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# Assessment of Water Quality Along the Mahim Creek in Mumbai using Water Quality Index Method

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**Abstract** The present investigation along the Mahim creek of Mumbai was performed for the study of water quality parameters like pH,dissolved oxygen, biochemical oxygen demand and fecal coliform using water quality index for the evaluation of the deterioration level. The study was carried for one year period during October 2016 to September 2017. Samples were collected from three stations viz. Mahim-Bandra Pipe Line, Bandra-Sion Link Road and Bandra-Kurla Complex along the creek. National Sanitation Foundation's Water Quality Index (NSFWQI) method followed with modified relative weights assigned by Central Pollution Control Board using unique score value that state the level of deterioration. Study reveals that the Mahim creek water quality was bad to very bad throughout the year indicating in appropriate for propagation of aquatic life and commercial fisheries mentioned in Seawater II. It could be due to domestic waste and industrial effluents released indiscrimenately that has severely deteriorated the quality of creek water. Present investigation suggests that, effluents treatment is required to bring them into the biodegradable belt and make sure that local sewer limits are maintained. Also illegal encroachment, reclamation construction, dumping along the creek should stopped and mangrove plantation should be made along the creek to protect the aquatic ecosystem and mangrove forest.

**Keywords** Water quality index, pH, Dissolved oxygen, Biochemical oxygen demand, Fecal coliform.

## Introduction

Quality of aquatic environment and natural abundance of fish and shell fish species along coastal water have been affected gradually due to the hasty industrialization, urbanization and enlargement of slum neighborhood. Without concern of appropriate development has resulted into expulsion of enormous quantity of industrialized effluents as well as domestic unprocessed dirt and liquid waste into the creek system that has significantly depleted aquatic organisms. Due to loss of aquatic organisms the ecosystem is greatly affected than terrestrial ecosystems. In existing situation, quality of aquatic ecosystems has become international and national health issues through ecological assessment point of view and it is

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found to be menace for aquatic yield due to dumping of wastes from inhabited complexes, industrialized effluents, household manure and fluid devastate from contiguous confined areas. For better indulgent, a water quality index (WQI) seems predominantly imperative issue delve into assessing the health condition of the creek water bodies (Baskaran et al. 2013, Hoseinzadeh et al 2015. Barakat et al. 2016). Elevated level of organic wastes results in high organic demand utilized by microbes, which latter produces ammonia from organic nitrogen compounds retards into fish metabolic activity and invertebrates communities residence in tainted creek system (Ayoola and Kuton 2009). According, to one of the study, around 2200 MLD of waste alone Mumbai metropolitan itself discharges into coastal waters. A number of studies have been conducted so far to determine contamination levels on the Mahim creek. Information on prelude surveys on effluence study of said creek reached at a disquieting stage and requires great awareness (NEERI 2011, Shah and Bhave 2014**).**

The present effort deals with the WQI to investigate the deterioration level at different stations along the Mahim creek of Mumbai coast. This study will help us in discerning the health status relentlessly affected due to unrestraint use of industrialized waste matter and household wastes from the nearby areas.

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## Materials and Methods

### Nationals sanitation foundation water quality index (NSFWQI)

The attempt was supported by the National Sanitation Foundation (NSF), US and applied to evaluate WQI of various water bodies which are critically polluted. In India, the NSFWQI is being utilized to examine quality of creek water resources by Central Pollution Control Board (CPCB), with a slight modification in relative weight. The proposed method for comparing the water quality of creek is based upon the basic parameters like pH, BOD (mg/L, DO (mg/L) and FC (MPN/100mL). The results from the water quality parameters were calculated using NSFWQI equation that finally results into a unique value subjected to assorted health status of the Mahim creek system.

### Study area

The Mahim creek is located at $19^0$03´02.88´´ N Lat and $72^0$50´37.18´´ E Long along western Arabian coast of India. This creek receives overflow from the Vihar and Powai lake during monsoon through the Mithi river which drains into creek and further ends into Arabian sea. The creek receives domestic untreated sewage as well as industrial desecrate effluents from nearby suburban complexes and small scale industrialized zone, owing to such wastes dumping and descend accumulation results into fetid smell and also brings into being of foremost sources of contaminants to the creek water. Also the creek is inundated by immeasurable stretch of mangroves, which is a small numbers have been ruined due to developmental actions along the creek belt. Runoff from the Mithi river further decreased with the commencement of post monsoon foremost to stagnant condition of water bodies due to expulsion of effluents and sewages into creek.

