Proceedings of the 4th International Conference on Civil Engineering for Sustainable Development (ICCESD 2018), 9~11 February 2018, KUET, Khulna, Bangladesh (ISBN-978-984-34-3502-6)

ASSESSMENT OF SUPPLIED WATER QUALITY OF RAJSHAHI WASA (RWASA) IN BANGLADESH

K Roy[1], S Akter[2] and M Islam[4]

[1] Lecturer, Department of Civil Engineering, Rajshahi University of Engineering & Technology, Rajshahi-6204, Bangladesh, e-mail: roykeya0944@gmail.com
[2] Department of Civil Engineering, Rajshahi University of Engineering & Technology, Rajshahi-6204, Bangladesh, e-mail: polyce67@gmail.com
[3] Department of Civil Engineering, Rajshahi University of Engineering & Technology, Rajshahi-6204, Bangladesh, e-mail: monzurul.ruet12@gmail.com

ABSTRACT

Recently, adequate and safe drinking water is a challenging issue in developing countries like Bangladesh. Poor quality of drinking water becomes injurious to human health. Rajshahi, the sixth largest city in Bangladesh, is facing drinking water scarcity. To overcome the scarcity, Rajshahi WASA is supplying water in Rajshahi city through a distribution network. However, according to peoples perception, the quality of water is very poor. The main objective of this study is to investigate the quality of water in those locations in the city where problems have arisen and to attempt to help and concern WASA about the condition of water quality. By surveying, defective areas, where poor quality of water was found, were selected and samples were collected from there according to the objection of local consumers who take up that water from Rajshahi WASA. Water quality parameters collected from different consumers against their sources (WASA point) were tested in the laboratory. These parameters include p^H, turbidity, iron (Fe), hardness and odor. From the lab test, it was noted that p^H of water in the selected areas was in allowable limt. However, in few wards, turbidity, iron, hardness, and odor deviated from their standard values. Health effect of iron includes warding off fatigue and anemia. Due to unpleasant odor of water, possible health effect including gastrointestinal illnesses (diarrhea, vomiting, cramps) may occur. Excessive turbidity, or cloudiness, in drinking water is aesthetically unappealing and may also represent a health concern. Water with excessive amounts of iron can have negative effects on the skin. So, Rajshahi City Corporation and Rajshshi WASA should take proper steps to improve water quality by proper treatment.

Keywords: *RWASA, quality assessment, physical parameter, chemical parameter.*

1. INTRODUCTION

Water is one of the most significant ingredients on earth as we use it to fulfill our daily necessities. Good drinking water quality is one of the most important elements to build human physiology and man's continued existence depends very much on its availability. An average man (of 53 kg – 63 kg body weight), requires about 3 litres of water in liquid and food daily to keep healthy. The importance of water to a human being cannot be over emphasized. A man can survive longer without food than without water. This fact apparently accounts for why water is regarded as one of the essential substances in life (Etim, Odoh, Itodo, Umoh, & Lawal, 2013). Increase in human population has exerted a vast pressure on the provision of safe drinking water especially in developing countries like Bangladesh. In Rajshahi, the water crisis was very high in the past few decades. To overcome the crisis of water in Rajshahi City Corporation, Rajshahi WASA was established in 2013 which provides water to the households of this city. But Rajshahi WASA could not serve satisfactory level of water quality to their consumers. But the water, they are distributing and the consumers are receiving, is being polluted in various ways as toxic and harmful elements. Possible cause of water pollution in Rajshahi city may be due to geological conditions, water treatment plants, pipe leakage of water treatment plants, corrosion of pipe of distribution system, due to increased human population, industrialization, the use of fertilizers in the agriculture and

man-made activity it is highly polluted with different harmful contaminants(Sagar, Chavan, Patil, Shinde, & Kekane, 2015). Even many consumers complain that they face odor problem, hair fall problems due to use this water.

According to the World Health Organization (WHO), 89% of the world population consumes drinking water from improved drinking water sources .Improved drinking water sources include piped treated water connections, public standpipes and protected dug wells (Alam, Dafader, Sultana, Rahman, & Taheri, 2017). Therefore, it is necessary that the quality of drinking water should be checked at a regular time interval because due to use of contaminated drinking water, the human population suffers from various water borne diseases (Sagar et al., 2015). Moreover, water quality control is a crucial part of environmental pollution studies (Murino & Palmieri, 2017). A number of scientific procedures and tools have been developed to assess the water contaminants. These procedures include the analysis of different physical parameters such as pH, turbidity, conductivity and chemical parameters like iron, chloride .These parameters can affect the drinking water quality adversely if their values are in higher concentrations than the safe limits set by the World Health Organization (WHO) and other regulatory bodies (Rahmanian et al., 2015).From the investigation of public opinion and lab test water quality in RCC ,it is revealed that iron, turbidity, and odor is the major problems to deteriorate water quality .These three parameters deviate from their standard extremely.

