WATER QUALITY AND EIA OF SIMPLE HATIRJHEEL LAKE

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ABSTRACT

Since water is so viral for all known forms of life, water pollution is most important issues of modern world. Now a days it becomes the first priority to save the limited source of fresh water from the pollutants. All the water treatment process is followed by the water health indicator test. These test includes Biochemical oxygen demand (BOD), Chemical oxygen demand (COD), E.coli test, TDS, Turbidity, Odor, pH, Iron concentration of water, Hardness of water etc. A considerable area of Dhaka city is covered by Hatirjheel Lake. So the environmental conditions of these lakes has a great influence over the city dwellers, its surroundings & visitors. The lake ecology system being destroyed for excessive waste water. The paper reports on the present water quality & the sources of water pollutant as well as the EIA on most important parameters. Different water quality indicator tests like BOD, E. coli & Turbidity are performed over the collected water sample. The samples were collected for laboratory test from different depths & points of Hatirjheel Lake. The tests were continued for nine weeks covering winter & summer season. Results from laboratory were 154 mg O2/L of BOD, 6700 CFU/100ml of E. coli & 109 FTU of Turbidity. These values were compared with standard data given by BECR-97 & USEPA. And EIA is done upon baseline survey considering 36 parameter divided into four major group. Though overall environmental impact of Hatirjheel is positive, impact of three major field are negative and necessary measures should need take immediately

Keywords: *Health indicator test; Water Quality; EIA; BOD; Turbidity.*

1. INTRODUCTION

Economic development projects brought innumerable benefits but also had unintended detrimental effects on people and natural resources. Human activities have resulted in the disruption of environmental and communal harmony. Such disruptions not only need to be identified and measured but also need to be managed in such a way that the positive externalities are maximized and the negative externalities are minimized. Environmental impact assessments help in understanding such impacts.

Hatirjheel Lake is located in the centre of Dhaka and is a crucial element in the city's drainage system. It used to be connected to a string of other lakes, the Banani, Dhanmondi and Gulshan Lakes, and to the Begun Bari Khal at the Rampura Bridge. So the environmental conditions of these lakes has a great influence over the city dwellers & its surroundings. Each lake catches different types of municipal wastes. The lake ecology system being destroyed for excessive waste water. As a result a greater changes happening in bio-diversity. Fish & others aquatic plants or organisms being vanished from the lake. Solid wastes are creating a worst problem. A thick layer of solid waste sediments are generating in lake bed. So, the plants that grows in the bed of a lake supplied as foods for fishes or other living organisms are not available now. On other hand reverse case is ongoing. Excessive nitrogen & phosphorous from wastes can be accumulated in lake water. As a result rooted aquatic plant & algae will grow fast; which leads to algal bloom that is a problem for navigation in lake water, as well as different environmental issues. The objectives of these research is to assess the Biochemical Oxygen Demand (BOD), Turbidity & Escherichia coli (E. coli) at various depths of Hatirjheel Lake and overall EIA of Hatirjheel Lake.

2. METHODOLOGY

Water sample are collected from different Depth and points from Hatirjheel and selected imported parameter are tested in laboratory. A baseline survey is done to select depth sensitive parameter required to consider for Hatirjheel and also for EIA. After that we have select 36 parameters in four major categories.

2.1 Study Area

Hatirjheel Lake is located at 23º48' N & 90º25' E of Dhaka city & length of the lake is 4.1 km which covers an area of 0.79 km2 (collected from Google earth). It has an average depth of 2.6 m. The widest part of the lake is approximately 0.46 km. The peripheral sides are, northern at Gulshan-Banani, southern at Banglamotor, eastern at Rampura & western at Tejgaon industrial area.

Sampling and Analysis Method

Sampling is a most sensitive part of any research. In our study we have followed sample collection guideline of DPHE for depth variant sampling and non-depth variant sapling. For water quality testing we have select 3 depth variant sample and 6 non-depth variant sample. On the other hand EIA data are collected by key informant interview, beneficiary interview and information from relative govt. organization and analysed with Environmental Evaluation System (EES) developed by Battelle Columbus Laboratories in the United States.

2.2 Sampling and analysis of Hatirjheel Water

For the testing of water quality we have selected the most polluted zones of Hatirjheel. They are: (a) Sonargaon inlet of Hatirjheel, beside Special Sewerage Diversion Structure, (b) Near BGMEA building and (c) Near Moghbazar. By a general selection for this lake BOD, E.coli, and Turbidity are selected as depth variant sample and P^H, Total Dissolve Solid (TDS), Total Suspended Solid (TSS), Phosphate, Ammonia, and Nitrate as non-depth variant sample. Total nine parameter are tested for nine weeks. Samples are tested in Environmental Lab of department of Civil Engineering in Ahsanullah University of Science and Technology (Depth variant test) and Department of Public Health Engineering (DPHE), Mohakhali (non-depth variant test). For non-depth variant test, samples are collected from three feet below the water surface. Standard test methods and apparatus are used in testing. Standard sample collection method are followed and instruments used for collecting water sample. Depth variant Sample water were collected from various depth of lake, for monitoring the condition of lake along the depth.

