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Original article

Water Quality of the Rivers and Water-bodies around Dhaka city: a Public Health Concern

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Abstract

Background: The deteriorating water quality in Dhaka city has emerged as a critical concern. The rivers and lakes in the vicinity of Dhaka city have experienced significant pollution due to the discharge of effluents, rendering them unfit for use. This contamination has also adversely impacted the quality of groundwater. ***Methodology:*** This research aimed to scrutinize the water quality of Dhaka city during the specific period of 2008 and 2009. Water samples were systematically collected from designated locations and subjected to thorough analysis at the BCSIR (Bangladesh Council of Scientific and Industrial Research) Laboratories in Dhaka, Bangladesh, focusing on specific parameters.Various physical, chemical, and biological properties of water were meticulously examined. ***Results:*** The study revealed that the water quality of Buriganga is notably worse than that of Tongi Khal, Turag river, and Balu river. Regions affected by this pollution emit unpleasant odors, attributed to fecal and chemical wastes, presenting environmental challenges. The dissolved oxygen concentration in Buriganga river, Tongi Khal, Balu, and Turag river was alarmingly below the standard value (4-6 mg/l). Chemical oxygen demand and biological oxygen demand in these rivers exhibited unfavorable conditions, with coliform bacteria exceeding acceptable limits. During the study period of 2008 and 2009, prevalent health issues included skin diseases and diarrhea, along with instances of Cholera, Typhoid, and Dysentery. Notably, water pollution was observed to have psychological effects on the residents. The water in Dhaka city, characterized by its fully black color and disagreeable odor, is unsuitable for recreational purposes. Fish populations dwindled, local fish species faced endangerment, and many were no longer observable in the four rivers surrounding Dhaka city. ***Conclusion:*** Polluted water detrimentally affects terrestrial plants and animals. As polluted water traverses over land surfaces, it contaminates soil, posing threats to plants and animals. Aquatic flora and fauna are also adversely affected by polluted water. Consequently, water pollution casts negative implications across every facet of the environment. The environmental predicament in Dhaka city, particularly pertaining to water quality, exerts direct and indirect influences on daily, personal, and social life.

Keywords: water pollution, environmental health, water quality, river, lake, canal, water bodies, pollution, impurities, Dhaka city.

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Introduction:

Water quality emerges as a critical environmental concern due to its fundamental role in supplying water for drinking, domestic use, irrigation, and supporting aquatic life, including fisheries. The degradation of river water quality in Dhaka is primarily attributed to human activities, unplanned urbanization, stormwater and sewerage systems, household waste, oil spills, sedimentation, and industrial effluent discharge into rivers, alongside encroachment on riverbanks.[1]

The repercussions of compromised water quality extend beyond immediate concerns, affecting climate, soil, plants, animals, and human life. Rivers in and around Dhaka have deviated from their natural state, exhibiting alterations in physical, chemical, and biological properties, rendering them unsuitable for any beneficial use. Contaminated river water is characterized by its black color, unpleasant taste, offensive odors, diminished aquatic life, and increased weed growth, transforming these water bodies into receptacles for a myriad of solid, liquid, and chemical wastes.[2]

Dhaka, the capital city of Bangladesh, holds paramount significance as the focal point of socio-economic and political activities in the country. This rapidly expanding metropolis is encompassed by vital rivers, serving as indispensable resources for its sustenance. These rivers play a pivotal role in providing drinking water, drainage systems, various fish species, and water routes for transportation.[3]

The severity of pollution has reached a point where water treatment becomes practically impossible. The Water Supply and Sewerage Authority (WASA) resorts to supplying water treated with chlorine and ammonia sulfate, resulting in an undesirable odor. River narrowing due to waste dumping and encroachments further impedes communication and forces residents near rivers to use polluted water, often unaware of the associated health risks. This, in turn, contributes to the spread of waterborne diseases.[3]

The discharge of solid wastes and effluents into rivers renders the water unfit for the survival of fish and other subaqueous organisms. Elevated levels of Biological Oxygen Demand (BOD) caused by waste influx lead to an oxygen crisis for aquatic life, posing a threat to biodiversity in and around the rivers. River pollution in Bangladesh mirrors a global issue, prompting the formulation of government rules, regulations, policies, and strategies to safeguard these invaluable water resources from further deterioration.[4]

