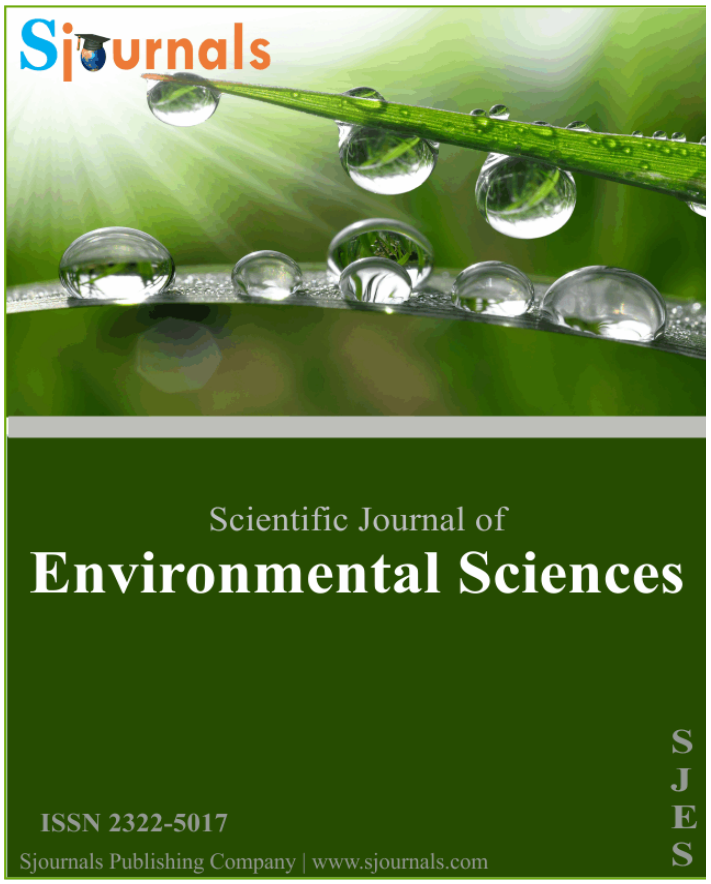


Scientific Journal of Environmental Sciences (2020) 9(1) 323-336
ISSN 2322-5017
doi: 10.14196/sjes.v9i1.2612

Contents lists available at Sjournals
Scientific Journal of **Environmental Sciences**
Journal homepage: www.sjournals.com

Case study

Drainage system, its water quality and heath effect: A case study of Rajshahi city, Bangladesh

Sumaya Tabassum*
Department of Civil Engineering, Rajshahi University of Engineering and Technology, Rajshahi-6204, Bangladesh.

*Corresponding author: sumayatabassum161@gmail.com

ARTICLE INFO

Article history,
Received 10 December 2019
Accepted 11 January 2020
Available online 18 January 2020
iThenticate screening 12 December 2019
English editing 10 January 2020
Quality control 17 January 2020

Keywords,
Hygienic environment
Sound survival
Water quality
Health effects

ABSTRACT

As a fast-growing, developing and populated city, Rajshahi needs a hygienic environment to ensure the sound survival of its dwellers. But it's an irony of fate that the mass people lack basic knowledge about it. However, most of the cities in Bangladesh didn't grow in a planned way. They have no continuous sewerage system. And the incomplete ill-developed drainage system has to carry wastewater, rainwater and liquid waste from the septic tank. Nevertheless, these wastewaters are directly disposed into nearby streams. This study investigated the condition of the drainage system, qualities of the water carried and the health effects of it. Firstly, drainage data was collected from Rajshahi City Corporation (RCC), Rajshahi Development Authority (RDA), journals and some other secondary sources. Then, a questionnaire survey was conducted randomly all over the city along with sample water collection. After the field survey, laboratory tests were done to know about water quality. Thus the feasibility of the prevailing hygienic environment was evaluated. Then the main problems were identified in this field and probable solutions were suggested.