### Sample collection

Three stations namely Mahim-Bandra Pipe line (S1) Lat. $19^0$03´02.88´´ N and $72^0$50´37.18´´ E Long. ; Bandra-Sion Link Road (S2) Lat. $19^0$03´05.99´´ N and $72^0$50´54.52´´ E Long. and Bandra-Kurla Complex (S3) Lat. $19^0$03´10.89´´ N and $72^0$51´11.01´´ E Long .were selected for study along the creek. Sampling stations were fixed at equidistance of 500m using GEP satellite imagery software (Version 7.3). The depth of S1 was 6-8 m depending on the tide.This station experienced maximum tidal influence. S2 between Bandra-Sion Link Road which was selected further north of S1. The depth at this station was around 8-10 m. S3 was selected west to S2. This region of the creek was the shallowest averaging around 4-6 m. This station had the slightest tidal sway, but received freshwater inputs from Mithi riverine system and sewage waste from industrial and residential areas. The

sampling was done from respective stations during postmonsoon (October 2016 to January 2017), pre-monsoon (February to May 2017) and monsoon (June to September 2017) for a period of one year. Surface water samples were collected fortnightly in 500 ml capacity of narrow mouthed polythene bottles from respective stations in triplicates during high tide and their monthly average values were presented. Water quality parameters viz. pH was measured using pH tester (Eutech Instruments), Fecal coliform (a three tube MPN technique), dissolved oxygen, and bio-chemical oxygen demand were analyzed according to the standard methods described in APHA (2012).

The NSFWQI is expressed mathematically as :

$$NSFWQI = \sum_{i=1}^{P} Wili$$

where, p = number of water quality parameters, Wi= weight of water quality parameter, Ii = sub index for $i^{th}$ water quality parameter. mohan

For bathing, contact water sports, propagation of aquatic ecosystem and commercial fishing, the water quality criteria for class sea water (SW) -II permissible limits and modified weights as per were pH 6.5-8.5 and 0.22; $DO_2$ > 4 mg/L and 0.31; color and odor with no noticeable color and offensive odor where weight is not prescribed ; BOD (3 days at $27^0$C) was < 3 mg/L and 0.19; floating matters nothing obnoxious or detrimental for use purpose weight is not given; fecal coliform standard count is 100MPN/100 mL and 0.28 respectively. The sub-index equation for computation of NSFWQI calculated as prescribed earlier. The range of the NSFWQI corresponding to various designed best use classification is presented in Table 1. Pearson correlation matrix was used to investigate the relationship between water quality parameters and WQI presented in Table 2.

**Table 1.** NSFWQI for various designed best use. *Source: CPCB 2001.

| Sl. No. | NSFWQI | Description of water quality | Remarks |
|---|---|---|---|
| 1 | 63 - 100 | Good to Excellent | Non polluted |
| 2 | 50 - 63 | Medium to Good | Non polluted |
| 3 | 38 -50 | Bad | Polluted |
| 4 | 38 and less | Bad to Very Bad | Heavily polluted |

**Table 2.** Correlation coefficient matrix of water quality parameters of three stations. **, Correlation is significant at the 0.01 level.

| Variables | pH | DO | BOD | FC | WQI |
|---|---|---|---|---|---|
| pH | 1 | -0.426** | 0.615** | 0.296** | -0.584** |
| DO | | 1 | -0.801** | -0.126 | 0.952** |
| BOD | | | 1 | 0.429** | -0.902** |
| FC | | | | 1 | -0.361** |
| WQI | | | | | 1 |

## Results and Discussion

WQI of the present Mahim creek water is recognized from important various physico-chemical parameters in different seasons. Fig. 1 to Fig. 4 represents the annual average variations of water quality parameters used to evaluate the water quality index of three sampling stations. It the station S1, maximum pH concentration recorded was 7.62 and minimum was 7.38 when compared to S2 showing highest and lowest concentration of 7.57 and 7.31 respectively followed by S3 with highest and lowest concentration of 7.69 and 7.32 respectively. In case of $DO_2$, S1 recorded highest 4.32 mg/L and lowest 2.68 mg/L concentration followed by S2 with 4.24 mg/L and 2.66 mg/L highest and lowest level respectively; subsequently S3 with highest 4.13 mg/L and lowest 2.60 mg/L concentration recorded. Similarly, S1 has shown high-