Table 1: Table: Sample collection level

Weeks	Depth of Water
1st, 2nd & 3rd	3 feet
4th, 5th & 6th	6 feet
7th, 8th & 9th	9 feet

2.3 Data Collection and analysis Method for EIA

Sample parameters are selected by a primary survey on most influencing things on and around Hatirjheel as well as it is compared with the Dhanmondi and Gulshan Lake area. Because those two city has experienced the gradual process of losing residential characteristics. There is very chance happen the same again in Hatirjheel if the surrounding and other developments cannot be controlled. Parameters are selected as important Environmental Component (IECs) through a two-step scoping process (UDFCD, 2001). Then relative importance of these parameters is selected based on LGED guideline (1992). The 36 decision factors or environmental parameters are grouped into four categories which are:

(a) Physical Resources
(b) Echological Resources
(c) Human use value
(d) Quality of Life value.

Aftr selecting parameters datas are collected key informant interview directly and indirectly related to Hatirjheel, interview and information from different govt. and non govt. organizations working on the development and future sustainibility of Hatirjheel. Two different types of survey on serrounding people and visitors are also taken.

Considering the situation prevailing in the country, a simple methodology has been developed for Environmental Impact Assessment of infrastructure projects. The methodology is based on Environmental Evaluation System (EES) developed by Battelle Columbus Laboratories in the United States. In this method, the existing environmental conditions will be the reference level and the positive and negative changes in environmental conditions resulting from the proposed project will be evaluated. The environmental impact will be assessed by Environmental Impact Values (EIVs) which may be defined mathematically as follows:

$$EIV = \sum_{i=1}^{n} (V_i) W_i$$

Where V_i is the relative change in the value of environmental quality of parameter i with respect to the existing situation. W_i is the relative importance or weight of parameter i, and n is the total number of environmental parameter related to the project. The computation of Environmental Impact Value (EIV) of a project needs determination of V_i, the value representing the magnitude of alteration of the environmental parameters, and W_i, the value representing relative weight or importance of the respective parameters.

2.4 Magnitude of alteration of the environmental parameters

The beneficial and adverse changes in environmental parameters resulting from a project, usually expressed in qualitative terms have been plotted in a scale to quantify the environmental alterations. (Kennedy, 2007)Since the changes of environmental parameters are measured with respect to existing condition, no change has 0 value. The adverse changes have been given values -1, -2, -3, -4 and -5 to represent very low, low, moderate, high and severe negative impacts respectively. Similarly +1, +2, +3, +4 and +5 represent very low, low, moderate, high and very high positive impacts respectively. A value from the scale representing the effect of the project on each parameter will be taken to compute the EIV of the project.

3. ILLUSTRATIONS

3.1 Water Quality Data Analysis

Among the nine parameter three (BOD, Turbidity and E. Coli) has considered as most sensitive to depth variation and other six (P^H, Total Dissolve Solid, Total Suspended Solid, Phosphate, Ammonia, and Nitrate) are considered as less sensitive to depth variation as well as the depth variation impact of those also considered as low.

3.1.1 Data analysis of depth-variant parameter

These data were collected and tested for nine weeks (10/12/14 to 04/04/15) covering winter & summer season. The test report shown in bellow:

Week no.	Date	Seasons	Collection Points (CP) of Hatirjheel Lake	Depth of water collection	Experiment Results		
					BOD5 (mgO2/L)	Turbidity (FTU)	E.coli (CFU/100 ml)
1			CP1:Sonargaon		78	108	3400
	10/12/14		CP2: BGMEA		80	49.01	4000
			CP3: Moghbazaar		44	37.52	4400
2			CP1:Sonargaon		120	101	2400
	24/12/14		CP2: BGMEA	3’	98	79	3000
			CP3: Moghbazaar		140	43.56	3200
3			CP1:Sonargaon		154	22.03	4200
	17/01/15		CP2: BGMEA		116	19.57	5000
			CP3: Moghbazaar		94	17.80	3600
4			CP1:Sonargaon		130	34.68	6700
	27/01/15		CP2: BGMEA		110	28.97	4500
			CP3: Moghbazaar		84	22.06	2300
5			CP1:Sonargaon		134	44.60	5500
	31/01/15		CP2: BGMEA	6’	98	33.65	3700
			CP3: Moghbazaar		82	27.98	3300
6	07/02/15		CP1:Sonargaon		94	29.48	4400
			CP2: BGMEA		108	30.50	2800
			CP3: Moghbazaar		88	19.87	2400
7	11/03/15		CP1:Sonargaon		80	23.87	4200
			CP2: BGMEA	9’	104	15.00	3800
			CP3: Moghbazaar		90	81	2400
8	21/03/15		CP1:Sonargaon	9’	56	42.55	5700
			CP2: BGMEA		86	22.91	2100
			CP3: Moghbazaar		72	27.9	3300
9	04/04/15		CP1:Sonargaon		76	109	6100
			CP2: BGMEA		98	34.78	1500
			CP3: Moghbazaar		94	28.26	2600

Winter (week 1 to week 6)

Summer (Week7 to week9)

3.1.1.1 Graphical Representation Based on Overall Data

BOD, Turbidity and E.coli variation based on overall data is shown below:

