THE IMPACTS OF DUMPING SOLID WASTE ON SURFACE AND GROUND WATER IN FARIDPUR MUNICIPALITY

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ABSTRACT

In recent years urban surface water resources have been under alarming threat of pollution due to improper management of wastes produced by various human activities. The groundwater quality is being degraded due to leachate generated from open dumping of waste in the environment. The study aims to understand the levels of pollutants in the groundwater and surface water regarding the distance from the dumping sites as compared to the guidelines provided by BD and WHO for drinking water. Surface water samples were collected from the Kumar river at sampling points located 100m upstream and 100m downstream from the main dumping site. Water samples from groundwater sources were directly collected from the improved tubewells. All samples were analyzed for physicochemical pollution indicators. The physiochemical parameters of surface water such as Turbidity, pH, EC, TDS, BOD & COD for the upstream gave values below the highest permissible level set by the BWDB. On the contrary, the downstream values for these physicochemical parameters were higher than the maximum permissible level set by BWDB. The testing results showed that the Kumar river to be of poor quality. For groundwater, the pH values of four sampling locations were alkaline. Although the EC values of all groundwater sampling locations exceeded BD standards but the TDS values of all locations were within the allowable limits. The concentration of pollutants in the river had positive interrelation with distances from the dumpsite. So, it is recommended that, the most crucial mitigation measure to reduce pollution of Kumar River is the proper management facilities. The results show that periodic water quality assessments and appropriate laws and legislation on dumping of solid waste into the river are needed.

Keywords: *Groundwater, Solid waste dumping site, Kumar River, TDS*

1. INTRODUCTION

Annual waste generation is increasing exponentially with rapid population growth, urbanization and industrial development in Bangladesh (Alam and Qiao, 2019). The dumping of non-segregated solid waste to landfll sites is the most prevalent waste disposal practice in developing countries such as Bangladesh (Jahan et al., 2016) and even in the part of developed countries (Mishra et al. 2019).At present there are 330 Pourashavas in Bangladesh (BBS, 2019). In most of the developing countries, solid waste disposal has been a chronic problem,particularly in areas with high population density, high production of refuse, and scarcity of land adequate forlandfills (Sadek and El-Fadel, 2000).Along with population explosion, municipal expansion, economic development and improvement of people's living standards, the amount of municipal solid waste has been increasing rapidly and its composition has become more multidimensional and complex.

In Bangladesh, the most general waste disposal method available is incineration, open dumping, composting and land filling. Unsuitable disposal of solid waste causes all types of pollution: air, soil, and water. Indiscriminate dumping of wastes contaminates surface and ground water supplies. In urban areas, solid waste clogs drains, creating stagnant water for insect breeding and floods during rainy seasons. Open burning of solid waste contributes significantly to urban air pollution. Contaminants from gasoline spills, households and other toxic wastes find their way to the dumping sites. Health and safety issues also arise from improper solid waste management. Insect and rodent vectors are attracted to the waste and can spread diseases such as cholera and dengue fever (Srigirisetty et al, 2017).

A huge quantity of solid waste produced within the Faridpur Municipality is not collected. As a result, a lot of solid wastes are left within the communities. In the communities, most of the houses have not appropriate sanitary facilities for liquid waste disposal and therefore major portion of grey water and black water generated are disposed off into the Kumar River. The dumpsite located near the Shariyatullah Bazar on the bank of Kumar River. Leachate from the dumpsite flow through surface runoff to Kumar River. Since most of the urban residents in Faridpur town predominantly use the water source to ascertain its suitability for domestic use. Therefore, the aim of the study was to find out the impacts of solid waste on ground and surface water quality.

The objectives of the present study are the followings:

- To determine the effects of solid waste on ground and surface water quality in Faridpur Municipality.
- To compare the level of pollutants in the tube wells and river water with the guidelines provided by WHO and BD Standards for drinking water.
- To establish the interrelation between the levels of pollutants in ground and surface water with distances from the dumping site.