This study represents the maximum and minimum values of physical parameters including turbidity, pH, odor and chemical parameters including hardness and iron against WHO standard and Bangladesh standard values. According to the analysis, if the parameters present in water is lower or higher than the required value the quality is deteriorated. The main purpose of this study is to investigate water quality with respect to locations where problems have appeared and to perform lab analysis about which of water quality parameters of defective locations deviate from their standard values. Furthermore, an attempt has also been made to concern and help Rajshahi City Corporation (RCC) and Rajshahi WASA by delivering noticeable information about the present condition of water quality in RCC and make them cautious to provide good quality water.

2. STUDY AREA

Rajshahi City-corporation is one of the six city-corporations located in the north-west part of Bangladesh. It lies between $24^0 21^/$ and $24^0 26^/$ north latitudes and between $88^0 28^/$ and $88^0 37^/$ east longitudes. The city is bounded on the east, north, and west by Paba Thana and on the south by the Padma River and the shape of the city is as like an inverted “T” with an area of about 47.78 sq. km (RCC). The maximum length along east-west direction is about 13 km and along north-south is 8 km (Rahman, 2004)

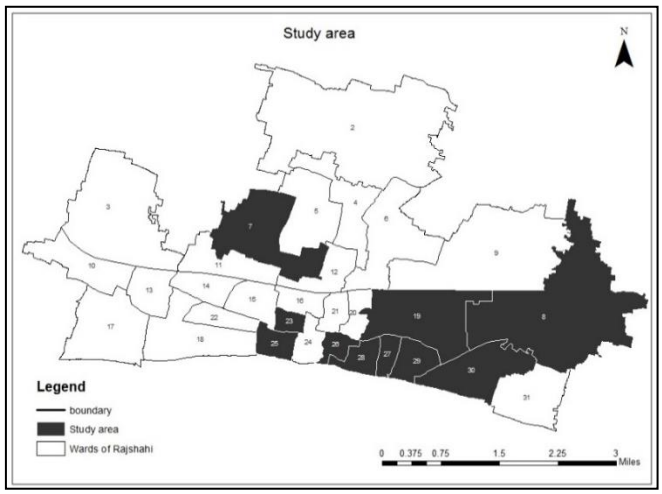

Figure 1: Study Area (prepared by author from Google Earth)

3. METHODOLOGY

3.1 Selection of sampling points

The criteria for selecting sampling points were based on the population density, geographical location, defective residential areas where problems have arisen are prosecuted in WASA by consumers against their sources. Out of 30 wards of RCC, 10 wards were selected for the present study based on public problems, which mainly covers the center part of the city. According to public objectives, 3 consumers (**S_1, S_2** and**S_3)** point were selected for each ward. All targeted locations are summarized in Table 1 and presented in Fig. 1.

Table 1: Water sample collection points (consumers and RWASA)

WASA Points(Source)	Ward No	Source of consumer(3 sample collect from different consumers)
Shipaipara pump	Ward 8	S_1 , S_2 , S_3
Dargapara pump	Ward 9	S_1 , S_2 , S_3
Shiroil colony jame moshjid	Ward 19	S_1 , S_2 , S_3
Ahammednagor	Ward 23	S_1 , S_2 , S_3
Talaimari shahidminar	Ward 25	S_1 , S_2 , S_3
Meherchandi alaka	Ward 26	S_1 , S_2 , S_3
Adorsho school	Ward 27	S_1 , S_2 , S_3
Kazla	ward 28	S_1 , S_2 , S_3
Khojapur ghorosthan	Ward 29	S_1 , S_2 , S_3
Binodpur	Ward 30	S_1 , S_2 , S_3

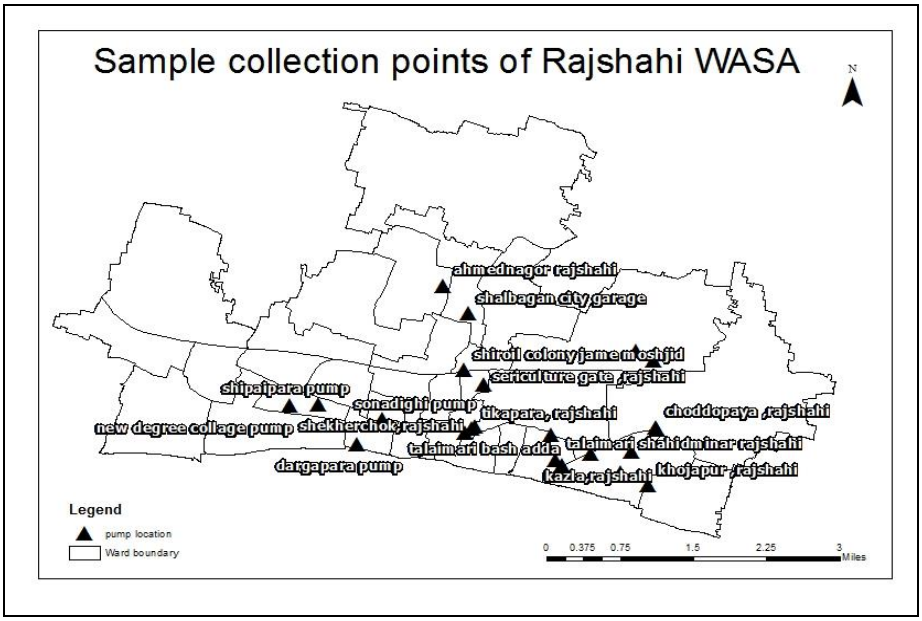

Figure 2: Sample collection points of Rajshahi WASA (Source: Google Earth)

