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Assessment of water quality index of temple tanks in Kadapa, Andhra Pradesh, India

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Abstract

The water quality of selected temple ponds in Kadapa was assessed in terms of their physical chemical characteristics. Temple water was showing alkaline character for all the studied samples. pH, TDS, sulphate and phosphate was found to be under the acceptable limit of WHO and ISI standards. Among the 10 samples few of them showed very low level of dissolved Oxygen. Potassium is found to be high in most of the pond water. The water quality index for the ten samples ranges from 41.03 to 163.50. An attempt has been made to study the extent of change in the quality of water near temples.

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Introduction

Water resources are declining day by day at the faster rate due to rapid urbanization and population load. The important ponds and kunds are very often used for religious activities. In India, manmade ponds have been used as alternate sources of drinking water and employed for washing cloths and bathing purpose by washer men and local people (Prakash *et al.*, 2009). Rapid growth of urban areas directly or indirectly affected existence of the ponds such as over exploitation of resources and improper waste disposal practice (Murhekar, 2011). Many temples in India have ponds in their vicinity called as temple ponds which are polluted by human activities like dumping of ritual materials, washing and bathing etc. The accumulation of various kinds of pollutants and nutrients through the domestic sewage, municipal effluents, and agricultural runoff in to the ponds leads to changes in the physical-chemical characteristics of fresh water.

In recent times temple tanks fallen into disrepair. A Temple tank is best example of uncontrolled human activities not only in festival seasons but also in off seasons as they are the essential sources of water for devolves visiting the temple. Temple devotees use the holy water for washing their limbs; sometimes they make a holy dip into the water. In India, traditionally settlements are located in and around temples. The temple complex includes a tank which is as important site for cultural actions and the temples and tanks occupy a prime position in the day to day living of the people (Madhavi Ganesan, 2008). Traditionally, where the rain fall was relatively low every effort was made to retain all the water that fell on the ground through appropriate water retention and conservation strategies such as at the erys, temple tanks and ponds.

Ponds are not only significant sources of water but also provide valuable habitats to the several microbes. Ponds are major problems in India due to various anthropogenic activities. A nutrient enrichments in ponds and lakes results in diminishing socio – economic as well as recreational values (Chatterjee and Raziuddin, 2001). Accordingly, it is important to test the water quality at regular time intervals or else contaminated water may cause a variety of water borne diseases. Water quality index is an evaluation method which reflects the combined influence of diverse water quality parameters and an effective tool to convey the information on quality of water to the concerned public and policy makers (Prerna Mitra and Reddy, 2016). So an investigation was undertaken to examine the water quality based on the physico - chemical characteristics of water samples collected from various locations of Temple in Kadapa and to provide information on the physical -chemical characteristics of Temple water in order to discuss it's suitability for human consumption based on computed water quality index values.

Materials and methods

Study Area

Kadapa district is located at 14°28`N 78°52`E occupies an area of 15,938 square kilometers. The city has rich cultural heritage with the influence of different dynasties. The district is known for its historic places such as Devuni Kadapa, Ameen Peer Dargah, Brahmamgari Matham, Sri VijayaDurga temple, Veyinoothulakona and Polathala.

Location of samples: 1 and 2. Brahamagarimattam temple, 3. Devunikadapa temple, 4. Sri vijayadurga temple, 5 and 6. Veyinothulakona temple, 7 – 10. Polathala temples.

In this study we have collected water samples in a cleaned polythene canes and stored in refrigerator. The standard methods of APHA (2005) and Manivasakam (2011) was followed for the analysis.

pH- The pH was measured by digital pH meter (Elico LI614).

Electrical Conductivity and TDS- EC was measured using conductivity meter (EC–Hanna, model HI 2300 EC/TDS/NaCl meter.

Turbidity- Turbidity are measured using Nephelometer (Elico CL 52D).

Total hardness- Total hardness has measured titrimetricaly by EDTA method.

Total alkalinity was determined by titrimetric method using phenolphthalein and methyl orange indicator.

Chloride- by Mohr's Argentrometric titration and K_2CrO_4 as indicator.

Sulphate- Spectrophotometric method.

Phosphate- by Stannous chloride method.

Nitrate was estimated by Phenol disulphonic acid method.

Dissolved Oxygen- DO are estimated by Winkler's method.