2. METHODOLOGY

2.1 Study Area

The study area is located in the city of Faridpur (23°35′44.88″N, 89°49′50.16″E) that is a large district in the south-west part of Bangladesh. It is situated beside the Padma River. Kumar River is flowing across the city. Faridpur is a tropical climate area where about 1873 mm of precipitation falls annually. The driest month is January, with 6 mm of rainfall. Most precipitation falls in June, with an average of 360 mm (Bangladesh Water Development Board, 2019). There are many schools, colleges, markets, shopping malls, business centers, residential buildings, commercial buildings and administrative buildings in Faridpur city and still constructing many of the above day by day as the city will be the next and 9th divisional city and headquarter of Bangladesh. So a huge amount of activities are occurs every day in the city and as a result a vast amount of solid waste is produced every single day. This is why this city is selected for the research work. The waste dumped at this site includes domestic waste, e.g. wood; fruits, vegetables peels, plastic, glass, cardboard, cloths, kitchen waste, construction waste. Further solid waste from the poultry market, refineries, fish market, dairy farm and hospital waste is also dumped at the site.

2.2 Sampling of the Surface Water and Groundwater

For surface water, the 9 water samples were collected from three different points of the Kumar River where 3 samples from upstream (U), 3 from downstream (D) and 3 from the middle point (M) where solid waste is dumped in the river. U and D are located at distance 100m from the dumpsite

Table 1: Sample collection points regarding distance from dumpsite in the Kumar River.

Sampling location	Distance from dumpsite (m)	Sampling location
U	100	Upstream
M	0	Middle (main dump site)
D	100	Downstream

Before sampling, all bottles were washed with distilled water and the bottles were rinsed again three times with the water to be sampled. Samples were collected in 1 litre plastic bottles at a distance of about 100 meters from each other point to analysis pH, EC, TDS, Turbidity and BOD. After collection, the bottles were sealed immediately to avoid exposure to air. The samples were taken from the mid-stream and approximately 0.30 meters below the surface.