Materials and Methods

Water samples were collected from three sampling stations of four rivers in and around Dhaka city and two lakes, Dhanmondi and Gulshan Lake, for surface water and from eight stations for groundwater quality analysis. Sampling stations were selected purposively. Water was collected through fieldwork during four seasons: winter, pre-monsoon, monsoon, and post-monsoon. Water parameters were categorized into three groups: physical, chemical, and biological parameters.Physical parameters included: Temperature, Turbidity (NTU), Electric conductivity (EC), Total dissolved solids (TDS), Odor and Color. Chemical parameters included: pH, DO, BOD, COD. Trace elements such as Total Alkalinity (Alk), Chloride (Cl), Phosphate (PO4), Nitrate (NO3), Cadmium (Cd), Chromium (Cr), and Zinc (Zn). Biological parameters included: Coliform bacteria (Fc), Hydrophytes, Fish.

To determine the geographical locations, MAGELLAN GPS 310 was used. All the parameters of water samples were analyzed in the laboratory with standard methods (APHA, 1995) except alkalinity (Trivedy and Goel, 1986). The following instruments were used for the analysis of water samples: pH meter Model HANNA, TDS meter, EC meter, DO meter, Shimadzu UV Visible Spectrophotometer Model UV mini-1240 Japan for colorimetric detections, Atomic Absorption Spectrometric methods to determine metals, Perkin-Elmer Model 3110 Atomic Absorption Spectrophotometer to detect Zn and other trace elements, BINDER Microbiological Incubator Model BD-53 Germany for analysis of Coliform bacteria.

Results

Analysis of Water Quality by Pearson's Correlation Matrix: The variations of water pollution in different seasons were identified and verified by comparing physical, chemical and biological data with Pearson's correlation two-tailed matrix. In Buriganga, DO had negative impacts on other parameters. In Turag, only two parameters, such as DO and turbidity had negative correlations and other parameters had positive correlations. The Tongi Khal and Balu had positive correlations with maximum parameters.

Analysis of water quality by ANOVA test:Seasonal variation of different parameters was determined by analyzing two years of data with the help of the ANOVA test in SPSS and the result was tabulated with List Significance Difference Duncan Multiple Range Test at 5% level. From the ANOVA test, it was found that there was a significant variation of physicochemical and biological parameters concentration in river water among four seasons. In Buriganga, TDS and TC had more significant values than other parameters. In Turag, only one most significant value was in NO3 with DO. Tongi Khal had significant value in four parameters: BOD, COD, Alkalinity and Cl. In Balu River significant values were with four parameters: TDS, BOD, Cl and NO_3.

Table 1: The water quality parameters of different stations of the four studied rivers

