STUDIES ON PHYSICOCHEMICAL PROPERTIES OF BURIGANGA RIVER WATER AND THE VEGETATION COVERAGE OF SURROUNDING AREA, DHAKA, BANGLADESH.

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ABSTRACT: *Buriganga River is originated from Dhaleshweri and is referred to as one of the most polluted rivers around Dhaka. In the last three decades, significant numbers of textile and tannery industries have been established on the banks of the river, apart from the industrial establishment a substantial amount of domestic waste has been dumped into the river water which dramatically contributed to the pollution increase of the river water. To investigate the quality of Buriganga river water. The study analyzed the status of 10 physiochemical parameters including pH (potential hydrogen), EC (electrical conductivity), TDS (total dissolved solids), DO (dissolved oxygen), Alkalinity, Acidity, Total hardness, Magnesium hardness, and Calcium hardness of Buriganga River, the study collected 11 water samples from 11 different locations of Buriganga River. The result indicates that most of the analyzed parameters exceed the limited standard set by WHO (world health organization) and DoE (department of the environment) in the Peoples' Republic of Bangladesh for healthy water. In addition, the decreasing trend of vegetation coverage in the surrounding area also suggested the increasing trend of urbanization. The research has shown the deteriorating situation of the Buriganga River and surrounding environment and suggested a strong recommendation to the concerned authorities. However, wide-scale research is needed to be conducted to further develop a realistic mechanism to cope with the increasing pollution.*

Keywords: *Buriganga, Water quality, River pollution, public health, Dhaka city*

1. INTRODUCTION

Buriganga River is originated from Dhaleshweri and is referred to as one of the most polluted rivers around Dhaka. A significant number of industries have been established on the banks of the river, apart from the industrial establishment a substantial amount of domestic waste has been dumped into the river water which dramatically contributed to the pollution increase of river water[1]. In recent years the condition and quality of river water have changed considerably as a result of excessive pollution from industries around the river, many industries and factories including textile and tannery industries have been deliberately dumping untreated or partially treated effluents into the river water[1]. This has decreased the quality of the river water which has made it impossible for the river to be used for essential purposes such as drinking water or daily needs. Nonetheless, the fast development of industrialization, the growth of population and communities living in the surrounding areas of the river banks, and other expansion activities that are going around the Buriganga river largely contributed to the worsening situation of the river[2]. Moreover, River water has been used for many purposes including transportation, irrigation, drinking, and fishing but unfortunately, these activities had become an obstacle to maintaining the water quality of the river and protecting the biodiversity of the river which has resulted in the river becoming a dumping ground. The use of water for drinking purposes has also disappeared and the prospect of aquatic life has been reduced which has resulted in a decrease in fishing in addition to that dumping plastic waste and small items in river water during travel has not been focused but was one of the main sources of the pollution[3].

1.1. Problem statement

Over the last decade, the quality of Buriganga river water has been changing; these changes have resulted from industrial growth, the increase of solid and liquid waste production and a wide range of uses for river water including transportation, agriculture, and fisheries[4]. All of these activities have contributed to the deterioration of river water, both physically, biologically, and chemically. Historically Buriganga River was one of the most important rivers in the country which was used by the people in many ways but the growth of the industries including textile and tannery factories has contributed to the production of a large amount of waste however these significant amounts of waste were dumping into the river intentionally, these contaminants have consisted of chemicals and heavy metals that pose a threat to the environment and the quality of river water[5]. As a result, in a short period, the river has become one of the most polluted rivers in the country, making it impossible to use the river at all in terms of domestic use. Moreover, many studies point to the deteriorating state of the river, and some of these studies have indicated that in a short period the river could become biologically dead[6]. In addition to the water quality, the vegetation coverage of surrounding areas was also decreased during the last 20 years.