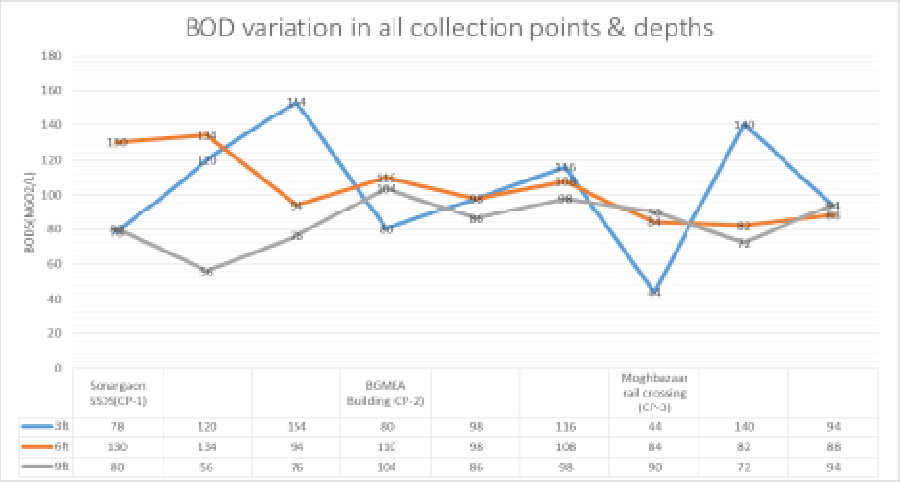
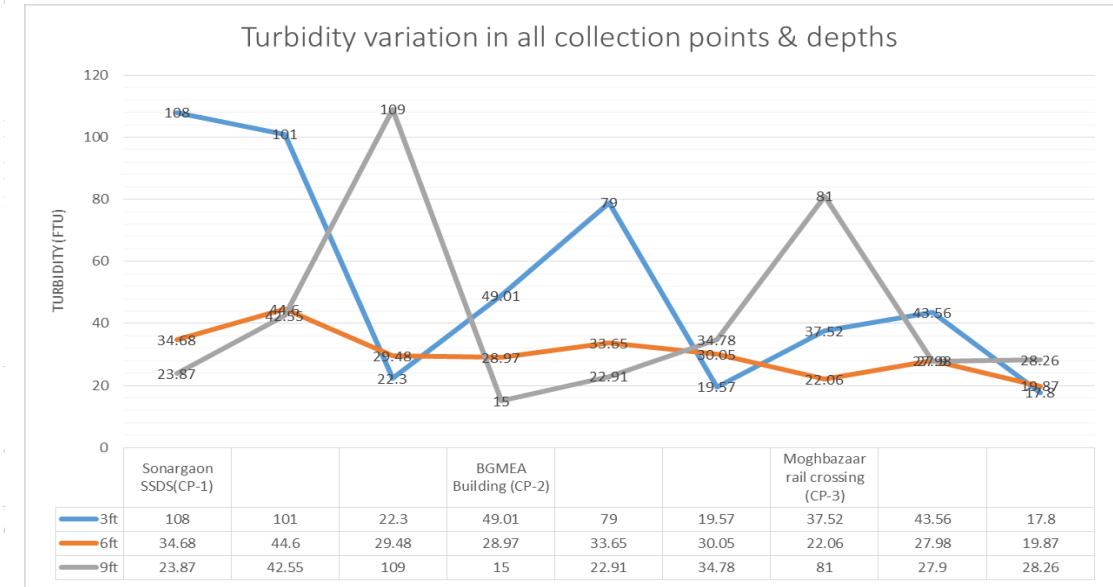


Figure 1(a): BOD analysis based on overall data

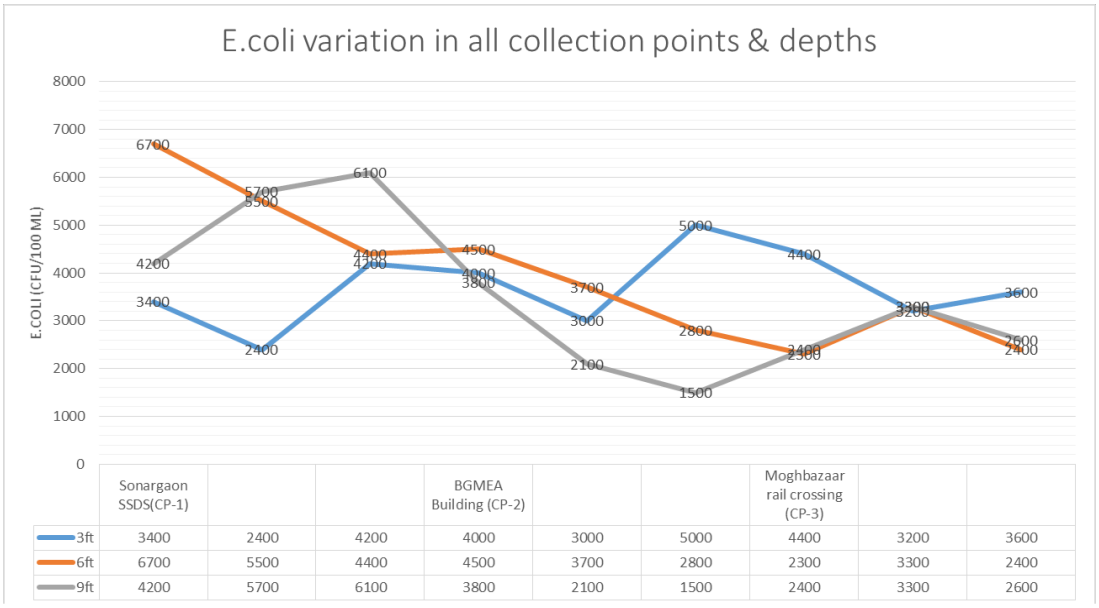
Overall data analysis for BOD gives the opportunity to realize the pollution levels of the lake at all collection points & depth at a glance.