1. Introduction

Heading towards technology grew the need for the development of cities. But Bangladesh, one of the poor countries didn't pay much heed to develop well-planned cities. Which results in many severe problems. Among them, only the drainage problem is highlighted in this work. Mitigation of health and environmental problems are burning issues of this era. Especially city life is more vulnerable to this. So, a well-functioning drainage system is a crying need for a hygienic city. With this aim, three different phases of the drainage project were initiated allotting 42.80 crore BDT in Rajshahi city (DMP, 2013). The first phase drainage project was started in 1994 by allotment of 20.38 crores BDT first time, but finally, it turns to BDT it 23.06 crores. About 34.75 km primary drain, 15.58 km secondary drains, 79 culverts 30 road-crossing and 2 flood rehabilitation centers were constructed in this phase. It was completed in June 2003 (DMP, 2013). The second phase drainage project was started on 1 July 2004. It was supervised by LGED (Local Government Engineering Department) through RCC and less than 215.95 million BDT allocated. About 9.40km primary drains, 9.97km secondary drains, and 4 Railway culverts are constructed in this phase (DMP, 2013). Third Phase Drainage Project was approved on allotting 42 crore BDT. RCC has declared about this on last 31 May 2013. Its implementation target has estimated in 2020 (DMP, 2013).

In 3rd phase development, construction of primary drain will be 1.15 km, secondary drain 16.04 km and tertiary drain 160.75 km. The estimated cost per meter for the primary drain will be 31,143.74 BDT and the secondary drain will be 7,363.30 BDT. And the cost of widening of Railway culvert over drains at New Bilsimla, Hologram and Jamalpur will be 105 lac BDT. Moreover, the total compensation cost for the structure will be 1938.74 lacs BDT and land will be 4054.17 lacs BDT (DMP, 2013).

Drains of Rajshahi City are filled 80% with sludge and the removed sludge are kept beside roads for 5-8 days for drying then carried to the landfilled site. It results in a decrease in the life of road due to carpeting & pollutes the environment. There is a proposal for de-sludging equipment and its probable cost-benefit ratio will be 1.05. Moreover, not only the modern system is used in developed countries but also wet sludge directly sent to the landfilled sites by truck. Nevertheless, the long drains will be cleaned at least 3 times a year (DMP, 2013). Many authors have studied this topic previously. Some of their important findings are listed in Table 1.

Table 1
Conclusions of previous authors.

SL No.	Authors	Year	Major conclusion of author(s)
1	Kolsky	1998	Flooding leads to further health problem
2	Ahmed and Rahman	2000	The drainage system plays the main role to solve waterlogging
3	Ali	2002	Though a huge amount of money is allocated for the construction and reform of drains, for the lack of proper planning drainage pattern failed to meet its demand and people suffer
4	Allimuddin	2002	Because of leakage and unplanned drainage system, city environment and people's living standard are deteriorated
5	Clemett et al.	2006	On drainage pattern, good condition of a city is very much depending
6	Rahman	2005	For the want of sufficient drain and planning, drainage network are failed to play an effective role in dropout the wastage from the city
7	Ashraf et al.	2009	Drainage planning made very little provision for flood storage
8	Hossain et al.	2010	Slum dwellers living in slums on the bank of wider drains are leading unhygienic lives
9	Mondal et al.	2010	Slum-dwellers living in slums on the bank of wider drains are leading hazardous lives
10	Haldar	2011	Most of the areas of this city have no planned drainage network and most of the households disposed their wastes haphazardly into the existing drains
11	Mondal and Shitan	2013	Slum-dwellers living in slums on the bank of wider drains are leading lives with a lower life expectancy
12	Ullah et al.	2013	Though the number of drains is not less due to lack of proper observation

			or clean most of the drains are failed to serve its function.
13	Faridatul and Jahan	2014	A significant portion of the citizens of Rajshahi city face both the drainage and waterlogging problem

So, from the views of the previous authors, the severity of drainage problem and the importance for their maintenance can easily be understood. The Third Phase Drainage Project will be completed within a short period and several developments have been done already. So, the present study made a field survey and compared the results with the previous studies. Moreover, it also dealt with the water quality of the drains and its health issues.

2. Methodology

Questionnaire survey and sample collection was conducted randomly according to the approach of Faridatul and Jahan (2014). It divided the whole city into six zones which is illustrated in Table 2 and Fig. 1.

