh for irrigation, drinking and industrial uses. All water samples are more or less suitable for industries like brewery, ice manufacture purpose, dairy farm and carbonate beverage. However, almost all waters were unsuitable for textile and laundering. All waters were suitable for drinking and irrigation uses; although some samples were rated to be unsuitable for some specific ions [13].

III. STUDY AREA

The study area Jhenaidah municipality is situated in the Jhenaidah District under Khulna division. Jhenaidah is located in the southwest part of Bangladesh. The study area is located between $23^{\circ}30'$ and $23^{\circ}35'$ North latitude and $89^{\circ}08'$ and $89^{\circ}12'$ East longitude. Jhenaidah Municipality is bounded by Harinakundu and Shailkupa upazilas on the north, Kaliganj (Jhenaidah) and Salikha upazilas on the south, Magura Sadar upazila on the east, Kotchandpur and Chuadanga Sadar upazilas on the west. Main rivers are Begabati, Nabaganga. Jhenaidah paurashava consists of 9 wards and 34 mahallas. The area of the pauroshava is 32.62 sq. km [14].

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 10, October 2018

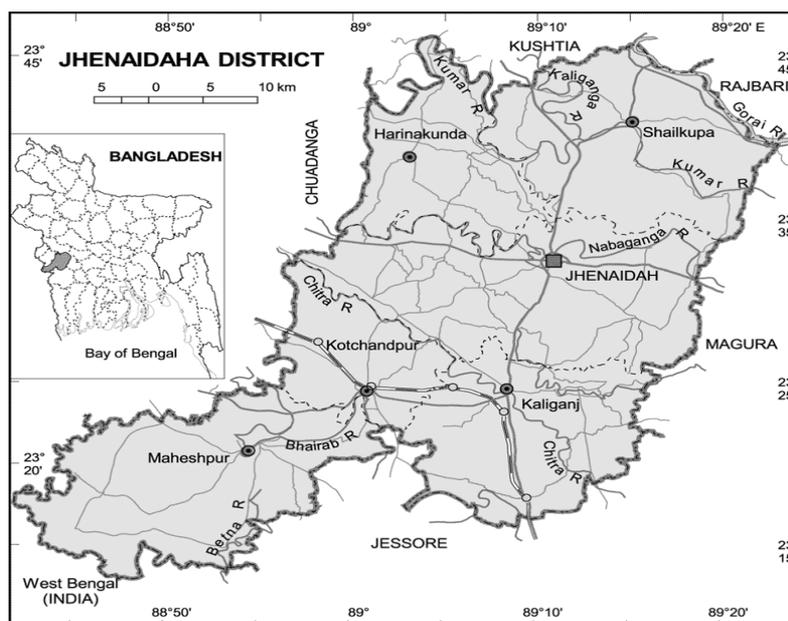


Figure 01: Map of the study area (source: Banglapedia)

IV. MATERIALS AND METHODS

It is the most important part of the present study for the degree of accuracy of analytical results. Before collection of the water samples, a field work was completed in Jhenaidah Municipal area. For ground water sampling, plastic bottles were collected and washed well with household fresh water about 6 or 7 times and then washed with distilled water about 2 or 3 times. The capacity of the volume of the sample bottle was 1 litre. Before sampling from the boreholes, the plastic bottles were rinsed with sample water about 2 times and the wells were pumped groundwater out of the wells sufficiently (at least ten minutes) so that groundwater samples were can represent the groundwater chemistry from where the samples were taken. Total 19 samples were collected from different municipal areas of Jhenaidah district, Bangladesh (Table 01). Immediately after collecting each water sample, pH, EC and TDS were measured in the field by a portable pH (HANNA) and EC/TDS meter (HANNA). Then the collected water samples were sealed on site. After collecting water samples were brought to the laboratory and kept below 4°C temperature. The rest of the water analyses were carried within two weeks from sample collection.