Calcium, Sodium and Potassium estimated by using Flame photometer (Elico CL 378).

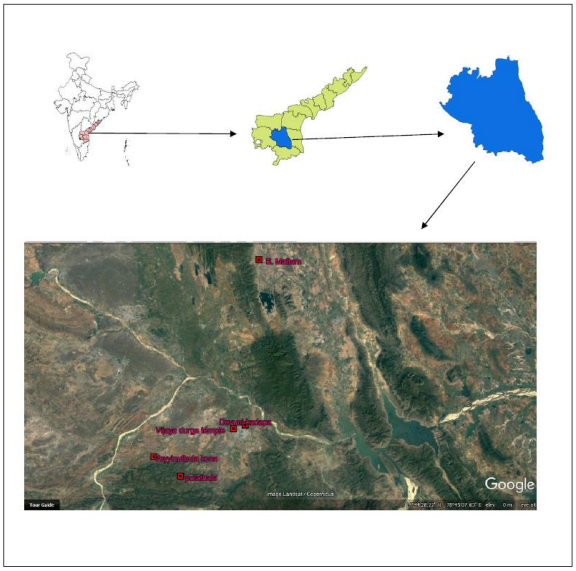

Fig. 1. Map of Study area.

Result and discussion

The results of the physicochemical analysis of different sampling sites are presented in Table 1.

The pH is a most important biotic factor. The pH values of the temple pond water ranged from 5.57 to 8.24, which are within the permissible limits of WHO standards 6.5- 8.5. pH plays an important role in chemical reaction in environment, many reactions are controlled by change in pH.

Electrical conductivity depends and increases with increase in ionic strength of water. Change in conductivity of sample may signal changes in mineral composition of raw water and intrusion of domestic water (Sayed and Gupta, 2010).

The EC values in the present study ranged between 4.315 to 1055.5µS/cm which was found below the permissible limit (1000µS/cm) (Fig. 2). In water Total dissolved solids are composed mainly of carbonates, bicarbonates, chlorides, phosphates and nitrates of calcium, magnesium, sodium, potassium, manganese, organic matter, salt and other particles (Mahananda *et al.*, 2010). TDS values of water samples varied from 2.155 to 517mg/L and are within the limits of WHO (Fig. 2).

Total hardness of water is due to the presence of bicarbonate, chloride and sulphate of calcium and magnesium (Kumar *et al.*, 2010). In the present study it was found that the total hardness ranges from 40 to 670mg/L. High values of hardness are probably due to regular addition of sewage and soaps into water from nearby areas (Fig: 2).

Turbidity is a measure of the degree to which the water loses its transparency due to the presence of suspended particulates. It is essentially a function of reflection of light from the surface and is influenced by the absorption characteristics of both water and its dissolved and particulate matter (Stepane *et al.*, 1959). Turbidity is considered as a good measure of the quality of water. Turbidity in water is in the range of 4.5 to 32 NTU.

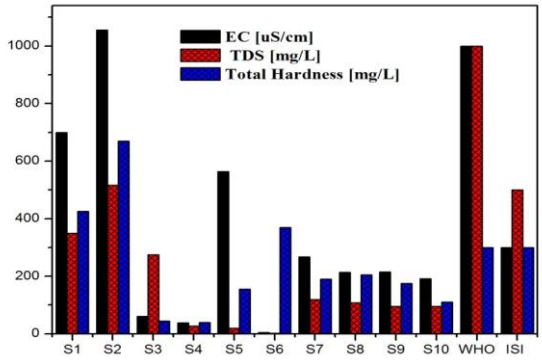

Fig. 2. EC, TDS and Total Hardness.

Total Alkalinity is due to salts of weak acids and bicarbonates to highly alkaline water are unpotable (Mahadev *et al.*, 2010). High values of total alkalinity may be attributed to the increase in organic decomposition during which CO_2 is liberated (Bharathi and Hosmani, 1973). Alkalinity can be considered as phenolphthalein alkalinity and methyl orange alkalinity.

As per the results obtained, phenolphthalein alkalinity ranges from 47.55 to 1100mg/L, methyl orange alkalinity ranges from 221.9 to 1061.9mg/L. WHO standards for total alkalinity are 200mg/L (Fig. 3).

