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Original Research Article

A Comparative Physical Parameters of Sri Kurmanadha Temple Pond and Sri Maninageswara Temple Pond, Srikakulam District, Andhra Pradesh, India

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Abstract

Data collected on certain physical parameters of Sri Kurmanadha, Srikurmam and Sri Maninageswar, Kallepalli, Temple Ponds, Srikakulam District, Andhra Pradesh from May 2014 to April 2016. The seasonal variations in water quality were recorded on monthly basis for a period of two years and correlation studies were also conducted among different physical parameters of both temple ponds. Water samples were analyzed for Physical Parameters like air temperature (28.25^0 C, 27.4^0 C), water temperature (24^0C, 24.35^0 C), transparency (32.1cm., 20.35cm.), EC (621µs/cm., 513.5µs/cm.), TSS (27mg/l., 35.5mg/l.) TDS (367mg/l., 298mg/l), pH (7.35, 7.5), DO (6.75mg/l, 6.5mg/l), COD (10.63mg/l, 10.36mg/l), BOD (3.31mg/l., 2.86mg/l.) total alkalinity (132.5mg/l., 128.5mg/l.), total hardness (80mg/l., 87.5mg/l.). Inter relationship between physical parameters (Pearson's Correlation matrix) was also recorded. In this observation temperature showed strong positive correlation with COD (r=0.91, r=0.88), BOD (r=0.96, r=0.89), and negative correlation with DO (r=-0.84, r=-0.97). EC showed significant positive correlation with TDS (r=0.85, 0.89), and negative correlation with DO (r= -0.82, r=-0..84), TDS showed positive correlation with pH (r=0.77, r=0.72), and total hardness (r=0.81, 0.78), pH showed positive correlation with COD (r=0.77, r=0.84), total alkalinity (r=0.94, r=0.86), total hardness (r=0.81, r=0.84), and negative correlation with DO (r= -0.87, r=-0.77), Dissolved Oxygen showed negative correlation with COD (r= -0.88, r=-0.93), BOD (r= -0.95, r=-0.93). Chemical Oxygen Demand showed positive correlation with BOD (r= 0.92, r=0.91) and total alkalinity (r= 0.75, r=0.79). Biological Oxygen Demand showed positive correlation with total alkalinity (r= 0.74, r=0.63). Total Alkalinity showed positive correlation with total hardness (r= 0.90, r=0.87). These observations could useful in the water quality monitoring and regulation in order to enhance the quality of water with better sustainable management of Sri Kurmanadha, Srikurmam and Srimaninageswar, Kallepalli, Temple Ponds.

Keywords: Physical Parameters, Pearson's Correlation Matrix. Sri Kurmanadha, SriKurmam and Sri Maninageswar, Kallepalli, Temple Ponds, Srikakulam District, Andhra Pradesh.

INTRODUCTION

Water is the essential component for all living beings on the earth environment and it is one of the vital elements of the ecosystem. Quality of water is needed for good health. Now a day's fresh water is subject to Serve competition among multiple human stake holders in many parts across the globe. Fresh water has become a scarce commodity due to over exploitation and pollution. (Guptha and Shukla 2006). Domestic, agricultural, industrial usages, water transport, vehicle washings and sewage discharges are some factors for eutrophication (Dwivedi and Pandey 2002). Ponds are good example for lentic fresh water ecosystem. In South India, every village is established a fresh water pond or temple pond. They play a vital role to fulfil the villager's water needs. The temples are focal points of various religious and cultural practices throughout the year and especially in festival days with worship materials (Setu Madhava Rao 2018). The neglected temple tanks are enriched with nutrients by surface runoff, temple effluents, holy dips, cleaning of cloths, limbs, and utensils, lighting of lamps

and spreading of holy powders (Sulbha and Prakasam, 2006). Due to all of these anthropogenic activities, the water bodies are subjected to varying degrees of pollution. The maintenance of healthy temple pond water is dependent on the physicochemical features. There is proper monitoring of temple ponds with necessary parameters with reference to the water quality. It may prevent the further deterioration of pond water (Jalal and Sanalkumar, 2013). The present study was conducted on impact of seasonal changes in physical properties of Sri Kurmanadha, Srikurmam and Sri Maninageswar, Kallepalli, temple ponds. The results were compared with surface water quality standards given by Bureau of Indian Standards.

