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RESEARCH ARTICLE

Application of Water Quality Index for the spatial evaluation of pond water quality: a study from Vizhinjam Panchayath, Thiruvananthapuram, Kerala, India

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Abstract

Ponds play many vital roles in maintaining the hydro geological equilibrium of an area. Today many ponds are facing permanent deterioration. So it is important to preserve the ponds with respect to the quantity and quality of the water. Ponds play a dual role of storing water on the surface and transmitting water to the subsurface, thus rejuvenating the surface and subsurface water environments in terms of quantity and quality. One of the major advantages of water quality index (WQI) is that, it incorporates data from water quality parameters in to a mathematical equation that rates the health of water quality with number. The present study aimed to determine the water quality of Vizhinjam Panchayath by using water quality index method. The quality of pond water was evaluated by testing various physico-chemical parameters namely pH, TDS, DO, Na, K, Cl, TH, Ca and Mg and their water quality index were calculated. The water quality indexes for all samples were found in the range of 8.4 to 38.11. Most of the pond water samples within study area were found to be excellent to good categories indicating the ponds are suitable for domestic purposes. The study has thus proved that the application of Water Quality Index as a useful technique for the overall assessment of the water quality of a water body. Site specific action plans has also been suggested as part of the study, the strict implementation of which shall ensure the protection and conservation of these small water bodies.

INTRODUCTION

Water is one of the most essential constituents of the environments. It is well known that clean water is absolutely essential for several purposes for healthy living (Mandalam et al., 2009). Ponds are useful in many ways it is one of the method of artificial infiltration of underground water. Water quality in an aquatic ecosystem is determined by many physical, chemical and biological factors (Sargaonkar and Deshpande, 2003). The main objective of water quality index is to turn complex water quality data into information that is understandable and useable by the public. It gives the public a general idea of the possible problems with water in a particular region. WQI is calculated from the point of view of the suitability of surface water for human consumption (Atulegwu and Njoku, 2004). The index is a numeric expression used to transform large number of variables data into a single number, which represents the water quality level (Sanchez et.al. 2007, Bordalo et.al, 2006). The objectives behind the study were to develop an overall picture of the pond water quality using WQI, assessment in the pond water quality, suitability of pond water for different purposes, and identify possible contamination causes.

Study area

The present study is carried out in Vizhinjam Panchayath (Fig.1) in Thiruvanthapuram District is located at west coast of India, Kerala. Physiogrsphically the study area comes under the coastal plains. Some areas of the beach were filled with rocks and small hills. The region enjoys a tropical to sub tropical climate with temperature ranging from 22^{o} and 30^{o}C and high relative humidity. The annual average rainfall of the study area is 2800mm.

Material and Methods

For the assessment of pond water quality of the Vizhinjam Panchayath, water samples collected from six ponds in Vizhinjam Panchayath. The water samples collected at the standard method of APHA (2005). In this study, for the calculation of water quality index, nine important parameters were considered (pH, TDS, DO, Na, K, Cl, TH, Ca, Mg). In order to calculate this index, first, each parameter must be weighted, ranges from 1 to 5. Table 1 shows the relative weight of each parameter. Table 3 shows the water quality status of each pond. WQI was calculated using the expression,

WQI = $\sum_{i=0}^{n} \boldsymbol{W}iQi.$

$\boldsymbol{W}$i= wi/ $\sum_{i=1}^{n} wi$

Qi= (Ci/Si)*100

If quality rating Qi =0 means complete absence of pollutants, While 0 < Qi < 100 implies that, the pollutants are within the prescribed standard. When Qi> 100 implies that, the pollutants are above the standards (Mohanty, 2004).