1.3. Objectives

This study will emphasize two distinctive objectives;

- To assess the status of water quality of the Buriganga river
- To analyze the vegetation coverage around the study area

2. METHODOLOGY

2.1 Study area

The Buriganga River is one of the most important rivers in Dhaka (the capital city of Bangladesh) it flows past the southwest outskirts of Dhaka city (Fig. 1). Its average depth is 7.6 meters (25 ft.) and its maximum depth is 18 meters {58 ft.}[7]. The study has used Buriganga river water as the primary water sample. For collecting samples the study has used eleven different places (Table 1) from the Buriganga River.

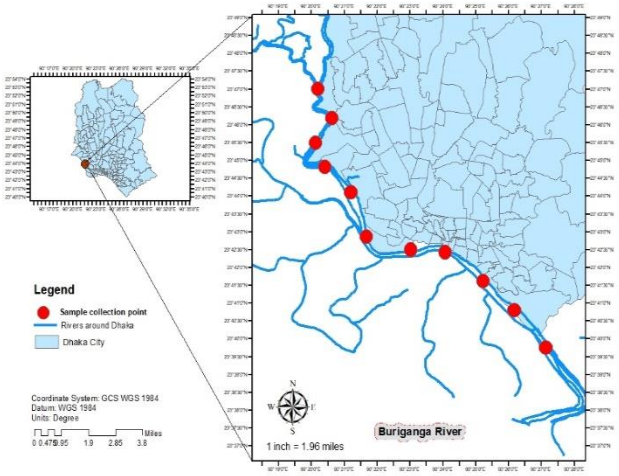


Figure 1: Map of the study area

2.2 Sample collection and Laboratory analysis

A study area of 18 km long was covered, 11 samples of water were collected and the distance between each two sample point locations was 2 km, 2 km distance was selected to cover the maximum area. Plastic bottles carefully cleaned with distilled water to avoid any unwanted contamination were used. Due to the covid19 pandemic situation, the study tried to collect all samples in one day while maintaining all necessary precautions and covid19 guidelines by ensuring wearing masks, gloves and maintaining social distancing.

For Physico-chemical analysis, the samples were brought to the laboratory just after the collection from the field and prepared for further laboratory analysis. The Physico-chemical parameters of water samples were analyzed following standard methodology [8]. The analyzed parameters included pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS), Acidity, Alkalinity, Total Hardness, Ca Hardness, Dissolved Oxygen (DO). pH and TDS, EC, and DO were measured by using HANNA pH/EC/TDS/Temperature Meter (HI9814), HANNA EC Tester (HI98304), and DO meter, LUTRON DO-5509 respectively. Total Acidity, Alkalinity, Total Hardness, Ca^{2+} Hardness were measured by the Titrimetric method and Mg^{2+} Hardness was measured by the deduction of Ca^{2+} Hardness from Total Hardness.

2.3 Physical observation of study area

Apart from data collection [sample collection] a field trip to the study area was held to find out and observe the general situation, it was observed, social interaction between the river and the communities living in the surrounding areas, industrial activity, and movement of people using river water for transportation. During the observation, general pictures were taken by using phones and also used to take notes to gather the information that was considered important or that may help in the future. However unfortunately the study did not get much opportunity to talk to local people because of the covid19 pandemic but managed to precisely observe the situation through both physical and visual observation.

2.4 Visual observation of study area

The development of technology has helped humans to conceptualize and understand how they interact with their environment and this has encouraged us to develop visual observation that reflects how the river has changed over the last five years. Though the main objective was to analyze the water parameters, the study realized the importance of providing an effective observation in the research. the study used the "continental hub" website which is a free platform that can help you to develop a visual observation in any area based on your interest by using all the available land sets, in our case due to the lack of effective physical observation because of the pandemic the study area was observed (Fig. 1) by visual analyses in addition to that this has also helped and made it easier for the study to find out the general situation and how the landscape and the interaction of the surrounding communities have changed over the last five years as the evidence showing. The study used the theme of "monitoring Earth from space" in L2A in true color based on BANDS 4,3,2,1 have focused on in the last 5 years by building time-lapse from 2017 to 2021 as shown in the following time-lapse pictures.