Table 01: Description of different sampling stations

Sample ID	Name	Location		Screen depth
Jh/GW/01	Humdo (Sadhupatee Secondary)	23°31.804N	89°10.265E	150 feet
Jh/GW/02	Jamee Masjeed (Truck Terminal)	23°32.226N	89°10.058E	75 feet
Jh/GW/03	Baperi para (Jurapukur)	23°32.608N	89°10.014E	250 feet
Jh/GW/04	Puratan Kaller Bazar	23°33.195N	89°09.053E	59 feet
Jh/GW/05	Laksmikul	23°33.185N	89°08.957E	120 feet
Jh/GW/06	Beergopinathpur	23°33.162N	89°08.662E	55 feet
Jh/GW/07	Joardarpara	23°33.720N	89°09.922E	90 feet

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 10, October 2018

Jh/GW/08	Arappur	23°33.194N	89°10.609E	120 feet
Jh/GW/09	Mid Arappur	23°32.220N	89°10.510E	105 feet
Jh/GW/10	Bananipara Bazar	23°32.490N	89°10.615E	220 feet
Jh/GW/11	Bananipara	23°32.200N	89°10.570E	270 feet
Jh/GW/12	Upazila Office premise	23°32.494N	89°10.647E	470 feet
Jh/GW/13	Old DC Court	23°32.700N	89°10.513E	105 feet
Jh/GW/14	Kalabagan (Phulhati Bridge)	23°32.945N	89°10.737E	150 feet
Jh/GW/15	Bhaistapur Bridge (Pabahatee)	23°33.932N	89°12.002E	100 feet
Jh/GW/16	Markeej Mashjid	23°32.978N	89°11.051E	465 feet
Jh/GW/17	Bhatiargadi (Uttarpara)	23°32.333N	89°11.202E	125 feet
Jh/GW/18	HamdoMolla Para (Purba Para)	23°32.101N	89°10.616E	200 feet
Jh/GW/19	Bypass Moor (Choto Kamr Kunda)	23°31.394N	89°10.193E	110 feet

In the experimental works, all of the Physical and Chemical parameters were measured in the laboratory of Environmental Science Discipline, Khulna University. The Physico-chemical parameters were determined by using the following methods/ instruments and the parameters units are given in the following **Table 02**.

Table 02: Methods of laboratory analysis of physico-chemical parameters

Physico-chemical parameters	Unit	Methods/Instruments
pH	Nil	HANNA instruments, pH 211(Microprocessor pH meter)
EC, TDS	µS/cm	TDS meter (HI-9635)
Na⁺, K⁺	mg/L	Flame photometric method (Flame photometer-models PEP 7)
Ca²⁺, Mg²⁺	mg/L	Titrimetric method using standard EDTA
HCO₃⁻	mg/L	Potentiometric titration method
H₄SiO₄, SiO₂, PO₄³⁻, SO₄²⁻	mg/L	UV-visible spectrophotometer method
Cl⁻	mg/L	Argentometric method (AgNO ₃ method)

V. RESULTS AND DISCUSSION

The results obtained from the study of some physicochemical parameters of drinking water samples collected from Jhenaidah Municipal area, Bangladesh have been shown in **Table 03** and **Table 04**.

Table 03: Physico-chemical parameters of the drinking water

Sample ID.	pH	EC	TDS	Na ⁺	K ⁺	Ca ²⁺	Mg ²⁺
		µS/cm	mg/L	mg/L	mg/L	mg/L	mg/L
JH/GW/C1/01	7.19	660	485.408	13.500	2.800	82.062	9.519
JH/GW/C1/02	7.58	494	447.297	13.800	2.700	54.094	18.275
JH/GW/C1/03	7.22	484	566.091	18.250	3.000	60.055	30.458
JH/GW/C1/04	7.43	750	596.669	15.800	3.500	58.055	36.549
JH/GW/C1/05	7.66	588	548.107	19.250	4.000	50.039	34.519
JH/GW/C1/06	7.64	293	356.213	13.800	2.100	36.070	16.153
JH/GW/C1/07	7.47	495	579.523	72.500	1.900	28.055	32.488