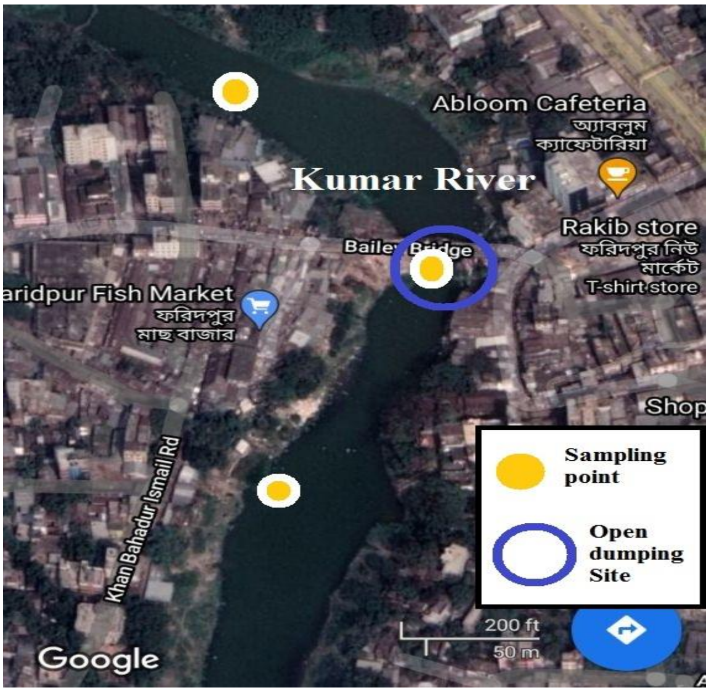


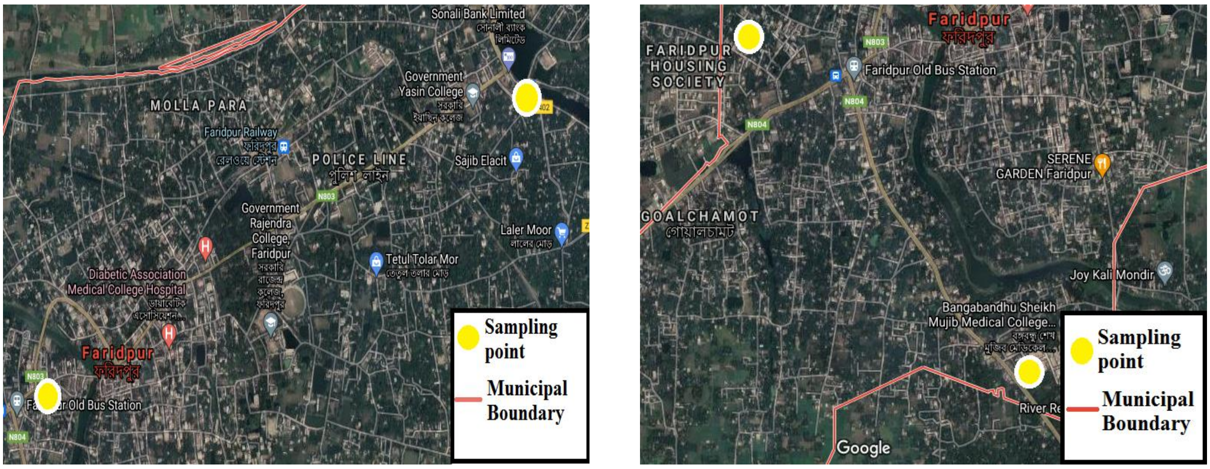
Figure 1: Sampling point for surface water (Kumar River).

For groundwater, eight different main waste dumping sites were identified and four specific sites were selected for sampling. They are Tepakhola bazar (L1), Shingpara (L2), Shovarampur (L3) and Faridpur Medical College (L4). Water samples were collected according to the Table 2.

Table 2: Sample collection points regarding distance from dumpsite from tubewell

Sampling Location	Depth of the tube well (ft)	Distance from dumping site (m)
L1	240	11
L2	120	3
L3	240	6
L4	400-450	5

The water samples were collected using 1 litre sampling bottles from the nearest tube wells to each of the dumpsites. Each sampling container was filled with sampled water and then croaked using lids. After that the containers kept in a cool box for transfer to laboratory for analysis.



(a) (b)

Figure 2: (a) Sampling point (L1 and L2) for groundwater; (b) Sampling point (L3 and L4) for groundwater

2.3 Sample Analysis

The analysis was done as per the standard methods. The physical parameters include pH, Turbidity, Electrical Conductivity, Total Dissolved Solid were determined in laboratory after collection of the samples. For the analysis of PH and turbidity the samples were transported to the Environmental Laboratory of Department of Civil Engineering, Faridpur Engineering College, Faridpur, Bangladesh. And for the analysis of EC and TDS the samples were transported to the Department of Public Health and Engineering (DPHE), Gopalganj, Bangladesh. The water samples for the analysis of BOD, COD, EC and TDS were carefully carried to the Environmental laboratory of the Department of Civil Engineering, Dhaka University of Engineering and Technology (DUET), Bangladesh. The pH was measured using model ”EcoScan pH 6” pH meter. Turbidity was measured using Turbidity meter. EC and TDS were measured by multimeter method.

2.4 Data Analysis

Data on the level of pollutants in the tube wells and river water was analyzed using descriptive statistics to obtain means. Interrelation analysis was performed through cross tabulations to determine the relationship between the level of pollutants in the surface water and tube wells as compared to the distances between the tube wells and the dumping sites. The data was analyzed using Microsoft Office excel.

3. RESULTS AND DISCUSSION

The variation in the physico-chemical parameters of surface water in the three different points i.e. U, M and D (along the river Kumar) are given in the Table 3.

Table 3: Surface water analysis of 9 surface water samples collected from Kumar River

Sampling points	pH (Avg.)	Turbidity (NTU) (Avg.)	Electrical Conductivity (μS/cm) (Avg.)	TDS (mg/L) (Avg.)	BOD (mg/L) (Avg.)	COD (mg/L) (Avg.)
Upstream	7.87	8.76	410	225	0.02	12.29
Middle (main dumping site)	8.40	34.12	1035	560	0.98	59.07
Downstream	7.89	21.38	1622	1285	2.16	88.20
Bangladesh standard value	7	10	700	1000	0.02	8.00
WHO standard value	7	10	150	1000	6.00	10

The physico-chemical parameters of ground water in the four different points i.e. L1, L2, L3 and L4 (Tube well of Tepakhola, Shingpara, Shovarampur and Medical College area respectively) are given in the Table 4.

