Assessment of Water Quality Index for the SurfaceWater in Betna Wetland of Morang District, Nepal

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Abstract: ***The research is aimed to assess the water quality index (WQI) for the surface water of Betna wetland. This has been determined by collecting the surface water samples and subjecting the samples to a comprehensive physicochemical analysis. For calculating the WQI, the following 11 parameters have been considered: Temperature (ambient and water), pH, turbidity, TDS (Total Dissolved Solid), Cl^- (chloride), EC (Electric Conductivity), DO (Dissolved Oxygen), TH (Total Hardness), PO_4–P (Phosphate – phosphorus), NO_3-N (Nitrate – nitrogen), COD (Chemical Oxygen Demand). The WQI for these samples has been found to be mainly from the higher values of turbidity, DO and P^H of the wetland water. The result of WQI has indicatedat the site-I, the calculated value (ΣSIi =87.63) showed the good quality, at the site-II the value of WQI (ΣSIi =124.51) showed the poor quality and at the site-III the value of WQI (ΣSIi =226.95) showed the water was unsuitable for drinking as per the classification givenand needs some proper treatment before consumption, and it also needs to be protected from the risk of contamination. The mean value of fecal coliform recorded was 1900 MPN/l00 ml which was crossed the WHO guide line.***

Keywords: Water quality standards, Water quality index, Betna wetland, Nepal.

I. *Introduction*

Wetlands are most diverse ecosystems in the world providing irreplaceable ecological functions and economic values [1]. Today the cry of "Environmental Pollution" is heard from all corners of the world. Pollution has now become a distinct threat to the very existence of mankind on this earth. Fresh water which is a precious and limited vital resource needs to be protected, conserved and used wisely by man. But unfortunately such has not been the case, as the polluted lakes, rivers and streams throughout the world testify. Water quality is the measure of the state or condition of water resources relative to the requirements of the biotic species and human needs.Generally both surface water and groundwater are acceptable for human consumption [2].

Water quality index (WQI) is used for the detection and evaluation of water pollution and may be defined as "a rating, reflecting the composite influence of different quality parameters on the overall quality of water."Water quality index is one of the most effective tools to communicate information on the quality of water to the concerned citizens and policy makers. Therefore, it is an important parameter for the assessment and management of surface water. WQI is defined as a rating reflecting the composite influence of different water quality parameters. WQI is calculated from the point of view of the suitability of surface water for human consumption [3].Hence, a comprehensive study has been carried out to find out the quality of wetland water by analyzing physicochemical and biological properties during pre-monsoon period of Betana wetland of Morang district in Terai region of Nepal.

II. *Materials and Methods*

Site description

The small and landlocked Kingdom of Nepal extends from the highest peak in the world to the plains of the Terai. It lies along the slopes of the Himalaya between China and India with a land area of 147 181 km2 being 800 km from east to west, and from 144 km to 240 km north to south, between 80 0 – 88 0 E and 260 - 310 N. The country borders India to the East, South and West and China to the North. Nepal possesses wetlands diversity covering a total of 0.42 million hectare, which represents 5% of the total landmass of the country [4].

Betana (lat 26°39'N, long 87°25'E, alt. 115 m msl) spread in 5.5 ha at the fringe of the jungle area, locally called Char-Koshe–Jhadi, is a natural freshwater ox-bow pond(Fig.-1). It lies in the Belbari municipality of Morang district, 26 km north-east away from Biratnagar metropolitan city.

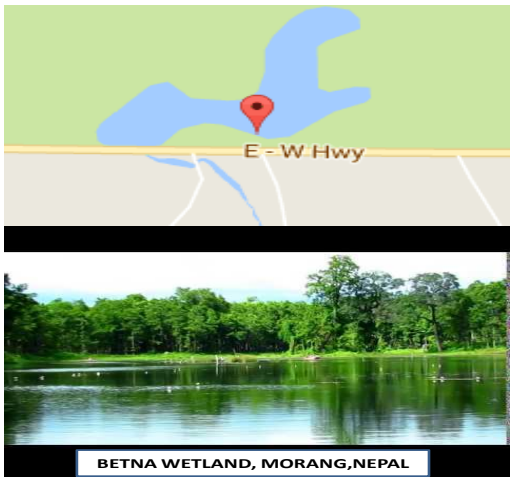

Figure1. Map of Betna Wetland in Morang district of Nepal.

III. *Methodology*

The physicochemical properties of surface water were examined out during pre-monsoon period (2017). Water samples were collected from the three different representative of the lake and were brought to the laboratory in 2.5 L plastic container for laboratory analysis. The parameters like temperature, pH, Dissolved oxygen, Free-carbon dioxide, Conductivity was determined on the spot while the rest of the parameters were determined in the laboratory. The overall analysis was done following the standard methods [5-6].

