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Assessment of Water Quality Changes at Two Location of Yamuna River Using the National Sanitation Foundation of Water Quality (NSFWQI)

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Abstract–*It is very important to assess the baseline characteristics of river water quality so that, sustainable development can be pursued. Water quality index calculates all the parameters and gives an easy decision making output to analyze the quality of water. A Simple but useful index is the National Sanitation Foundation-Water Quality Index (NSF-WQI). The four important parameters was selected base on the modified CPCB weight age India, were used in which the changes in biological oxygen demand, fecal coli form, dissolve oxygen and PH was used for the calculation of index. Considering the above parameters an attempt has been made to assess the quality of two stations of Yamuna River for 2000, 2005 and 2010.This study revealed that the two stations viz. Nizamuddin, Delhi and Agra d/s undergoes the categories of bad and very bad water according to NSFWQI, with a range 0-25% and 25-50% for both 2000, 2005 and 2010.this shows how heavily polluted the Yamuna River was at the two stations and indicates the level of high anthropogenic activities in the area.*

Keywords: *Water Quality Index, Yamuna River, Index*

1. INTRODUCTION

Water in the initial creation is created clean and free from any contamination but human development, urbanization and industrialization causes different pollutants enter into the human environment, particularly water resources that decrease its quality (AmirBeygi, 1383)[1]. Water is essential for all socioeconomic development and for maintaining healthy ecosystems. As population increases and development calls for increased all locations of groundwater and surface water for the domestic, agriculture and industrial sectors; the pressure on water resources intensifies, leading to tensions, conflicts among users, and excessive pressure on the environment. The increasing stress on freshwater resources brought about by ever rising demand and profligate use as well as by growing pollution worldwide is of serious concern.

WQI is widely used tool in different parts of the world to solve the problems of data management and to evaluate success and failures in management strategies for improving water quality [2]. The index is a numeric expression used to transform large quantizes of water characterization data into a single number, which represents the water quality level (Abbasi 2002). A number of indices have been developed to summarize water quality data for communication to the general public in an effective way. In general water quality indices incorporate data from multiple water quality parameters into mathematical equation that rates the health of water body with a single number (Sanchez et al., 2007,

Abbasi 2002).That number is placed on a relative scale to justify the water quality in categories ranging from very bad to excellent. This number can be easily interpreted and understood by political decision markers, non-technical water manager and the general public. The water quality index (WQI) has been considered as one criterion for drinking water classification based on the use of standard parameters for water characterization [3].Water is a unique resource because it is essential for all life and it constantly cycles between the land and the atmosphere. The same water that is used for crop and animal production can also be shared with the public and the aquatic and terrestrial ecosystems (Cooper *et al.,* 1998). Water resources are of great environmental issues and studied

by a wide range of specialists including hydrologists, engineers, ecologists, geologists and geomorphologists (Kumar and Dua, 2009). It has become an important issue for them as it affects not only human uses but also plant and animal life [4].For healthy living, potable safe water is absolutely essential. It is a basic need of all human being to get the adequate supply of safe and fresh drinking water.

Horton (1965) proposed the first WQI; a great deal of consideration has been given to the development of index methods. A water quality index provides a single number that expresses overall water quality at a certain location on several water quality parameters and turns complex water quality data into information that is understandable and useable by the general people. WQI is a mathematical instrument used to transform large quantities of water quality data into a single number which represents the water quality level while eliminating the subjective assessments of water quality and biases of individual water quality experts.

2. MATERIAL AND METHODS

2.1Study Area

River Yamuna, the largest tributary of the Ganga River, is a holy river in Indian mythology and one of the most polluted rivers in India. Several pilgrimage centers are located at the bank. Therefore many stretches, especially these close to urban center e.g. Delhi, Mathura, Agra, which introduce a huge quantity of untreated water into the river, are highly polluted. Most important usages of Yamuna water are irrigation, domestic water supply and industrial use. This causes a high discharge of polluted water into the river. Sources from domestic use cause about 85 % of the total pollution. Besides there are several diffused sources of pollution such as open defecation, bathing, washing, dumping of garbage and dead bodies, immersion of idols etc.

