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Evaluation of Water Quality in Thrissur-Malappuram Kole Wetlands of Kerala using Water Quality Index

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Abstract: This study assessed water quality of Kole wetlands in Thrissur-Malappuram which serves as a natural water reservoir. The Kole wetland water samples were collected from the four study areas and the chemical parameters were analysed. The Water Quality Index (WQI) was computed by weighted arithmetic index method. The WQI and possible usage of each category was analysed. It was observed that WQI of the site-1 and site-3 indicated "very poor" and "poor" water quality status, respectively. The site-2 represented very good status in water quality index and the site-4 indicated high pollution regarding WQI status and categorised as "unfit for consumption" and need proper treatment before use.

Keywords: Water Quality Index; Kole wetlands; Pollution, Physico-chemical parameters

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Introduction

Wetland ecosystems, including rivers, lakes, marshes, rice fields and coastal areas, provide many services that contribute to human well-being. water is the elixir of all life and quality water is essential for our existence. Kole wetlands works as a chief water resource of an area. Thrissur and Malappuram Kole wetlands are one of the major Kole wetland system in Kerala. It acts as an important natural reservoir in this area. The water quality of Thrissur- Malappuram Kole wetlands is very important, in which the water nourishes the irrigational resources by underground connections to wells, ponds, lakes and rivers. So, it is essential to monitor water quality of the Kole wetland. The study was conducted in Kole wetlands of Thrissur and Malappuram, one of the largest Kole wetland system in Kerala. The geology of study area composed of permanently water filled canals, seasonally submerged and rice cultivated lands. The Kole lands spread over villages, cities and may drain into brackish water lakes. The Kole wetlands of Thrissur is characterized by tropical wet and dry conditions. The main recharge source of water

is by precipitation.

Materials and Methods

The 'Kole Lands' (Fig. 1) is spread over Thrissur and Malappuram districts of Kerala. This is said to be the Rice Granary of these districts at par with Kuttanad the 'Rice Bowl' of Kerala. Rice cultivation in Kole lands is said to have started way back in the eighteenth century. Kole lands lie between Bharathapuzha in the north and Chalakudy River in the south. It is located between 10° 20' and 10° 40' north latitudes and 75° 58' and 76° 11' east longitudes (Johnkutty and Venugopal, 1993). The Muriyad wetland is situated 8 km north east of Irinjalakuda town of Trissur district. Kurumali-Karuvannur River is the northern boundary. The total field area is 1,215 ha. The water spread is a narrow central strip running north to south from Karuvannur to Thommana. The Nedumthode (Thamaravalayam canal) running along the centre of the wetland is the major opening, which functions for the discharge of floodwater and letting irrigation water into the fields. M.M. Canal (Muriyad-Moorkanad Canal) is the only outlet for floodwater. Ponnani Kole, situated in south western region of Malappuram district, is the northern most extension of the Vembanad Kole, the Ramsar site. The study area is extending from southern bank of Bharathapuzha in the north to Narnipuzha in the south in a stretch of about twenty kilometers. The study was conducted at Site -1(Maranchery), Site-2 (Kuranniyur), Site-3 (Enamav) and Site-4 (Nedupuzha).

In this study Maranchery, Kuranniyur, Enamav and Nedupuzha as four sites of Thrissur Kole wetlands were selected and collection of water samples were conducted in random sampling method for the testing of physico-chemical parameters in August 2018. The water samples were analysed for pH, Alkalinity (mg/l), Total hardness (mg/l), Total hardness (mg/l), Calcium (mg/l), Magnesium (mg/l), Chloride (mg/l), Fluoride (mg/l), Iron (mg/l), Nitrate (mg/l), Sulphate (mg/l) and TDS (mg/l) as described by APHA (1995). The calculation of water quality index was done by weighted arithmetic index method (Brown *et al*., 1972) using MS excel. Using water quality index, water quality status classification was done according to Brown *et al*. (1970).

