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Limnological studies of Tiruvanaikaval and Ucchipilaiyar Kovil temple ponds in Tiruchirappalli

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Abstract
Water samples from two different locations namely, Tiruvanaikaval: Ramatheertham and Ucchipilaiyar Kovil Temple ponds were collected to study the physico-chemical and biological properties. Analysis of various samples significantly resulted in varied reports on pH, Electrical Conductivity, Total Dissolved Solids, Hardness, Chloride, Sodium, and Potassium. The investigation showed that the both temple ponds were polluted due to anthropogenic activities. Thiruvanaikaval's water quality index values: Rama theertham was of poor quality (45-64) while Ucchipilaiyar Kovil temple pool water was of medium quality (50-69). Therefore, it is informed that the temple pond water cannot be used directly for drinking (as theertham) and that it requires prior treatment.

Keywords: temple pond water, Tiruvanaikaval: Ramatheertham and Ucchipilaiyar Kovil

Introduction

Water storage refers to the process of holding water in some holding area for a period of time. There are multiple locations on Earth where water is stored, and the water stays there for variable periods of time depending on where exactly it is being stored. It is important to investigate water storage from several different viewpoints. In the hydrologic cycle, these water storage locations vary drastically and include any natural storage area in the atmosphere, on the surface of the Earth, or below ground. For hydroelectricity, water storage is important as it includes lakes and hydroelectric reservoirs, which are utilized to generate electricity. Water storage can also include any man-made method of holding water, although these generally don't hold much of the overall volume of water on Earth, and include rain barrels or larger scale water towers for towns [1].

In India, temples have historically played an important role in harvesting their surplus water in tanks; every village has at least one temple, associated with each of which is a 'Sacred grove' ('Kaavu') and a 'Sacred tank' ('Kulam'/ 'Thirtham'). For every pond, there was an unwritten dictum among the local folks, as to the traditional practice of maintenance of tanks, which sluice to be opened and how one would ration water in times of shortage. Apart from servingas water harvesting devices, these tanks are found to facilitate the growth of a wide variety of plants ranging from herbs to hefty tree species in the sorrounding moist banks, as well as algal and other aquatic vegetation in the water [2].

The indigenous temple style in India is characterized by gable roofs made of wood and tiles. The temple may have a square, rectangular or round plan, on the basis of which the shape and size of the reservoir are determined. Hence, larger temples have larger reservoirs. Most of the larger reservoirs in antiquity had inlets and outlets with locks that controlled the inflow and outflow of water. This helped to keep the water circulating constantly, with the contaminated water being constantly washed away and freshwater (rain / river) water flowing in. Besides, there were also canals connecting several reservoirs to each other, and with the advent of drilling wells and modern water distribution systems, with clogged inlets and outlets, damaged and overgrown walls, many reservoirs have been reduced to a plain, functional legacy from the past. As a consequence, water quality also decreased significantly due to eutrophication and microbial growth [3].

Although India's sacred groves have undergone extensive research, neighboring ponds have been least studied. And since Tamil Nadu has around 5,000 temples, most of which have a sacred reservoir attached, a project has been undertaken to study temple reservoirs in South India for various aspects such as hydrography, microbial biodiversity and the economic importance of these structures. This work lists some of the most important utility values of the Tiruchirappalli temple tanks. The County Water Development Agency (DWDA) has identified 336 ponds and the fisheries department has about 200 ponds for fish farming, the sources say. In each pond 1000 fingerlings of freshwater species "katla", "rohu" and exotic carp species were released. Limnology plays a very important role in the decision-making process in aquaculture practices [4]. The present work focus on the hydrobiology of two temple ponds namely Thiruvanai Kaval: Rama theertham, and Ucchipilaiyar kovil and also the temple pond are suitable for fish culture. The pond water quality were also compare with Cauvery river water.

