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Assessment of Surface Water Quality by Using Water Quality Index of Sanbarish Pond of Morang District, Nepal

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Abstract

A study of surface water of Sanbarish pond has been carried out to examine the quality for drinking and other domestic purpose as well as to evaluate the water pollution status of wetland on the basis of the presence of different physicochemical and microbiological parameters. 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 indicated the calculated value (ΣSIi = 95.59) showed the good quality for drinking as per the classification given and needs some proper treatment before consumption, and it also needs to be protected from the risk of contamination. The mean value of fecal coli form recorded was 1166.67 MPN/l00 ml which was crossed the WHO guide line.

Keywords: Water quality index; Surface water; physicochemical Sanbrish wetland; Nepal.

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1. Introduction

Water is the Earth's most precious resource. Comprising around 70% of the planet, life without water would not be possible as it is so today. It is therefore natural that water-based environments comprise some of the most ecologically important features on Earth. Wetlands are a broad and significantly important sub-grouping of these water-based environments. Wetlands are defined by Ramsar as: "areas of marsh, fen peat land fresh brackish salt, or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, , or , including areas of marine water the depth of which at low tide does not exceed six meters" [1]. These wetlands form some of the most ecologically important and productive landscapes on the planet [2]. Some wetlands are also used as sources of wild foods, medicines and fuel wood [3-5]. Wetlands may also be indirectly important to people's livelihoods, through their influence on downstream aquatic habitats and their role in recreational and cultural activities, and may also contribute to tourism activities that lead to business and employment opportunities in nearby communities. Wetland ecosystems are economically important resources because they increase biodiversity and serve as nutrient traps (Hansson and his colleagues 2005). Their multifunctional abilities have led to an increased interest in the restoration and construction of wetlands [6].

2. Materials and Methods

2.1. Site description

Nepal is a small landlocked kingdom 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 km^2 being 800 km from east to west, and from 144 km to 240 km north to south, between 80^0 – 88^0 E and 26^0 - 31^0 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 [7]. The name of the pond is Sanbarish which is of great mythological importance for the local people such as Rajbanshi, Kewrat, Gangain, Tajpuria, Dhimal, Santhal etc. of this area since the time of unknown, located at Gobindpur VDC ward no 4 of Morang district of Nepal. Now the place (after federal modification of Nepal in 2015) is addressed in Ratuwamai Rural Municipality, 30 km east from Biratnagar metropolitan city of Morang district. The pond has been named after the very religious divine king Sanbarish. The local tribal people (dhami, gosain) used to celebrate annually on date of 1^{st} Baisakh (first day of the New Year of BS) by praying the king Sanbarish according to their special manner. The total area of pond is about 2.5 hector situated at an elevation of 66m above MSL. Its geographical coordinates are $26^0$31'01.761''N latitude and $87^0$35'00.816E longitude (Fig. 1).

Figure 1: Location map of Sanbarish Pond in Morang district of Nepal

2.2. Methodology

The hydro-chemical properties of surface water were examined during the post-monsoon period (2019). Water samples were collected from three different sites in 2.5 L plastic container for laboratory analysis and brought to the Environmental Biology Research Laboratory (Department of Botany), Mahendra Morang Aadarsh Multiple Campus (Tribhuvan University), Biratnagar, Nepal. 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 [8-9].

2.3. Calculation of WQI

The WQI has been calculated to examine 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 [10]. 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 Sanbarish wetland has been calculated using the method given in Table-2[8].

Table 1: Parameters analyzed of the wetland water

Parameters/units	Post-monsoon 2018			
	Site I	Site II	Site III	Mean
Water depth (ft)	2	7	10	6.33
Air Temp.(^{0}C)	24	24	24	24
Water Temp.(^{0}C)	27.5	27.5	27.5	27.5
Turbidity(NTU)	15	12	12	13
TDS	117.5	235.1	195.2	182.6
Cl^-	6.99	5.99	6.99	6.66
EC	427	465	525	472.33
pH	7.5	7.3	7.3	7.37
DO	5.2	5.2	6.5	5.63
HCO_3^-	56	50	50	52
TH	78.5	92	79.6	83.37
NO_3^-N	0.03	0.027	0.027	0.03
PO_4^-P	0.83	0.76	0.81	0.8
COD	2.2	2.7	5.5	3.47
Fecal coli form (MPN/100ml)	2200	1100	200	1166.67

* Except p^H, all other variables expressed in 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.