	Sonargaon SSDS(CP-1)			BGMEA Building (CP-2)			Moghbazaar rail crossing (CP-3)		
3ft	108	101	22.3	49.01	79	19.57	37.52	43.56	17.8
6ft	34.68	44.6	29.48	28.97	33.65	30.05	22.06	27.98	19.87
9ft	23.87	42.55	109	15	22.91	34.78	81	27.9	28.26

Figure 1(b): Turbidity analysis based on overall data.

Pollution levels of Hatirjheel Lake spreading all over the lake & depth as well. The variations turbidity indicate the magnitude of pollutions.



	Sonargaon SSDS(CP-1)			BGMEA Building (CP-2)			Moghbazaar rail crossing (CP-3)		
3ft	3400	2400	4200	4000	3000	5000	4400	3200	3600
6ft	6700	5500	4400	4500	3700	2800	2300	3300	2400
9ft	4200	5700	6100	3800	2100	1500	2400	3300	2600

Figure 1(c): E.coli analysis based on overall data.

Variations of e.coli are easily recognizable through the scattered graph. It co-relates all fluctuations of results, which is measured at various points & depths.

3.1.1.2 Comparison of BOD, E.coli & Turbidity with BECR & US EPA standards:

Comparison of Laboratory results for BOD, E.coli & Turbidity shows the actual magnitude of pollutions in Hatirjheel Lake. At each collection point & different depth of the lake, the values of lab result exceed the standard values given by BECR & USEPA. Among these parameter, E.coli crosses the limit extremely higher

than other. Because Hatirjheel Lake receives a huge amount of combined sewer waste, which contains harmful coliform bacteria that originates from human & animal fecal wastes.

Table 2: Standards for inland surface water according to BECR & USEPA

Name	BOD (mg/L)	E.coli (CFU/100ml)	Turbidity (FTU)
Lab result	119	5533	77.01
BECR Standard (for recreational water)	6	200	---
US EPA Standard (for recreational water)	0.04	235	50

3.1.2 Data analysis of non depth-variant parameter

The hatirjheel lake and gulshan banana lake within the project area receives discharge from both domestic and industrial sources. Polluted water flows to Rampura Khal from Gulshan Lake through Hatirjheel. This is one of the reasons of pollution of lake water. The rainwater was supposed to enter the lake through the Panthapath box culvert to hold the rainwater. But at present, solid waste also enters the lake. Screens were set up to stop solid waste from entering the lake but piles of huge solid waste caused stagnation in the Dhanmondi, Kalabagan and Panthapath areas. Through physical, chemical and bacteriological analysis of water sample it has been observed turbidity, Total suspended solids, Ammonia, COD, BOD etc. are way above the standard values. The test results are shown in table 3.1.2:

Table 3: Values of lake water quality parameter within study area

Water quality parameter	Concentration present
pH	7.1
Total dissolved oxygen (TDS)	288 mg/L
Total suspended solid (TSS)	60 mg/L
Phosphate (PO4)	3.4 mg/L
Ammonia (NH3)	12.5 mg/L
Nitrate (NO3)	.33 mg/L

3.2 ENVIRONMENTAL IMPACT ASSESSMENT

3.2.1 Policy and Legislation

The roles and responsibilities of different ministries and departments related with the enforcement of environmental requirements are briefly described below:

3.2.1.1 Ministry of Environment and Forest (MoEF)

The Ministry of Environment and Forest (MoEF) is the key government institution in Bangladesh for all matters relating to national environmental policy and regulatory issues (AIA, 2009). Realizing the ever-increasing importance of environmental issues, the MoEF was created by replacing the Ministry of Forest in 1989 and is at present a permanent member of the Executive Committee of the National Economic Council. This group is the major decision-making body for economic policy issues and is also responsible for approving all public investment projects. The MoEF oversees the activities of the following technical/implementing agencies:

- ✓ Department of Environment (DoE)
- ✓ Department of Forest (DoF)
- ✓ Forest Industries Development Corporation (FIDC)

Related Other Organizations:

There are several other organizations, which are related with certain social and environmental functions. These organizations include:

- Ministry of Land: Land Reform and Land Acquisition Directorate
- Ministry of Water Resources: Bangladesh Water Development Board (BWDB)

• Ministry of Fisheries and Livestock: Directorate of Fisheries

3.2.1.2 Relevant National Policies and Legislation Relevant to Environment

National Strategies, Policies, Acts and Rules related to the environment include the following:

- Environment Pollution Control Ordinance, 1977.
- Environmental Quality Standards for Bangladesh, 1991
- National Conservation Strategy (NCS) 1992
- Environmental Policy (1992)
- National Environmental Management Action Plan (NEMAP) 1995
- Environmental Conservation Act (1995)
- Environmental Conservation Rules (1997)

The 1997 rules were formed gradually leading to the strategy that was developed in 1992. The policy was enunciated based on the strategy. The NEMAP followed the policy. The Acts and rules naturally followed the plan through legislative actions.

3.2.1.3 Relevant acts related to Environment

- Relevant acts related to Environment
- Bangladesh Wildlife Preservation Act (1973; Amended in 1974)
- Forest Policy (1994)
- Compliance with International Requirements
- Rio Declaration
- Convention on Biological Diversity, Rio de Janeiro, (1992)
- Convention on Wetlands of International Importance Especially as Waterfowl Habitat, Ramsar (1971)
- United Nations Convention on the Law of the Sea, Montague Bay, (1982)

3.2.2 Description of Environmental Baseline

Climate: There are three main seasons: Summer (March to May), Rainy season/Monsoon (June to October) and winter season (November to February). The rainy season is hot and humid having about 85 percent of the annual rainfall. The winter is predominately cool with comparatively low humidity. Bangladesh Meteorological Department (BMD) is the source of the analyzed data and last available 10 years data are analyzed to generate the result.