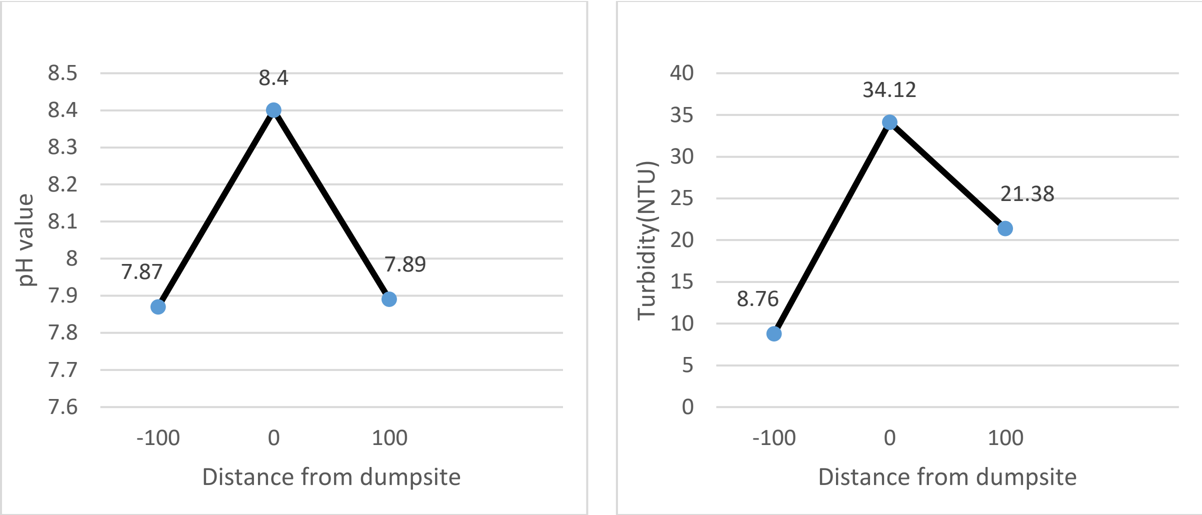
Table 4: Groundwater analysis of groundwater samples collected from 4 different tubewells

Sampling points	pH	Turbidity (NTU)	Electrical Conductivity (μS/cm)	TDS (mg/L)
L1	8.67	7.33	1243	708
L2	8.73	22.40	1152	660
L3	8.85	6.19	1330	759
L4	8.76	5.88	1094	626
Bangladesh standard value	7	10	700	1000
WHO standard value	7	10	150	1000

Surface Water Analysis

For surface water, the upstream pH value was 7.87, for middle point was 8.40 and for downstream was 7.89 which are represented in the Table 3. The water at middle point was slight alkaline than the upstream and downstream water. Anyway, all these three points were alkaline and the values exceed the standard values of Bangladesh and WHO. Figure 3(a) shows a positive interrelation between pH and the distance from the dumpsite even though this interrelation was not significant.

The upstream turbidity value was 8.76 NTU, for middle point was 34.12 NTU and for the downstream was 21.38 NTU, which are represented in the Table 3. All values were exceed the limit of standard value of turbidity. There was a positive interrelation between the turbidity and distance from the dumpsite. From the result, it is depicted that the value of turbidity is higher at the point of main dumping than the other two points.