2.5 Supervised Image Classification

The method used here to identify and calculate the land cover amount of the study area inputs some supervised samples in ArcGis software, later the software itself calculates the pixel of the image data and shows the output. The amount of land cover used in an area can be calculated with the help of production. In this case, the land cover shows the amount of increase or decrease meant for a particular land cover category.

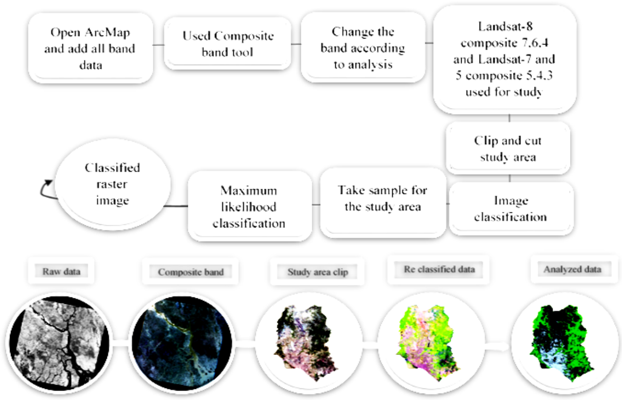


Figure 2: Pictorial presentation of the methodology

2.6 Statistical analysis

All experimental results are presented as the mean ± S.D. (n = 3). Statistical analyses were performed using the software SPSS for Windows (Release v17.0, SPSS INC., Chicago, USA).

3. RESULTs AND DISCUSSIONs

In this section, the study tried to demonstrate all the findings and results that were examined from the beginning of the research to the end of our selected study area. The study tried to concentrate on the status of physic-chemical parameters of water (pH, EC, TDS, Alkalinity, Acidity, Total hardness, Calcium hardness, Dissolved oxygen, Magnesium hardness), and the vegetation profile along the study area.

3.1 Physico-chemical parameters of water

pH: The pH is an important indicator of the quality of water[9], in the present study the highest pH level was recorded in sample 1 whereas the pH was lowest in sample 4, this

Table 1: Location of Sample collection sites.

Sample No.	Sample locations name	Latitude	Longitude
01.	Gabtali bridge	23°47'2.23"N	90°20'7.78"E
02.	Gabtali	23°46'53.41"N	90°20'10.31"E
03.	Green city housing	23°45'28.89"N	90°20'8.62"E
04.	Basila Bs	23°44'48.29"N	90°20'38.17"E
05.	Gudaraghat	23°44'1.77"N	90°21'10.62"E
06.	Kholamora ghat	23°42'51.19"N	90°21'39.67"E
07.	Tara Masjid	23°42'39.06"N	90°23'58.14"E
08.	Babu Bazar Bridge	23°42'29.33"N	90°24'5.53"E
09.	Mirerbag	23°41'31.21"N	90°25'16.03"E
10.	Shyampur Terminal	23°40'52.61"N	90°26'5.00"E
11.	Pagla	23°39'43.56"N	90°27'15.72"E

demonstrate that the pH level of sample 4 was quietly acidic [Fig. 3(A)]. As the study observed in the area, the study found that due to the presence of industrial effluents the pH of sample 4 was low compared to all other samples. In the study the standard pH level in all samples was within the permissible limit, there was no substantial dissimilarity between all 11 sample locations.

EC (electrical conductivity): EC is an important indicator of the capacity of water in conducting an electrical current. In the present analyses, the highest values were recorded in sample 1 were the lowest was recorded in sample 9 [Fig. 3(B)]. This demonstrates that the presence of impurities in sample locations