Table 2
Studied zones of Rajshahi city (Faridatul and Jahan, 2014).

SL No.	City zone	Area coverage (Ward No.)	Sample size
1	City Centre	9, 11, 12, 13, 15 & 20	60
2	East City Centre	21, 22, 23, 24, 25 & 27	60
3	West City Centre	3, 6, 7, 8 & 10	50
4	Eastern Fringe	26, 28, 29 & 30	40
5	Western Fringe	1, 2, 4 & 5	40
6	Northern Fringe	14, 16, 17, 18 & 19	50

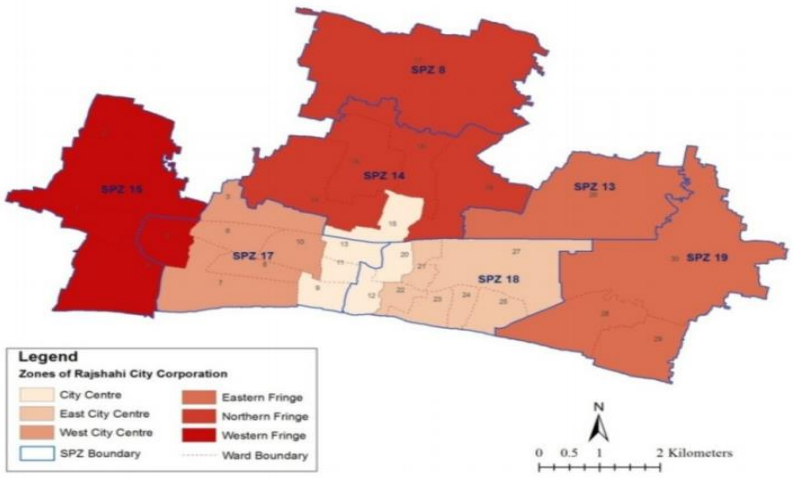


Fig. 1. Studied zones of Rajshahi cty (Faridatul and Jahan, 2014).

From the survey, drainage system status, waste flow type, cleaning interval and waterlogging of those zones were inquired. In addition to that, samples were collected from 5 disposal sites namely Dargapara, Padma Garden, Kumarpara, Boubazar, and Boro Kuthi Ghat which is depicted in Fig. 2. Then, the collected samples were tested for pH, electric conductivity, CO_2, Alkalinity, BOD (Biochemical Oxygen Demand), DO (Dissolved Oxygen), Chloride concentration, COD (Chemical Oxygen Demand) and microbial parameters. Field and laboratory test methods adopted to determine the water qualities have been listed in Table 3. Total coliform count was determined by membrane filtration technique and standard plate count was determined using serial dilution of the sample in sterile buffered water.

Table 3
Methodology used for water quality determination.

No	Parameter	Method	Apparatus/Device	Reagent	Indicator
01	PH	Colorimetrical/ Electrochemical	DZB-718 Portable Multi parameter analyzer	Standard PH solution	
02	Conductivity		Conductivity meter	Potassium Chloride	
03	CO_2 of water	Titration	1. Measuring cylinder 2. Burette	Standard N/44 Sodium Hydroxide	Phenolphthalein
04	Alkalinity	Titration	1. Measuring cylinder 2. Burette	Standard N/50 Sulphuric Acid	1. Phenolphthalein 2. Methyl Orange
05	BOD		DZB-718 Portable Multi parameter analyzer		
06	DO		DZB-718 Portable Multi parameter analyzer		
07	Chloride concentration	Titration	1. Measuring cylinder 2. Burette	Silver Nitrate Solution	Potassium Chromate
08	COD	Titration		Standard Ammonium oxalate and potassium permanganate	

a)

b)

c)

d)

e)

Fig. 2. Studied disposal Sites- a) Dargapara, b) Boubazar, c) Kumarpara, d) Padma Garden, e) Boro Kuthi Ghat.