Materials and Methods

Study Area

The samples were collected from Thiruvanaikaval: Rama theertham and Ucchipilaiyar kovil temple pond Tiruchirappalli (Fig1). Rama theertham: This is outside the temple. It is directly opposite the temple across the road from G.S.T. It located on the way to Srirangam and the "Thai Poosam theppam" music festival is celebrated. The Ucchipilaiyar kovil floating festival of the famous Rockfort Sri Thayamunaswamy Temple is located in the near the Teppakulam. It is 550 meters length and 200 meters width.

Methodology

Physico – Chemical Examination of Ground Water Samples

The physico – chemical parameters of the Thiruvanaikaval: Rama theertham, and Ucchipilaiyar kovil temple ponds water was analysed using the standard analytical procedures [5]. The colour of the samples was noted by visual observation, odour measurement by smelling the sample pH and Temperature noted immediately after collection. The samples were collected in the sterilized plastic bottles and brought to the Zoology Research Laboratory, Jamal Mohamed College, Tiruchirappalli, T.N, India, and stored in a refrigerator at 4°C till further processing.

Bacteriological Study

Use an inoculating needle to streak the sample to grow colonies isolated on nutrient agar. The plate was then incubated at 37°C for 24 hours for bacteria. After 24 hours, check the morphology of the colonies growing on the plate, and use the same type of colonies for gram staining.

Identification of Bacterial Species

Further identification of isolated bacterial cultures, and then identification using standard microbiological methods

Fungal Examinations

Aseptically place a bit of sterile channel paper in a petri dish with tweezers. Spot a clean U-formed glass pole on the channel paper. (In the event that you hold it with tweezers, you can clean the bar by consuming.) Pour enough sterile water (around 4 ml) on the channel paper to totally wet it. Spot the sterile glass slide on the U-formed pole with forceps. Delicately disinfect with a surgical blade, at that point cut a 5 mm square bit of medium from Sabouraud's agar or Emmons medium plate. Addition a surgical tool to eliminate the agar block, and cautiously move it aseptically to the focal point of the glass slide. Vaccinate the four sides of the agar square with spores or mycelial parts of the parasitic being tried. Prior to getting the spores, make certain to touch off and cool the circuit. Aseptically, place a sterile cover slip on the upper surface of the agar solid shape. Spot the top on the petri dish and hatch at room temperature for 48 hours. Following 48 hours, check the slides under low force. On the off chance that development has just happened, there will be hyphae development and spore creation. On the off chance that the development is inadequate and there are no conspicuous spores, let the form develop for another 24-48 hours prior to making the recolored slides.