Result and Discussion

Fig.1 Location map of the study area

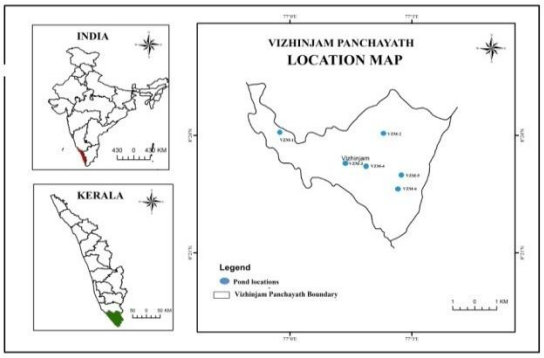

Table: 1 Relative weight of physico-chemical parameters

Parameter	Standard (BIS, 1992)	Weight (Wi)	Relative weight (wi/$\sum_{i=1}^{n} wi$)
pH	6.5-8.5	1	0.028
DO	5	1	0.028
TDS	500	3	0.085
Na	200	5	0.142
TH	300	5	0.142
Ca	75	5	0.142

Mg	50	5	0.142
Cl	250	5	0.142
K	200	5	0.142

(All values except *p*H is in mg/L)

Table: 3 Water Quality Index (WQI) and water quality status

WQI	Water Quality Status
0-25	Excellent water quality
26-50	Good water quality
51-75	Poor water quality
76-100	Very poor water quality
>100	Unfit for drinking

The study analysed variations in physico-chemical characteristics with respect to the following parameters the results of which are discussed below. Table 2 depicts the physico-chemical variables and the WQI of the water of six different ponds selected for the present study.

Table: 2 Results of physico-chemical parameters and WQI

	Parameter										
Pond	**pH**	**TDS**	**DO**	**Na**	**K**	**Cl**	**TH**	**Ca**	**Mg**	**WQI**	**Status**
VZM-1	6.05	486.8	0.62	44	2	35.5	105	28.56	8.16	38.11	Good
VZM-2	5.49	65.45	1.56	8	0	7.1	20	4.08	2.38	8.40	Excellent
VZM-3	4.51	124.6	2.39	25	1	14.91	20	4.08	2.38	15.11	Excellent
VZM-4	6.2	148.6	4.58	25	2	14.2	55	10.2	7.16	18.32	Excellent
VZM-5	6.9	175.8	10.46	67	4	24.85	35	8.16	3.54	20.25	Excellent
VZM-6	6.99	293.2	4.36	43	2	42.6	100	24.48	9.42	30.77	Good

(VZM- Vizhinjam, TDS- Total Dissolved solids, DO- Dissolved Oxygen, Na- Sodium, K- Potassium, Cl- chloride, TH- Total Hardness, Ca- calcium, Mg- Magnesium, WQI- Water Quality Index, All values except *p*H is in mg/L)

Physico-chemical parameters

pH: In this study pH(fig 2) values found in the range from 4.51 to 6.99. The maximum value was observed in VZM-6 and minimum was observed in VZM-3. The VZM-3 was highly acidic and the pH rage was 4.51 and is much lower than the recommended limit (6.5 - 8.5) of WHO (1992). This may be due to the enhancement of microbial activity, causing excessive production of CO_2 and reduced pH. The pH affects most of the biological processes and biochemical reactions in water body (Arya et al., 2011a, b).

Total Dissolved Solids: The main source of TDS (figure.3) in pond water is the seepage of industrial and domestic wastes. The TDS concentration in the present study area ranged from 65.45 (VZM-2) to 486.8 (VZM-1) mg/L. ponds are observed within the permissible limit (500mg/L). The pond VZM-2 (486.8) showed very high TDS. But other pond water samples are observed in low TDS so it indicates the water is less mineralized and comparatively lesser pollutants.

Dissolved Oxygen: The present investigation indicated that the concentration of dissolved oxygen (figure 4) fluctuated between 0.62 (VZM-1) mg/L to 10.46 (VZM-5) mg/L. The permissible value recommended for DO is 5mg/L as per Indian standard. Dhanalakshmi et al., (2013) studied the Eutrophic pond pollachi reported the DO range between3.2 to 5. Low value of DO was noticed which may be to increase of Photosynthetic activity.