3. Field survey

Primary drains are the main drain of an area. The total length of the primary drains (Fig. 3(a)) of Rajshahi city is 33km having an average width of 5m (196.8”) and an average depth of 2m (78.72”). Secondary drains (Fig. 3(b)) are interlinked with primary drains to flow their wastage and water. The total length of this drain is 48km in the city, average width 1.2 m (47”) and average depth 0.90 m (35”). About 200 tertiary drains (Fig. 3(c)) are there in Rajshahi city whose total length is 140 km (DMP, 2013).

a) Primary drain (Location: Darga para)

b) Secondary drain (Bhodra)

c) Tertiary drain (Badurtola)

Fig. 3. Different types of drains of Rajshahi city.

a) Identification of type of drain

b) Collection of samples

c) Water quality assessment

d) Accumulation of waste at drainage bend

e) Over flowing drain

f) Water logged drain

g) Irregular width of drain

h) Broken drains

i) Slum on the bank of wide drain

j) Accumulation of solid waste inside open drain

k) Accumulation of sludge blocked the drain completely

l) Sanitary connections with drains

m) Cleaning of drains

n) Cleaner uses hand instead of tools

o) Drain water is directly being used for irrigation

Fig. 4. Field survey of existing drains.

Fig. 4 shows the field visit and sample collection from the predetermined sites and the shortcomings were evident while doing the survey. The ongoing third phase drainage project is depicted in Fig. 5. Waterlogging and deposition of solid wastes were observed in some cases.