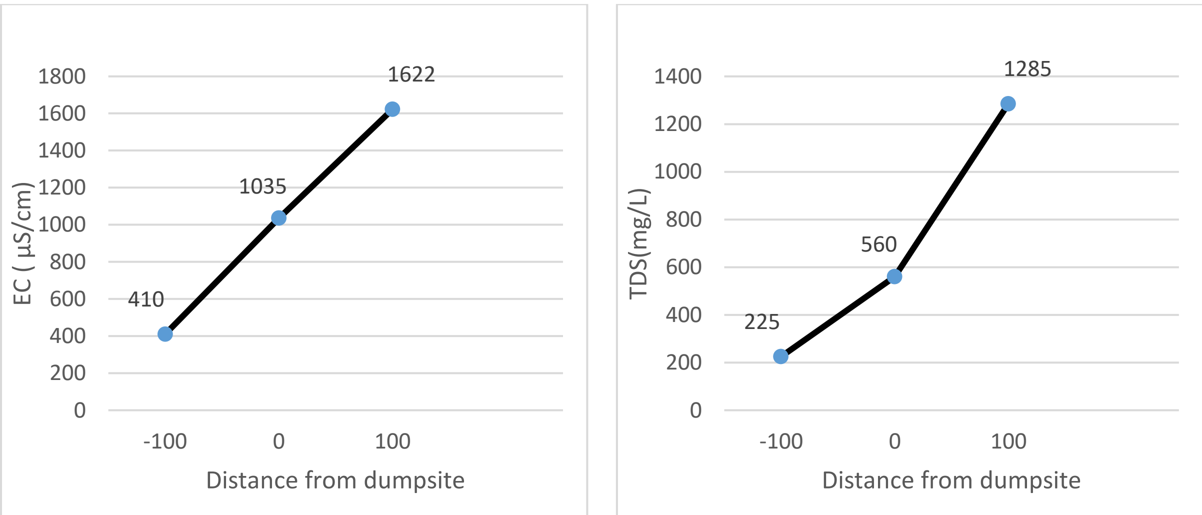


(a) (b)

Figure 3: (a) Interrelation between the pH values of surface water samples and distances from dumpsite;(b) Interrelation between the Turbidity values of surface water samples and distances from dumpsite.

The upstream EC value at 100m away from the solid waste dumping site was 410 µS/cm, at dumpsite was 1035 µS/cm and downstream value was 1622 µS/cm at 100m away from dumpsite which are represented in the Table 3. The values of the middle point and downstream is higher than the Bangladesh guideline. That means the water is alkaline and actually not appropriate for aquatic life. That is caused by the dumping huge amount of solid waste by the riverside. The EC values have changed in river water regarding the distance from the dumpsite.

The TDS values of upstream, middle point and downstream were respectively 225 mg/L, 560 mg/L and 1285 mg/L which indicated that the higher amounts of dissolved solid present in the water at middle and downstream rather than upstream. The standard guideline for TDS value of drinking water by Bangladesh and WHO is 1000 mg/L. There was a positive interrelation between levels of TDS and distance from the dumpsite such that the levels were generally higher in downstream.

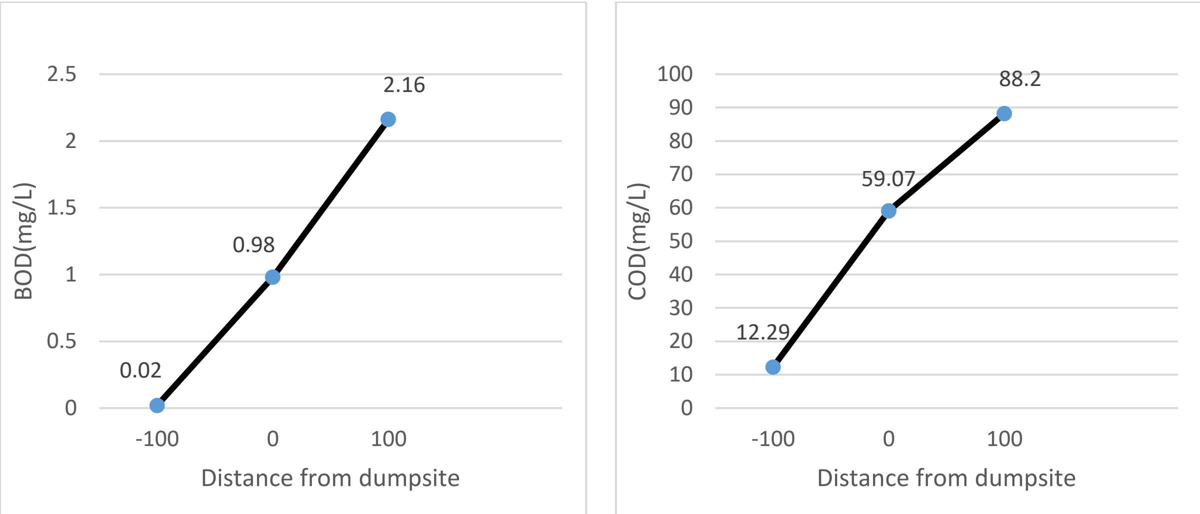


(a) (b)

Figure 4: (a) Interrelation between the EC values of surface water samples and distances from dumpsite; (b) Interrelation between the TDS values of surface water samples and distances from dumpsite.