River	Buriganga			Turag			TongiKhal			Balu		
Stations→	BG1	BG2	BG3	T1	T2	T3	Tk1	Tk2	Tk3	BL1	BL2	BL3
Parameters↓	Mean ± SD	Mean± SD	Mean± SD	Mean± SD	Mean± SD	Mean± SD	Mean± SD	Mean± SD	Mean ± SD	Mean± SD	Mean± SD	Mean± SD
NTUppm	**6.5± 0.85**	**6.73± 1.36**	**8.94± 2.68**	**6.19± 0.26**	**6.24± 0.26**	**6.13± 0.23**	**6.75± 0.97**	**6.34± 0.31**	**6.28± 0.25**	**7.56± 1.21**	**7.48± 1.06**	**7.88± 1.79**
EC µs/cm	**579.0 ± 416.8**	**501.6 ± 299.5**	**505.9 ± 279.5**	**737.4± 736.1**	**299.9± 114.5**	**574.9± 389.3**	**607.0± 426.6**	**503.6± 259.5**	**1612 ± 896.3**	**556.5± 229.4**	**490.9± 196.0**	**521.5± 232.1**
TDS ppm	**380.8 ± 179.5**	**458.4± 220.5**	**379.5± 175.9**	**1127± 256.8**	**465.8± 101.8**	**347.6± 220.1**	**451.1± 222.6**	**379.1± 278.2**	**710.8 ± 333.6**	**933.4± 350.5**	**705.1± 124.9**	**698.6± 134.2**
pH	**7.13± 0.18**	**7.32± 0.16**	**7.18± 0.16**	**7.78± 0.37**	**7.41± 0.30**	**7.35± 0.21**	**7.41± 0.09**	**7.36± 0.13**	**7.31± 0.15**	**7.29± 0.35**	**7.30± 0.27**	**7.10± 0.43**
DO ppm	**3.06± 2.52**	**2.21± 2.15**	**2.85± 2.37**	**2.36± 2.36**	**5.05± 1.75**	**1.76± 2.07**	**2.19± 2.10**	**2.29± 2.23**	**2.29± 2.02**	**2.73± 2.11**	**3.50± 0.95**	**3.19± 1.29**
BOD ppm	**15.29 ± 9.6**	**24.6±15. 66**	**17.2± 9.30**	**15.3± 11.89**	**11.9± 8.48**	**13.8± 8.68**	**20.0± 12.12**	**15.1± 8.33**	**16.4± 7.68**	**15.4± 9.62**	**14.3± 10.27**	**15.78±8. 86**
COD ppm	**48.44 ± 8.1**	**72.38±25.6**	**54.2± 14.4**	**54..6± 8.07**	**49.5± 6.59**	**51.6± 5.21**	**53.0± 13.5**	**52.4± 9.52**	**49.3± 10.9**	**55.6± 5.95**	**54.1± 6.06**	**53.4± 7.41**
Alk ppm	**174.1 ± 90.8**	**201.5±10 4**	**155.1± 87.6**	**131.0± 83.8**	**123.4±83 .9**	**125.3± 81.4**	**173.5±70.7**	**153± 80.1**	**170± 72.9**	**125.1± 57.9**	**127.1± 55.4**	**128.4± 57.9**
Cl ppm	**17.89 ± 7.6**	**28.63±10.6**	**18.1±10.09**	**15.44±8.8**	**14.8± 8.12**	**17.5±12.9**	**19.1± 7.95**	**15.4± 6.78**	**18.14 ± 7.55**	**18.81±7.66**	**17.7± 8.79**	**17.9±9.31**
PO_4 ppm	**11.9± 6.15**	**14.21±7. 61**	**13.85±5. 93**	**11.0± 8.69**	**3.78±1.7 9**	**1.66± 0.74**	**2.83± 0.45**	**10.3± 10.3**	**6.29± 5.15**	**11.8± 3.71**	**8.76± 3.54**	**9.65± 3.98**
NO_3 ppm	**15.3± 4.26**	**21.25±7. 27**	**18.7± 4.87**	**8.85±6.7 5**	**3.23± 1.54**	**1.57± 0.43**	**2.48± 0.81**	**11.4± 8.33**	**8.03± 2.14**	**5.63± 4.09**	**3.53± 1.0**	**3.44± 2.23**
Cd ppm	**2.18± 0.54**	**4.04± 1.62**	**1.26± 1.25**	**2.63± 2.59**	**1.03± 0.98**	**1.11± 0.57**	**1.29± 1.63**	**3.29± 5.23**	**2.36± 3.34**	**2.85± 0.64**	**1.59± 1.43**	**1.83± 1.67**
Cr ppm	**8.34± 7.01**	**8.06± 9.31**	**7.60± 8.67**	**4.21± 4.84**	**0.58± 0.18**	**0.45± 0.24**	**0.54± 0.23**	**6.10±6.48**	**4.95± 4.72**	**2.79± 0.67**	**2.49±1.0 2**	**2.36± 0.77**
Zn ppm	**1.52± 0.55**	**1.64± 0.61**	**1.53± 0.57**	**1.34± 0.73**	**0.65± 0.51**	**0.33±0.0 7**	**0.53± 0.09**	**0.89± 042**	**1.0± 0.48**	**0.80± 0.21**	**0.69± 0.18**	**0.60± 0.18**
TC mpn	**1965 ± 511**	**1943± 408**	**2263± 431**	**2115± 397**	**2215±28 5**	**2010±44 6**	**2447±27 8**	**3700±12 16**	**4188 ± 1723**	**1833± 482**	**1901± 544**	**1874±551**

All average values are in ppm except EC (µs/cm), pH, TC (mpn) and FC (mpn).

Table-2: Seasonal variation of different parameters of river water (2008-09)

