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Paper ID-053
1st National Conference on Water Resources Engineering (NCWRE 2018)
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Assessment of Water supply system and water quality of Rajshahi WASA in Rajshahi City Corporation (RCC) area, Bangladesh

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ABSTRACT
Safe drinking water access is a basic human right for development issue. Water quality assessment at scale formed to ensure drinkable water requires valuation of measurement of water quality parameter and investigation of water pollution and the recognition of main pollution factors. In Rajshahi city, RWASA (Rajshahi Water Supply & Sewerage Authority) supplies water to meet the need of the water demand through a distribution network in Rajshahi City Corporation (RCC) area. But according to the people's perception, the quality is deteriorated due to some circumstances. The study aimed to assess the water quality parameters (i.e. physical and chemical parameter) and the supply system of RWASA. 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 odour. According to the study, around 65-70% people are not using RWASA supply water for drinking purpose. The rest (30-35%) people use the supplied water by boiling for a certain period and purifying by filters. This paper will also review the existing water supply scenario of Rajshahi City and the roles of different service providers and stakeholders. The questioner survey conducted by the responses from a random sample of 40 households in this study. The results indicate that that P^H of water in the selected areas was within an allowable limit, but however, in few wards, turbidity, iron, hardness and odour deviated from their standard values. These conclusions may provide useful and effective for rising the awareness of water quality improvement and water supply management.
Keywords: RWASA, water supply, water distribution network, water quality, physical and chemical parameter.

INTRODUCTION
Good drinking water quality is one of the most important elements. 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). Water use has been rising due to increasing populations. Rajshahi WASA was established in 2013 to fulfil the water crisis. But WASA could not provide good quality water. So, the peoples of this city suffer many water borne diseases. Furthermore, consumers complain about water quality. Even during the literature review there are no studies were found on physicochemical parameters of supplied water quality in Rajshahi city.

Possible causes of supplied water pollution in Rajshahi city may be widespread application of PVC pipe, locally available metals like iron, manganese. On the other hand supplied water may also pollute during transfer, treatment, distribution or storage (Fernández-Navarro et al., 2017). To find out different water quality problems a questionnaire was made to interview the people from selected wards. 40 WASA samples (consumers and sources) were collected from 10 wards in this city. Then samples were analysed by lab test for some important water quality parameters. Selected parameters were turbidity, iron, hardness, p^H, and odour. But in some wards concentration of iron and hardness was deviated WHO standards and Bangladesh drinking water standard (BDS). Odour problems find almost all water samples. P^H values fell within allowable range recommended by WHO and BDS. Elevated concentration of iron may cause severe health problems (Memon, Soomro, Akhtar, & Memon, 2011).

This study represents the maximum and minimum values of selected parameters. The main purpose of this study is to investigate water quality with respect to locations where problems have been appeared and to perform lab analysis about which of water quality parameters of defective locations deviate from their standard values. Furthermore, 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.

METHODOLOGY

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 Papa 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) (Rahman, 2004). The overall methodology can be described by a flow chart.

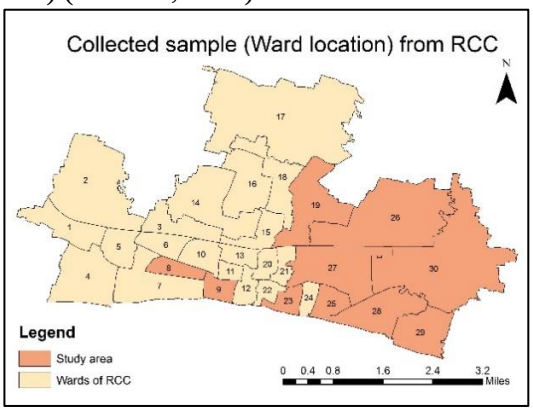

Figure 01: Study area (prepared by author)