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 10, October 2018

JH/GW/C1/08	7.36	723	645.149	32.800	2.900	64.086	28.610
JH/GW/C1/09	7.45	673	639.491	30.000	3.200	52.101	38.580
JH/GW/C1/10	7.33	860	642.965	24.250	4.000	68.078	26.702
JH/GW/C1/11	7.33	580	684.413	20.250	2.900	72.172	29.214
JH/GW/C1/12	7.35	718	710.322	32.250	3.200	67.109	24.488
JH/GW/C1/13	7.25	783	564.312	28.250	4.100	60.039	28.763
JH/GW/C1/14	7.28	510	566.503	12.800	1.300	66.070	30.458
JH/GW/C1/15	7.75	558	588.296	17.800	2.800	74.047	28.580
JH/GW/C1/16	7.59	675	703.545	21.000	3.300	62.062	29.793
JH/GW/C1/17	7.18	675	657.977	29.000	2.000	64.047	28.885
JH/GW/C1/18	7.18	600	620.816	23.800	3.000	54.070	34.641
JH/GW/C1/19	7.29	640	769.285	28.750	3.300	74.047	32.793

The spatial (19 sampling stations) showed a distinct variation in physical properties and chemical composition of the ground water in the study area.

Table 04: Chemical parameters of the drinking water

Sample ID.	HCO ₃ ⁻ mg/L	Cl ⁻ mg/L	SO ₄ ²⁻ mg/L	PO ₄ ³⁻ mg/L	H ₄ SiO ₄ mg/l	SiO ₂ mg/L
JH/GW/C1/01	300.000	18.995	0.500	0.032	58.000	36.250
JH/GW/C1/02	260.000	43.175	0.250	0.004	55.000	34.375
JH/GW/C1/03	354.000	24.815	0.510	0.004	75.000	46.875
JH/GW/C1/04	369.000	45.990	2.600	0.175	65.000	40.625
JH/GW/C1/05	330.000	57.355	0.940	0.004	52.000	32.500
JH/GW/C1/06	210.000	28.360	0.830	0.900	48.000	30.000
JH/GW/C1/07	398.000	10.635	0.940	0.005	35.000	21.875
JH/GW/C1/08	430.000	40.265	0.480	0.008	46.000	28.750
JH/GW/C1/09	425.000	31.905	0.860	0.845	57.000	35.625
JH/GW/C1/10	410.000	35.715	1.400	0.320	72.500	45.313
JH/GW/C1/11	427.000	38.995	1.150	0.233	92.500	57.813
JH/GW/C1/12	425.000	32.900	0.200	0.175	125.000	78.125
JH/GW/C1/13	360.000	42.170	0.500	0.490	40.000	25.000
JH/GW/C1/14	348.000	38.995	0.480	0.900	67.500	42.188
JH/GW/C1/15	365.000	28.360	0.400	0.310	71.000	44.375
JH/GW/C1/16	380.000	40.900	3.900	0.090	162.500	101.563
JH/GW/C1/17	400.000	42.540	0.500	0.006	91.000	56.875
JH/GW/C1/18	389.000	37.905	0.750	0.150	77.500	48.438
JH/GW/C1/19	458.000	31.905	0.200	0.290	140.000	87.500

pH: The chemical composition of the groundwater in the study area is variable with pH values ranging from 7.75 to 7.18 these results indicate that the groundwater of the study area shows a gentle pH range and most of the groundwater is very much weakly alkaline and they are not varied in spatial area.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 10, October 2018