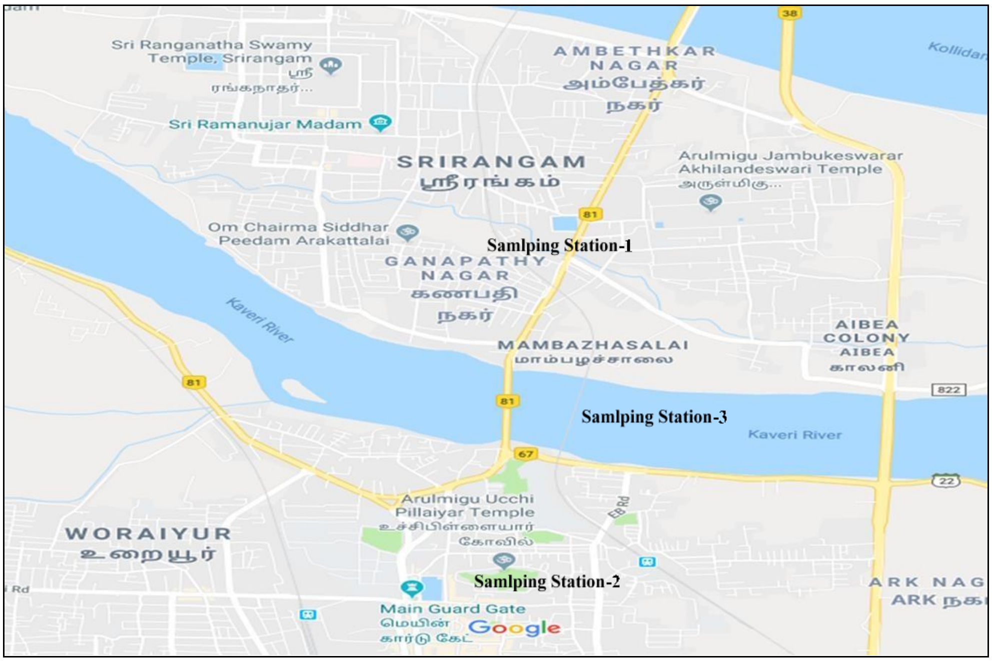

Fig 1: Shows the sampling stations Thiruvanaikaval (Ramatheertham), Ucchipilaiyar kovil Teppakulam and Cauvery river, Tiruchirappalli.

Results and Discussion

Physical and Chemical Parameters

For the present study the water samples were collected from two Sampling stations Thiruvanaikaval: Rama theertham and Ucchipilaiyar kovil. The water quality parameters were compared with nearer Cauvery river water. These samples were analysed for physical and chemical parameters such as Temperature, pH, Colour (Hazen units), Odour Electrical Conductivity (Micromhos/cm@250C), Dissolved Oxygen (Mg/l), Salinity (ppt), Carbonate (Mg/l), Total Dissolved Solids (Mg/l), Suspended Solids (Mg/l), Total hardness (CaCo3) (Mg/l), Alkalinity (CaCo3) (Mg/l), Bicarbonate (Mg/l), Chloride (Mg/l), Calcium (Mg/l), Magnesium (Mg/l), Sodium (Mg/l), Sulfate (Mg/l), Potassium (Mg/l), Nitrate (Mg/l), Fluoride (Mg/l) and Turbidity (NTU),the results are presented in Table 1.

The results of the present study reveal that the sample from the stations was colourless or clear and odourless. The distinct possibility of odour problem developing in the distribution system and thus, causing unpalatable drinking water cannot be ignored. Such incidents are normally found to be due to the delayed reaction of chemicals, being routinely used as a all domestic and industrial purpose, with organic compounds present in the finished water. If the water is consumed during this period i.e., before complete chlorination occurs, typical chlorophenolic odour will be apparent and consequently result in unacceptable water [6].

The temple ponds water temperature levels were ranged from 30.2 to 30.4 ^{0}C. The optimum range of temperature for the aquaculture pond is between 28°C- 30°C. Increase in temperature beyond 30°C increases the activity level and the metabolism. This also increases the growth rate. If the temperature still increases then the fishes reaches a threshold of physical and nutritional tolerance, which is 33 °C in poor quality water or 35°C in good quality water and remains stationary at the pond bottom [7]. Hydrogen ion concentration of the water samples were ranged between 8.0- 8.3 and it was more or less equal to Cauvery river water (7.50). Hydrogen ion concentration provides a good estimate of acidity and alkalinity of water. It depends chiefly upon the presence of Co2, Carbonates and Sulphates of Calcium and Magnesium. Most natural waters have pH from 4 to 9 and the majorities are alkaline due to carbonates and bicarbonates of Calcium and Magnesium dissolved in water. The pH estimation of water is changed by solid acidic or basic waste [8]. Such polluted water often shifts to acidity [9].

In natural waters dissolved solids are composed mainly to carbonates, bicarbonates, chlorides, sulphates, phosphates and nitrates of calcium, magnesium, sodium, potassium, iron and manganese etc., Among the sample analysed for the Electrical Conductivity levels in temple ponds water were ranged from 520-1650 Micromhos/cm@25^{0}C) in Rama theertham and Uchhipillayar temple ponds water EC were compare than that of Cauvery river water (267 Micromhos/cm@25^{0}C Electrical conductivity (EC) is a proportion of how well an answer conducts power. It is related to salt content; the higher the salt content, the higher the EC will be. Freshwater fish generally thrive over a wide range of electrical conductivity [10].