3.2 Sample collection

All drinking water samples were taken from tap water of residential area from different consumers of different locations as well as from where consumers get those tap water in their households. The samples were marked according to their sources and consumers. The samples were collected in1-litre polyethylene (PE) bottles, which were pre-treated by washing with dilute HCl (0.05m) and later rinsed with distilled water. They were then air-dried in a dust free environment (Etim et al., 2013). Collected samples were promptly carried to the Environmental Engineering laboratory of the Department of Civil Engineering of RUET. These sample bottles were sealed and placed in a dark environment at a constant temperature range to avoid any contamination and the effects of light and temperature (Rahmanian et al., 2015).

4. ANALYSIS AND RESULTS

4.1 Analytical instruments

All physical and chemical parameter analyses are performed according to the standard methods for the examination of water.

4.1.1 Immediate analysis

Some physical parameters of water were measured as soon as possible after collecting the samples due to obtaining an accurate value. These parameters include Turbidity. All probes should be thoroughly rinsed and completely dried with lint- free wipes or compressed air. The recommended order for calibration of the individual probes on a multipara meter is p^H, and turbidity(WHO, 2008). Almost all these important water quality parameters were measured within four hours of collection.(Fahmida, Lemon, Islam, & Kader, 2013)

4.1.2 Lab analysis

Chemical parameters were performed by lab analysis. These parameters include iron, hardness .The concentration of Iron, hardness are determined by titration method. To investigate the quantity of iron in water some chemicals involve KCN, standard iron solution, 0.3N HCL, $KmnO_4$ (if necessary) were used. The p^H of the water samples was measured by

using multi-parameter analyzer (Model DZB-718). The instrument used to determine turbidity is turbidity meter. The test to indicate hardness was done by soda reagent method in the laboratory. Required chemical included 0.02N H_2SO_4, Methyl orange indicator, and soda reagent. Iron in the sample was indicated by titration method in the laboratory. $KmnO_4$, KCN, iron solutions and distilled water were required.

4.2 Physical parameter analysis

4.2.1 PH level

pH is defined as one of the most important water quality parameters. pH value indicates the acidity or alkalinity of the water (Rahmanian et al., 2015). A sample is considered to be acidic if the pH is below 7.0. It is alkaline if the pH is higher than 7. Alkaline water shows disinfection in water (Alam et al., 2017). Both alkaline and acidic water harmful to people.

The normal drinking water pH range mentioned in WHO standards and BDS guidelines are between 6.5 and 8.5. The pH values of all the drinking water samples were found in the range between 6.5 and 8.5 (Fig- 3). So, pH of all samples should remain within allowable limit according to WHO standards and BDS guideline.

