

Study of Physico-Chemical Parameters and Pond Water Quality Assessment by using Water Quality Index at Athiyannoor Panchayath, Kerala, India

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Abstract

This study was designed to assess the quality of pond water in Athiyannoor panchayath, Thiruvananthapuram District, Kerala, with respect to the physico-chemical parameters including Temperature, pH, EC (Electrical Conductivity), TDS (Total Dissolved Solids), TA (Total Alkalinity), DO (Dissolved oxygen), TH (Total Hardness), NaCl (Salinity), Ca (Calcium), Mg (Magnesium), Cl (Chloride), Na (Sodium) and K (Potassium). The results were evaluated and compared with WHO and BIS water quality standards. From the data obtained, the water quality index was calculated to quantify overall pond water quality status of the area. It is found that based on the WQI results the samples are falling under excellent category and hence suitable for domestic purposes.

Keywords physico-chemical parameters, pond water, water quality, water quality Index (WQI)

Introduction

Life on the earth is never possible without water. Water is one of the most essential constituents of the environments. Less than 1% water is present in ponds, lakes, rivers, dams, etc., which is used by man for industrial, domestic and agricultural purposes. Ponds are useful in many ways and it is one of the methods of artificial infiltration of underground water. Water quality in an aquatic ecosystem is determined by many physical, chemical and biological factors [1]. The term water quality was developed to give an indication of how suitable the water is for human consumption [2] and

is widely used in multiple scientific publications related to the necessities of sustainable management [3].

Several methods are available to analyze the water quality data that changes depending on informational goals, the type of samples, and the size of the sampling area. WQI is calculated according to the suitability of surface water for human consumption. WQI index is a numeric expression used to transform large number of variables data into a single number, which represents the water quality level [4-5].

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 was carried out in Athiyannoor Panchayath in Neyyattinkara Taluk, which is located at west coast of India in TVM district, Kerala (Figure 1). Physio-graphically, the study area is present in the coastal plains. Some areas of the beach are filled with rocks and small hills. Geomorphologically, the area is dominated by lateritic plateau. The climate in the tract is moderately hot and humid. The maximum mean daily temperature during the hottest month of March is about 35°C and mean daily minimum during the coldest month of January is about 24.4°C. The annual average rainfall of the study area is 2800 mm. Coconut plantation is the predominant type of vegetation.

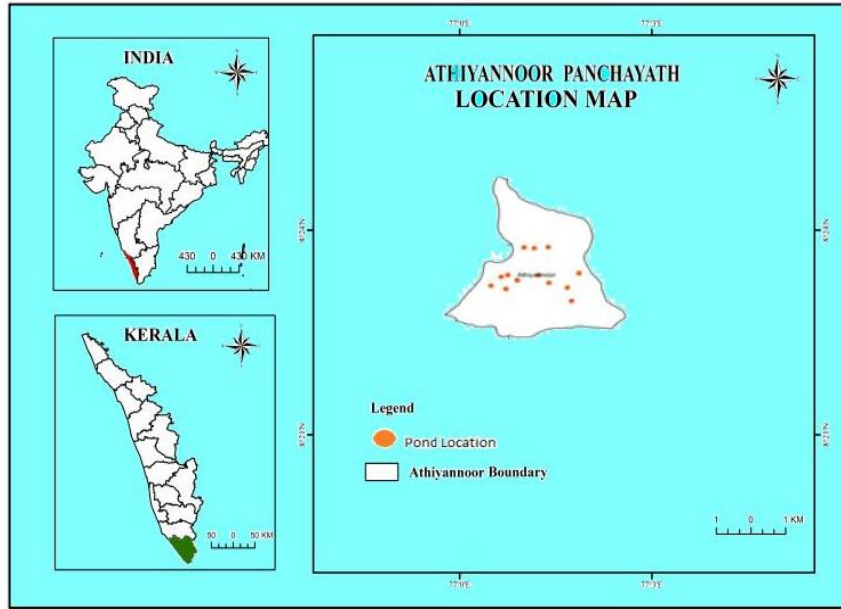


Figure 1. Location map of the study area

Material and Methods

The water samples were collected from fifteen ponds in Athiyannoor Panchayath. The sampling and analysis of various physico-chemical attributes were done following the standard procedures as detailed in APHA [6]. The experimental results were compared to the permissible limit of drinking and irrigation water quality standard (BIS, IS-10500, FAO). 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 was assigned weights, ranging from 1 to 5. Table 1 shows the relative weight of each parameter.

Table 1. Relative weight of physico-chemical parameters

Parameter	Standard (BIS, 1992)	Weight (Wi)	Relative weight (wi/∑ _{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

Table 2 shows the water quality index and water quality status. WQI was calculated using the expression,

$$WQI = \sum S_{li}$$

$$S_{li} = W_i * Q_i$$

where

- S_{li} is the sub-index of ith parameter
- q_i is the rating based on concentration of ith parameter
- n is the number of parameters

$$W_i = w_i / \sum_{i=1}^n w_i$$

where

- W_i is the relative weight
- w_i is the weight of each parameter
- n is the number of parameters.