The salinity levels in temple ponds water were between 0.24-0.25ppt and slightly higher than that of Cauvery river water (0.22ppt). Salinity is a measure of the concentration of salts dissolved in a body of water. Common salts dissolved in water include chlorides, sulfates, sodium carbonate, potassium carbonate, calcium carbonate, and magnesium carbonate. Compare your salinity measurements to these typical concentrations 35 ppt Seawater in the open ocean, 27-33 ppt Seawater along the coast, <5 ppt Freshwater, < 0.5 ppt Drinking water [11].

The Turbidity of the temple ponds water was BDL. Water turbidity is important as it determines the amount of light penetration that occurs in the water column of a pond. This in turn will have an effect on the temperature of the water and the amount of vegetation and algae that will grow in the pond itself. For example a highly turbid pond will allow less light penetration therefore the temperature of the water will be lower [6].The Total Hardness of the temple ponds water was ranged from 75- 165mg/l and it was higher than that of Cauvery river water (77 mg/l). Numerous inorganic (mineral) substances are dissolved in water. Among these, the metals calcium and magnesium, alongside their counter particle carbonate (CO3-2) involve the reason for the estimation of 'hardness'. Optimum hardness for aquaculture is in the range of 40 to 400 ppm of hardness [7].

In the present studies carbonate concentrations are found to be BDL- 48mg/l in and Cauvery river water was 4.27 mg/l. Fluctuations in these values among the sampling stations with the concentration of carbonate linked to the status in and around environment. The entry of more domestic sewage might be the main cause for carbonate content [12]. Carbonate is a naturally occurring ion found in almost all kinds of water bodies. It is also an important ion imparting hardness to the waters [11]. Carbonate has been found to occur in ground water in concentration ranging from a few to several thousand milligrams per litre.

Bicarbonate is the abundant citation in land waters imparting hardness. The values of Bicarbonate were 195mg/l in temple ponds water and it was higher than that of Cauvery river water (24.0 mg/l). Also the carbonate and bicarbonate caused by far the greatest portion of the hardness occurring in natural waters. Hardness of water is objectionable from the viewpoint of water use for aquaculture purpose. So the hardness of the water increases day by day. Hard water is unsuitable for domestic /other purpose and reports indicate that it has a role in heart diseases [13].

The chlorides concentrations temple ponds water were between 71.0- 287.0mg/l and it was higher than that of Cauvery river water (60 mg/l). While chlorine is extremely deadly to fish, chloride is a part of most waters and is fundamental in helping fish keep up their osmotic equilibrium. In commercial catfish production, chloride (in the form of salt) is often added to water to obtain a minimum concentration of 100 mg/L [10]. Ground water usually contains more chloride than surface water. Ground water gets its chloride from the solubility of chlorides when water percolates. Through topsoil and deeper formation chloride is the best indicator of pollution and it is most troublesome anion for irrigation. Sulfate is a normally happening anion found in practically a wide range of water bodies. It may undergo transformation to sulphur or hydrogen sulphide. It is also an important anion imparting hardness to the waters [11].

Sodium ions have been found to occur in ground water in concentration ranging from a few to several thousand milligrams per litre. Sulphate and sodium interfere with the normal functioning of the intestine. In the present studies Sodium concentrations are found to be 46- 248mg/l in temple ponds water and Rama and Uchhipillayar temple ponds water were compare than that of Cauvery river water (58 mg/l). Fluctuations in these values among the sampling stations with the concentration of sodium linked to the status in and around environment. More entry into the salt and marine chemical industries may be the main reason for the increase in sodium content [14].