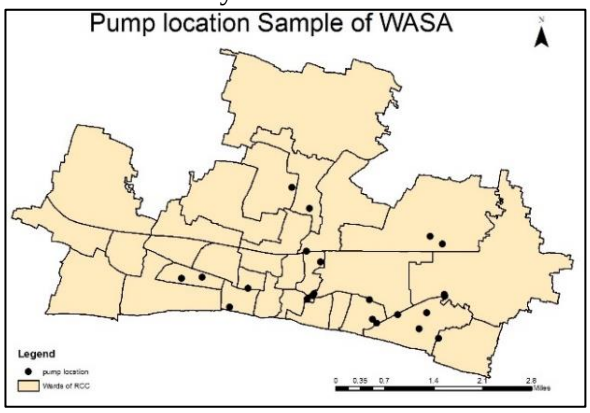

Figure 02: pump location (prepared by author)

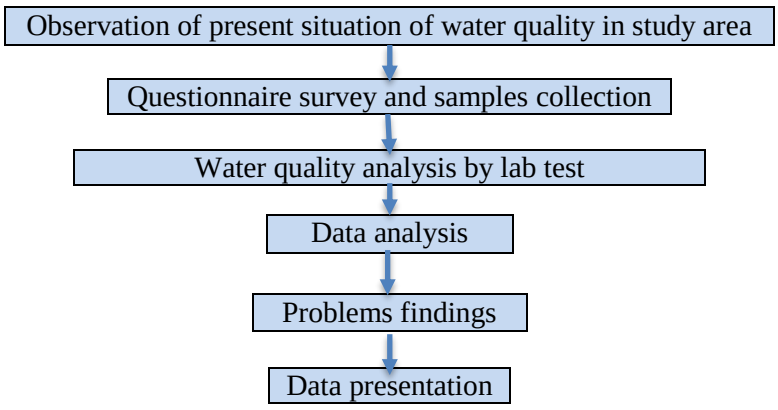

Figure 03: Flow chart of methodology

Sample collection

Out of 30 wards of RCC, 10 wards were selected for the present study based on public problems. According to public objectives, 3 user's (S1, S2 and S3) points were selected for each source. A total 40 samples were collected and analysed to evaluate important water quality parameters. Water samples were collected from tap of different residential area in1-litre polyethylene (PE) bottles and pre heated by washing with dilute HCl and later rinsed with distilled water (Etim et al., 2013). Collected samples were carried in public health lab of RUET safely.

Lab analysis

Some important physical parameters like P^H, turbidity were determined as soon as possible after collection. Otherwise accurate value could not possible to obtain. Almost all these important water quality parameters were measured within four hours of collection (Fahmida, Lemon, Islam, & Kader, 2013). The recommended order for calibration of the individual probes on a multipara meter is pH, and turbidity (WHO, 2008).

Table 01: Experimental methods and allowable limit

Selected parameters	Experimental methods	BDS	WHO
P^H	P^H meter	6.5-8.5	6.5-8.5
turbidity	Turbidity meter	10	5
Iron	Titration method	.3-1	.3
odour	Threshold odor number (TON).	odorless	odorless
Hardness	Soda reagent method	200-500	500

RESULTS AND DISCUSSIONS

Questioner Survey Report, analysis of p^H, Hardness, iron, odour and Comparison between Sources and consumers problems are described in this section. Every parameters are compared to BDS and WHO standards. Furthermore health effect of poor quality water is described.

Table 02: Questioner Survey Report

Reasonable questions	**Percentage of investigated problems**					
What kind of water used	WASA			Non WASA		
	40%			**60%**		
Present condition of water supply system	WASA			Non WASA		
	Good	Excellent	Bad	Good	Excellent	Bad
	10%	**5%**	**85%**	**40%**	**20%**	**40%**
Do you drink supplied water from RWASA directly?	yes			no		
	60%			**40%**		
Water supply interruption	evening			1-2 hours		
	yes	no		yes	no	
	25%	**75%**		**30%**	**70%**	
Which time water quality is worse?	morning	evening		night		
	80%	**5%**		**15%**		
Found black water	yes			no		
	70%			**30%**		
Iron problem	yes			no		
	90%			**10%**		
Odour problem	yes			no		
	95%			**5%**		
Water supply problem in summer season	yes			no		
	5%			**95%**		
What process follow to purify supply water	filter	boiling		medicine		
	17%	**58%**		**25%**		
Suffered from water borne diseases	yes			no		
	55%			**45%**		
What type diseases?	Diarrhoea	cholera		others		
	45%	**25%**		**30%**		