Sodium: The present study investigate the Na (figure 5) concentration ranging from 8 (VZM-2) to 67 (VZM-5) mg/l. The BIS has laid down the permissible limit of sodium, which is 60 to 120 mg/l. Similar concentration was observed in Brahmaputra (6.3ppm) by Raymahasay (1970).

Potassium: The potassium (figure 6) content in pond water was found in the range of 0 (VZM-2) to 4 (VZM-5) mg/l. In this study all the ponds are within the permissible limit (200mg/L) as per Indian standards. Jemi and Balasingh (2011) observed the potassium varied the range between 2.34 to 3.81mg/L.

Chloride: The observed chloride (figure 7) content in the study area were ranges from 7.1 (VZM-2) to 35.5 (VZM-1) mg/l. Chloride concentrations in excess of 250 mg/l can give rise to detectable taste in water. Kumar et al (2014) shows the chloride concentration range varied from 84 to 126ppm.

Total Hardness: In the present study the hardness (figure 8) values ranges from 20 to 105 ppm. The maximum value observed in the pond VZM-1. The minimum value observed in the pond VZM-2 and VZM-3. Choudary et al (2012) observed that in rural pond Sarsaram, total hardness of water ranged from 90 to 120.

Calcium: In the present study, the calcium (figure 9) concentration varies from 4.08 (VZM-2 and VZM-3) to 28.56 (VZM-1) ppm. The decrease in amount of calcium may be due to its absorption by living organisms. Gupta and Bhuiyan (2007) found calcium content varied from 0.013mg/L to 2.6mg/L.

Magnesium: Magnesium (figure 10) is often associated with calcium in all kind of water, but it concentration remain generally lower than the calcium (Venkatasubramani et al. 2007). In the present study, the magnesium concentration ranges from 0 to 10.89ppm. Gupta and Bhuiyan (2007) reported the Mg ranged from 2.042 to 5.15mg/L.