The BOD values of upstream, middle point and downstream were respectively 0.02 mg/L, 0.98 mg/L and 2.16 mg/L which indicates the higher amounts of pollutants present in the water at middle and downstream rather than upstream that are represented in the Table 3. The results show that the BOD value is lower at upstream. The value was increased with the distance from upstream to middle point and middle to downstream. Hence, there was a significant interrelation between the value and the distance of each point.

From Table 3, the COD values of upstream, middle point and downstream are respectively 12.29mg/L, 59.07 mg/L and 88.20 mg/L which indicates the higher concentration of organic material present in the water at all three points. There was a positive interrelation between the value of COD and the distance from the dumpsite that was significant. The positive relationship indicates that the value of COD in the river increased with distances downstream from the dumping site.

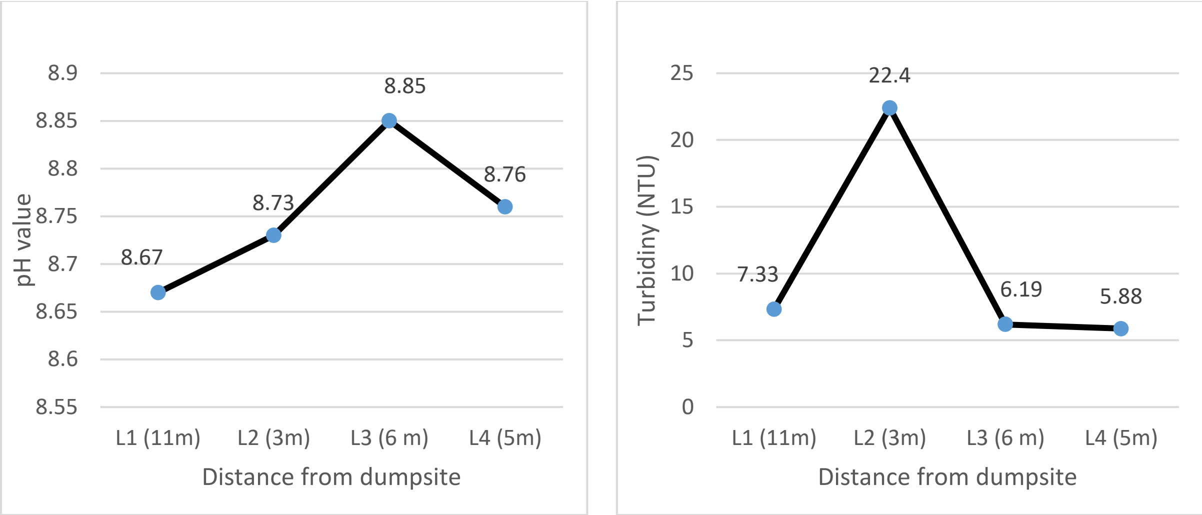


(a) (b)

Figure 5: (a) Interrelation between the BOD values of surface water samples and distances from dumpsite; (b) Interrelation between the COD values of surface water samples and distances from dumpsite.

Ground Water Analysis

For ground water, the pH values were 8.67 for the tube well water located at Tepakhola bazar (L1), 8.73 for the tube well water located at Shingpara, Goalchamot (L2), 8.85 for the tube well water located at Shovarampur (L3) and 8.76 for the tube well water located at medical college area (L4).