According to public interview 40% community use WASA's water and 60% use non WASA water. Present condition of water supply system by WASA is not good. Blackish water, odour and iron problems are 70%, 95%, and 90% respectively. At morning public receive worse quality of water. 45%, 25% people suffer from diarrhoea and cholera respectively.

The supplied water in Rajshahi WASA and Non-WASA is ranked from bad to excellent. Basically, supplied water from WASA is bad compare to non WASA water. About 85% WASA water was bad. Only 10% was good [Fig. 04]

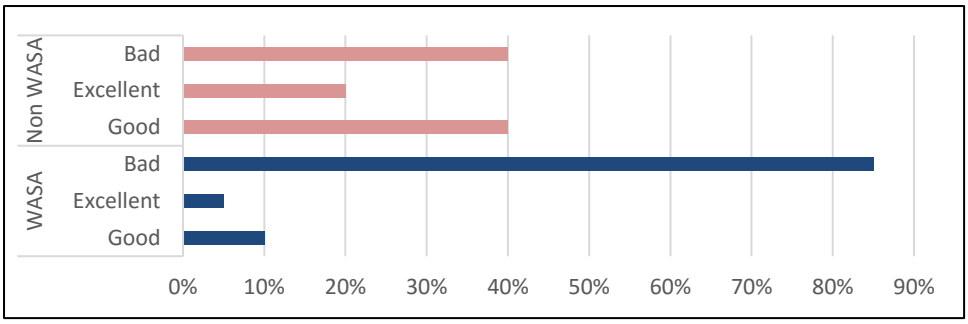

Figure 04: Water supply system and quality of Rajshahi WASA and Non- WASA

P^{H} Value:

P^{H} value indicates to the acidity or alkalinity of the water (Rahmanian et al., 2015). The pH also specifies the degree of acidity or alkalinity of water (Guettaf, Maoui, & Ihdene, 2014). Samples collected from WASA and their consumers had p^{H} 6.4 to 7.5. All samples satisfied WHO standards and BDS ranges 6.5-8.5 [Fig. 05].

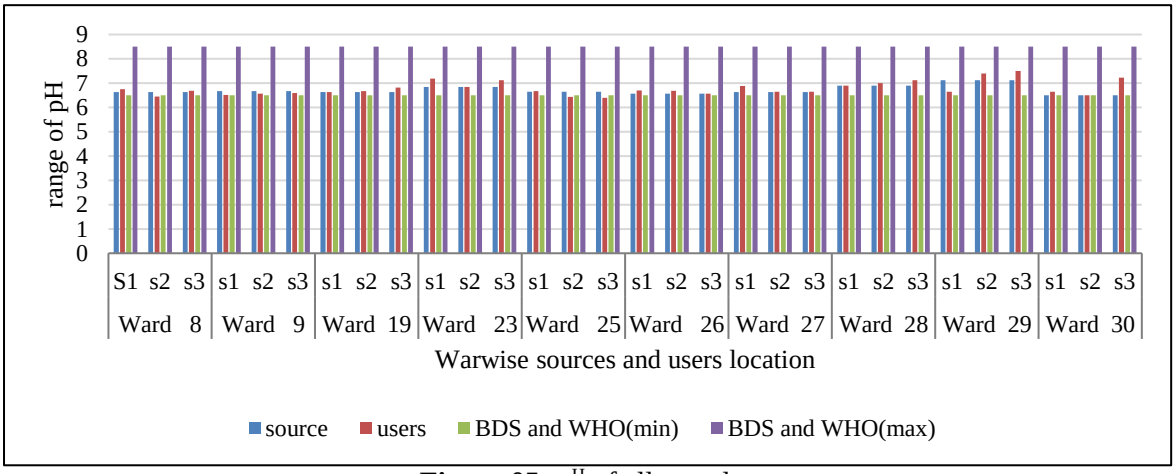

Figure 05: p^{H} of all samples

Odour

Out of 40 samples collected in the study area, the majority of the users about 90% had objectionable odour. Rest of the water samples collected from sources contained free from odour.