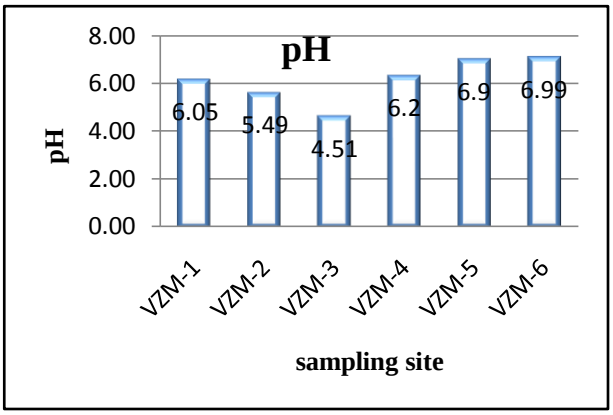

Fig.2 pH variation of the study area

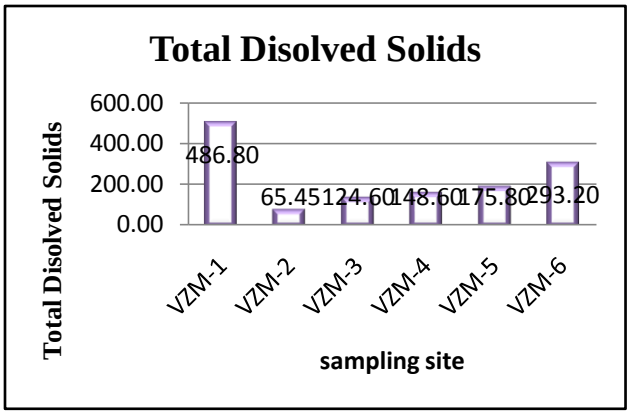

Fig.3 TDS variation in the study area

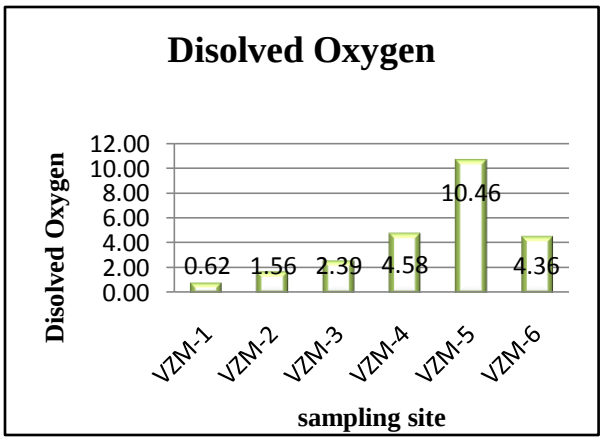

Fig.4 DO variation in the study area

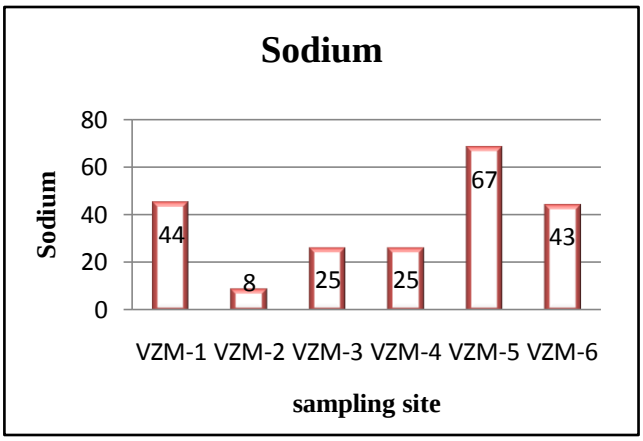

Fig.5 Na concentration in the study area

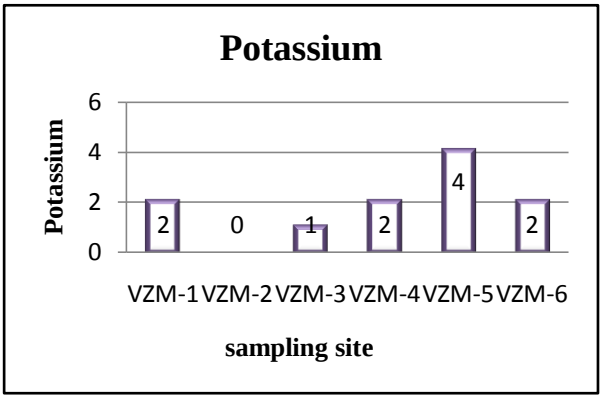

Fig. 6 K concentration in the study area

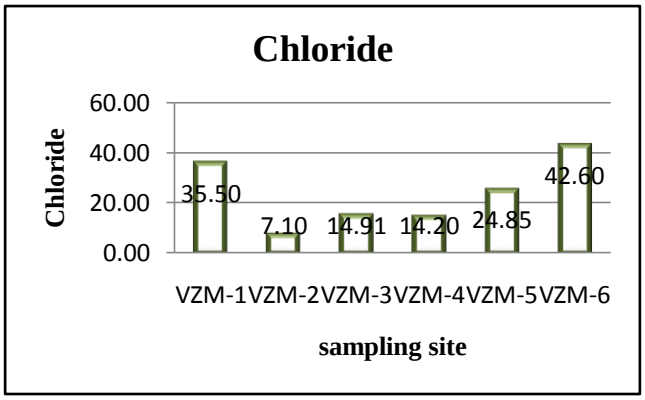

Fig. 7 Cl concentration in the study area

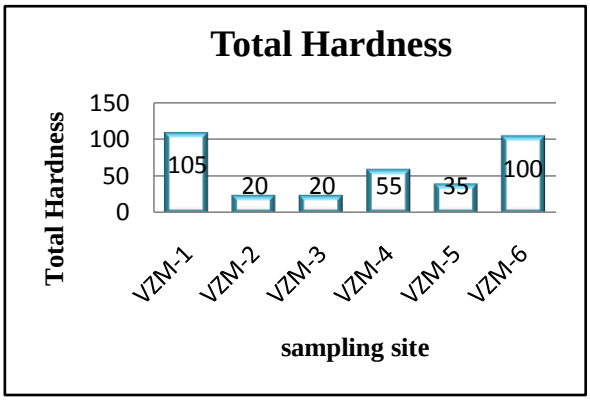

Fig. 8 TH in the study area

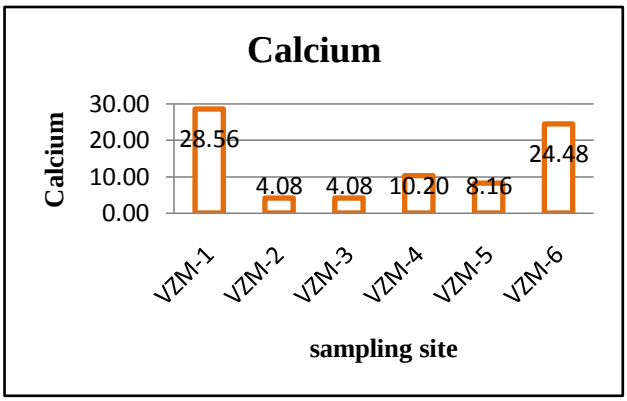

Fig.9 Ca concentration in the study area

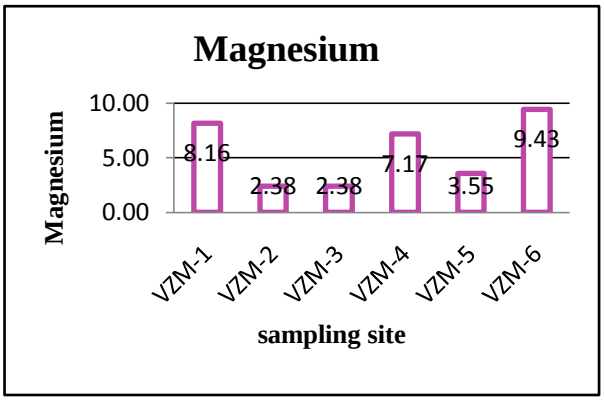

Fig.10 Mg concentration in the sudy area

Water Quality Index (WQI)

It is simple and easy to understandable for decision makers quality and possible use of any water body (Bordalo et al. 2006). In this study, the water quality index of pond water samples are found in the range of 8.40 to 38.11. The present study shows that four ponds is belonging to excellent category (VZM-2,VZM-3, VZM-4, VZM-5) whereas the rest two pond falls in good category (VZM-1, VZM-6). Tiwari et.al.,(2014) studied in West Bokaro coalfield. WQI values range from 21 to 131 and average 73 respectively. High water quality index shows the pollution level increases. It causes due to the low DO and high TDS concentration. Hence the study identifies two critically polluted sites in the study area viz. VZM-1, VZM-6 the reason for which can be attributed to high inhabitation and human influences such as disposal of wastes, washing of clothes and cattles by the local people. So it can be designated as suitable for domestic purposes, whereas, stringent rejuvenation and reconstruction methods need to be adopted for conserve the ponds in the study area. Hence application of Water Quality Index technique for the overall assessment of the water quality of a water body is a useful tool.

Conclusion

Water supports life on earth and around which the entire fabric of life is woven. Ponds, as a sources of water, are of fundamental importance to man. Fresh water is needed for all living organisms, so water quality is essential to each and every water resources. The above study indicates that excellent and good quality water exists in Vizhinjam Panchayath. From the foregoing observations in the study area, it is implied that, the pollutants are within the prescribed standard. However, Samples show that the water requires treatment before its utilization. Suitable water treatment methods need to be adopted to reduce the concentrations of contaminants in the study area. Stringent rejuvenation and reconstruction methods need to be adopted for the said sites since these are used as domestic sources of drinking water. The study has thus proved that the application of Water Quality Index is a useful technique for the overall assessment of the water quality of a water body. This study can offer the requisite information for the authorities to pursue sustainable approaches on pond water resource planning and management.

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