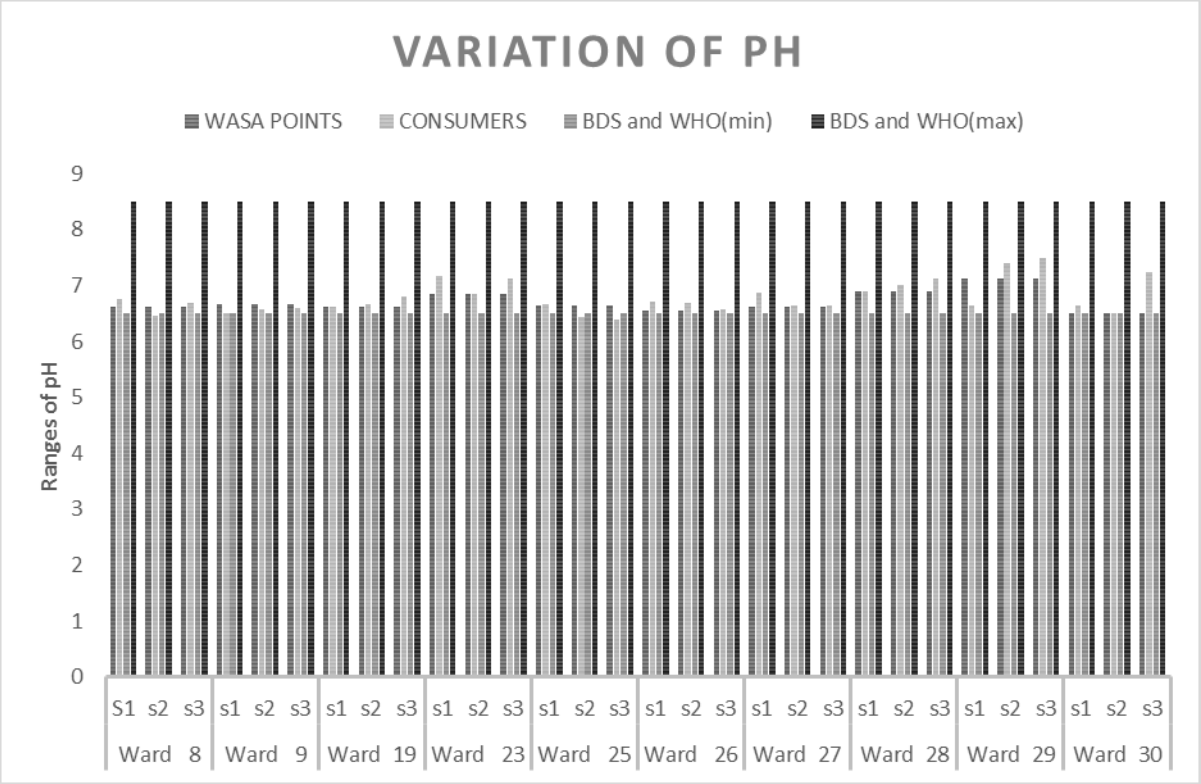

Figure 3: Variation of p^H

4.2.2 Odur

The odor is one of the most important parameters of water and water must be odorless(Hossain, Nahida, & Hossain, 2014). But this study result shows that about 90% sample found objectionable odor. The odor was determined by the threshold odor number (TON).Study results of all samples for odor are represented in (Fig- 3)

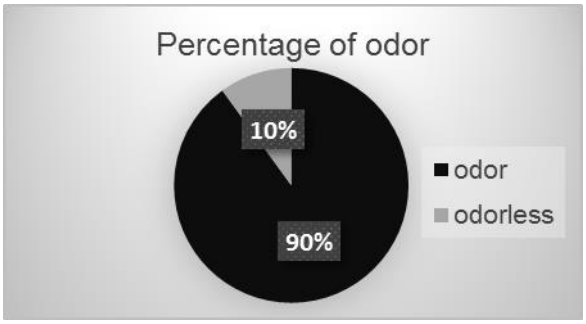

Figure 4: Percentage of odor

4.2.2 Turbidity

An excess amount of Turbidity of water is not suitable as it causes quick clogging of filtered. Turbidity is a measure of light transmission and indicates the presence of suspended material (Rajon & Bari, 2014). According to WHO standards & BDS guideline the allowable turbidity for drinking water is 5 NTU and 10 NTU respectively. Turbidity in excess of 5 NTU is usually objectionable for aesthetic reasons.

It is clear that from 40 samples, half of the samples collected from consumers exceed their WHO standards. Ward 25, 27, 29 & 30 exceed BDS value. Samples from both consumers and WASA in ward 8, 9, 19, 26 & 23 were within allowable limit according to BDS and WHO standards. The maximum turbidity was found 25.22 NTU in ward 25 from consumer and minimum found 0.52 NTU in RWASA point. It can be seen that there is a variation of turbidity for different collected samples which varies from almost 0-25.22. (Fig- 5).