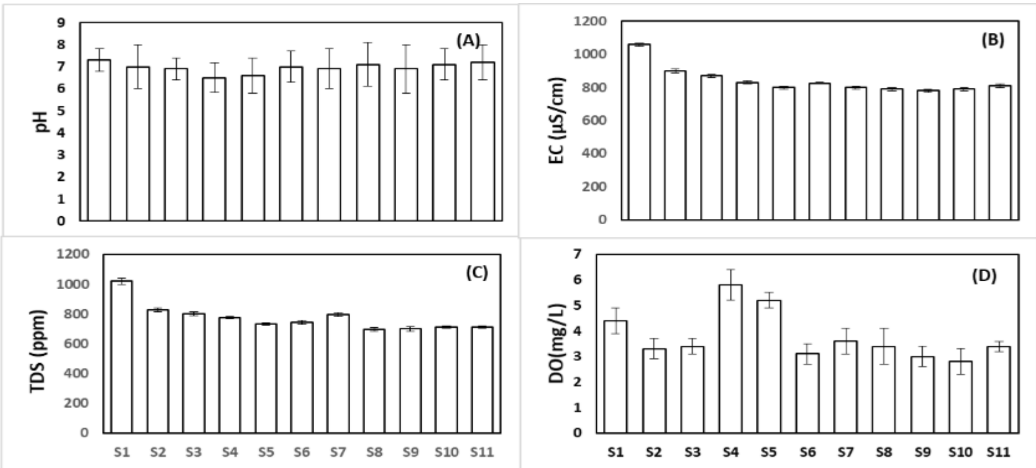


Figure 3: Analysis of pH [A], EC (µS/cm) [B], TDS (ppm) [C] and DO (mg/L) [D] of water sample collected from Buriganga river.

TDS (total dissolved solids): Total dissolved solids can be described as the number of solids that are present in given water[7]. The study observed that the highest level of total dissolved solids was found in sample 1 and the lowest was found in sample 8 and sample 10 respectively [Fig. 3(C)]. The result of all sample analyses showed a significant presence of TDS in Buriganga river water however except for sample 1, the test showed that the TDS level was within the permissible limit set by the department of environment of the peoples' republic of Bangladesh which is 100mg/l [10]. Nonetheless, the presence of this huge amount of TDS is because of the intentional waste dumping from households and industrial activity.

DO (dissolved oxygen): Dissolved oxygen is an important indicator of the quality of suitable water. The study found that the highest level of DO was found in sample 4 were the lowest was found in sample 10 which was also found by [9]. According to the guideline set by the DoE (Department of the environment), the level of DO has to be 5mg/l for the ideal maintenance of the health of aquatic species in water[7]. However, any value less than five can be referred to as alarming. Our study highlighted that the DO value was significantly low in all 11 sample analyses [Fig. 3(D)].

Acidity: Acidity can be described as the ability of water to neutralize bases. the study analyzed the level of acidity of 11 samples collected from Buriganga river water by using the titration method, the result of our analyses shows that the highest value was found in sample 8 and the lowest value was found in sample 9 [Fig. 4(A)]. This highlighted that the acidity level was substantially high in all sample locations which indicated the presence of highly contaminated water.

Alkalinity: In general water can be highly alkaline due to the presence of weak acid and a significant amount of base[11]. After analyses of 11 water samples collected from our study area using the titration method the highest alkaline water was found in sample 3 and the lowest was found in sample 5 [Fig.4(B)]. The study highlighted that the alkalinity level of the Buriganga river is considerably high and beyond the standard limit set by WHO (world health)