MATERIALS AND METHODS

Study Area

Physical parameters were observed in the Sri Kurmanadha, Srikurmam and Sri Maninageswar, Kallepalli, temple ponds were carried out for a period of two years from May, 2014 to April 2016. Sri Kurmanadha Temple Pond is located in Srikurmam village at latitudes 18º27”N and with longitude 84º00”E and it is 13 k. m. away from the Srikakulam town, Srikakulam district in Andhra Pradesh. Surface area of the water in the pond during the rainy season is around 3.2 hectare and depth is 15 meters. Water spread area in summer is around 2 hectare, with 6 meter in depth (Fig 1). It is oldest historical temple pond. Pilgrims visit this temple every day around the country. The temple priest utilizes the pond water for consecration ceremony, bathing, washing clothes and ritual practices of Hindus. The temple effluents are mixing with water every day and on the other hand villagers bathing, washing vessels, troughed the offering material garbage into the pond. At the same time some floating hydrophyte flora along with aquatic fauna are present.

Sri Maninageswara Temple Pond is located in Kallepalli village near to Srikakulam town, at latitudes 18º37”N and with longitude 83º92”E. It is a small pond. Inlet and outlet of water facility is available for agricultural purposes. Surface area of the water in the pond during the rainy season is around 1.5 hectare and depth is 5 meters. Water spread area in summer is around 0.5 hectare, with 1 meter in depth. This Lord Shiva temple rushed in Mondays and month of Kartheekam every year. Pond water mixed with temple effluents, offering materials, washing hands & feet, bathing and troughed garbage (Fig 1).

Sampling Collection

Water samples were collected from the study areas as close to the surface from 5 points of the ponds with help of a bucket and filled in 2 liter sample bottles. These were transported to the laboratory for pre decided physical factors analysis every month in a two-year study period and average values were taken (Senthil Kumar and Sivakumar 2008, Sivakumar and Kurupaswamy 2008). The procedure for collection, storage and analysis of water samples were followed as described in standard methods (APHA, 1998). At spot, air and water temperatures were measured with a centigrade gloss mercury thermometer with the range of Oºc to 110ºc calibrated to tens, transparency (Secchi Depth) was measured by Sacchi Disc and the pH of the water was determined by digital pH meter (Model HANNA instrument). Total suspended solids were as per Ambasht (1990) and the others such as electrical conductivity, total dissolved solids, DO (Winkler’s method), total alkalinity, total hardness (EDTA titration method), COD, BOD were determined at laboratory as per APHA 1998.

RESULTS AND DISCUSSION

Data was collected on the physical parameters of the study sites, Sri Kurmanadha, Srikurmam & Sri Maninageswar, Kallepalli, during May 2014 to April 2016 was presented in Fig. 2 A&B; 3 A&B; 4 A&B; 5 A&B, 6 A&B and 7 A&B and Table 1, 2 A&B .

Air and water temperatures are the important physical factor which influencing the abiotic and biotic components of the aquatic environment. In the present investigations in both temple ponds, maximum air temperature (34.6^0C, 34.7^0C) and minimum were reported (21.9^0C, 20.1^0C) in the month of May 2014 and January 2015 (Tab. 1A) Maximum water temperature (29.5^0C, 29.3^0C) was observed in the month of May 2014, 2015 and minimum (18.5ºC, 19.4^0C) was recorded in December, January 2015 (Fig. 2B) as reported by the earlier observations of Javiad and Ashok (2012), Jyotsna *et al*., (2016). Air temperature showed more seasonal fluctuations than the water temperature due to the seasonal effect of summer and winter.

In the present study average depth of transparency was maximum (44.3cm, 38.9cm) in the month of May 2015, April, 2016 while minimum (19.9cm, 17.8cm) was observed in the month of July 2014, August 2015 (Fig. 3A). Similar observations were made by Dhanalaxmi (2013) and Anjali Bhayal *et al*., (2016). These varying trends showed that during summer light penetration is more and monsoon season water was turbid due to surrounding areas inflow.

Electrical conductivity is a factor that indicates the purity and quality of the water. It depends on mineralization of organic matter and its ionic forms (Agbair *et al*., 2015). Higher electrical conductivity values (627µs/cm., 635µs/cm.) were recorded in April 2016, May 2015 while the lower value (319µs/cm, 392 µs/cm.) was recorded in the month of January 2015 December 2014 (Fig 3A). These observations were agreed with the reports of Rajani (2009). Electrical conductivity is found to be good indicator of the overall water quality. As per SWQS (IS 2296: 1992) EC is 1000-2250µs /cm. The effect of presence of total suspended solids is the turbidity due to silt and organic matter (Mahanada *et al*., 2010). More total suspended solids were recorded (42mg/l., 67mg/l.) in the month of July

2014 and less TSS were observed (12.0mg/l., 4.0mg/l.) in the month of January 2016 and November 2014 (Fig 3B). Similar results were made by Elayaraj *et al*., (2016) Madhavarao and Narsimha Rao (2016).