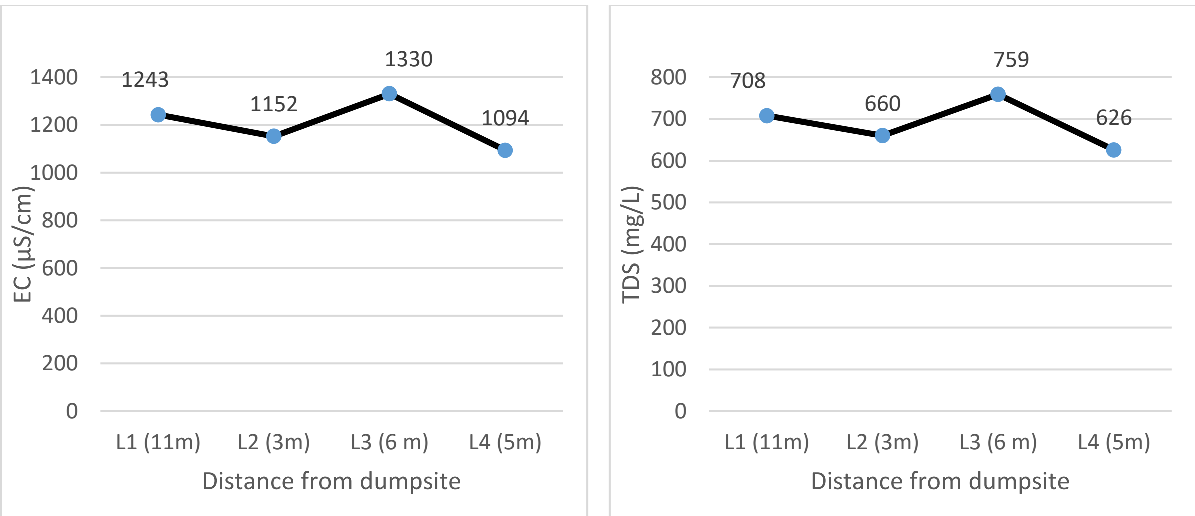


(a) (b)

Figure 6: (a) Interrelation between the pH values of ground water samples and distances from dumpsite;(b) Interrelation between the Turbidity values of ground water samples and distances from dumpsite.

Results in Figure 6(a) show that the pH did not interrelate significantly with the distance of the tube well from the dumpsite. The turbidity values were 7.33 NTU for point L1, 22.40 NTU for L2, 6.19 NTU for L3 and 5.88 NTU for L4 which are represented in the Table 4. The turbidity value of L2 area was the greater value than the rest. According to the all-standard values by different organization, these four point's waters are not suitable for any drinking case. Figure 6(b) shows that there was a negative interrelation between turbidity of tube well water and the distance of the tube wells from the dumpsite which was not significant.

For EC, the values were 1243 µS/cm for L1, 1152 µS/cm for L2, 1350 µS/cm for L3, 1094 µS/cm for L4. All value were higher than the Bangladesh standard guideline for drinking water. There was a positive interrelation between EC of tube well water and the distance of the tube well from the dumpsite. For groundwater (tube wells), the TDS values were 708 mg/L for L1, 660 mg/L for L2, 759 mg/L for L3, 626 mg/L for L4. The presence of potassium, sodium, chlorides increases the TDS level. The results from figure show that the TDS levels increased with the decreasing distance from the dumpsite.



(a) (b)

Figure 7: (a) Interrelation between the EC values of ground water samples and distances from Dumpsite; (b) Interrelation between the TDS values of ground water samples and distances from dumpsite.

4. CONCLUSION AND RECOMENDATIONS

The laboratory analysis of typical parameters shows that except pH all other concentration values exceeded the BD standards for drinking water. The physio-chemical analysis using parameters such as TDS, Turbidity, EC, BOD and COD of the upstream gave values well below the maximum allowable level set by the Bangladesh Water Development Board (BWDB). On the contrary, the downstream values for these physio-chemical parameters were to a larger extent far above the maximum acceptable level set by Bangladesh Water Development Board (BWDB). Hence, the water in the vicinity of the dumpsite presents alarming threat to public health. Any use of this water for domestic purposes should be disallowed as its use will lead to waterborne diseases such as cholera and typhoid. Finally, the extent of contamination of groundwater due to leachate percolation depends on distance of the water source from the dumpsite and the sampling side. Results show that concentrations of contaminants are higher at sampling sites that are downstream from the dumpsite. The interrelation analyses suggest that both surface water pollution of Kumar River is affected by the distances between the sampling points and the dumping site.

- Public awareness campaigns play a vital role in waste reducing, reusing and recovering, which can limit the amount of waste generated.
- Further research is needed on the safe distance between the dumping site and the source of portable water to reduce leachate pollution.
- The water source from Kumar River is a health hazard particularly to pregnant mothers and infants because of the presence of the physiochemical contaminants.
- Preferable laws and legislations on dumping of solid waste into the river should be established.
- Proper distance from the surrounding water body should be maintained for waste dumping and dumping site should be properly managed.

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