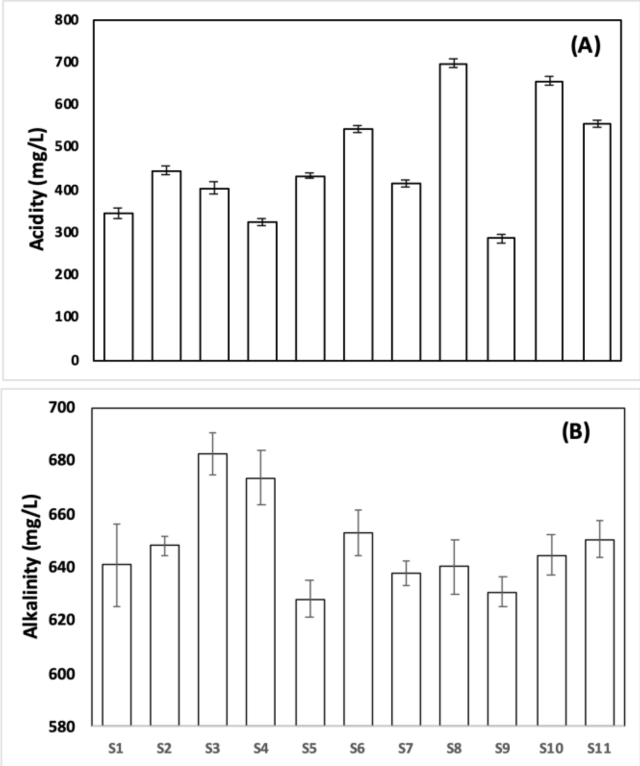


Figure 4: Status of Acidity (A) and Alkalinity (B) of water collected from Buriganga river

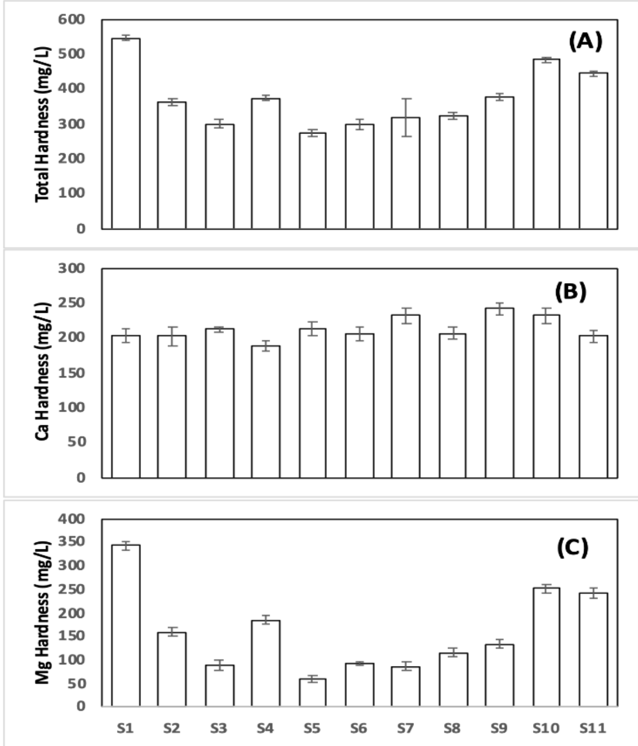
organization). After critical evaluation, the study concluded that the alkalinity is high because of the unstable changes in pH which can directly influence the status of alkalinity in water. Moreover, the dumping of sewage from households as it is contained chemicals from cleaning agents in addition to the presence of untreated industrial effluents has contributed to the increase of alkalinity level in Buriganga river water.

Total hardness: Water hardness can be described as the ability of water to react with soap, in other words, water hardness is the number of minerals especially calcium and magnesium that are available in the water. Hard water contains a significant amount of dissolved minerals while soft water has fewer dissolved minerals[12]. In the present study, the highest and lowest value of Total hardness found in sample 1 and sample 3 [Fig. 5(A)].

Calcium Hardness: 11 samples of water were analyzed to detect the calcium hardness of the study area, it is noteworthy that the highest value was found in sample 9 while the lowest value was found in sample 4 [Fig. 5(B)].

Magnesium Hardness: Due to the relation between total hardness, calcium hardness, and magnesium hardness the study has analyzed the value of magnesium hardness by calculation [Fig. 5(C)].

3.2 Vegetation coverage around study area: Dhaka is losing its vegetation because of the increasing amount of urbanization [13] which is impacting its water area too. That is why the river around Dhaka is getting polluted with time [14]. The image classification analysis has taken a 2-kilometer area around the water sampling point to show the impact of water pollution on vegetation around the



Buriganga River. The analysis identified a huge vegetation loss in the last two decades. According to the analysis, the total vegetation amount in the two-kilometer area in 1994 was about 2295 hectares of land which was 30% of the