a) Reinforcement alignment of drain

b) Casting of drain

c) Frame work of drains

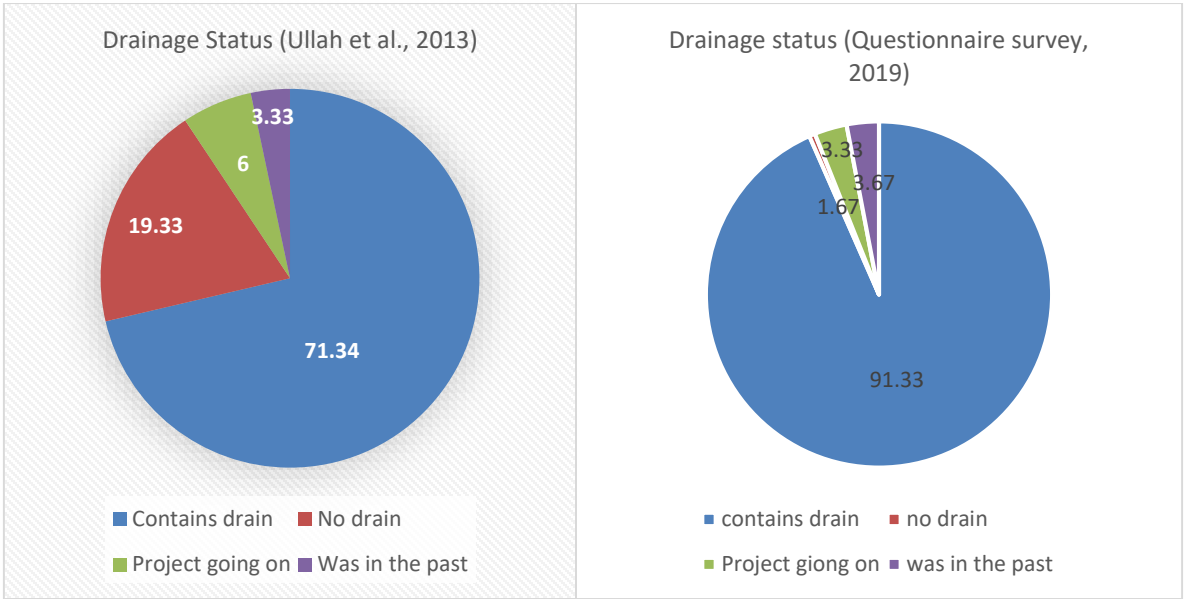
d) Curing of drains

e) Drains under constructions are also vulnerable to waterlogging

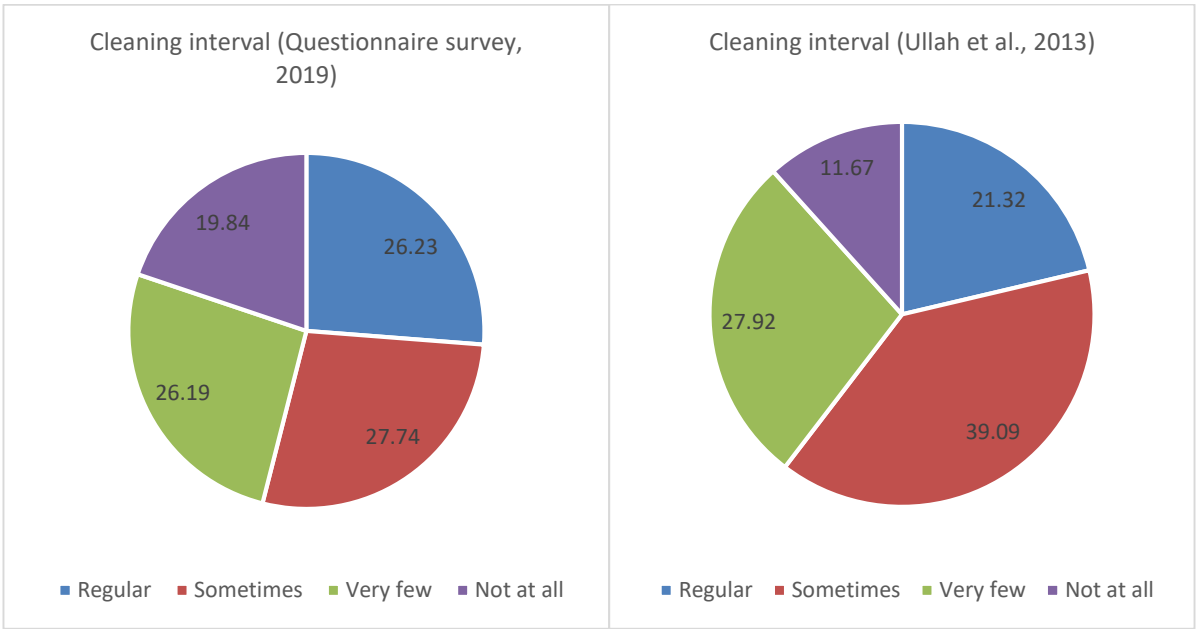
Fig. 5. Field visit to 3rd phase drainage development of Rajshahi city.

4. Results and discussion

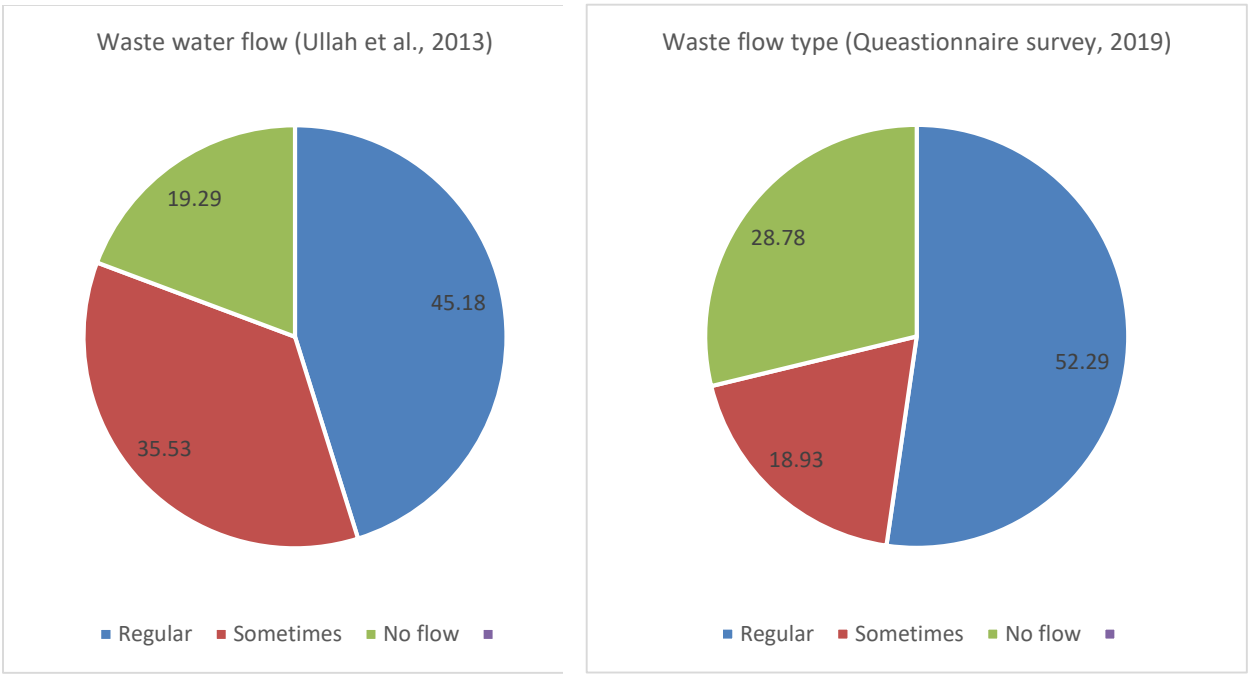
The data which were obtained from the questionnaire survey have been illustrated in pie charts and compared with the results obtained from previous works. Fig. 6(a) shows that the number of drains increased to a significant value. Regular cleaning of drains of some important places of the city was undertaken. But due to shortage of employer, RCC fails to provide that facilities to whole city which is illustrated if Fig. 6(b). In case of new drains, regular wastewater flow was observed. Due to waterlogging and poor maintenance, the number of flow less drains also increased (Fig. 6(c)). New drains eliminated waterlogging problems of many areas. On the other hand, unplanned growth of the city leads to waterlogging of old drains which is depicted in Fig. 6(d).