- **Nizamuddin**: 14 km downstream from Wazirabad barrage (near Sarai Kale Khan Bus stand) at Delhi – Ghaziabad (Noida) Road Bridge on Yamuna River. The water quality at this location reflects the impact of wastewater discharge. Nizamuddin Bridge is around 3 km downstream of the I.T.O. Bridge. In between two power plants are located, so that it is possible to estimate the influence on the River Quality and determine how polluted the Nizamuddin is as shown in Fig. 1.

Fig. 1: Nizamuddin Bridge (Wikimapia 2012)

- **Agra downstream:** Near temple at West Burzi of Tajmahal monument (Behind the monument) about 310 km downstream from Wazirabad Barrage. The location depicts the impact of wastewater discharges from Agra city, this location also contribute immensely toward the damage of Yamuna River as show in the Fig. 2.0 below.

Fig. 2: Location and some of activities at Agra d/

2.2Data Source

The samples were collected and analyses throughout the years from January to December from Yamuna river by central pollution control board (CPCB), The two different Stations at Yamuna River were selected in order to study the water quality changes using the National sanitation foundation (NSFWQI) as well as the Modified CPCB weight age factors for 2000, 2005 and2010, from the selected parameters.

The Data was obtained from the status of water quality in India compiled by CPCB, The yearly average of each parameters was taken, and the calculation of water quality index was based on Four important physico-chemical parameters viz. Dissolved oxygen(DO),Fecal coli form(FC),PH, Biological oxygen demand(BOD).

Reason for selecting the location

- Yamuna leaves Delhi as sewer, laden with the city's biological and chemical wastes
- Agra D/s becomes the main municipal drinking water source
  The existing treatment facilities are inadequate to treat the pollutants (Both Delhi and Agra) [5].

2.3Calculation of WQI

National Sanitation Foundation Water Quality Index (NSF WQI):

NSF WQI is an excellent management and general administrative tool in communicating water quality information. This index has been widely field tested and

applied to data from a number of different geographical areas all over the world in order to calculate WQI of various water bodies' critical pollution parameters were considered[6].

In India the NSF WQI is being used by CPCB, with a slight modification in weights ***(Abbasi, 2002, CPCB, 2001)***

The NSFWQI is expressed mathematically as:

$$\text{NSFWQI}=\frac{\sum Q_{Value\ x\ Weight}}{\sum Weight}$$

In this equation, NSF-WQI= Index of National Sanitation Foundation, Q= qualitative parameter value and W= weight of parameters are considered. NSF-WQI can be calculated by using sub-index equation of each parameter and their weighted. After evaluating the considered index, water quality can be ranked relating it to a descriptive category (Kumar et al., 2011) [7].

The modified weights (Wi) and the sub-index/ quality value as per CPCB, are given in **Table 1.0 and 2.0,** respectively. The range of the NSF WQI corresponding to various designated best use classification is given intable3.0

Table 1: Original and Modified Weights for the computation of NSF WQI Based on DO, Fecal Coli forms, pH and BOD*

Water Quality parameters	Original Weights from NSF WQI	Modified Weights by CPCB
DO	0.17	0.31
FC	0.15	0.28
PH	0.12	0.22
BOD	0.10	0.19
Total	0.54	1.00