Turbidity

Turbidity indicates the presence of suspended material such as clay, silt, finely divided organic material, and other inorganic material. Higher turbidity may create possible bacterial contamination(Rajon & Bari, 2014). According to WHO & BDS guideline the allowable turbidity for drinking water are 5 NTU and 10 NTU respectively.

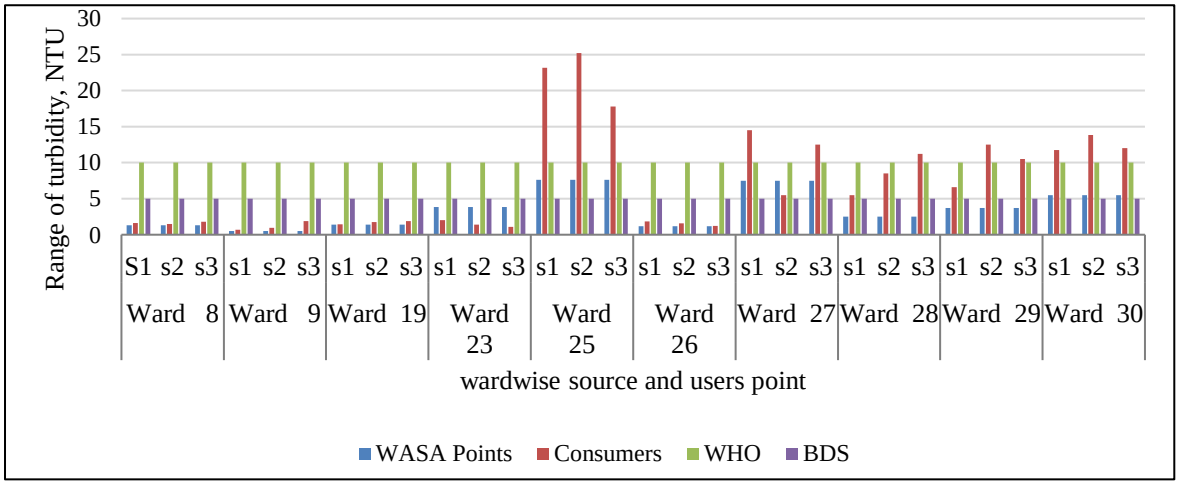

Figure 06: Representation of turbidity of all samples

Out of 40 samples, 20 samples of users had turbidity higher than WHO standards. In ward 25 contained maximum value 25.22NTU which is the 5 times of WHO standard and 7.5 times of BDS. Ward 25, 27, 29 & 30 exceed BDS value. Turbidity ranged 0.52-25.22NTU [Fig. 06].

Hardness

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 (Alam, Dafader, Sultana, Rahman, & Taheri, 2017). In targeted study area hardness ranged from 35-530mg/l. 11, 14, 10 samples collected from sources and consumers fell within soft ranges 35-72mg/l, moderately hard ranged from 75-148mg/l, hard ranged from 150-248mg/l, rest of the samples found very hard respectively. 3 samples exceed BDS limit 200-500mg/l [Fig. 07].