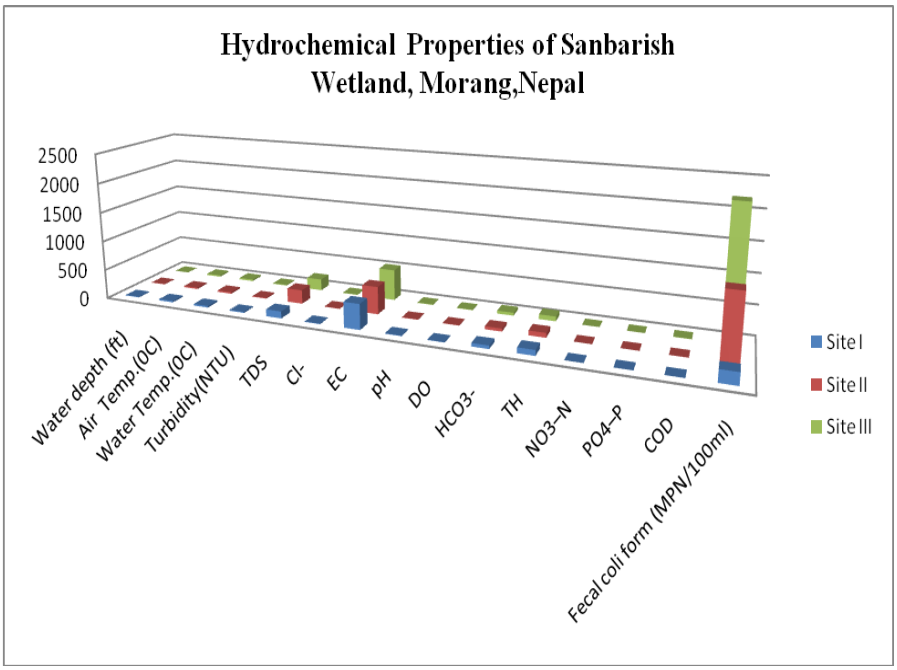

Figure 2: Hydrchemical Properties of Sanbarish Wetland, Nepal

Table 2: 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)**	**WQI**	
				Qi	**SIi**
P^H	8.2-8.8	4	0.114285	83.75	9.57
Turbidity(NTU)	1.5	2	0.057142	866.67	49.52
TDS (mg/L)	500	5	0.142857	36.52	5.21
Cl^- (mg/L)	250	3	0.085714	2.66	0.23
EC (µs)	1000	2	0.057142	47.23	2.7
DO mg/L	5	4	0.114285	112.6	12.87
HCO_3^- mg/L	150-300	3	0.085714	23.11	1.98
TH mg/L	200	2	0.057142	41.69	2.38
PO_4^-P mg/L	0.1-1.0	2	0.057142	160	9.14
NO_3^-N mg/L	50	5	0.142857	0.06	0.01
COD mg/L	10-20	3	0.085714	23.13	1.98
		Σwi= 35	ΣWi= 0.99		ΣSIi =95.59
Class of water					Good

Table 3: WQI based water quality classification (Ramakrishnaiah and his colleagues 2009).

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

3. Results and Discussion

Different studies on the surface water quality and water quality index have been carried out all over the world to assess the quality of water [12-19]. The water quality index of Sanbarish wetland has been evaluated during post-monsoon period (2018) on the basis of some important physiochemical parameters (Table-1 and Figure-2). The average air temperature recorded was 24^0C whereas the average water temperature was 27.5^0C of the wetland. The mean turbidity value of the wetland water was 13 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 were 182.6 and 6.66 mg/L respectively, which are 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 472.33 µs which is under the WHO guideline. Similarly, the mean pH value was recorded 7.37 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 5.63 mg/L which 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 0.03 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 0.8 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 Demand is the amount of oxygen required for the oxidation of chemical wastes. The mean value of COD recorded was 3.47 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 1166.67 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 [11]. It also causes acute renal failure and hemolytic anemia in adults [12]. So far as the WQI of Sanbarish wetland water is concerned, the calculated value ($\Sigma SIi = 87.63$) showed the good quality for drinking as per the classification given (Table-3).

4. Conclusion

As the result of WQI showed that the water at the site-I is only suitable for drinking purposes whereas at 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.

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