Calculation of Water Quality Index (*WQI*):

The weighted arithmetic index method (Brown *et al*., 1972) was used as follow:

Step 1:

Calculated the unit weight (Wn)

Factors for each parameter by using the formula Wn $=\frac{K}{Sn}$

$$\text{Where, } K = \frac{1}{\frac{1}{S_1}+\frac{1}{S_2}+\frac{1}{S_3}\ldots\ldots\ldots\ldots+\frac{1}{Sn}} = \frac{1}{\sum\frac{1}{Sn}} \qquad (1)$$

Sn = Standard desirable value of the n^{th} parameters

On summation of all selected parameters unit weight factors, Wn=1 (Unity)

Step 2:

Calculated the sub-index (Qn) value by using the formula

$$Qn=\frac{[(Vn-Vo)]}{[(Sn-Vo)]}*100 \qquad (2)$$

Where, Vn= Mean Concentration of the n^{th} parameters

Sn= Standard desirable value of the n^{th} parameters

V_0= Actual values of the parameters in pure water

(Generally, V_0=0, for most parameters, except for pH)

$$QpH=\frac{[(VpH-7)]}{[(8.5-7)]}*100 \qquad (3)$$

Step 3:

Combining Step 1 and step 2, WQI is calculate as follows

$$\text{Over all WQI}=\frac{\sum WnQn}{\sum Wn} \qquad (4)$$

Results and Discussion

A total of 12 parameters were determined out of which pH, Total hardness (mg/l), Calcium (mg/l), Magnesium (mg/l), Chloride (mg/l), Fluoride (mg/l), Iron (mg/l), Nitrate (mg/l), Sulphate

Table 1: Water Quality Index of sample of site -1

Physico-chemical parameters	Site 1, Sn	$\frac{1}{Sn}$	A=$\sum\frac{1}{Sn}$	K=$\frac{1}{A}$	Wn=$\frac{K}{Sn}$	Ideal value (V_o)	Mean Con.Value (V_n)	M=$\frac{Vn}{Sn}$	Qn=M×100	Wn×Qn
pH	8.5	0.117647059	4.738369	0.211043	0.024829	7	6.85	0.8058	80.588	2.0008
Turbidity (NTU)	5	0.2	4.738369	0.211043	0.042209	0	95.65	19.13	1913	80.74508
Alkalinity(mg/l)	200	0.005	4.738369	0.211043	0.001055	0	27.5	0.1375	13.75	0.014509
Total hardness (mg/l)	200	0.005	4.738369	0.211043	0.001055	0	86.5	0.4325	43.25	0.045638
Calcium (mg/l)	75	0.013333333	4.738369	0.211043	0.002814	0	17.68	0.235733	23.57333	0.066333
Magnesium (mg/l)	30	0.033333333	4.738369	0.211043	0.007035	0	4.66	0.155333	15.53333	0.109273
Chloride (mg/l)	250	0.004	4.738369	0.211043	0.000844	0	36.66	0.14664	14.664	0.012379
Fluoride (mg/l)	1	1	4.738369	0.211043	0.211043	0	0.23	0.23	23	4.853991
Iron (mg/l)	0.3	3.333333333	4.738369	0.211043	0.703477	0	0.79	2.633333	263.3333	0.019697
Nitrate (mg/l)	45	0.022222222	4.738369	0.211043	0.00469	0	1.89	0.042	4.2	0.019697
Sulphate (mg/l)	400	0.0025	4.738369	0.211043	0.000528	0	99.58	0.24895	24.895	0.013135
TDS (mg/l)	500	0.002	4.738369	0.211043	0.000422	0	166.3	0.3326	33.26	0.014039
Sum		4.73				1				87.91