Table 2. Water Quality Index (WQI) and status of water quality

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 quality rating scale for each parameter was calculated by dividing its concentration in each water sample by its respective standards and multiplied the results by 100.

$$Q_i = (C_i/S_i) * 100$$

where

q_i is the quality rating

C_i is the concentration of each chemical parameter in each sample in milligrams per liter

S_i is the World Health Organization standard for each chemical parameter in milligrams per liter according to the guidelines.

Results and Discussion

The study analyzed variations in physico-chemical characteristics with respect to the following parameters the results of which are discussed below.

pH:

The pH (Potential Hydrogen) of a solution refers to its hydrogen ion activity and is expressed as the logarithm of the reciprocal of the hydrogen ion activity at a given temperature. The permissible limit of pH in drinking water is within 6.5 – 8.5 according to Bureau of Indian Standard (BIS). The value of pH in pond water samples of the study area ranges between 4.62 to 7.21. Slight deviation towards acidity in some samples can be attributed to the anthropogenic activities like improper irrigation process and weathering process in the study area.

Electrical conductivity:

Electrical conductivity (EC) is the ability of an aqueous solution to conduct the electric current. Electrical Conductivity is a useful tool to evaluate the purity of water [7]. The most desirable limit of EC in drinking water is prescribed as 1.500 $\mu\text{s}/\text{cm}$. The source of EC may be an abundance of dissolved salts due to poor irrigation management, minerals from rain water runoff, or other discharges. Electrical Conductivity ranged from 42.94 – 137.1 $\mu\text{s}/\text{cm}$ in the study area. Shrivastava and Kanungo [8] studied the pond water quality in Surguja District, Chhattishgarh and reported the range of EC in between 115.11-212.13 $\mu\text{mhos}/\text{cm}$.

Total dissolved solid:

Total dissolved solids (TDS) denote mainly the various kinds of minerals present in water. The permissible value recommended for TDS is 500 mg/l prescribed by IS 10500 and BIS, FAO. TDS

ranged from 25.44 - 89.5 ppm. The present study observed pond water samples having low TDS which indicates the water is less mineralized and comparatively with lesser pollutants. Shrivastava and Kanungo [8] analyzed the Pond Water of Surguja District, Chhattishgarh and reported the range of TDS in between 152.12- 265.97 ppm.

Dissolved oxygen

The presence of dissolved oxygen is essential to maintain the higher forms of biological life and to keep proper balance of various pollutions thus making the water bodies healthy. The chemical and biochemical process undergoing in water body are largely dependent upon the presence of oxygen. Estimation of dissolved oxygen is a key test in water pollution and waste treatment process control. The permissible value recommended for DO is 5mg/L as per Indian standard. In the present investigation dissolved oxygen ranged from 1.76 – 8.4 mg/l. Most of the ponds in the study area showed high DO which may be due to the increased solubility of oxygen at lower temperature.

Salinity:

Salinity is the saltiness or dissolved salt content of a body of water. In the study area, the pond water salinity ranged from 27.9- 70.98 ppm which are well within the drinking water quality standards. Shrivastava and Kanungo [8] studied the Pond Water of Surguja District, Chhattishgarh and reported the range of salinity in between 5.13-6.27 ppt.

Temperature:

Temperature is one of the most important factors in the aquatic environment [9]. It affects the physical and chemical properties of water and also affects the aquatic vegetation, organisms and their biological activities. Temperature values in the ponds in the study area ranged from 26.8 to 29.6°C. Choudary et al., [10] study the ponds of Sasaram, Bihar observed the temperature range varies from 23oC to 27oC.

Sodium:

Sodium is a natural constituent of raw water, but its concentration is increased by pollution sources such as rock salt, precipitation runoff, soapy solution and

detergent. Presence of high concentration gives bitter taste to water. The concentrations of sodium in the study area ranged between 3 to 19 mg/l, which is well within the permissible limit (200mg/L) prescribed as Indian standards. So it is suitable for domestic purposes. Mishra et al., [11] studied the pond water quality in Varanasi where the sodium quantity varied between 40.8mg/L to 93.5mg/L.

Potassium:

The major natural source of potassium in ground water is feldspar, some micas and clay minerals. The concentration of potassium in the pond water samples of the present study area ranged from the 0 to 4 mg/L. In this study all the ponds are within the permissible limit (200mg/L) as per Indian standards. Mishra et al., [11] observed the pond in Varanasi which showed the potassium content in the water samples ranging from 6.05mg/L to 24mg/L.