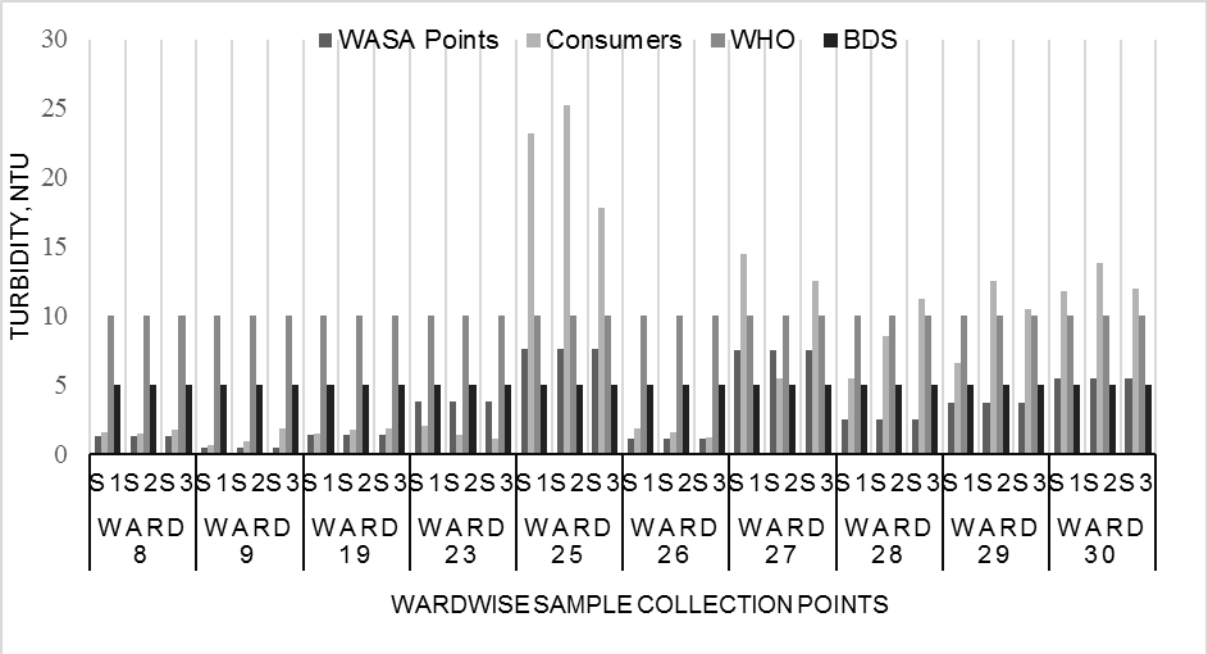

Figure 5: Variation of Turbidity

4.3 Chemical parameters analysis

4.3.1 Iron

Iron is one of the most important constituents of blood in human and another living organism. Iron is an essential element for human nutrition and metabolism, but in excess quantities results in toxic effect like hemochromatosis in tissues(Sagar et al., 2015). Iron enters drinking water supplies from natural deposits in the earth or from agricultural and industrial practice(Fahmida et al., 2013).
4 samples (ward 9 & 26) did not find objectionable iron but rest of the samples found objectionable iron deviated from BDS and WHO standards. The maximum value of iron found 3 mg/l in ward 29 from consumer deviated from BDS and WHO standards and minimum value found 0.02 in ward 9 from Consumer. About 90% samples exceed BDS (Bangladesh drinking water standards) and WHO standards (Fig- 6).

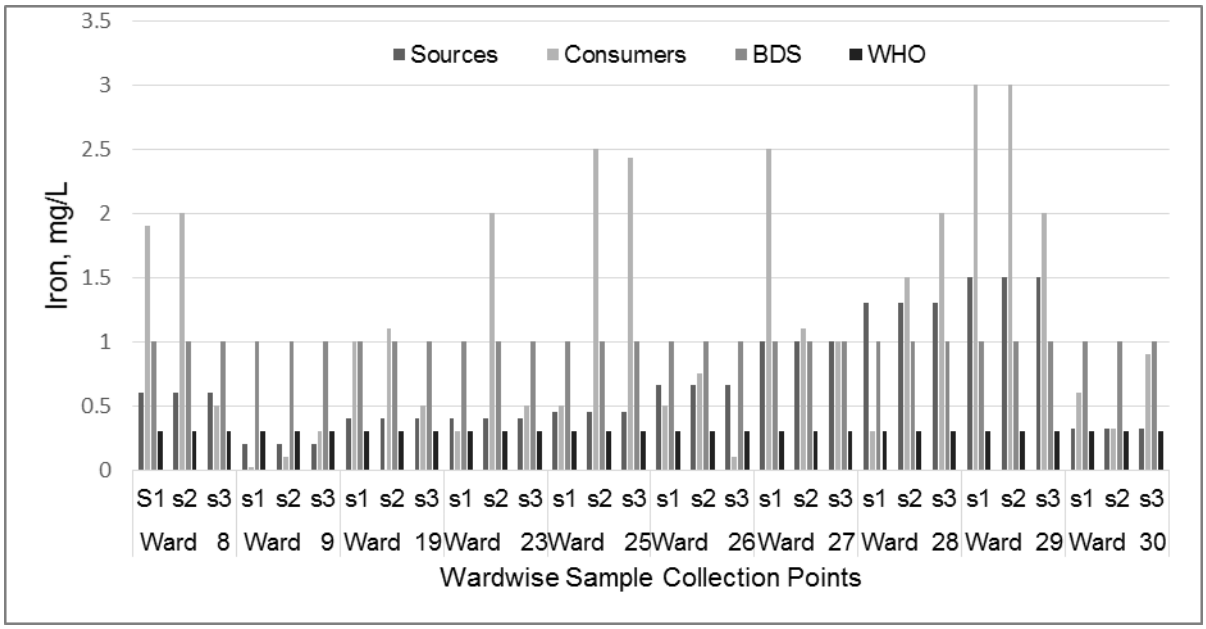

Figure 6: Variation of Iron (Fe)

4.3.2 Hardness (AS $CACO_3$)

Total hardness is the summation of calcium and magnesium hardness in mg/L As $CaCO_3$ (Sagar et al., 2015). Water can be classified as soft (<75 mg/L), moderately hard (75-150 mg/L), hard (150-300 mg/L) and very hard (>300 mg/L) according to the concentration of calcium and magnesium. It is an important criterion for determining the usability of water for domestic, drinking and many industrial applications. Water having hardness below 300mg/L is considered portable, but beyond this limits cause gastro-intestinal irritation (Alam et al., 2017).