Rainfall: Data from 2001 to 2011 has been used for the analysis and the data source is Bangladesh Meteorological Department (BMD). (BBS, 2002) The annual average rainfall in this area is about 2161 mm/yr. The monthly average maximum rainfall was recorded as 433 mm in the month of July and the monsoon rainfall was about 1742 mm. Maximum rainfall in a single day is found 333 mm in September and maximum average rainy days in a month is found 24 in June

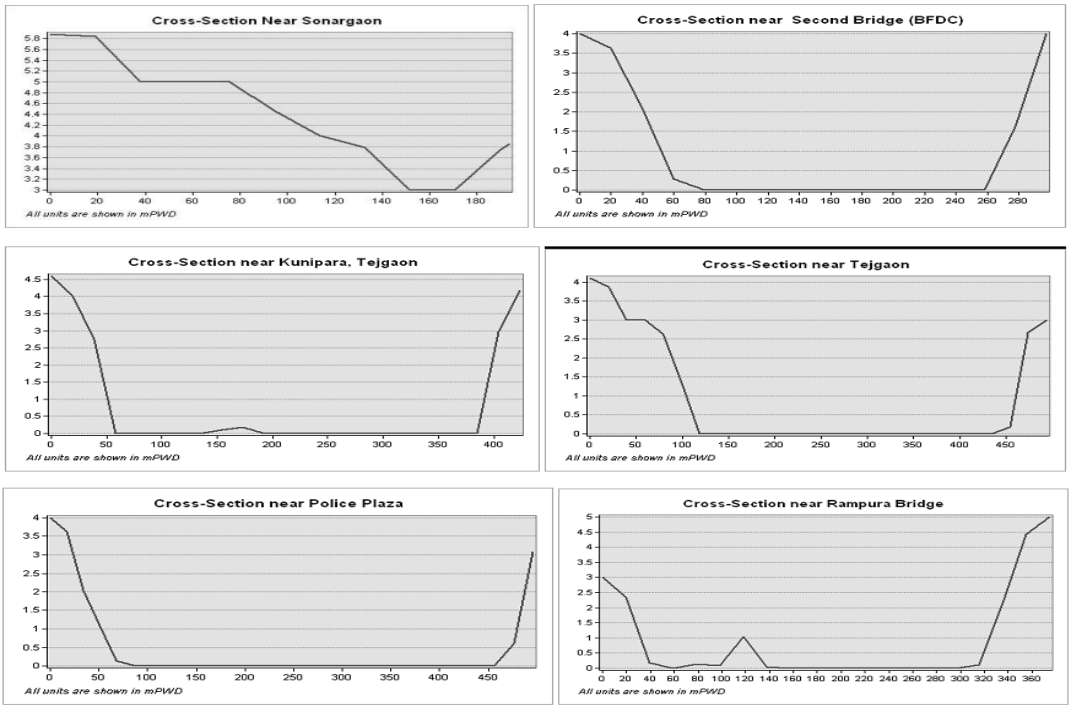
Temperature: The Bangladesh meteorological data at the Dhaka station from 2001 to 2011 shows that the monthly average maximum temperature in months varies from 24°C to 34°C while the maximum temperature occurring over the months of March to May is around 340 C. The monthly average temperature varies from 19°C to 29°C

Relative Humidity: The Dhaka station has been considered for Relative Humidity data analysis. The monthly average relative humidity varies from 60% to 81% in last ten years (2001 to 2011). In the summer, average relative humidity varies from 60% to 72%, in the Monsoon, 81% to 71% and in the winter, it again decreases up to 71% to 60% Due to high level of humidity, the Monsoon, more sweating occurs.

Evaporation: The monthly average evaporation in this area is 18 mm/day and the maximum evaporation occurs in the summer season of last ten years (2001 to 2010) for the Dhaka station (Source BMD). The maximum evaporation is 25 mm/day, which occurs in the month of April. The minimum evaporation is 11 mm/day in the month of January (BBS, 2001).

Air Quality: The average wind speed becomes high in the monsoon season and low in the dry season for last ten years (2001 to 2010, Source BMD). The monthly average wind speed is 2.4Km/day in the summer, 3.5Km/hr in the Monsoon and 2.9Km/hr in winter (Figure 4-6). The maximum wind speed occurs in July to September.

3.2.3 Hydrological Profile



3.3 Potential Environmental Impacts and degree of impacts

3.3.1 Physical resources

Surface water quality: Surface run-off includes the pollution load run-off due to all human and other related concerns such as domestic, industrial, agricultural and other activities Through physical, chemical and bacteriological analysis of water sample it has been observed turbidity, Total suspended solids, Ammonia, COD, BOD etc. are way above the standard values (UDFCD, 2001). Dissolved oxygen is only 5.3 mg/l where the standard value is 6 mg/L. So the overall surface water quality is poor and day by day it's degrading. The degree of impact due to implementation of the proposed development plan has been considered as -4.

Ground Water Quality: ground water is good in quantity but may require some treatments to improve its chemical characteristics. The analysis of water supplies is the prime criteria for determining the quality of ground water of a particular area. The degree of impact has been considered as +2.