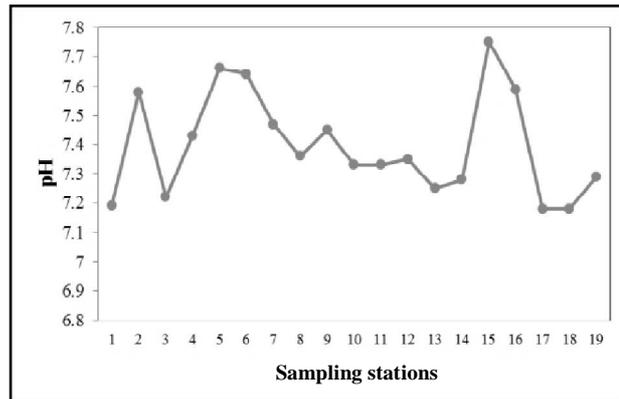


Figure 02: Spatial variation of pH at different sampling stations

The maximum value of pH was found at Bhaiatapur Bridge (sample no. 15) areas with a pH value of 7.75. pH in the most natural waters falls approximately within the range of 4 to 9, depending on the concentration of carbonate, bicarbonate and hydroxyl ions present [15].

EC and TDS: Electrical conductivity (EC) varied from 860 $\mu\text{S}/\text{cm}$ to 293 $\mu\text{S}/\text{cm}$ in study area. The electrical conductivity content showed a gradual changes pattern along the spatial variation.

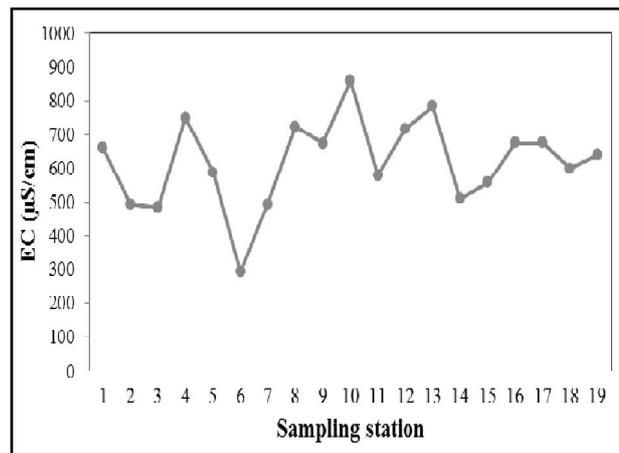


Figure 03: Spatial variation of EC at different sampling stations

Similar gradual changes pattern was observed in case of TDS values. The highest value of TDS were found in groundwater 769.28 mg/L and minimum value 356.21 mg/L.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 10, October 2018

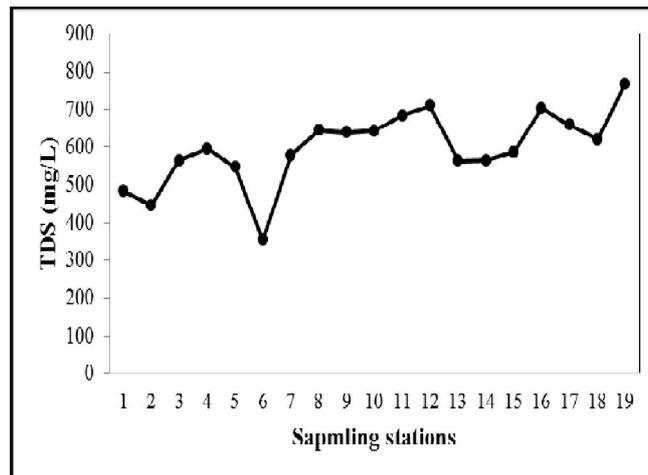


Figure 03: Spatial variation TDS at different sampling stations

From graph of both TDS and EC, it was noticed that they differ from each other in some stations and their maximum values station were different. However, at the same time sample GW/06 has the minimum value for both EC and TDS.

Major cations: Major cations included Na^+ , K^+ , Ca^{2+} , and Mg^{2+} shown in table 03. Calcium was high in concentration, which was from 82.062 mg/L to 28.055 mg/L, and the lowest was Potassium 4.1 mg/L to 0.475 mg/L. Sodium concentration 72.5 mg/L to 12.8 mg/L. Magnesium was found ranging from 38.579 mg/L to 9.519 mg/L.