Figure 5: Status of Total Hardness (A), Ca Hardness (B), and Mg Hardness (C) of the water sample collected from the Buriganga river

study area. And on that 2 kilometers study area almost 65% of the study area land was covered which was about 4940 hectares of land. But in 2000 the vegetation area decreased significantly and it became 1845 hector of land which is 24% of the total area. Similarly, in 2005 it decreased again and become only 20% of total land which is 1535 hectors only, on the other hand, the urban area increased about 10% and become 72% of total land area which is 5553 hectors of land. In 2010 the map showed similar data which indicated that in 2010 about 7% of total study areas vegetation was lost and become only 14% of total land use which is about 1091 hectors of the land but the urban area become 79% and increased by about 7% from 2005. In the same way, vegetation area continued decreasing in 2015 too. In 2015 the vegetation area become 622 hectares which are about 8% of total land use but the urban area increased by about 5% and it is about 6470 hectares which is almost 84% of total land use. Unfortunately in 2020 the vegetation area only remains 4% of the total land cover and 87% of the total land cover of the 2kilometer buffer becomes an urban area which is about 6680 hectares of land. These findings clearly showed that a huge amount of vegetation has been lost around the Buriganga River, which is one of the most significant water sources in Dhaka city.

Table 2: Vegetation impact around the study area

	Time (Area in Hectors and Percent)											
Type	**1994**		**2000**		**2005**		**2010**		**2015**		**2020**	
	Area	**Percent**	**Area**	**Percent**	**Area**	**Percent**	**Area**	**Percent**	**Area**	**Percent**	**Area**	**Percent**
Vegetation	2294.55	30.00%	1844.91	24.12%	1535.04	20.07%	1091.25	14.27%	622.89	8.14%	366.21	4.79%
Urban area	4939.74	64.58%	4924.08	64.37%	5553.27	72.60%	6064.47	79.28%	6469.74	84.58%	6680.07	87.33%
Water area	415.08	5.43%	880.38	11.51%	561.06	7.33%	493.65	6.45%	556.74	7.28%	603.09	7.88%
Total	**7649.37**	**100%**	**7649.37**	**100%**	**7649.37**	**100%**	**7649.37**	**100%**	**7649.37**	**100%**	**7649.37**	**100%**