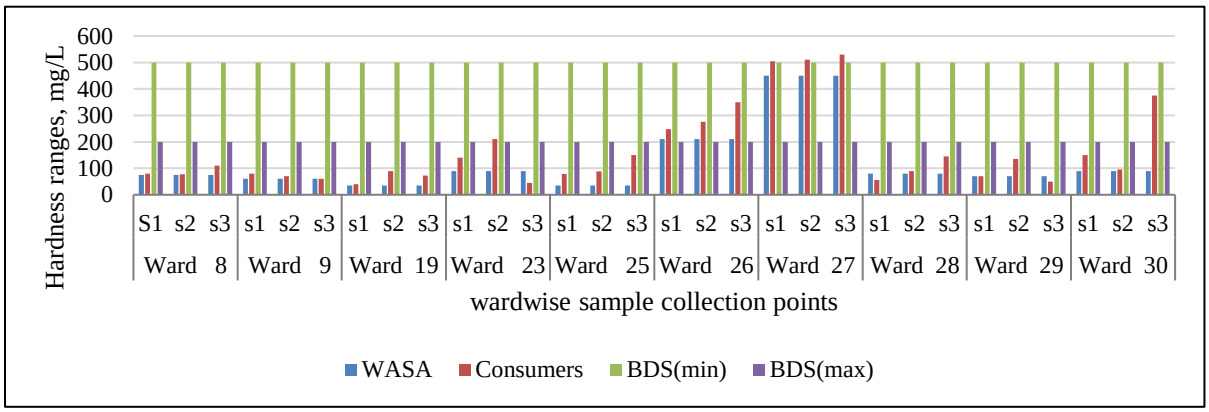

Figure 07: Hardness of all samples

Comparison between Sources and consumers problems

Turbidity deviate from its standard value 25% at sources but when water reaches to the consumers house the problem increase 3 times of sources that means 75%. Hardness, odor, iron problem was 22%, 21%, and 27% at sources but this problems rise up to 78%, 79% and 73% at household water samples respectively. Possible causes of this ecological imbalance may be due to treatment process which include coagulation-flocculation, disinfection, filtration, adsorption, and sedimentation among others. Contaminants produce from such processes and incorporate with water. Another contaminants may be incorporated during water distribution and storage (Fernández-Navarro et al., 2017)[Fig. 08].

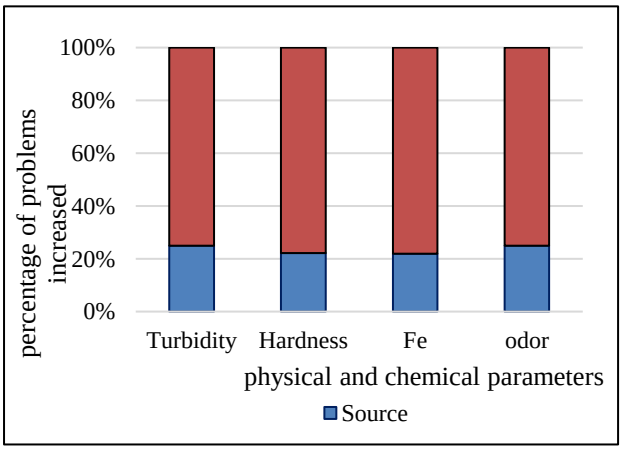

Figure 08: percentage of problems increased from source to consumers

Health Effect

If iron levels are too high, serious health effects like iron overload can develop. Water with excessive amounts iron can have negative effects on skin. It can damage healthy skin cells, which can lead to

wrinkles. Iron leaves residue on anything it touches (Etim et al., 2013). 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). Water having hardness below 300mg/L is considered portable, but beyond this limits cause gastro-intestinal irritation (Alam et al., 2017). 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)

CONCLUSIONS

By performing lab test and analysing all data it revealed that majority of samples contained high concentration of iron. About 90% samples had Odour problems. Few samples had extreme level of turbidity and hardness. All samples had reasonable P^H value 6.5-8.5. From public opinion and lab test it can be concluded that Rajshahi WASA cannot provide water at satisfactory level to the consumers. So Rajshahi WASA authority should take necessary steps to mitigate such problems.

ACKNOWLEDGMENTS

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 assistant engineer of WASA Md. Mahbubur Rahman, for his painstaking endeavour to go through the manuscript.

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