Parameters	Seasons			
	Winter	Pre-monsoon	Monsoon	Post-monsoon
	Mean±SD	Mean±SD	Mean±SD	Mean±SD
NTUppm	7.65±1.83	6.58±1.66	6.60±0.97	7.03±1.19
EC µs/cm	1139.33±664.08	624.83±301.07	292.29±185.20	474.21±335.15
TDS ppm	771.38±275.12	555.29±293.04	497.92±336.23	538.25±322.54
pH	7.47±0.36	7.38±0.19	7.14±0.30	7.30±0.21
DO ppm	0.87±1.45	1.98±1.77	4.66±1.03	3.61±1.67
BOD ppm	27.88±5.10	20.15±7.96	5.74±3.85	10.73±4.41
COD ppm	65.90±13.91	54.63±10.79	45.21±4.41	50.0±5.41
Alk ppm	237.46±31.72	161.54±57.74	89.21±63.86	107.08±51.62
Cl ppm	30.31±5.46	18.21±5.97	10.68±4.75	13.59±3.90
PO4 ppm	13.47±7.79	6.29±4.0	5.81±4.04	10.52±6.86
NO3 ppm	12.22±10.11	6.78±5.94	6.81±5.19	8.58±8.11
Cd ppm	4.64±2.81	1.49±1.17	0.85±0.80	1.45±1.48
Cr ppm	9.22±8.50	1.44±0.94	1.78±1.24	3.62±2.82
Zn ppm	1.39±0.88	0.69±0.32	0.80±0.33	0.97±0.39
TC mpn	2594±995	2352±1027	1978±952	2568±988

All average values are in ppm except EC (µs/cm), pH, TC and FC (mpn).

Table-3: Different parameters of Lakes water in study period 2008 and 2009

Lakes	year	NTU	EC	TDS	pH	DO	BOD	COD	TC
	2008	11.38	27.33	172.67	7.16	0.50	2.17	31.43	500.00
Dhanmondi	2009	8.37	27.73	175.67	7.21	0.57	2.70	32.00	523.33
Average	2008	9.76	32.83	201.33	7.15	0.48	13.58	52.72	751.67
	2008	8.13	38.33	230.00	7.13	0.47	25.00	74.00	1003.33
Gulshan	2009	8.90	40.33	156.67	7.30	0.40	30.00	79.67	1023.33
Average	2009	8.63	34.03	166.17	7.25	0.48	16.35	55.83	773.33

All average values are in ppm except EC (µs/cm), pH, TC and FC (mpn).

Table 5: Comparative Water Quality of different sources with BDWS and WHO Standards

Para-meters	Sources							
	Buriganga River	Turag River	Tongi Khal	Balu River	Lakes Water	Ground Water	BD	WHO
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Standard	GVS
NTUppm	**7.56 ± 2.30**	**6.20±0.25**	**6.48±0.61**	**7.64±1.34**	**9.20±3.73**	**1.7±1.81**	**5**	**≤ 5**
EC µs/cm	**535.79± 333.29**	**526.61±491.52**	**934.54±756.24**	**522.96± 211.81**	**33.43 ±6.63**	**272.81±82.15**	**-**	**-**
TDS pm	**402.9± 186**	**640.0 ±393.70**	**534.25±300.35**	**779.04± 245.08**	**183.75±39.29**	**151.56 ±34.23**	**165-500**	**≤ 100**
pH	**7.21± 0.18**	**7.51±0.34**	**7.34± 0.12**	**7.23 ± .36**	**7.20±0.22**	**7.3±0.19**	**6.5-8.5**	**6.5- 8.5**
DO ppm	**2.71 ± 2.28**	**2.98 ±2.44**	**2.22 ±1.99**	**3.14 ±1.50**	**0.48±0.09**	**-**	**6**	**-**
BODppm	**18.83 ±11.94**	**13.38 ±9.38**	**16.84±9.76**	**15.16 ±9.19**	**14.97±3.56**	**-**	**0.2**	**-**
CODppm	**57.77±19.34**	**51.87±6.64**	**51.67±10.93**	**54.38±6.29**	**59.28±23.92**	**-**	**4**	**-**
Alk ppm	**176.21±91.94**	**124.0±78.73**	**167.67±71.70**	**126.88±54.56**	**-**	**106.81±12.06**	**100**	**100**
Cl ppm	**21.20±10.26**	**15.66 ± 9.63**	**17.57±7.30**	**18.15±8.25**	**-**	**47.44 ±16.78**	**150 - 600**	**250**
PO_4 ppm	**13.33±6.40**	**6.16 ± 6.27**	**6.55 ±7.06**	**10.06±3.81**	**-**	**-**	**6**	**-**
NO_3 ppm	**18.61±6.16**	**4.46 ± 4.89**	**7.04 ±5.97**	**4.20 ±2.82**	**-**	**-**	**10**	**50**
Cd ppm	**2.45 ± 1.64**	**1.57±1.70**	**2.31 ±3.64**	**2.09±1.38**	**-**	**-**	**0.005**	**0.003**
Cr ppm	**7.95± 7.93**	**1.74±3.15**	**3.82 ±5.06**	**2.54± 1.82**	**-**	**-**	**0.05**	**0.05**
Fe ppm	**-**	**-**	**-**	**-**	**-**	**0.42±0.3**	**0.3-1.0**	**0.3**
Mn ppm	**-**	**-**	**-**	**-**	**-**	**0.3±0.23**	**0.1**	**0.5**
Zn ppm	**1.56 ±0.55**	**0.77±0.64**	**0.82 ±0.41**	**0.70± 0.20**	**-**	**-**	**5**	**3**
FC mpn	**-**	**-**	**-**	**-**	**-**	**3.19±0.9**	**0**	**0**
TC mpn	**2069±466**	**2131±378**	**3440±1398**	**1869±504**	**763±305**	**0**	**0**	**0**