Potassium values were ranged from 66.0- 94.0mg/l in the temple ponds water and it was higher than that of Cauvery river water (10.9 mg/l). For inland creation of marine shrimp, lake water may require supplementation with both potassium and magnesium, as saline inland waters ordinarily contain less of these components than weaken ocean water of equivalent saltiness [10]. Potassium in water bodies is responsible for the growth of blue green algae (Patel and Tiwari, 1989). Potassium that is present in the aquatic system may either be assimilated by algae and aquatic macrophytes or transferred to underlying sediments where it undergoes denitrification.

The temple ponds water nitrate concentrations were ranged between 19.0- 40.0 mg/l. Depending on the watershed soil, land use and fertilizer management, this level can be increased. Nationally, the median nitrate-nitrogen concentration in domestic wells tested between 1994 and 2004 was 0.55 mg/L [15]. However, nitrate is non-toxic to fish and harmless to health unless the content is extremely high (more than 90 mg/L NO3-N) [10].

Sulfate is one of the most abundant elements in natural water imparting hardness in them. The concentrations of Sulfate in temple ponds water were between 38- 96 mg/l and it was higher than that of Cauvery river water (16 mg/l). Sulfate is a common compound in water. It is produced by the dissolution of minerals from soil and rocks. Typical levels are 0 to 1,000 mg/L. Some well water and most coastal pond water will have higher sulfate concentrations. Some well water and most coastal pond water will have higher sulfate concentrations. Fish can tolerate a variety of sulfate concentrations, and only when the water is used for other purposes (such as watering cattle or irrigating crops), the sulfate content is more than 500 mg/L worthy of attention [10].

Table 1: Physical and Chemical parameters of Thiruvanaikaval temple pond (Rama theertham S1), Ucchipilaiyar kovil Teppakulam- S2 and Cauvery river- S3.

S. No	Parameter	Sample 1	Sample 2	Sample 3
1	Temperature (^{0}C)	30.2	30.4	29.2
2	pH	8.0	8.3	7.50
3	Colour (Hazen units)	Colourless	Colourless	Colourless
4	Odour	Odourless	Odourless	Odourless
5	Electrical Conductivity	520	1650	267
6	Dissolved Oxygen (Mg/l)	4.8	4.7	5.2
7	Salinity (ppt)	0.25	0.24	0.22
8	Carbonate (Mg/l)	00	48	4.27
9	Total Dissolved Solids (Mg/l)	366	992	495
10	Suspended Solids (Mg/l)	BDL	BDL	BDL
11	Total hardness (CaCo3) (Mg/l)	75	165	77
12	Alkalinity (CaCo3) (Mg/l)	160	295	205
13	Bicarbonate (Mg/l)	195	195	24.0
14	Chloride (Mg/l)	71	287	60
15	Calcium (Mg/l)	24	20	36.1
16	Magnesium (Mg/l)	04	28	25.3
17	Sodium (Mg/l)	46	248	58
18	Sulfate (Mg/l)	38	96	16
19	Potassium (Mg/l)	66	94	10.9
20	Nitrate (Mg/l)	19	40	4.26
21	Fluoride (Mg/l)	0.53	0.51	0.28
22	Turbidity (NTU)	BDL	BDL	13

The concentrations of fluoride in temple ponds water were ranged from 0.47- 0.53mg/l. Fluoride is a trace element usually found in water at levels of 0.51 to 0.53 mg/L. It can be added to water to prevent human tooth decay (at a concentration of 0.7 mg/L). Levels at or above 3 mg/L are reported to cause losses of some fish species, depending upon complex water conditions [10]. Calcium is one of the most abundant elements in natural water imparting hardness in them. The concentrations of calcium in the temple ponds water were between 20.0 and 24.0mg/l in Rama theertham and Uchhipillayar temple ponds water were lower than that of Cauvery river water (36.1 mg/l). Magnesium is the second abundant citation that gives the soil hardness. The value of magnesium 4.0 – 28.0mg/l in temple pond water and it was compare with the Cauvery river water (25.3 mg/l). Calcium and magnesium are the largest part of natural water hardness. Hardness of water is objectionable from