Test results show that about 10% samples (ward 26,27 & 30) found very hard, 10% hard(WARD 23, 26 & 28), 45% moderately hard (ward 8, 9 & 25) and 35% soft water (ward 19). Maximum value from the test was 485 mg/L found from ward 27 consumer and the minimum value was 35 mg/L from WASA point. About all samples were within BDS and WHO standards (Fig- 5)

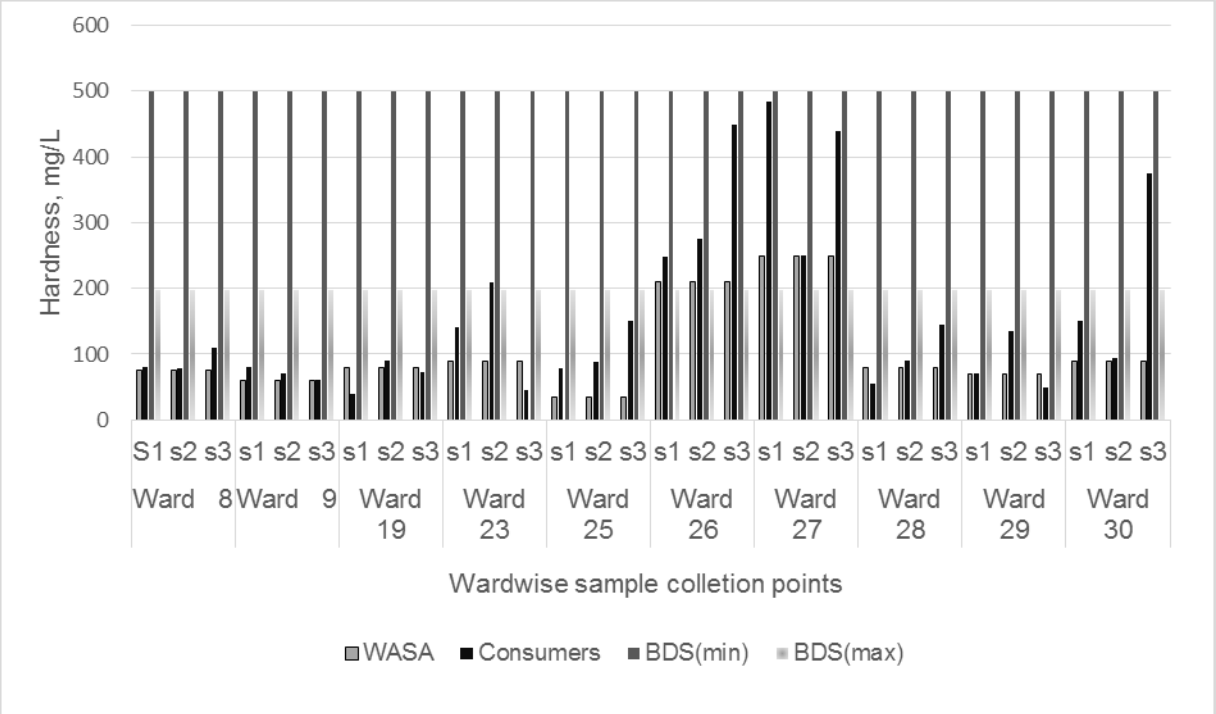

Figure 7: Variation of hardness

Table 2: Maximum and Minimum value of whole samples

Parameter	WASA(max)	Consumer (Max)	WASA (Min)	Consumer (Min)	BDS	WHO standards (2006)
pH	7.3	7.5	6.56	6.40	6.5-8.5	6.5-8.5
Turbidity(NTU)	7.5	25.22	0.52	0.70	10	5
Iron(mg/l)	2	3	0.2	0.02	0.3-1	0.3
Odor	odor	odor	odor	odor	odorless	Odorless
Hardness (mg/l)	150	485	50	200	200-500	500

4.4 Causes of poor quality of water and its health effect

The major source of iron may be the geologic formation of Rajshahi area or iron release from corroded iron pipes in drinking water distribution systems: effect of dissolved oxygen. Odor problems create due to Minerals such as iron or copper, may leach into the water from the pipes or due to Bacteria growing in pipe or from organic matter or bacteria that are naturally present in lakes and reservoirs during certain times of the year("Color ,taste and odor problems in drinking water," 2011). Turbidity is caused by particles suspended or dissolved in water that scatter light making the water appear cloudy or murky (MPCA, 2008).Particulate matter can include sediment - especially clay and silt, fine organic and inorganic matter, soluble colored organic compounds, algae, and other microscopic organisms. Excessive Iron in drinking water is classified as a secondary contaminant according to the EPA (Murino & Palmieri, 2017).