All average values are in ppm except EC (µs/cm), pH, TC (mpn), and FC (mpn).

Discussion:

The public health status of a nation stands as a pivotal indicator of socio-economic development. Furthermore, the cornerstone of public health primarily hinges upon the quality of drinking water. Human activities have significantly altered the natural environment to fulfill societal needs. Consequently, both soil and water are experiencing contamination, leading to adverse effects on various species such as fish, amphibians, reptiles, birds, and mammals, attributable to these developmental interventions.[1]

Dhaka City, classified as a mega city with a population exceeding ten million, is experiencing unprecedented urban growth. The demand for water in the city is escalating steadily, resulting in recurrent and severe water shortages, both in terms of quality and quantity. This study addresses the prospective requirements for water, encompassing considerations for both its quality and the requisite volume to meet the needs of the city's residents. Currently, the rivers in and around Dhaka City pose a significant environmental challenge, yielding direct and indirect consequences on various aspects of daily, personal, and social life. Notably, the detrimental effects of water pollution manifest prominently in human health, with direct repercussions on fishery resources. The adverse impact on aquatic flora and fauna is particularly pronounced, given their dependence on water bodies for crucial stages in their life cycles.

The Buriganga River exhibits an exceptionally high level of water pollution compared to other rivers. Within Dhaka City, 49% of various wastes are indiscriminately dumped into the Buriganga River. The water of this river contains toxic chemicals such as lead, arsenic, chromium, and cadmium, as reported by the Department of Environment in 1990.[2] Notably, the dissolved oxygen (DO) levels in the river vary significantly, with a maximum of 6.10 mg/l observed at the Bangladesh-China Friendship Bridge station during the post-monsoon season of 2009 and a minimum of 0.5 mg/l in winter. The river is considered biologically dead, and its water, with a maximum biological oxygen demand (BOD) of 45 mg/l (exceeding the Bangladesh standard of 30 mg/l), is unsuitable for various purposes including fish breeding, drinking, cooking, swimming, and other domestic uses. The critical DO level for the survival of aquatic life is 6 mg/L, and alarming readings of 0 mg/L were noted from Kamrangirchar to Pagla and at the Bangladesh-China Friendship Bridge point. In the Turag River and Tongi Khal, where numerous industries are concentrated in the Export Processing Zone (EPZ) area, effluents are discharged directly through numerous canals without any treatment. The rivers' water is tainted black and foul-smelling due to sewerage and domestic waste from approximately 800,000 inhabitants in the Tongi area. The rivers, resembling dead khals, witness the flow of substantial effluents, adversely impacting rice production.

The Balu River reports DO levels consistently below the desirable limit of 4 mg/l. Rahman and Hadiuzzaman (2005) identified Narai Khal as the primary source of ammonia in the Balu River system, characterized by very low DO and high Coliform values.[5] Hazardous levels of pollution were notably observed at Hazaribagh and Tongi Railway Bridge stations. During both lean (April-May) and high flow (July-August) periods, the DO levels were below acceptable critical levels, rendering the river water unsuitable for sustaining aquatic life. The winter season witnessed exceedances of permissible limits for DO, BOD, COD, and Coliform bacteria. Reduced DO levels led to elevated BOD and COD readings. The dry season (November-April) saw heightened concentrations of ammonia and algae in water intake, alongside concerns about high organic loading and the presence of toxic metals. Dhanmondi Lake, a water body within the city, faces pollution from sewerage and household garbage, with a bacterial count reaching 1200/ml. The Tejgaon washing and dyeing company discharge around 12,000 cubic liters of highly toxic wastewater into the lake, further contributing to its deterioration.[3] Phosphate pollution in rivers and lakes triggers algal blooms (eutrophication), diminishing water DO and disrupting the natural food chain. The water in Dhanmondi Lake has acquired a green hue.