IV. *Calculationof WQI*

The WQI has been calculated to evaluate the suitability of surface water quality of wetland for drinking purposes. The WHO (2004) standards for drinking purposes have been considered for the calculation of WQI [7]. For the calculation of WQI,11 parameters such as: pH, turbidity, TDS, Cl^-, electrical conductivity (EC),DO free-carbondioxide (FCO_2), bicarbonate(HCO_3^-), total hardness (TH), phosphate (PO_4-P), Nitrate-N (NO_3-N) and COD have been used. The WQI of Betna wetland has been calculated using the method given inTable-2[8].

Table1. Parameters analyzed of the wetland water

Parameters/units	Pre-monsoon 2017			
	Site I	Site II	Site III	Mean
Water depth (ft)	1	5	10	5.33
Air Temp.(^{0}C)	25	24.5	23	24.17
Water Temp.(^{0}C)	29	29.2	29.5	29.23
Turbidity(NTU)	13	17	35	21.67
TDS	147.2	255.3	212	204.83
Cl^-	6.99	5.99	6.99	6.66
EC	446	565	625	545.33
pH	7.2	7.2	7.3	7.23
DO	5.2	5.6	7.5	6.1
HCO_3^-	54	54	48	52
TH	78.5	92	79.6	83.37
NO_3^-N	0.03	0.027	0.027	0.028
PO_4^-P	0.93	0.86	0.91	0.9
COD	1.8	3.7	13	6.17
Fecal coliform(MPN/100ml)	1500	1700	2500	1900

* Except p^H, all other variables expressed in ppm or mg/l or otherwise mentioned. TDS= Total Dissolve Solid, EC = Electric conductivity, DO= Dissolved Oxygen, HCO_3^- = Bicarbonate alkalinity, TH = Total Hardness, Cl^- = Chloride, PO_4–P = Phosphate – phosphorus, NO_3-N = Nitrate – nitrogen, COD = Chemical Oxygen Demand.

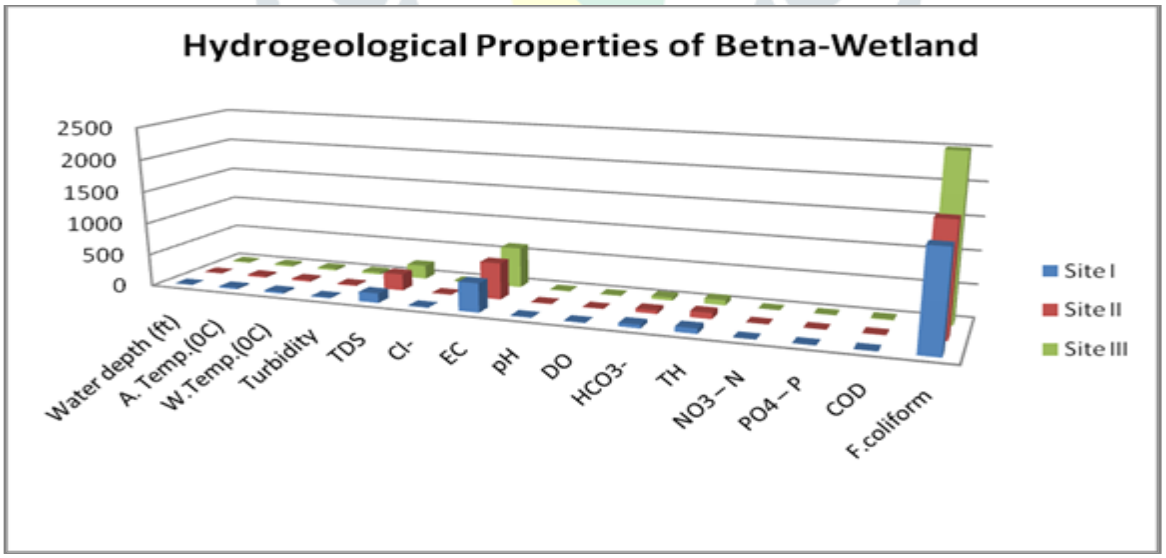

Figure2. Hydrogeologicalical Properties of Betna Wetland

Table2. WHO standards and calculated relative weight (Wi),quality rating scale (Qi) and sub index values (SIi) for each parameter.