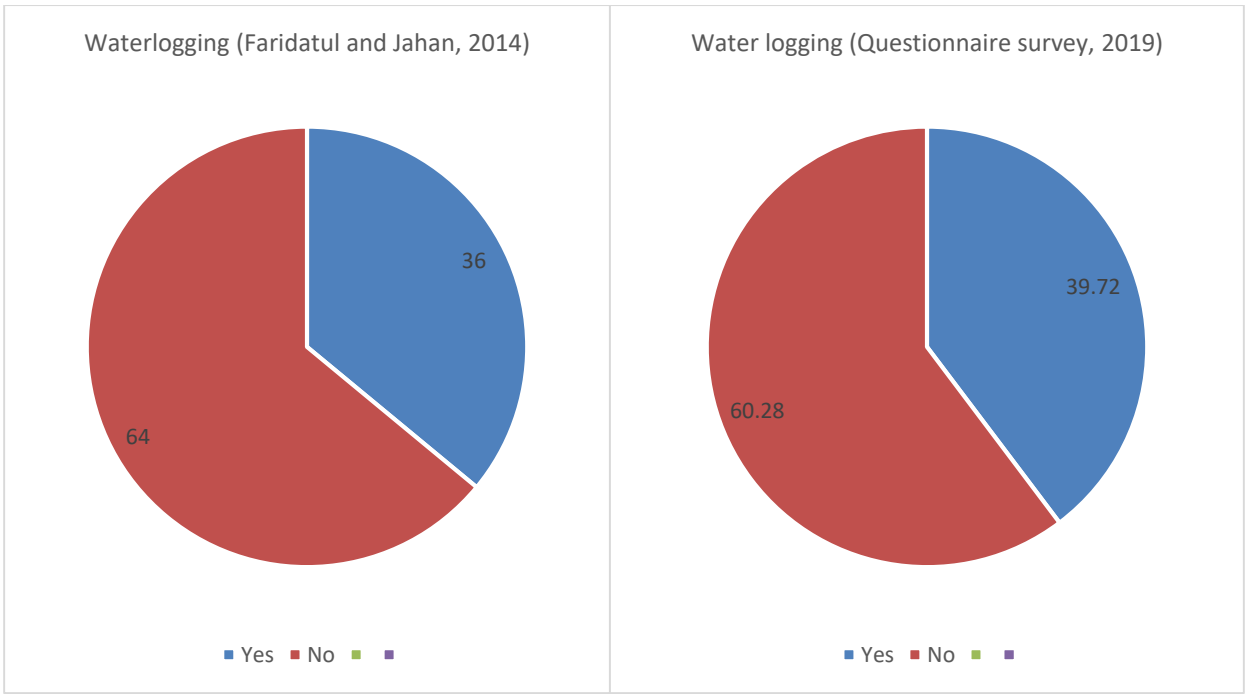
(a)



(b)



(c)



(d)

Fig. 6. Comparative study of questionnaire survey with previous works.