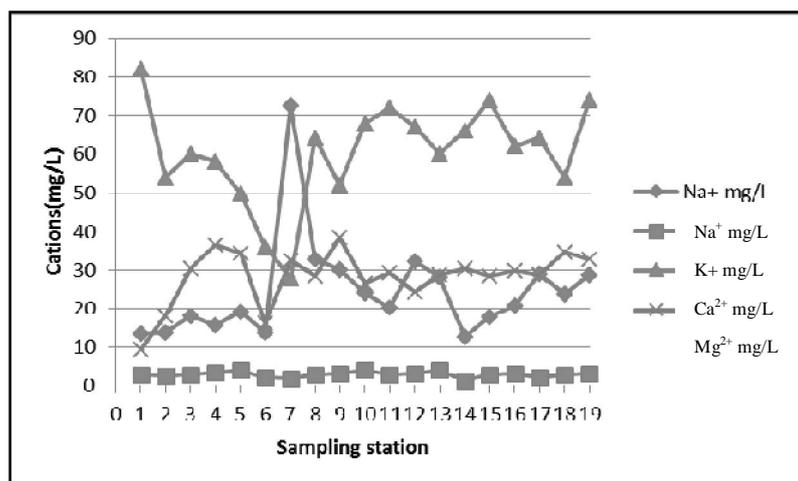


Figure 04: Spatial variation of the major cations of groundwater

The ionic order of the major cations from highest to lowest is $\text{Ca}^{2+} > \text{Na}^+ > \text{Mg}^{2+} > \text{K}^+$. From the figure it was seen that K^+ value do not differ or varied in study area but Na^+ showed a variation in sampling station and Ca^{2+} also Mg^{2+} showed a little variation in study area.

Major anions: Major anions included Cl^- , SO_4^{2-} , PO_4^{3-} , and HCO_3^- shown in Table 03. The concentration of bicarbonate was higher than others and it ranges 458 mg/L to 210 mg/L. The lowest concentration showed by phosphate between 0.03 mg/L to 0.004 mg/L.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 10, October 2018

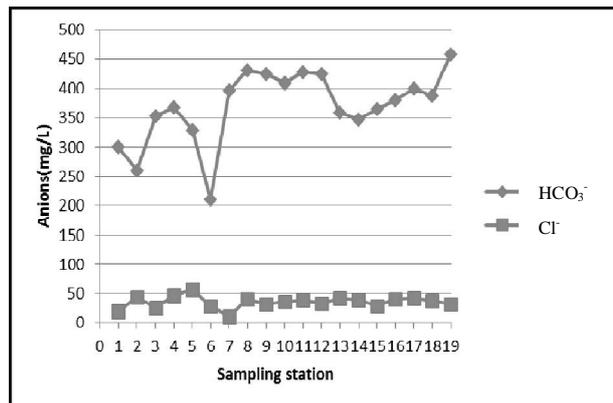


Figure 05: Spatial variation of major anions of ground water

Chloride show the concentration between 57.355 mg/L to 10.635 mg/L and sulfate is between 3.9 mg/L to 0.2 mg/L. The ionic order of the major anions from highest to lowest is $\text{HCO}_3^- > \text{Cl}^- > \text{SO}_4^{2-} > \text{PO}_4^{3-}$.