the viewpoint of water use for domestic purpose. So the hardness of the water increases day by day. Hard water is unsuitable for domestic purpose and reports indicate that it has a role in heart diseases [13].
The water sample was collected from temple ponds and processed to identify the microorganisms were present. The results were presented in Table 2-3. The results for microscopic examination such as staining and cultural characters, colony morphology. The bacteria were isolated from water samples yielded 6 colonies isolates from each stations and gram positive and gram negative bacteria's are identified. Enteric bacteria are believed to exist in freshwater bodies under starvation conditions, and their growth is mainly limited by the lack of suitable carbon sources. Although this hypothesis is based on the use of selected enteric bacteria as an indicator of fecal contamination, there is evidence that the growth of enteric bacteria may be limited in certain river waters [16]. Bacteria were isolated from the water sample, and 16 isolates were obtained, representing 6 different types of bacteria, namely Escherichia coli, *Klebsiella pneumoniae, Vibrio cholera, Proteus* Sp., *Pseudomonas pneumoniae* and *Staphylococcus aureus*. The conclusion drawn from this study is that water is often contaminated by microorganisms, and this contamination may play a role in the spread of potentially harmful organisms [12]. In Asia there is not a good awareness about water borne diseases, from this study it was concluded that the water is commonly contaminated with microbes and this contamination may be human activity and playing a role in the transmission of disease to devotees. Three sample replicates were collected for temple ponds to increase accuracy of the result. Cultures were maintained on Sabouraud agar medium by using lacto phenol cotton blue stain, the isolated fungi were identified. The present study showed that *Aspergillus rlavus, A. rumiqatus, Mucor* sp*, Rhizopus, A. niger*and, *A. flavus*were registered in terms of species richness and abundance According to reports, aquatic fungi and molds from freshwater sources are the cause of infections in aquatic species [18]. The presence of toxic aquatic fungi in water often infects aquatic animals, including animals for human consumption. These fungi not only affect fish, but also fish eggs [19]. By observing the changes in its physical appearance and the inability to produce a protective layer due to the damage caused by the toxic substances secreted by the fungus, the infected fish can be seen [20].

Table 2: Morphological and cultural characteristics of the organisms isolated from temple pond water samples.

S. No	Samples	CFU	Gram's Staining	Morphology	Colony Morphology	Percentage
1.	ThiruvanaiKaval (Rama Theertham)	168 x10^7	G +ve G +ve G +ve G –ve G +ve	Rod Rod Cocci Rod Rod	Large irregular white flat Small circular elevated opaque Puncti yellow Puncti white Irregular white wrinkled	G +ve - 80 G –ve - 20
2.	Teppakkualm	48 x10^7	G -ve G-ve	Rod Filament	Small circular opaque Puncti warm opaque	G +ve - 00 G –ve - 100

Table 3: Fungi morphological and identify the isolated organisms from temple pond water.

S. No	Sample	CFU	Colony Morphology	Fungal name
1	Thiruvanaikaval (ramartheetham)	16x10^3	Orange, green colour	*Aspergillus rlavus A.rumiqatus Mucor. sp Rhizopus pennicilium.sp*
2	Teppakkulam	5x10^3	Yellow with green, Green colour	*A.niger A.flavus Mucor*

Conclusion
From this investigation and the foregoing discussions, it can be concluded that available water from Thiruvanai Kaval: Ucchipilaiyar kovil temple ponds water samples most of the parameters are elevated or more or less equal to Cauvery river water. The pond water is commonly contaminated with microbes and this contamination may be human activity and playing a role in the transmission of disease to devotees. Thiruvanaikaval: Rama theertham and Ucchipilaiyar kovil temple ponds were suitable for the fish culture.

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