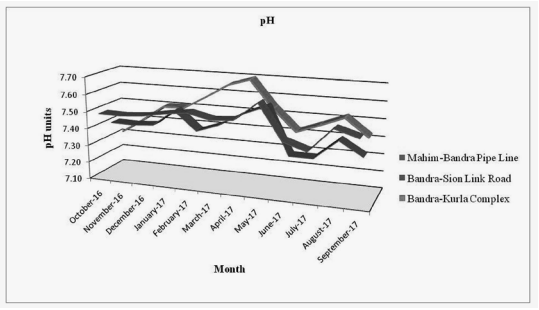


**Fig. 1.** Annual average variations of water pH.

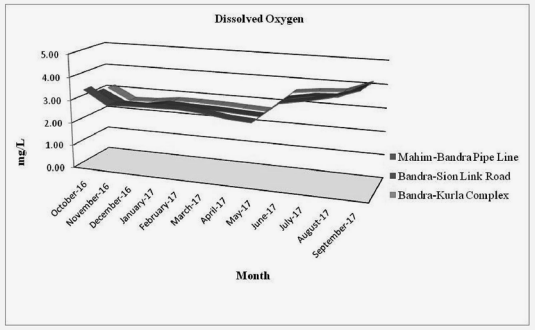


**Fig. 2.** Annual average variations of DO.

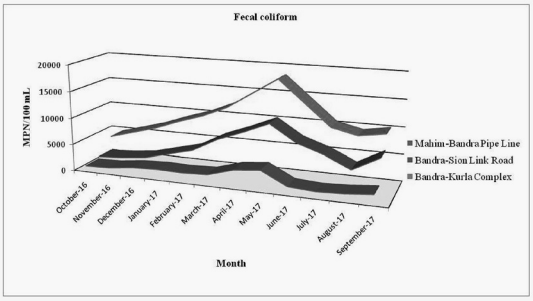


**Fig. 4.** Annual average variations of fecal coliform.

est 13.53 mg/L and lowest 8.13 mg/L concentration of BOD when compared to S2 with 13.71 mg/L and 8.32 mg/L highest and lowest concentration observed respectively followed by maximum 14.12 mg/L and 9.15 mg/L of minimum level of BOD recorded in S3. In the case of fecal coliform, S1 showed highest 4000 MPN/100mL and lowest 1100 MPN/100ml when compared with S2 indicating highest and lowest concentrations 11000 MPN/100mL and 1500 MPN/100mL respectively followed by maximum and minimum 18000 MPN/100mL and 4200 MPN/100mL respectively in location S3. In the present study, low DO levels, high BOD concentration and worst FC quantification warrants urgent mitigation measures in the creeks as supported by Kamble et al. 2010, Stephen et al. 2014, Tiwari and Bajpai 2014. Dhawan et al. (2014) reported the growth of unwanted algae due to leaching of fertilizers in water bodies results into higher BOD. There was evidence of discoloration and foul smell observed along all three stations that shows the deterioration of water bodies due to various contaminants thereby causing detrimental impact on the aquatic organisms especially copepods from the zooplankton groups of the creek water (Minutoli et al. 2007).Also floating matters were observed that may be obnoxious or detrimental for benefit use purposes (NIO 2006, Lad and Patil 2014). All the parameters found beyond the standards of CPCB, wich makes worse usages especially for aquatic life and commercial fishing. The present study reveals that, the WQI results of each parameter assessed for water quality can be compared with the existing historical data. The overall average WQI unique value computed from three stations were 43.38 with standard deviation of 4.37, which classifies the creek water under bad to very bad category. Average maximum, median and minimum WQI score recorded for S1, S2 and S3 was 44.73, 43.59 and 41.84 with standard deviation of 4.56, 4.39 and 4.00 respectively that classifies into bad, bad and bad to very bad water quality respectively and is supported earlier. From the study it was projected that the WQI varies from station to station and would expose any point-source effects on the Mahim creek water. However, it was not the sampling station that varies significantly but the variation occurred due to seasonal alteration (Berlemann 2013, Singare et al. 2014).