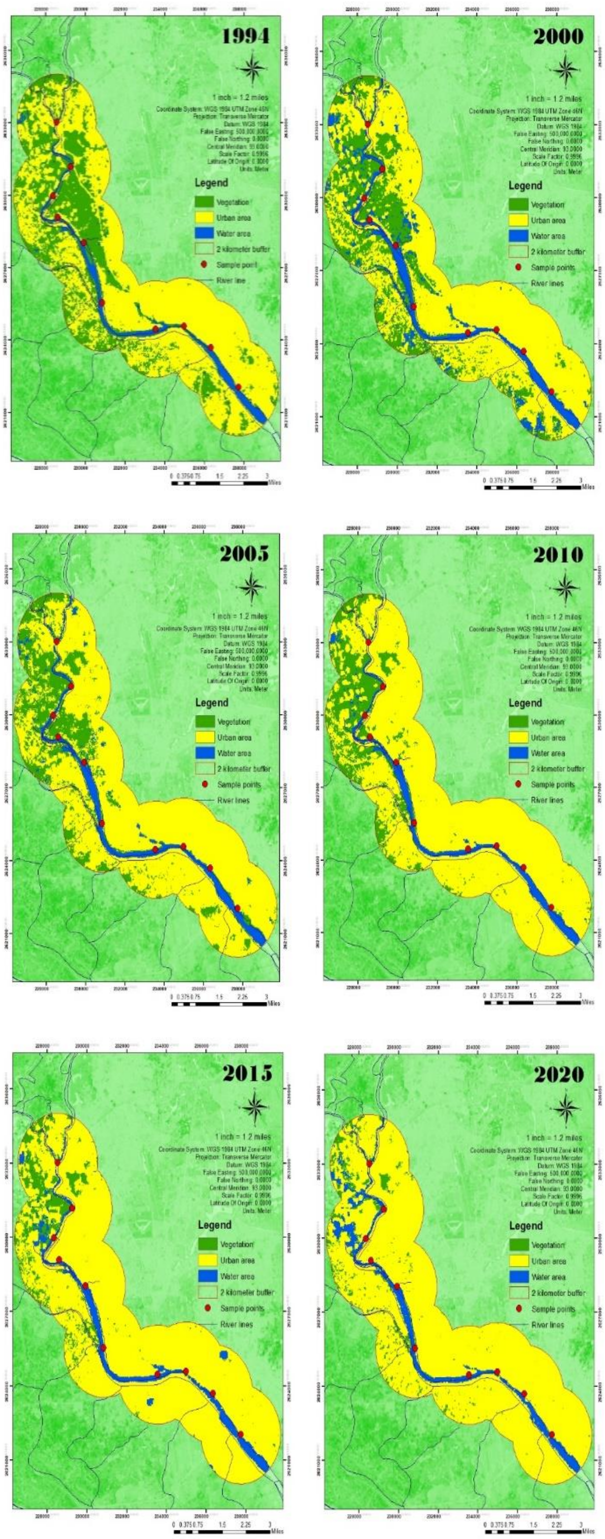


Figure 6: Impact on Vegetation around the study area

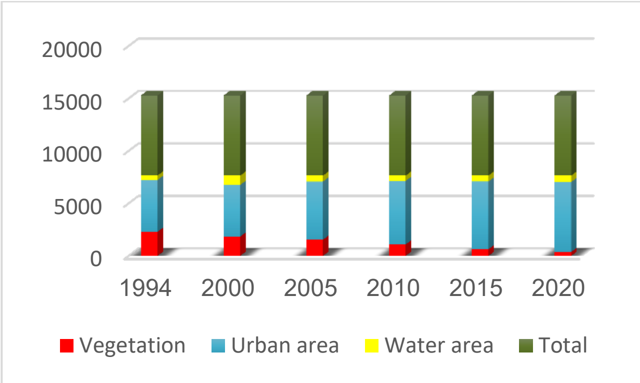


Figure 7: Vegetation impact around study area (Buriganga river)

4. RECOMMENDATION

In recent times, there has been a sharp rise in the pollution of the Buriganga River, which has led to a number of problems, including the risk of unhealthy drinking water from the river and fishing disturbance, which has affected the livelihoods of the people living in the area. In addition to that, the river is in danger of becoming completely biologically dead, which could have a momentous impact on the environment and biodiversity of the river. In order to protect the river, which is very important, the study suggests the following steps that can help us to save the Buriganga River[1].

The government and the other concerned authorities must come up with policies, rules, and regulations that:

- Control unauthorized vessels from industries around the river.
- Control excessive dumping of waste from sewage
- Control the dumping of municipal waste disposal in the river.
- Be well aware of unauthorized activities that are going on the river banks.
- Materialize the previous rules and regulation set by the DoE (Department of environment)
- Improve the quality and protection of river water.
- Textile and tannery industries must be reallocated from the surrounding areas of the Buriganga River.
- Set specific standard and limits of chemicals used by textile and tannery industries
- Monitor contaminated water from textile and tannery factories and ensure factories to do initial and secondary waste water treatment before disposal.
- Monitor unauthorized waste disposal from textile and tannery industries

5. CONCLUSION

The study has observed that some physiochemical parameters of the Buriganga river are exceeded the limited standard set by WHO (world health organization) and DoE (Department of Environment) for healthy and free water from pollution. The study shows that the dissolved oxygen was significantly low in some locations, with highlighted unstable acidity and alkalinity values, In some locations, the acidity level was within the permissible limit while some locations were considerably low. In addition to that, the study underlined the high level of TDS and a substantial hardness in the sample water. Furthermore, the study has observed that the location near the industrial zones has the most polluted water compared to the other locations.

Moreover, the vegetation impact analysis around the study area suggested that a significant amount of vegetation decreased in the last 20 years. The increasing water pollution and decreasing trend of vegetation around the Buriganga River ultimately reduce the ecosystem of the surrounding area.

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