If iron levels are too high, serious health effects like iron overload can develop. Water with excessive amounts iron can have negative effects on your skin. It can damage healthy skin cells, which can lead to wrinkles. Iron leaves residue on anything it touches (Etim et al., 2013). If clean dishes with it, produce orange or dark red stains on plates and cutlery eventually. Excessive turbidity, or cloudiness, in drinking water is aesthetically unappealing, and may also represent a health concern. Turbidity can provide food and shelter for

pathogens (Perlman, 2016). If not removed, turbidity can promote regrowth of pathogens in the distribution system, leading to waterborne disease ("Color ,taste and odor problems in drinking water," 2011). Due to unpleasant odor of water, possible health effect gastrointestinal illnesses (diarrhea, vomiting, and cramps) may occur. When People smell strong odors, it may get headaches or feel dizzy or nauseous(ATSDR, 2017). If an odor lasts a long time or keeps occurring, it also could affect mood, anxiety and stress level.(Sagar et al., 2015) So, drinking and domestic water must be free from physical and chemical contaminants.

4.5 Problems identification from consumers

From the overall investigation of all consumers and by surveying their opinions, it was found that about 46% people complain about facing odor problem, 30% for the iron problem, 17% for turbidity problem and 7% for hardness problem. Especially, in ward 29, 30 and 19, people suffer a lot due to Iron problem. People in ward 29, 30 25 complain that they found black colored water. In the ward, 25 people use turbid water. Almost all wards that were surveyed odor problem is severe. Few ward has some hardness problem.

Table 3: Percentage and frequency of different identified problems according to public objections

Ward no	Turbidity problem	Iron problem	Odor problem	Hardness	P^H
Ward 8	0 (0%)	1(33.33%)	2(66.67%)	0(0%)	0(0%)
Ward 9	1(33.33%)	1(33.33%)	1(33.33%)	0(0%)	0(0%)
Ward 19	0(0%)	2(66.67%)	1(33.33%)	0(0%)	0(0%)
Ward 23	1(33.33%)	1(33.33%)	0(0%)	1(33.33%)	0(0%)
Ward 25	1(33.33%)	0(0%)	2(66.67%)	0(0%)	0(0%)
Ward 26	0(0%)	2(66.67%)	1(33.33%)	0(0%)	0(0%)
Ward 27	0(0%)	2(66.67%)	1(33.33%)	0(0%)	0(0%)
Ward 28	1(33.33%)	1(33.33%)	0(0%)	1(33.33%)	0(0%)
Ward 29	1(33.33%)	2(66.67%)	0(0%)	0(0%)	0(0%)
Ward 30	0(0%)	2(66.67%)	1(33.33%)	0(0%)	0(0%)
sum	5(17%)	14 (30%)	9 (46%)	2 (7%)	0(0%)