Air & Noise Pollution: Due to development of the land volume of traffic will increase which will cause noise pollution. Degree of impact due to implementation of the development plan has been considered as -3.

Soil Quality: The study area was a dumping place before the implementation of hatirjheel project so soil quality was not much of a concern. Now if the development plan is implemented impervious portion within the area will increase which will affect the soil quality and degree of impact will be negative. After implementation of the project degree of impact has been considered as -2.

Climate: In our Impact Assessment Climate is considered as Zero (0)

Hydrology: The annual average rainfall in the project area is about 2161 mm. Storm water from outside and inside the project area discharges through the lakes. within the project area ground water met at depth 5 m to 9 m below the surface and the seasonal fluctuation of the ground water table rouges from 0.5 meters to 2.50 meters. Degree of impact is considered as -1.

3.3.2 Ecological resources

Fisheries*:* By observing the values of COD and BOD of lake water it is very clear no fish can survive in this water. The degree of impact is considered as -2.

Aquatic *biology:* The main aquatic flora in this area is Kalmilata, Kochuripana. Tepapona etc. The main aquatic faunas in this area are some fishes in the lakes within the study area. But due to increasing pollution of the lake water DO level is depleting and no of aquatic faunas are diminishing. The degree of impact has been considered as -3.

Terrestrial *flora* and *fauna:* Due to implementation of the development plan degree of impact on terrestrial flora and fauna has been considered as -1.

Forest*:* There is no specific forest or reserved forest seen in this area. There are greeneries at some places and there are tree plantation on both side of the roads and homestead seen in the project area. The degree of impact has been considered as +1.

3.3.3 Human use value

Agriculture*:* There is no record of agricultural activities within the project area so due to implementation of the project the impact has been considered as zero (0).

Water Supply: There is piped water distribution system from DWASA's water distribution system network that cover almost all of the built up areas. Within the study area there is about 14 km water supply line exists with 22-25 deep tube wells (DTWs) exist. 95% people say that they have piped water distribution system. But only 65% of people are satisfied with the quality and amount of supplying water. The impact is considered as +4.

Navigation The lakes within the study area was used for minor navigation. But due to development of road network it reduced to nil. As prior navigation was not of much significance the impact due to implementation of the project is considered as -1.

Power and Gas Supply: lectricity is mainly supplied in Dhaka city area by DESA and DESCO through 132 /33 kV grid substation and 33/11 kV substations located at different places in Dhaka city. Lion part of the study area under the jurisdiction of DESA including Noyatola, Modhubag, West Rampura, Ullan, Kawran Baazar, Tejgaon Industrial Area, Kunipara etc. A very little part North including Merul Badda, Niketon, and Banani falls within the service area of DESCO. There is about 4.39 km transmission line of 132 KV and 5.97 km of 33 KV exits within the study area boundary. Due to implementation of the project the impact on power supply is considered as +3.

Drainage: DWASA has 12.65 Km drainage infrastructures including lake, khal box culvert, strom sewer, pipe drain and others. Most of the cases these networks work as the secondary drain to drive the storm water along household waste water (partly) to natural primary drainage network (khal). Most significant issue here that total length of pipe drain and storm sewer is about 5.5 Km (average Dia of Pipe 0.9-1.8 m) which is very much less to meet the excessive demand of population. Average Dia for DCC owned piped drains varies from 0.3-0.9 m and average width of open drains varies from 0.2-0.8 m (UDFCD, 2001). Usually these drains are constructed by connecting with secondary drain of DWASA or major outlets. The degree of impact due to implementation of the project is considered as -1.

Sewerage and waste disposal: DWASA is the designated authority of Dhaka city for operation and maintenance of sewerage networks. Currently only 30% of the city area is served by the sewer system of which only 20% of the population have connections (UDFCD, 2001). The present condition of sewerage line is not up to the mark. But degree of impact after implementation of the development plan has been considered as +1.

Sanitation: The population of the study area are presently using disposal system such as septic tank. The overall sanitary sewage collection and distribution system of the area is of moderate nature. The degree of impact has been considered as +1.

Recreation: Hatirjheel turned into a pretty big recreational place for general people. The city people get a place to breathe, to be amused, to absorb the tiredness of city life and to be socialized. Every day huge number of visitors used to come here to enjoy the natural beauty of the lake, to pass some moment of pleasure with close ones. Lakeside landscaping and the bridges soothe the eye of the visitors (Aminuzzaman, 2002). The degree of impact has been considered as +2.

Flood control: The sample households affected by the flood were asked about the major problems they encountered during the time of flood.
The overall impact is negative and the degree of impact considered as -3.

Industry and commerce: Tejgaon industrial area is within the boundary of study area. The plan is to develop this area as a residential area rather than an industrial area. So after implementation of the project degree of impact has been considered as +1.

Road and railway: Tongi Diversion Road, New Eskaton Road, Mogh Baazar road, Pathapath road, Satrasta road, DIT road, Tejgaon-Gulshan Link road Tejagaon Rampura and Outer Circular road are major arterial roads of this area. Average width of these roads varies from 40-70 feet Most significant issue is here that almost 60% road of this area having a ROW less than 20 feet
The impact has been considered as -1.

Land use: Due to implementation of Hatirjheel Lake and Begunbari Khal Development project land value of surrounding areas increases over night at an abnormal rate. Previous value of per katha land within the project area varies from 8-25 lakh. But field inspection has revealed that present value of single katha land varies from 60 lakhs to 1 crore Values of Lake adjacent plots are higher than distant ones as expected. The degree of impact considered as +4.