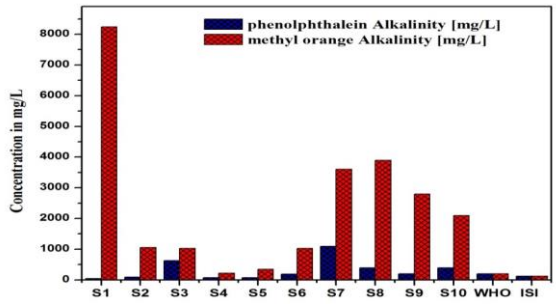

Fig. 3. Total Alkalinity.

The maximum level of chloride was 733.90mg/L and minimum level of chloride was 0.6mg/L.S7, S8, S9 and S10 are above the permissible limits. Chloride was one of the major anion found in water and are generally combined with calcium, magnesium or sodium. High chloride content indicates the accumulation of the polluting substances in these tanks (Ravichandran *et al.*, 2009). Sulphate occurs naturally in water as a result of leaching from gypsum and other common minerals. Sulphate in assessed water sample ranges from 0.0960 to 3.715mg/L. Phosphate level in pond water samples varies between 0 to 1.2mg/L. Phosphates are not toxic to people or animals unless they are present in high levels. The value of nitrate in studied water body was highest at S2 - 193.94mg/L and S5- 137.158mg/L. Higher nitrate levels in drinking water pose a health risk to infants because they may cause Methemoglobinemia, a condition known as "blue baby syndrome". The higher inflow of water and consequent land drainage cause high values of nitrate in these ponds (Thilaga *et al.*, 2005). Runoff and decomposition of organic matter is the main sources of nitrate in the water bodies. The U. S. Environmental Protection Agency also uses 10mg/L as N as a mandatory national standard for public supplies under the safe drinking water act.

Dissolved Oxygen (DO) is an important water quality parameter for support of aquatic life. Dissolved oxygen is the regulator of metabolic processes of plant and animal communities and indicator of water condition. This factor provides more information about the overall health of water bodies than any other chemical parameters. DO was recorded maximum value of 11.45mg/L at S4 and minimum value of 2.76 at S10. Similar study was reported in the analysis of temple tanks in Kanyakumari district (Maria Pushpam, 2013). Lower dissolved oxygen in S1, S7, S8, S9 and S10 indicates higher organic input and stagnancy of water (Panda *et al.*, 2004; Dasgupta *et al.*, 2001). Dissolved oxygen below 5ppm suggests aquatic contamination of water which leads to oxidation of substance, decomposition of organic matters (Sekabira *et al.*, 2010). The low DO is due to increase in temperature (Dwivedi and Sonar, 2004).

Table 1. Physical and Chemical characteristics of temple water.

Parameters	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	WHO Standards	ISI Standards
pH	7.41	7.07	5.57	5.85	7.93	8.24	7.37	6.62	5.96	5.59	6.5 -8.5	8.5
EC (µS/cm)	699.5	1055.5	60.8	38.7	564	4.315	267.7	213.5	214.55	190.95	1000	300
Total Dissolved Solids (mg/L)	349	517	274.5	27.35	19.55	2.155	119.15	107.8	95.35	95.35	1000	500
Turbidity (NTU)	1.8	2.2	4.6	10	6.6	2.4	6.4	9	9.6	12.8	5	10
Total Hardness (mg/L)	425	670	45	40	155	370	190	205	175	110	300	300
Total Alkalinity (mg/L)	47.55 8242	95.1 1061.95	634 1030.25	79.25 221.9	79.25 348.7	190.2 1030.25	1100 3600	400 3900	200 2800	400 2100	200	120
Chloride (mg/L)	3.85	6.35	0.7	0.6	2.95	15.35	733.90	584.12	419.37	419.37	250	250
Sulphate (mg/L)	2.101	2.483	1.162	1.438	3.255	3.715	0.192	0.176	0.112	0.096	200	150
Phosphate (µg/L)	0.2	0	0	0	0	0	1.2	0.4	0.9	0.5	250	25
Nitrate (mg/L)	38.218	193.9418	0	0.4268	137.158	50.925	0.8245	11.931	1.4065	4.7045	45	45
Dissolved Oxygen (mg/L)	3.18	7.42	7.632	7.314	11.448	6.996	0	0	0	2.756	4- 6	5
Calcium (mg/L)	0.4	1.4	0	0	0.2	0.4	375	350	162.5	162.5	75	75
Sodium (mg/L)	26.3	69.1	22.1	24.05	28.6	39.3	3.0	3.0	0.75	1.5	---	200
Potassium (mg/L)	26.65	76.8	21.65	23	31	41.65	3.95	3.7	2.35	0.8	15	20