The pH value of water samples from different sites is listed in Table. 4. Direct disposal of this water into surface water results in an acidic environment to aquatic life. And, soil receiving this water will lose its buffer action. The electric conductivity of wastewater from different sites is listed in Table. 5. The safe limit of conductivity in Bangladesh, WHO, and FAO for irrigation use are 2250, 1200 and 3000 µ-moh/cm respectively. So, neither drains nor disposal sites supply safe water for irrigation. The Environment Quality Standard (EQS) for alkalinity, COD, BOD, DO in Bangladesh are 150 mg/L, 200mg/L, 40 mg/L and more than 6 mg/L respectively for

surface water. The average values of those parameters didn't satisfy the safe limits (Table. 6). And, the high value of Chloride concentration and CO_2 denotes excess contamination of that samples. Table. 7 shows the microbiological parameters at different sites and it indicated the alarming health risk.

Table 4
pH value of samples from different sites.

SL No.	Name of site	pH range	Discussion
1	Tertiary drain	6.5 to 8.5	1. Out flow of water closet and public toilet containing urine are alkaline 2. Water from laundry and bathroom containing soaps and detergent are alkaline 3. During storm, the pH turns 6.5
2	Secondary drain	4.2 to 7	1. Most of the sites had pH 6 to 7 2. Near industries, pH turns acidic
3	Primary drain	3.9 to 6.5	1. pH value changed frequently
4	Disposal site	4 to 6.5	1. pH value changed frequently

Table 5
Conductivity (µ-mho/cm) of samples from different sites.

SL No.	Name of site	Conductivity (µ-mho/cm)	Discussion
1	Tertiary drain	715 2750	1. Near restaurant and kitchen, due to oil the conductivity decreases 2. During rain, the conductivity was decreased
2	Secondary drain	710 3175	1. Temperature changes of dawn to dusk affect the conductivity
3	Primary drain	711 3100	1. Due to absence of cover over drains, soil mixes with waste water and ions from clay contribute in conductivity
4	Disposal site	1800 3200	1. Due to elimination of large suspended particles by screening, conductivity increased.

Table 6
CO_2 (mg/L), Alkalinity (mg/L), BOD (mg/L), DO (mg/L), Chloride concentration(mg/L), COD (mg/L) of samples from different sites.

SL No.	Name of site	CO_2 (mg/L)	Alkalinity (mg/L)	BOD (mg/L)	DO (mg/L)	Chloride concentration (mg/L)	COD (mg/L)
1	Tertiary drain	4.43	362	88	1.59	460.02	538
2	Secondary drain	4.9	371	97	1.26	481.12	580
3	Primary drain	6.11	452	108	1.06	525.43	627
4	Disposal site	5.77	447	102	1.14	512.54	610

Table 7
Microbiological parameter at different sites.

Microbiological parameter	Sites	Results	BDS Standard 1240:1989
Total plate count cfu/ml	Tertiary drain	700 to 1700	Less than 1000
	Secondary drain	1050 to 1800	
	Primary drain	1500 to 2600	
	Disposal site	1675 to 2100	
Total coliform MPN/100ml	Tertiary drain	30 to 72	Nil
	Secondary drain	90 to 107	
	Primary drain	92 to 111	
	Disposal site	93 to 108	

5. Conclusion

The general people lack health education, cultivators use the drain water for irrigation, cleaners use their hand in cleaning without any precautions and city dwellers throw solid wastes directly into drains. Besides, many of the drains are overflowing and waterlogged. Flooding over roads occurs from those drains after storms even at peak hours. And, the accumulation of a high volume of sludge makes the drains more vulnerable. Moreover, the wastewater carried by drains is directly disposed into river Padma after screening only the large suspended solids.