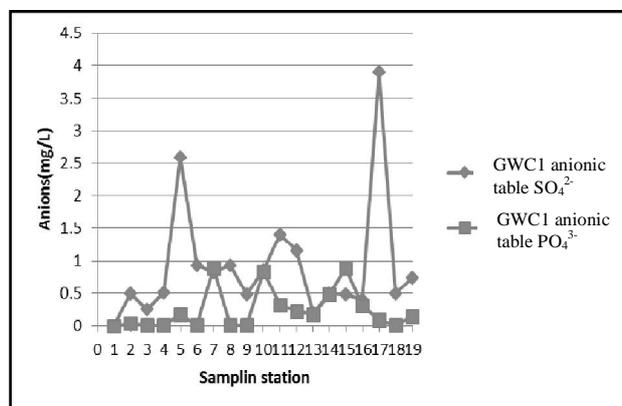


Figure 05: Spatial variation of major anions of ground water

Quality comparison with WHO standards: Not all the water around us is potable. Different types of water have different quality and significance quality is required for specific purpose. Groundwater is mainly used for drinking and household purpose. It is closely related to the health of the person who drinks it. So, the quality should be maintained on the basis regional and world standards. To assess the suitability of people, water for drinking, WHO (world Health Organization) and Bangladesh has standards for different parameters [16]. Along with the standards they are reported here. The EC was higher in water sample. The gastrointestinal irritation in human being may be due to higher EC content in ground water. Here EC values do not exceed the permissible limit by WHO. None of sample crossed the desirable limit in case of SO_4^{2-} , Cl^- and K^+ but except those others parameter crossed their desirable limit. But none of the ground water sample indicated the higher concentration exceeding the maximum allowable limit. Since the ground water of study area belongs within the permissible limit so it was safe from various types of health hazards causes by high concentration of ion (**Table 06**).

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 10, October 2018

Table 05: Drinking water quality comparison with WHO standard [9]

Parameter	WHO standard (1997) (desirable- permissible)	Sample exceeding desirable limits	Sample exceeding permissible limits
EC ($\mu\text{S}/\text{cm}$)	500-1500	All but 02, 03, 06, 07	None
TDS (ppm)	500-1500	All but 01, 02, 06	None
Na ⁺ (ppm)	50-200	07	None
K ⁺ (ppm)	10-12	None	None
Ca ²⁺ (ppm)	75-200	01	None
Mg ²⁺ (ppm)	30-150	03, 04, 05, 07, 14, 18, 19	None
Cl ⁻ (ppm)	250-600	None	None
HCO ₃ ⁻ (ppm)	300-600	All but 01, 02, 06	None
SO ₄ ²⁻ (ppm)	200-600	None	None
PO ₄ ³⁻ (ppm)	-	-	-

Drinking water quality comparison with Bangladesh standards: Numerous water quality problems exist in ground water system in Bangladesh, especially in southeastern. The recommended maximum permissible limit for the calcium and magnesium concentration in drinking water are exceeding by sample 01 and 04, 09 respectively (Table 06). Other parameter didn't show any potential health hazards in the present study. So it can be said that the ground water of study area is suitable for drinking except some hardness issue to some extent.

Table 06: Drinking water quality comparison with Bangladesh standards [10]

Parameter	Bangladesh standards	Sample exceeding maximum allowable limits
EC($\mu\text{S}/\text{cm}$)	1000	None
TDS (ppm)	1000	None
Na ⁺ (ppm)	200	None
K ⁺ (ppm)	12	None
Ca ²⁺ (ppm)	75	01
Mg ²⁺ (ppm)	30-35	04, 09
Cl (ppm)	150-600	None
HCO ₃ (ppm)	-	None
SO ₄ ²⁻ (ppm)	400	None
PO ₄ ³⁻ (ppm)	6	None

VI. CONCLUSION

The physiochemical analysis of ground water considering both water quality standard and spatial variations of the Jhenaidah municipality situated in southwest coastal Bangladesh suggests that the water in this municipality are safe for drinking and domestic uses except some hardness issue. The dominant concentration of Ca²⁺ and HCO₃⁻ indicated that the water chemistry probably controlled by carbonate weathering and silicate weathering. Non-considerable spatial variations of concentration of ions have been found in the Jhenaidah municipality, major cationic order found was observed Ca²⁺ > Na⁺ > Mg²⁺ > K⁺ and major anionic order was HCO₃⁻ > Cl⁻ > SO₄²⁻ > PO₄³⁻. This study confirms that most of the major physical and chemical parameters of ground water meet the Bangladesh and WHO standard with little deviation and it reflect their suitability of drinking and domestic purposes. Now a continuous assessment of the groundwater is needed in this locality to verify the temporal variation as well as the contaminations possibility by trace metal or heavy metal.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 10, October 2018