Table 2: Water Quality Index of sample of site -2

Physico-chemical parameters	Site 2, Sn	$\frac{1}{Sn}$	A=$\sum \frac{1}{Sn}$	K=$\frac{1}{A}$	Wn=$\frac{K}{Sn}$	Ideal value (V_o)	Mean. Con. Value (V_n)	M=$\frac{Vn}{Sn}$	Qn=M×100	Wn×Qn
pH	8.5	0.117647	4.738369	0.211043	0.024829	7	7.21	0.848235	84.82353	2.106049
Turbidity (NTU)	5	0.2	4.738369	0.211043	0.042209	0	1.96	0.392	39.2	1.654578
Alkalinity(mg/l)	200	0.005	4.738369	0.211043	0.001055	0	30	0.15	15	0.015828
Total hardness (mg/l)	200	0.005	4.738369	0.211043	0.001055	0	38.1	0.1905	19.05	0.020102
Calcium (mg/l)	75	0.013333	4.738369	0.211043	0.002814	0	12.78	0.1704	17.04	0.047949
Magnesium (mg/l)	30	0.033333	4.738369	0.211043	0.007035	0	5.51	0.183667	18.36667	0.129205
Chloride (mg/l)	250	0.004	4.738369	0.211043	0.000844	0	30.33	0.12132	12.132	0.010241
Fluoride (mg/l)	1	1	4.738369	0.211043	0.211043	0	0.096	0.096	9.6	2.026014
Iron (mg/l)	0.3	3.333333	4.738369	0.211043	0.703477	0	0.19	0.633333	63.33333	44.55354
Nitrate (mg/l)	45	0.022222	4.738369	0.211043	0.00469	0	4.93	0.109556	10.95556	0.05138
Sulphate (mg/l)	400	0.0025	4.738369	0.211043	0.000528	0	32.06	0.08015	8.015	0.004229
TDS (mg/l)	500	0.002	4.738369	0.211043	0.000422	0	98.83	0.19766	19.766	0.008343
Sum		4.73			1					50.62

Table 3: Water Quality Index of sample of site -3

Physico-chemical parameters	Site 3, Sn	$\frac{1}{Sn}$	$A=\sum\frac{1}{Sn}$	$K=\frac{1}{A}$	$Wn=\frac{K}{Sn}$	Ideal value (V_o)	Mean. Con. Value (V_n)	$M=\frac{Vn}{Sn}$	Qn=M×100	Wn×Qn
pH	8.5	0.117647	4.738369	0.211043	0.024829	7	7.06	0.830588	83.05882	2.062234
Turbidity (NTU)	5	0.2	4.738369	0.211043	0.042209	0	2.48	0.496	49.6	2.093547
Alkalinity (mg/l)	200	0.005	4.738369	0.211043	0.001055	0	37.16	0.1858	18.58	0.019606
Total hardness (mg/l)	200	0.005	4.738369	0.211043	0.001055	0	53	0.265	26.5	0.027963
Calcium (mg/l)	75	0.013333	4.738369	0.211043	0.002814	0	15.2	0.202667	20.26667	0.057029
Magnesium (mg/l)	30	0.033333	4.738369	0.211043	0.007035	0	5.9	0.196667	19.66667	0.13835
Chloride (mg/l)	250	0.004	4.738369	0.211043	0.000844	0	31.16	0.12464	12.464	0.010522
Fluoride (mg/l)	1	1	4.738369	0.211043	0.211043	0	0.184	0.184	18.4	3.883193
Iron (mg/l)	0.3	3.333333	4.738369	0.211043	0.703477	0	0.19	0.633333	63.33333	44.55354
Nitrate (mg/l)	45	0.022222	4.738369	0.211043	0.00469	0	3.84	0.085333	8.533333	0.04002
Sulphate (mg/l)	400	0.0025	4.738369	0.211043	0.000528	0	44.43	0.111075	11.1075	0.00586
TDS (mg/l)	500	0.002	4.738369	0.211043	0.000422	0	119.16	0.23832	23.832	0.010059
Sum		4.73			1					52.9