Parameters	WHO Standards	Weight (wi)	Relative weight (Wi)	Site-I		Site-II		Site-III	
				Qi	SIi	Qi	SIi	Qi	SIi
P^H	8.2-8.8	4	0.114285	81.82	9.35	81.82	9.35	81.82	9.35
Turbidity(NTU)	1.5	2	0.057142	866.67	49.52	1416.67	80.95	3083.33	176.18
TDS (mg/L)	500	5	0.142857	29.44	4.21	51.06	7.29	42.4	6.05
Cl^- (mg/L)	250	3	0.085714	2.8	0.24	2.4	0.21	2.8	0.24

EC (µs)	1000	2	0.057142	44.6	2.55	56.5	3.23	62.5	3.57
DO mg/L	5	4	0.114285	104.0	11.89	112.0	12.8	150	17.14
HCO_3^- mg/L	150-300	3	0.085714	18.0	1.54	18.0	1.54	16.0	1.37
TH mg/L	200	2	0.057142	39.25	2.24	46.0	2.63	39.8	2.27
PO_4^-P mg/L	0.1-1.0	2	0.057142	93.0	5.31	86.0	4.91	91.0	5.2
NO_3^-N mg/L	50	5	0.142857	0.06	0.01	0.06	0.01	0.06	0.01
COD mg/L	10-20	3	0.085714	9.0	0.77	18.5	1.59	65.0	5.57
		Σwi= 35	ΣWi= 0.99		ΣSIi =87.6		ΣSIi =124.51		ΣSIi =226.95
Class of water					Good		Very poor		Unfit for drinking

Table3. WQI based water quality classification (Ramakrishnaiah *et al*., 2009).

WQI value	Water Quality Category
< 50	Excellent water
50-100	Good
100-200	Very Poor
>300	Unfit for drinking

V. *Resultsand Discussion*

The water quality index of Betna wetland during pre-monsoon period (2017) has been evaluated on the basis of some important physiochemical parameters (Table-1 and Fig.-2).

The averageair temperature recorded was 24.17 ^{0}C whereas the average water temperature was 29.23^{0}C of the wetland. The mean turbidity value of the wetland water was 21.67 NTU, which crossed the WHO guideline value of 1.5 NTU. The turbidity value depends upon the amount of total solids, plankton density, suspended materials and various human activities. The mean values of Total Dissolved Solid and chloride were204.83 and 6.66 mg/L respectively, whichare remaining under the WHO guideline.

Electric conductivity of water depends upon the concentration of ion and nutritional status of the water body. The mean value of Electric conductivity of the wetland water was recorded 545.33 µs which is under the WHO guideline. Similarly, the mean pH value was recorded 7.23 which are under the permissible limit. The pH of waters depends upon the geological nature of the source and the presence of dissolved solids. Similarly, the amount of dissolved oxygen in the wetland was recorded to be 6.1 mg/Lwhich is slightly elevated the WHO guideline value of 5 mg/L for drinking water whereas total hardness was found to be 83.37mg/L which is below the WHO guide line.

Nitrate-Nitrogen content of the lake water was 0.028 mg/L, which is under the WHO permissible limit. Nitrogen content of water is of great significance for the algal growth. The concentration of PO_4-P in the lake water was 0.9 mg/L which was under the WHO guide line. It is a pollution indicator, as its higher amount responsible for eutrophication in freshwater and it acts as growth limiting factor and is an important nutrient for microorganisms. Chemical Oxygen Demandis the amount of oxygen required for the oxidation of chemical wastes. The mean value of COD recorded was 6.17 mg/L which was under the tolerance limit.

The fecal coli form bacteria have also been detected from the wetland water in which the mean value of fecal coli form recorded was 1900 MPN/l00 ml which was crossed the WHO guide line. The presence of fecal coli form in all the sites showed that water is highly contaminated with the fecal material of man and other animals due to which the wetland water is not suitable for drinking purpose before proper treatment. The presence of total coli form in water is an indication of fecal contamination and is responsible for most water borne diseases such as meningitis, cholera and diarrhea as well as morbidity and mortality among children [8]. It also causes acute renal failure and hemolyticanemiain adults [9].

So far as the WQI of the wetland water is concerned, at the site-I, the calculated value (ΣSIi =87.63) showed the good quality, at the site-II the value of WQI (ΣSIi =124.51) showed the poor quality and for the site-III the value of WQI (ΣSIi =226.95) showed the water is unsuitable for drinking as per the classification given (Table-3).

VI. *Conclusion*

As the result of WQI showed that the water at the site-I is only suitable for drinking purposes whereasat the site-II and Site-III of wetland water is highly polluted and can only be used to anthropogenic activities such as agricultural activities and cottage industries. Application of Water Quality Index (WQI) in this study has been found to be useful in assessing the overall quality of water and to get rid of judgment on quality of the water. This method appears to be more systematic and gives comparative evaluation of the water quality of the wetland. It is also helpful for public to understand the quality of water as well as being a useful tool in many ways in the field of water quality management. The presence of fecal coli form in the wetland water is responsible for spreading water borne outbreaks. The waterborne diseases are closely related with the conditions of living and environmental sanitation in the community. Therefore, it should be effectively controlled by appropriate water management and safe disposal of excreta.

VII. *Acknowledgments*

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