3.3.4 Quality of life value

Scio economic aspects: According to the Socio-economic Survey, the main occupation of the house owners of the Hatirjheel area are Business (55.10%) and Service (28.57%). Other occupations are Engineer, Housewives and Journalists. The average monthly income of the house owners are 202045 Tk. Education level of most (43%) of the house owners are Bachelor. 23% of them are completed Masters and 16% completed up to SSC. The average family members of the Hatirjheel area are 6. Most (51%) of the house owners are residing in the Hatirjheel area from more than 20 years. About 29% of the owners are residing from 10 to 20 years period. Most (81.63%) of the house owners inherited the property from ancestors. Few (18.37%) of them are owned by purchasing. After implementation of the plan degree of impact on socio economic condition has been considered as +2.

Resettlement: Resettlement of population displaced by land acquisition within the study area is an important negative social impact of the project. This is considered to be relatively long term. The cost for resettlement and compensation is considered as a negative impact of hatirjheel project. The degree of impact is considered as -2.

Population: The population is increasing in the area. According to Census, 2011 over two million population lives in Badda, Gulshan, Khilgaon, Ramna and Tejgaon Thana
The degree of impact is negative and considered as -1.

Agricultural land loss: There was not much agricultural activities before so after implementation of the project loss of agricultural land is not of great concern. But the degree of impact is negative and is considered as -1.

Public Health: Due to the development of the study area various kinds of diseases reduced significantly. During rainy season ad flood, occasionally contaminated rainwater from the city enters lakes and low land carries pathogens which is obviously negative impact. The degree of impact is considered as -1.

Parasitic disease: Parasitic diseases within the project area are mainly mosquito borne diseases. Jaundice, typhoid, fever, paratyphoid, fever are also common. Mosquito borne diseases are dengue or break bore fever, encephalitis, filoriasis, malaria, yellow fever etc. the degree of impact is negative and considered as -1.

Nutrition: Standard of living is not upgraded here as the whole area previously was a backyard. People were used to dump their waste and non-usable things here. This place was also known for drug addiction and criminals. The degree of impact is considered as -1.
Public safety: Within the study are there is the head office of RAB-2. Despite of that 59.14% of the house owners states that they have security problems in their locality after implementation of the project degree of impact is considered as +1.
Urban space: As a whole in the project area had some recreational facilities (Aminuzzaman, 2002). There are sports zone and playground in some blocks of the project area. There are some greeneries within the project area. The degree of impact is considered as +1

Landscape : For construction purpose many people are employed. Availability of gas and electric supply is ensured in the area. The degree of impact is positive and considered as +3.

Shopping Centre: After implementation of the development plan the impact has been considered as +1.

Medical facility: Available medical facility within the study area is not up to the mark. More than half of the people commented about insufficient medical facility during field survey. After implementation of the project degree of impact is considered as +1.

Educational facility: About 57.14% of the house owners responded that educational institutes are not sufficient in their locality. It has been found that there is no significant educational institute within the project area. After implementation of the project degree of impact is considered as +1.

Disposal of garbage: The total amount of the residential area is about 237.49 acres where more than 2 lakhs population lives (Graves and Gooch, 1986). By considering the waste generation rate 0.5 kg per person per day (as per ADB standard) almost 100 ton of waste generates residential areas every day. Some contractors are working within these areas for collecting waste on door to door basis as a business (Marsh and Viglione, 1992). Occupants of these residential areas have to pay Tk. 200-500 per month as a service charge. Usually these contractors' use human hauler or special types of van to collect from households and carry them to secondary disposal point of nearby dustbins or containers. The degree of impact is negative and considered as -2.

Table 4: Impact assessment

Parameters	Relative importance (Wi)	Degree of impact (Vi)	Relative impact	EIV
Physical Resources	120			-145
Surface water quality	25	-4	-100	
Ground water quality	30	+2	+60	
Air and noise pollution	20	-3	-60	
Soil quality	15	-2	-30	
Climate	15	0	0	
Hydrology	15	-1	-15	
		subtotal	-145	
Ecological Resources	100			-120
Fisheries	30	-2	-60	
Aquatic biology	20	-3	-60	
Terrestrial flora and fauna	25	-1	-25	
Forest	25	+1	+25	
		subtotal	-120	
Human Use Value	380			+290
Agriculture	35	0	0	
Water supply	35	+4	+140	
Navigation	30	-1	-30	
Power/Gas supply	35	+3	+105	
Drainage	30	-1	-30	
Sewerage and waste disposal	30	+1	+30	
Sanitation	30	+1	+30	
Recreation	30	+2	+60	
Flood control	40	-3	-120	
Industry	20	+1	+20	
Road/Railway	35	-1	-35	

Land use	30	+4	+120	
		subtotal	+290	
Quality of Life Values	400			-15
Socio economic	30	+2	+60	
Resettlement	35	-2	-70	
Population	25	-1	-25	
Agricultural land loss	30	-1	-30	
Public health	40	-1	-40	
Parasitic diseases	30	-1	-30	
Nutrition	35	-1	-35	
Public safety	35	+1	+35	
Urban space	20	+1	+20	
Landscape	25	+3	+75	
Shopping Centre	20	+1	+20	
Medical facility	25	+1	+25	
Educational facility	30	+1	+30	
Disposal of garbage	25	-2	-50	
		subtotal	-15	
TOTAL				+10

From the impact assessment table it has been found that total environmental impact value is positive but EIV for Physical resources, Ecological resources and quality of life value shows negative impact. So a comprehensive mitigation plan is necessary. Some mitigation measures for minimizing the negative impact value are provided here.