*** CPCB 2001**

Table 2.0 Sub –Index Equations for Water Quality Parameters (NSF WQI)*

Water Quality Parameters	Range Applicable	Equation
DO (Percent saturation)	0-40% saturation 40-100% saturation 100-140% saturation	IDO = 0.18+0.66 x (% Saturation DO) IDO = -13.55+1.17 x (% Saturation DO) IDO = 163.34-0.62 x (% Saturation DO)
B.O.D.(mg/l)	0-10 10-30 >10	IBOD = 96.67-7 (BOD) IBOD = 38.9-1.23 (BOD) IBOD = 2
pH	2-5 5-7.3 7.3-10 10-12 <2,>12	IpH = 16.1+7.35 x (pH) IpH = -142.67+33.5 x (pH) IpH = 316.96-29.85 x (pH) IpH = 96.17-8.0 x(pH) IpH=0
Fecal Coli form (counts/100ml)	1-10^3 10^3-10^5 >10^5	IFC = 97.2-26.6 x log(FC) IFC = 42.33 -7.75 x log(FC) IFC = 2

*** Abbasi, 2002**

Table 3: NSF WQI for Various Designated Best Use

Serial No	NSF WQI	Description of Quality (1978)	Class by CPCB	Remarks
1	63-100	Good to Excellent	A	Non polluted
2	50-63	Medium to Good	B	Non polluted
3	38-50	Bad	C	Polluted
4	38 & less	Bad to Very Bad	D,E	Heavily polluted

***CPCB, 2001**

3. RESULTS AND DISCUSSION

River water quality can be assessed by the analysis of nutrients, chemistry, and biology. The criteria for a healthy river are that it should contain at least 5 mg/L of Dissolved Oxygen (vital for the survival of marine life) and about 3 mg/L of Biochemical Oxygen Demand. Further the Pathogens (disease causing bacteria's) represented by the Fecal Coli forms counts should not exceed 500 per 100 ml of water. India River water qualities have been categories in five classes (http:// edugreen.teri.res.in/explore/maps/water.htm) [9]. It can be also seen that the water quality of two stations is found in '**Bad to very bad**' quality range during the years 2000, 2005 and 2010. Evaluation of NSFWQI has been shown in **Table 4.0.**

Table 4: Evaluation of NSFWQI for two stations at Yamuna River.

	2000Yrs	2000Yrs	2005Yrs	2005Yrs	2010Yrs	2010Yrs
WQI	**Nizamuddin**	**Agra D/s**	**Nizamuddin**	**Agra D/s**	**Nizamuddin**	**Agra D/s**
DO	6.84	50.0	6.0	38.0	6.9	52.0
FC	1737727	1442891	2952100	618417	4893333	260182
PH	7.6	7.9	7.43	7.69	7.7	7.7
BOD	18	21	23	15	16.8	7.9
NSFWQI	23.65	35.43	23.4	32.52	27.1	33.88
Rating	Very bad	bad	Very bad	bad	bad	bad
CPCB Rating	D,E	D,E	D,E	D,E	D,E	D,E

The above Table 4 reveals that, water quality (WQ) was found to be in the range of **very bad to bad** at Nizamuddin and Agra d/s, because the NSFWQI comes within the range of 0-25and 25-50 at both the location during the period of 2000.2005 and 2010. The index values ranged from a minimum of 23.4 during the year2005 at Nizamuddin and reached a maximum of 33.88 in year 2010 at Agra D/S. The conditions in it often stray from the normal levels. It is evident from the results that water quality in the Yamuna River is in bad quality considerably, due the fact that Yamuna from Delhi is full of biological and chemical waste from the city.

4. CONCLUSIONS

On the basis of the Modified factors given by CPCB India and NSFWQI, it was concluded that the water quality of Yamuna River is only suitable for industrial cooling, irrigations

because it fall under the category D, E [9]. Since 1975, there had been rapid urbanization, Industrialization and agricultural development in Yamuna basin, which have directly or indirectly affected the Yamuna water quality. It is also conclude that the both the two stations revealed the heavily pollution level with high anthropogenic activities in the area, therefore, the significant measure to be undertaken for abatement of pollution in river Yamuna areas are:

- Industries should treat their effluents so as to confirm the specified Requirements.
- To reduce over exploitation of river water for various human activities,
- Disposal of garbage, solid, semi-solid, waste into river, its tributaries and Drains should be restricted.
- Community participation in various Yamuna water quality restorations Programmed should be encouraged.

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