Gulshan Lake, another water body in the city, is contaminated with garbage and sewage from surrounding areas like Gulshan, Baridhara, Kalachandpur, Nadda, and Shaorabazar. Consequently, the lake water emits a foul odor and exhibits a bluish color. The DO values range from 0.2 to 0.6, falling below standard values and rendering the water unsuitable for aquaculture.

Groundwater, traditionally considered a reliable source of drinking water, faces contamination risks from polluted surface water leaching.[6] Abandoned landfill sites, often in proximity to residential areas, contribute to this risk.[4] Chemical agents and contaminants leach into surface and groundwater, particularly from inorganic waste decomposition, agricultural pesticide residues, and industrial discharges.[7] The infiltration of residual fertilizers into soil with irrigation or rainwater exacerbates nitrogen pollution.[8] In Dhaka City, groundwater contamination by fecal coliform results from leaching from polluted surface water, poor tube well design, faulty construction, and management. The deteriorating capacity of groundwater to sustain both human and ecosystem needs is a significant concern.[9] The seepage of chemicals into shallow aquifers renders the water unfit for human consumption.[10] Of the 24 samples analyzed, 17 exceeded the World Health

Organization's recommended value for drinking water (0.01 mg/l), and two exceeded the Bangladesh guideline of 0.05 mg/l. Although we have identified certain similarities in our findings with those of other researchers, a more comprehensive examination underscores the unmistakable trend of ongoing deterioration in the water quality of the water bodies situated in and around Dhaka city. This concerning pattern suggests a pressing need for thorough investigation and targeted interventions to address the root causes of this decline and implement effective measures for water quality improvement.

Conclusion:

Water holds a central position in the fabric of human existence, representing the single most crucial natural resource essential for the sustenance and well-being of humanity. Recognizing the paramount significance of ensuring access to safe drinking water and safeguarding water reservoirs from contamination, the United Nations General Assembly, on 22nd March, designated this day as 'World Water Day.' Furthermore, the UN, acknowledging the imperative nature of addressing water-related challenges, declared the period from 2005 to 2015 as the "Water for Life" decade.

On the 4th of October 2009, the Ministry of Environment and Forest took a significant step by publishing a Gazette, officially declaring four rivers in the vicinity of Dhaka city as ecologically vulnerable. The pervasive issue of water pollution in Dhaka city accentuates the need for strategic interventions. The anticipated outcomes of ongoing research endeavors aim to provide valuable insights for the establishment of water-processing plants and comprehensive water management strategies.

Looking ahead, the projections indicate that the expansion of urban and rural areas, intensified land utilization, aquaculture practices, and the burgeoning population will necessitate increased consumption of water resources. Notably, during the dry season, water scarcity emerges as a substantial challenge in urban areas for domestic purposes and in rural areas for irrigation needs. The escalating extraction of groundwater contributes to the decline in aquifer water levels and the infiltration of contaminated groundwater from surface water sources.

Consequently, addressing the water-related challenges in Dhaka city requires a meticulous spatial assessment of surface water quality along the peripheral rivers. This assessment is indispensable for identifying viable solutions based on the judicious conjunctive use of both surface water and groundwater resources, ensuring the optimal utilization of available water reservoirs.

Recommendations

1. To improve the water quality of Dhaka city, it is essential to regularly clean solid and liquid wastes. Dumping wastes into rivers and lakes should be stopped, and waste dumping places should be replaced with suitable locations far away from water bodies that could not seepage water level.

2. To prevent the serious degradation of surface water quality and stabilize an effective ecosystem, waste effluent treatment should be established to remove pollutants for utilization and recycling of waste as much as possible.

3. To develop a state of knowledge and capability that will enable the country to design future water resource management, environment-friendly chemicals and machineries should be used in those industries, where as much as possible.

4. An effective plan is needed for river-side industrialization, urbanization, and slums.

5. The water qualities of the four studied rivers are deteriorating rapidly, which will not be suitable for potable water supply even after treatment. Therefore, the rivers Jamuna, Meghna, and Padma may be the potential sources for the water treatment plants to supply water.

6. Proper application of existing laws in protecting point sources of pollution should be ensured. In the case of non-point sources of water pollution, chemicals used in crops should be limited as little as possible by formulating and adopting legal measures and motivating city dwellers. Information technology, media, and mass communication should be improved to take effective measures for public awareness. Major agencies with activities in the water sector and those that have environmental cells and EIA should work cooperatively for large effective projects.

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