Table 4: Water Quality Index of sample of site -4

Physico-chemical parameters	Site 4, Sn	$\frac{1}{Sn}$	A=s 1/Sn	K=$\frac{1}{A}$	Wn=$\frac{K}{Sn}$	Ideal value (V_o)	Mean. Con. Value (V_n)	M=$\frac{Vn}{Sn}$	Qn=M×100	Wn×Qn
pH	8.5	0.117647	4.738369	0.211043	0.024829	7	7.03	0.827059	82.70588	2.053471
Turbidity (NTU)	5	0.2	4.738369	0.211043	0.042209	0	10.2	2.04	204	8.610558
Alkalinity(mg/l)	200	0.005	4.738369	0.211043	0.001055	0	30.84	0.1542	15.42	0.016271
Total hardness (mg/l)	200	0.005	4.738369	0.211043	0.001055	0	49.83	0.24915	24.915	0.026291
Calcium (mg/l)	75	0.013333	4.738369	0.211043	0.002814	0	13.98	0.1864	18.64	0.052451
Magnesium (mg/l)	30	0.033333	4.738369	0.211043	0.007035	0	8.38	0.279333	27.93333	0.196505
Chloride (mg/l)	250	0.004	4.738369	0.211043	0.000844	0	53	0.212	21.2	0.017896
Fluoride (mg/l)	1	1	4.738369	0.211043	0.211043	0	2.82	2.82	282	59.51415
Iron (mg/l)	0.3	3.333333	4.738369	0.211043	0.703477	0	0.66	2.2	220	154.7649
Nitrate (mg/l)	45	0.022222	4.738369	0.211043	0.00469	0	4.17	0.092667	9.266667	0.043459
Sulphate (mg/l)	400	0.0025	4.738369	0.211043	0.000528	0	28.05	0.070125	7.0125	0.0037
TDS (mg/l)	500	0.002	4.738369	0.211043	0.000422	0	145.3	0.2906	29.06	0.012266
Sum		4.73			1					225

Table 5: Determination of WQI status of Kole wetlands based on Brown *et al*. (1970)

Site	Site name	WQI	Status
1	Marancherry	87.91	Very poor
2	Kuranniyur	50.62	Good
3	Enamav	52.9	Poor
4	Nedupuzha	225	Unfit for consumption

Table 6: Water quality status classification according to WQI by Brown *et al*. (1970).

Water quality index	Water quality status	Possible usage
0-25	Excellent	Drinking, Irrigation, Industrial
26-50	Good	Drinking, Irrigation, Industrial
51-75	Poor	Irrigation and Industrial
76-100	Very poor	Irrigation
>100	Unfit for consumption	Proper treatment required before use

(mg/l) and TDS (mg/l) were found to be within the permissible limits of BIS. The Turbidity was beyond the permissible limit in the sample of site-1 and site-4. The calculation of Water Quality Index of Maranchery (Site-1), Kuranniyur (Site-2), Enamav (Site-3) and Nedupuzha (Site-4) are shown in Tables 1, 2, 3 and 4, respectively. The classification of WQI and status evaluation of four sites according to Brown *et al*. (1970) are shown in Tables 5 and 6.

The study revealed that the water quality index and status vary with sites. As per Table 6 of water quality classification (Brown *et al*.,1970), the site-1 showed very poor water quality owing to its WQI of 87.91 which is in a range of 75-100 on WQI scale. The site-2 was near to good status of water quality as its WQI value (50.6) close to the upper limit of the range 26-50 on WQI scale and site-3 with "poor" water quality due to its WQI of 52.9. Based on the WQI results, water from site-1, site-2 and site-3 can be utilized for irrigation and industrial purposes. The site-4 indicated WQI of 225 which is far greater than 100 on WQI scale and it indicated high pollution and can be categorised as "unfit for consumption" and need proper treatment before use. In the context of high threat to Kole wetlands due to pollution by unmanaged use of pesticides and herbicides, this study shows the necessity of the periodical monitoring and analysis of WQI in Kole wetlands, which has pivotal role in irrigation and restoration of groundwater table in an area.

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