REFERENCES

- [1] S. K. Dhaka and N. Bhaskar, Assessment of Ground Water Quality in Terms of Water Quality Index and Regression Analysis of Water Quality Parameters, Journal of Basic and Applied Engineering Research, Vol. 4(4), pp. 339-342,2017.
- [2] R. K. Biswas, M. K. Roy and K. I. Haque, Assessment of Groundwater Quality for Drinking Purpose in Some Parts of Jhenaidah District, Bangladesh. International Journal of Geology, Earth and Environmental Sciences, Vol. 3(1), pp. 195-204,2013.
- [3] N. Aghazadeh and A. A. Mogaddam, Assessment of Groundwater Quality and its Suitability for Drinking and Agricultural Uses in the Oshnavieh Area, Northwest of Iran, Journal of Environmental Protection, Vol. 1, pp. 30-40,2010.
- [4] S. Singh, N. J. Raju and C. Ramakrishna, Evaluation of Groundwater Quality and Its Suitability for Domestic and Irrigation Use in Parts of the Chandauli-Varanasi Region, Uttar Pradesh, India. Journal of Water Resource and Protection, Vol. 7, pp. 572-587, 2015.
- [5] J. Sowrabha and J. Narayana, Assessment of ground water quality using for drinking purpose in Shivamogga Town, Karnataka, India. International Journal of Current Microbiology and Applied Science, Vol. 3(12), pp. 381-388,2014.
- [6] S. Sarder, M. N. Uddin, M. S. Reza and A. H. M. N. Jamil, Evaluation of Drinking Water Quality in Jessore District. Bangladesh. Journal of Biotechnology and Biochemistry, Vol. 3(4), pp. 59-62,2017.
- [7] A. Narsimha, N. Anitha, V. Sudarshan and Manjulatha, Evaluation of Groundwater Quality and Its Suitability for Drinking Purposes in Gunthakal Area, Ananthapur District, Andhra Pradesh, India, Advances in Applied Science Research, Vol. 4(2), 70-76, 2013.
- [8] H. Annapoorna and M. R. Janardhanab, Assessment of Groundwater Quality for Drinking Purpose in Rural Areas Surrounding a Defunct Copper Mine, International conference on water resources, coastal and ocean engineering, Elsevier B.V. Aquatic Procedia, Vol. 4, pp. 685 – 692, 2015.
- [9] D. Dohare, S. Deshpande and A. Kotiya, Analysis of Ground Water Quality Parameters: A Review. Research Journal of Engineering Sciences, Vol. 3(5), pp. 26-31, 2014.
- [10] M. Sultana, A. S. M. Saifullah, M. B. Latif, S. A. Mamun and D. S. Sultana, Drinking Water Quality at Academic Institutions of Tangail Municipality, Journal of Environmental Science & Natural Resources, Vol. 6(1), pp. 247 - 252 , 2013.
- [11] M. Akter, T. Sikder and A. K. M. A. Ullah, Water Quality Assessment of an Industrial Zone Polluted Aquatic Body in Dhaka, Bangladesh, American Journal of Environmental Protection, Vol. 3(5), pp. 232-237, 2014.
- [12] A. Rahman, P. Ahamed, M. Jamal, M. A. Salam and M. A. Yousuf, Analyses of Private Drinking Tube-Wells Water From Kushtia District, Bangladesh, Journal of Engineering Science, Vol. 8(1), pp. 87-94, 2017.
- [13] M. E. Haque, J. Islam, S. M. S. Ahmed, K. M. M. Islam and N. Muhammad, Major Ion Chemistry of the Groundwater under Jhenaidah District of Bangladesh for Irrigation, Drinking and Industrial Uses, International Research Journal of Pure & Applied Chemistry, Vol. 10(4), pp. 1-14, 2016.
- [14] DoE (Department of Environment), Bangladesh Gazette, No. DA-1, Ministry of Environment and Forest, pp. 1324-1327, 2005.
- [15] R. Ramesh and M. Anbu, Chemical Methods for Environmental Analysis-Water Sediment, Macmillan India Ltd., pp. 15-67, 1996.
- [16] WHO, Guideline for Drinking Water Quality, Geneva, Switzerland, Vol. 1, 1997.