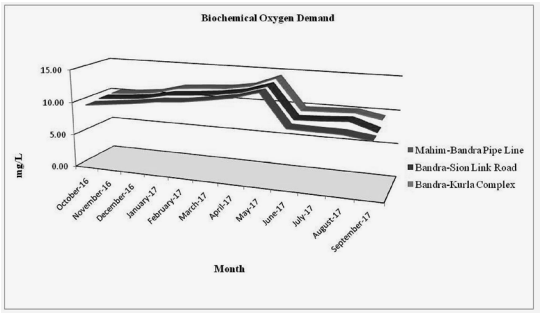


**Fig. 3,** Annual average variations of BOD.

Fig. 5. shows seasonal variation in WQI among locations S1, S2 and S3. During monsoon, the highest WQI fell into medium to good water quality class for

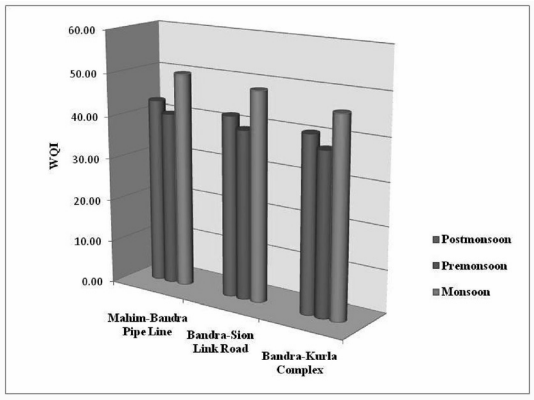


**Fig. 5.** Annual average variations of water quality index during postmonsoon, premonsoon, monsoon.

S1 and S2 recorded 50.25, 48.80 and 46.41 respectively, except for S3 at source sampling point the lowest WQI of 48.9 placing it in the bad to medium water quality category. Similarly, during postmonsoon both S1 and S2 showed highest 43.30 and 42.35 WQI respectively which fell under bad water quality category when compared to lowest WQI 41.06 for S3 again indicating bad water quality. Subsequently, during premonsoon, only S1 was observed with highest score of 40.63 WQI when compared to S2 and S3 with lowest 39.62 and 38.04 WQI respectively ranking into bad to very bad water quality. During all the season, S3 is found of lowest WQI indicating bad to very bad water quality which is due to *Escherichia coli,* $DO_2$ and BOD concentrations. During premonsoon, warmer water allows *E. coli* to persist and does not hold as much $DO_2$. Also increase in the decaying organic material too affect $DO_2$ (Varshney et al. 2006). In the present study using WQI, accumulated enough data to have a solid baseline and understanding of water quality on Mahim creek which is heavily deteriorated by urban and industrial effluents is supported by Devi and Nagendran (2017), Chauhan and Bhardwaj (2017).

Table 2 shows that pH shows negative correlation with $DO_2$ and it is independent of BOD, FC where significant correlation is recorded and negative correlation with WQI. In the present study water pH ranged from neutral to alkaline indicating the waste water effluent contamination. Below pH 6.5 and $DO_2$ <4 mg/L, alters metabolism, retards growth of aquatic species, reproduction and causes heavy mortality (Tiwary and Thakur 2012). After pH, BOD is another indicator of water quality that has shown close correlation with fecal coliform and inverse relationship with $DO_2$. Both BOD and FC were negatively correlated with WQI and used to assess the waste water pollution of surface and ground waters influenced by biodegradable organic matter as supported by numerous researchers (MPCB 2016).

Based on the results obtained, it can be said that, some of the samples have $DO_2$, BOD and fecal coliform levels exceeding the standard limits as prescribed by CPCB. WQI concludes that the Mahim creek water quality was bad to very bad throughout the year indicating that the water is unsuitable for fisheries and relevant activity mentioned is SW II standards. It could be that due to domestic waste and an industrial effluent released indiscriminately has severely deteriorated the quality of Mahim creek water. Present investigation suggests that, the effluents treatment is required to bring them into the biodegradable belt and make sure that local sewer limits are maintained. Also illegal encroachment, reclamation construction, dumping along the creek should be stopped and mangrove plantation should be done along the creek to protect the aquatic ecosystem and mangroves.

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