Item	Types of environmental impact	Mitigation measures
Surface water quality	Negative	Implement and update as necessary a comprehensive plan for the watershed, and develop the research necessary to guide a management program. All types of effluent should be treated before discharging into the surface water. Inform residents within the watershed about how their actions impact the system and enlist their support in preservation efforts. Increase public awareness and participation in the management of the lake. Restore the polluted portions of the lake through constructing and operating regional storm water treatment facilities throughout the watershed.
Air and noise pollution	Negative	Roadway noise can be reduced by the use of noise barriers, limitation of vehicle speeds, alteration of roadway surface texture, limitation of heavy vehicles, use of traffic controls that smooth vehicle flow to reduce braking and acceleration, and tire design. Seal complete earth works to reduce air pollution. Pave or seal, keep clean, and spray with water surfaces and routes heavily used by vehicles. Operate construction equipment at low and slow settings, limit working hours, monitor and enforce noise levels to reduce noise pollution. Inform surrounding communities when loud

		construction activities will occur to reduce their impact during construction. (O'Donoghue and Clarke, 2010)
Soil quality	Negative	Enhance organic matter. Avoid excessive tillage. Prevent soil compaction.
Road/railway	Negative	Reduce roadside activities. Remove illegal businesses on the footpath.
Public Health	Negative	The public health and surface water quality items are interrelated and could be dealt integrally. Improvement of surface water quality will eventually improve public health.
Aquatic biology	Negative	Aquatic sanctuary/conservation recommended.
Terrestrial flora and fauna	Negative	Change in land use will exert long term effects on terrestrial flora and fauna. So sanctuary/conservation is recommended.
Disposal of garbage	Negative	Community based garbage collection and disposal should be adopted. No of local dustbin should be increased. Waste collection from local dustbins should be done on a regular basis. Increase public awareness and participation in the management of waste.

4. CONCLUTION

The study focuses on the water quality and environmental, hydrological and morphological investigation of Hatirjheel. In our data analysis we shows how much polluted this lake is and by EIA recommendation we try to show some solution to get rid of it. Hatirjheel is facing a rapid development and when development is rapid environmental degradation is must. As the project needs to be sustainable a proper development plan integrated with consideration of environmental issues should be implemented. The EIA analysis that has been performed here shows positive environmental impact value (EIV). But EIV of physical resources, ecological resources and quality of life values showed negative result. So proper mitigation and monitoring plan should be incorporated. As per our study we are recommending 25% green belt in the landscaping of development area. Also buffer zone for specific pollutant category is to be considered for balanced development. The green belt and landscaping should be prepared as per master plan, Recycle waste water and Proper investment and management planning of project to overcome environmental degradation (Santhanam, Martin, Goody and Hicks, 2011). Vegetated storm water infiltration systems, such as, rain gardens, bio retention, storm water planters, and tree box filters are depressed vegetated areas that use native soils or porous engineered soils, plants, and their root systems to capture and treat urban runoff, and help infiltrate the water to the subsurface.Vegetated infiltration systems can be used which are effective at reducing the volume of runoff by soil retention, plant uptake, evapotranspiration, and infiltration. We will also recommend to use porous Pavement covers a variety of stabilized surfaces that can be used for the movement and parking of vehicles (automobiles, trucks, construction equipment, light aircraft, etc.) and storage of materials and equipment.

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REFERENCES

Urban Drainage and Flood Control District (UDFCD), Denver, Colorado, June 2001. Urban Storm Drainage Criteria Manual.

Kennedy/Jenks Consultants, August 2007. The Truckee Meadows Low Impact Development Handbook. <http://www.cityofreno.com/Index.aspx? Page=996

The American Institute of Architects (AIA), January 2009. National Wildlife Federation (NWF) Headquarters. <http://www.aiatopten.org/hpb/site.cfm?ProjectID=73>.

BBS, (2002), Report on Household Expenditure Survey, Bangladesh.

BBS, (2008), Bangladesh Bureau of Statistics 2008, 2008 Statistical Yearbook of Bangladesh, 25th edition, BBS, Bangladesh.

BBS, 2011); Bangladesh Bureau of Statistics 2011, Census Report of Bangladesh, BBS, Bangladesh.

M. Aminuzzaman, (2002) "Recreation Facilities for the Middle Class of Dhaka City" Democracy Watch, Dhaka, July 2002.

Graves, A.L. and Gooch, R.S. (1986). "Central Arizona Project Start Up." Proceedings of the Water Forum '86: World Water Issues in Evolution. ASCE, New York, N.Y., Vol. 1, 546-551.

Marsh, A., & Viglione, D. J. (1992). A Conceptual validation study of the texture response on the Rorschach. *Journal of Personality Assessment, 58*(3), 571-579.

O'Donoghue, T., & Clarke, S. (2010). *Leading learning: Process, themes and issues in international contexts*. London: Routledge..

Santhanam, E., Martin, K., Goody, A., & Hicks, O. (2011). *Bottom-up steps towards closing the loop in feedback on teaching: A CUTSD project*. Paper presented at Teaching and Learning Forum – Expanding horizons in teaching and learning, Perth, Australia, 7-9 February 2001.