Chloride:

The chloride concentration can be used as an important parameter for detection of contamination by sewage. The Chloride concentration in the study area ranged from 7.1 – 28.24 mg/l. The permissible limit of chloride is 250 mg/l. High chloride content may harm metallic pipes and structures as well as growing plants. Chlorides in excess impart the salty taste to water and people not accustomed to high chloride are subjected to laxative effect.

Total Hardness:

Hardness of water is a measure of its capacity to form precipitates with soap and scales with certain anions present in the water. Hardness concentration values ranged from 15 to 50 ppm in the study area. According to APHA [6] the desirable limit for total hardness is 300 mg/l. Compared to the desirable limit, the values of the samples is found to lie within the limit and was satisfactory. Mishra et al., [11] studied the pond water quality in Rairangpur, Varanasi and found that the hardness values varied from 146 to 268mg/L.

Calcium:

Calcium is an important nutrient for aquatic, organism and it is commonly present in all water

bodies [12]. In the present study, the calcium concentration varied from 0 to 8.16 ppm. The decrease in amount of calcium may be due to its absorption by living organisms.

Magnesium:

The concentration of Magnesium in the study area ranged between 0 to 7.24 mg/l. The maximum permissible limit of calcium hardness is 30 mg/l [13]. Magnesium is often associated with calcium in all kind of water, but its concentration remains generally lower than the calcium [14]. Decrease in level of Mg reduces the phytoplankton population.

Total Alkalinity:

The permissible value of alkalinity as recommended by the Indian standards is 250 mg/L as CaCO₃. The amount of alkalinity concentration of the water sample collected in the study area ranged from 10 to 60 mg/L.

Water Quality Index (WQI)

The Water Quality Index is used to aggregate diverse parameters and their dimensions into a single score, displaying a picture of the water quality of Athiyannoor panchayath. In this study, the water quality index of pond water samples are found in the range of 6.47 to 16.17 (Figure 2). Water Quality Index of all water samples depicted in Table 3. This shows that the water sample is belonging to excellent category.

Table. 3 Water Quality Index of all samples

Pond Name	Water Quality index(WQI)
ATH-1	6.47
ATH-2	3.86
ATH-3	10.34
ATH-4	7.88
ATH-5	12.72
ATH-6	11.15
ATH-7	12.82
ATH-8	16.17
ATH-9	5.06
ATH-10	13.27
ATH-11	8.5
ATH-12	10.82
ATH-13	11.03
ATH-14	5.66
ATH-15	13.91

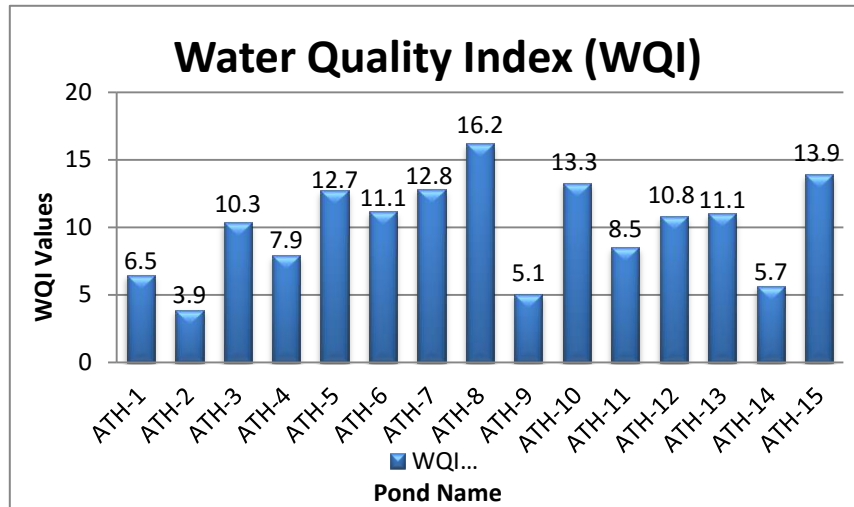


Figure 2. Bar diagram showing Water Quality Index change

So it can be designated as suitable for domestic purposes. WQI can play a big role in mitigating the pollution problems often encountered in different surface water bodies. The analysis reveals that the pond water of the area needs to be protected from the perils of contamination

Conclusion

The present study was under taken to define the quality of water samples with special reference to physicochemical properties to decide its WQI. For the assessment of pond water quality of the Athiyannoor Panchayath, water samples collected from fifteen ponds in Athiyannoor Panchayath. For assessing the suitability of drinking water, the water quality data of the analyzed samples were compared with the prescribed drinking water standard of BIS 1991 (IS:10500) and have been considered for the calculation of WQI. The water quality indices (WQI) were in the range 6.47 to 16.17 indicating the excellent water quality in the study area. This study can offer the requisite information for the authority to protect and conserve these small water bodies.

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