The polluted wastewater is injurious to the health of city people, cleaners, the water of disposal sites, soil and crops which are being irrigated with that water. Consequently, different water-borne diseases will be epidemic; aquatic life and irrigation efficiency of the river will be affected; the salinity of soil will be increased by losing its salinity; crops especially the root crops will be contaminated. And, the waterlogging helps in the reproduction of mosquitoes.

First and foremost, government and welfare organizations must grow consciousness among peoples regarding drainage issues. Besides, RCC has to provide sufficient dustbin at convenience so that people can easily throw their domestic solid waste there. They need to employ more cleaners; use insecticides periodically; use cover on drains keeping sufficient provision for rainwater intrusion and convenience for cleaning; reconstruct and reformat the broken, inadequate and overflowing drain considering storm-water flow and population growth; provide a minimum treatment to wastewater at disposal sites; restrict irrigation with drain water, sanitary connection with drains and disposal of solid waste into drains; and ensure proper maintenance of the existing drains.

Acknowledgements

The authors would like to gratefully acknowledge the support provided by the Department of Civil Engineering, Rajshahi University of Engineering and Technology (RUET) during the research work. Nusrat Jahan, Md. Mahadi Hasan, Md. Nahid Hasan Swapon, Abdullah Al Sami, and, Saraf Anika from the department of Civil Engineering (RUET) helped a lot during the field survey.

References

Ahmed, M.F., Rahman, M.M., 2000. Water supply and sanitation, rural and low income urban communities. Bangladesh, ITN.

Ali, M., 2002. Present condition of Rajshahi city, Rajshahi. Popular Publishers, Dhaka; Bangladesh.

Alimuddin, Z., Abdullah, M., 2002. Urban drainage system, Malaysia. Don Publishers. Dhaka, 32-33.

Ashraf, A.M., Chowdury, A.S.M., 2009. Drainage planning in the cities of Bangladesh. J. Bangladesh Inst. Plan., 2, 49-60.

Clemett, A., Amin, M.M., Ara, S., Akan, M.M.R., 2006. Background information for Rajshahi city, Bangladesh. WASPA Asia Project Report 2.

D.M.P., 2013. Drainage design report, 2013. Drainage Master Plan (DMP), Rajshahi City Corporation. Rajshahi; Bangladesh.

Faridatul, I., Jahan, S., 2014. People's perception regarding the development of community facilities: A case study of Rajshahi city corporation. J. Bangladesh Inst. Plan., 7, 1-16.

Haldar, K., Chakraborty, D., 2011. Conventional approach of planning drainage system for an urban area: A study on Rajshahi city, Bangladesh.

Hossain, M.K., Halder, D., Mondal, M.N.I., Haque, M.N., 2010. Direct and indirect effects of socio-economic and demographic factors on age at death of infant and child of slum area in Rajshahi city, Bangladesh. Int. J. Curr. Res., 11, 100-106.

Kolsky, P., 1998. Storm drainage: An intermediate guide to the low-cost evaluation of system performance. London, Intermediate Technology Publicatation.

Mondal, M.N.I., Rahman, M.M., Hossain, M.K., 2010. Socio-demographic condition and health complications of street-based sex workers in Rajshahi city, Bangladesh. Res. J. Med. Sci., 4(3), 119-124.

Mondal, M.N.I., Shitan, M., 2013. Factors affecting the HIV/AIDS epidemic: An ecological analysis of global data. Afr. Health Sci., 13(2), 294-303.

Rahman, M.M., 2005. Surface water quality in Rajshahi city. J. Geo Environ., 4, 15-22.

River Water Quality Report, 2014. Department of environment, ministry of environment and forest, Bangladesh. ISSN: 2226-1575.

Ullah, M.M.M.N., Hossaina, M.S., Shahiduzamana, M., Islam, M.S., Choudhary, M.S.R., 2013. A study on some aspects of drainage system in Rajshahi city, Bangladesh. Sci. J. Environ. Sci., 2(6), 118-124.

How to cite this article: Tabassum, S., 2020. Drainage system, its water quality and heath effect: A case study of Rajshahi city, Bangladesh. Scientific Journal of Environmental Sciences, 9(1), 323-336.