Calcium, Sodium and Potassium are very common ions in water samples due their higher solubility in water and association with carbonates and sulphate. Calcium levels in assessed samples ranges from 0 to 375mg/L. Higher levels of calcium found in the sample S8- 350, S9 & S10- 162.5mg/L. This is in accord to the water of theerthams of Ramanathaswamy temple (Sankara Gomathy *et al.*, 2013). Sodium levels in the samples ranged from 0.75 to 69.1mg/L. Higher levels of sodium may cause bitter in taste. This result is supported by the findings of Mishra *et al.*, (2014). Potassium levels in samples ranged from 0.8mg/L to 76.8mg/L. Higher values of potassium were found in the S1 to S6 which exceed the WHO permissible limit (Fig. 10). Potassium remains mostly in solution without undergoing precipitation (Lashari *et al.*, 2009; Mahananda *et al.*, 2010). Similar observation was also revealed by Ravichandran *et al.*, (2009).

Table 2. Water quality standards, recommending agency and unit weights.

Parameters	Standard Value	Ideal Value	Unit weight (W_n)	Observed Value (S1)	Quality rating (qn)	W_nq_n
pH	8.5	7	0.205	7.41	27.3	5.597
EC (µS/cm)	300	0	0.006	699.5	233.2	1.399
Total Dissolved Solids (mg/L)	500	0	0.003	349	69.8	0.209
Turbidity (NTU)	10	0	0.174	1.8	18	3.132
Total Hardness (mg/L)	300	0	0.006	425	141.7	0.850
Total Alkalinity (mg/L)	120	0	0.014	8242	6868	96.152
Chloride (mg/L)	250	0	0.007	3.85	1.5	0.010
Sulphate (mg/L)	150	0	0.012	2.101	1.4	0.017
Phosphate (µg/L)	25	0	0.069	0.2	0.8	0.055
Nitrate (mg/L)	45	0	0.039	38.218	84.9	3.311
Dissolved Oxygen (mg/L)	5	14.6	0.348	3.18	118.9	41.38
Calcium (mg/L)	75	0	0.023	0.4	0.53	0.012
Sodium (mg/L)	200	0	0.009	26.3	13.2	0.119
Potassium (mg/L)	20	0	0.087	26.65	133.3	11.59
			ΣW_n= 1.002			ΣW_nq_n = 163.83
WQI				163.50		

Table 3. Water quality Index.

Location	WQI	Remarks
S1	163.50	Unsuitable
S2	97.38	Very Poor
S3	74.58	Poor
S4	41.03	Good
S5	66.53	Poor
S6	121.64	Unsuitable
S7	74.81	Poor
S8	74.86	Poor
S9	43.46	Good
S10	51.77	Poor

The overall water quality index was calculated by aggregating the quality rating with the unit weight linearly.

$WQI = \Sigma W_nq_n/\Sigma W_n$

Water quality index in the present study are presented in Table 3. The high values of WQI were found in Sample 1 and 6.A very poor category of water quality index (WQI) may be due to excessive flow of agricultural and domestic waste. The water quality index value of this study exhibits that, the water body contains high organic matter and eutrophic conditions.

Table 4. Water Quality Classification Based on WQI Value.

WQI range	Water quality status	Possible usage
0–5	excellent water quality	drinking, irrigation and industrial
26–50	good water quality	drinking, irrigation and industrial
51–75	poor water quality	irrigation and industrial
76–100	very poor water quality	irrigation
Above 100	unsuitable for drinking	proper treatment required before use

Source: Brown *et al.*, (1972), Chatterji and Raziuddin (2002).

Conclusion

The present investigation reveals that the selected water samples of temple, the total hardness, Turbidity, Alkalinity, chloride, potassium crossed the permissible limits at many locations. There was no Dissolved Oxygen in S7, S8 and S9 samples. The water quality index ranges from 41.03 to 163.50. Water infection commonly results during bathing, washing, drinking in the preparation of food or the consumption of food thus infected.

Therefore there is a need of some treatment before usage and also required to protect that area from contamination.

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