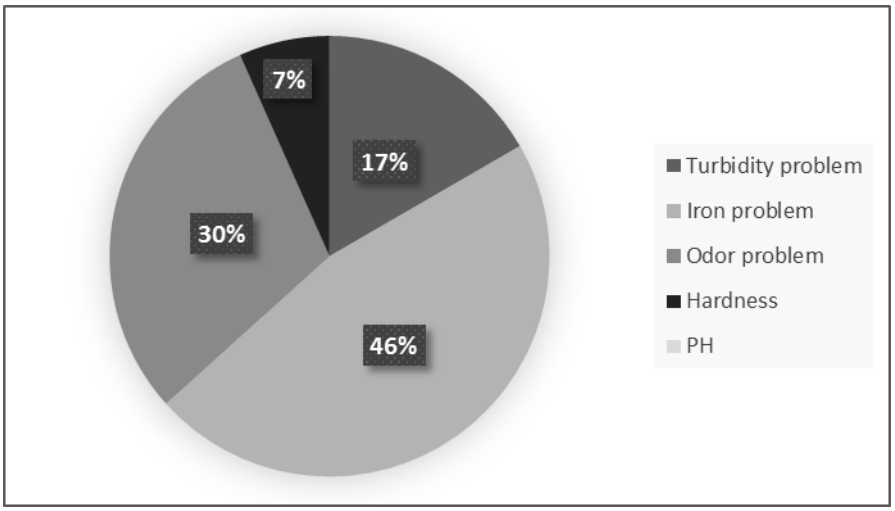

Figure 8: Different investigated problems by surveying consumers opinion

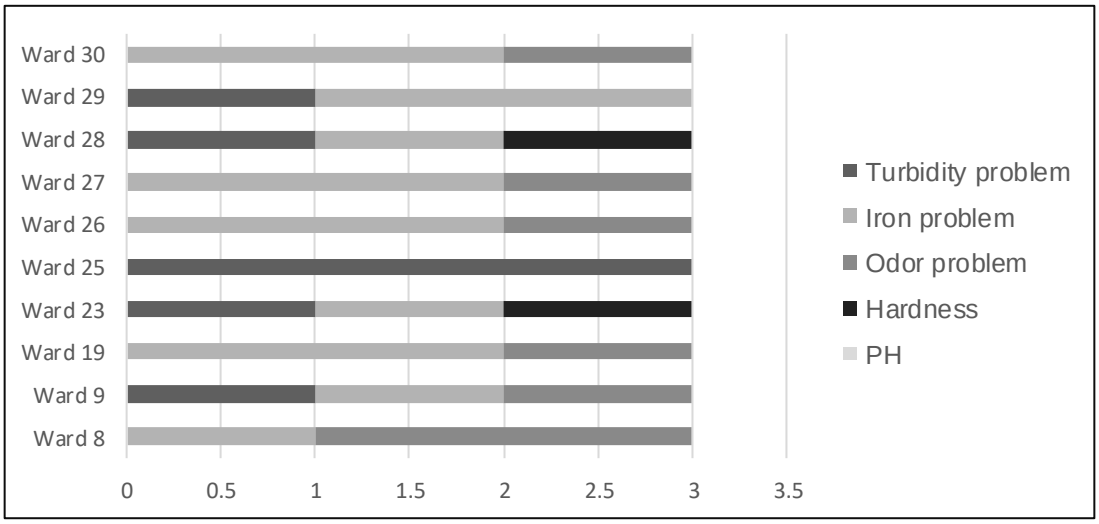

Figure 9: Ward-wise problem identification from public opinion

5. CONCLUSIONS

Rajshahi city householders are suffering from inadequate water supply as well as they suffer from various water related diseases. Water quality test of targeted sample exhibited that water quality of samples is not satisfactory. The p^H values of all the drinking water samples were found in the range between 6.5 and 8.5. So, P^H of all samples remains in within allowable limit according to WHO standards and BDS guideline. The hardness of all samples was within allowable limit for drinking purpose according to BDS guideline. But, the concentration of iron and turbidity in WASA point and household samples of the study area were very high. About 90% samples found to have an odor. In ward 25, turbidity over the tolerable range was found. But the drinking water must be clean and less turbid for sound health. 95% samples have been found to have iron from the lab test and they exceed WHO standard and BDS standard. So, the authority of RWASA should take necessary steps to improve the poor quality of water.

ACKNOWLEDGEMENTS

The authors are highly grateful to the authority of WASA and the department of civil engineering, RUET and Non-teaching staff for providing necessary laboratory facility, for his constant encouragement and support. .They are also highly indebted to the assistant engineer of WASA Md. Mahbubur Rahman, for his painstaking endeavor, to go through the manuscript.

REFERENCES

Alam, M. F., Dafader, N. C., Sultana, S., Rahman, N., & Taheri, T. (2017). Physico-Chemical Analysis of the Bottled Drinking Water available in the Dhaka City of Bangladesh,*Journal of Materials and Environmental Sciences, 8*(6), 2076-2083.

ATSDR. (2017, 10 February). *Environmental Odor.* Retrieved 15 Octobor, 2017, from https://www.atsdr.cdc.gov/odors/faqs.html

Color ,taste and odor problems in drinking water. (2011, january). Retrieved 15 octobor, 2017

Etim, E. E., Odoh, R., Itodo, A. U., Umoh, S. D., & Lawal, U. (2013). Water Quality Index for the Assessment of Water Quality from Different Sources in the Niger Delta Region of Nigeria. *Frontiers in Science, 3*(3), 89-95. doi: DOI: 10.5923/j.fs.20130303.02

Fahmida, K., Lemon, M. H. R., Islam, M. S., & Kader, M. A. (2013). *Assessment of Supplied Water Quality of Khulna WASA of Bangladesh* ,Paper presented at the International Conference on Mechanical, Industrial and Materials Engineering Rajshahi.

Hossain, M. L., Nahida, S. K. N., & Hossain, M. I. (2014). Water quality status of recreational spots in Chittagong City *Journal of Water Resources and Ocean Science, 3*(3), 38-44. doi: doi: 10.11648/j.wros.20140303.12

MPCA. (2008). Turbidity: Description, Impact on Water Quality, Sources, Measures Retrieved 20 October 2017

Murino, J., & Palmieri, J. (2017). 5 Harmful Effects of High Levels of Iron in Water. Retrieved 15 octobor, 2017, from http://www.pbwatersoftening.com/5-harmful-effects-high-levels-iron-water/

Perlman, H. (2016, 2016). Turbidity.Retrieved 15 octobor, 2017, from http://water.usgs.gov/edu/turbidity.html

Rahman, M. M. (2004). Surface Water Quality in Rajshahi City *The Journal of Geo-Environment, 4*, 15-20.

Rahmanian, N., Ali, S. H. B., Homayoonfard, M., Ali, N. J., Rehan, M., Sadef, Y., & Nizami, A. S. (2015). Analysis of Physiochemical Parameters to Evaluate the Drinking Water Quality in the State of Perak, Malaysia. *Journal of Chemistry*.

Rajon, M. A., & Bari, D. M. N. (2014). *Surface Water(Pond) quality of Rajshahi city.* Rajshahi University of Engineering & Technology, Ruet.

Sagar, S., Chavan, R., Patil, C., Shinde, D., & Kekane, S. (2015). Physico-chemical parameters for testing of water- A review *International Journal of Chemical Studies, 3*(4), 24-28.

WHO. (2008). Guidelines for Drinking-water Quality (Vol. 1): World Health Organization.

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