The maximum total dissolved solids found in both temple ponds were (398mg/l., 379mg/l.) in May 2015 while minimum (165mg/l, 217mg/l) were in November 2015, December 2014 (Fig 3B). Similar findings were made by Rajnarayan (2007) and Jaklin Jemi (2011). The highest TDS might be due to surface runoff, temple disposals and accumulation of the anthropogenic activity to waste disposals around the temple pond (Vidhya Lakshmi and Avinash 2014).

In the present investigation, the higher hydrogen ion concentration (8.2, 8.6) was recorded in June 2015, May 2014 and lower pH (6.5, 6.4) was observed in the month of November 2015, September 2014 (Fig.4 A). As per Surface Water Quality Standard (IS 2296: 1992) pH is 6.5 - 9. Similar findings were made by Elayaraj and Selvaraju (2014). The pH values of both these ponds showed alkaline trend with a slight variations. The pH values were fluctuated from monsoon to summer due to higher rate of inflow in the monsoon season and higher rate of evaporation and less inflow in the summer season (Sharma *et al*., 2011, Setu Madhava Rao and Mohan Narsimharao, 2020). Maximum dissolved oxygen value (7.9mg/l., 7.9mg/l.) was recorded in the month of September 2015, February 2016 and minimum value (5.6mg/l., 5.1mg/l.) was observed in the month of May 2015 (Fig.4 A). According to the observations, DO levels were medium range in the pond with an average of 6.5mg/l. As per SWQS (IS2296; 1992) DO is 4-6mg/l suitable for good water. Similar findings were observed by Jyothi *et al*., (2013).

BOD of the study ponds, maximum values were (5.66mg/l., 4.48mg/l.) in May 2015 and April 2016, while minimum values were (0.95mg/l., 1.24mg/l.) in December 2015 and January 2016. BOD is indicates for more organic pollution (Raj Narayan *et al*., 2007). Similar observations were recorded by Sachidanandamurty and Yajurvedi, (2004 & 2006). The COD is a reliable parameter for judging the extent of pollution in water 25 (Amirkolaie, 2008). Higher COD values were (16.98mg/l., 17.51mg/l.) in June 2015 and May 2014 and lower values were (4.28mg/l., 3.24mg/l.) observed in December 2014 and October 2014. These findings correlated with the findings of Nazeen *et al*., (2013) & Shib Abir (2014). Total alkalinity of the study ponds maximum was (185mg/l., 172mg/l.) in June, May 2015 and minimum was (80mg/l., 85mg/l.) in the months of October, December 2014 (Fig. 4B). In the present investigation alkalinity more in summer season and less in post rainy months. Similar observations made by Ajayan *et al*., (2013) in Ananthapura Temple Lake of Kasaragod, Kerala and Tidame and Shinde (2012). Higher value of total hardness (105mg/l., 120mg/l.) was observed in the months of May, April 2014 and while lower value (55mg/l., 55mg/l.) was recorded in the months of September 2014 and January 2016 (Fig 4B). As per SWQS (IS 2296:1992) hardness is 300 mg/l. The increase in hardness can be attributed to the lower levels of water volume due to high rates of evaporation. Similar observations were recorded by Karthikyan *et al*., (2018).

Table 1: Physicochemical Parameters of Sri Kurmanadha Temple Pond A & Sri Maninageswar Temple Pond B (Mean and ± SD 99.9%)

Sl. No	Parameters Studied	Sri kurmanadha Temple Pond (Pond A)	Sri Maninageswar Temple Pond (Pond B)
1	Air Temperature	27.85 ± 2.69	27.56 ± 2.56
2	Water Temperature	24.37 ± 2.38	24.29 ± 2.11
3	Transparency	28.17 ± 3.23	31.14 ± 3.68
4	Electrical Conductivity	569.04 ± 76.28	484.33 ± 41.49
5	Total Dissolved Solids	344.41 ± 44.24	280.12 ± 30.39
6	Total Suspended Solids	22.29 ± 6.57	22.95 ± 10.39
7	pH	7.3 ± 0.29	7.3 ± 0.35
8	Dissolved Oxygen	6.92 ± 049	6.87 ± 0.48
9	BOD	3.08 ± 1.06	2.35 ± 0.69
10	COD	8.55 ± 2.54	9.28 ± 2.85
11	Total Alkalinity	118.12 ± 19.92	116.33 ± 16.95
12	Total Hardness	84.20 ± 9.53	84.16 ± 13.62

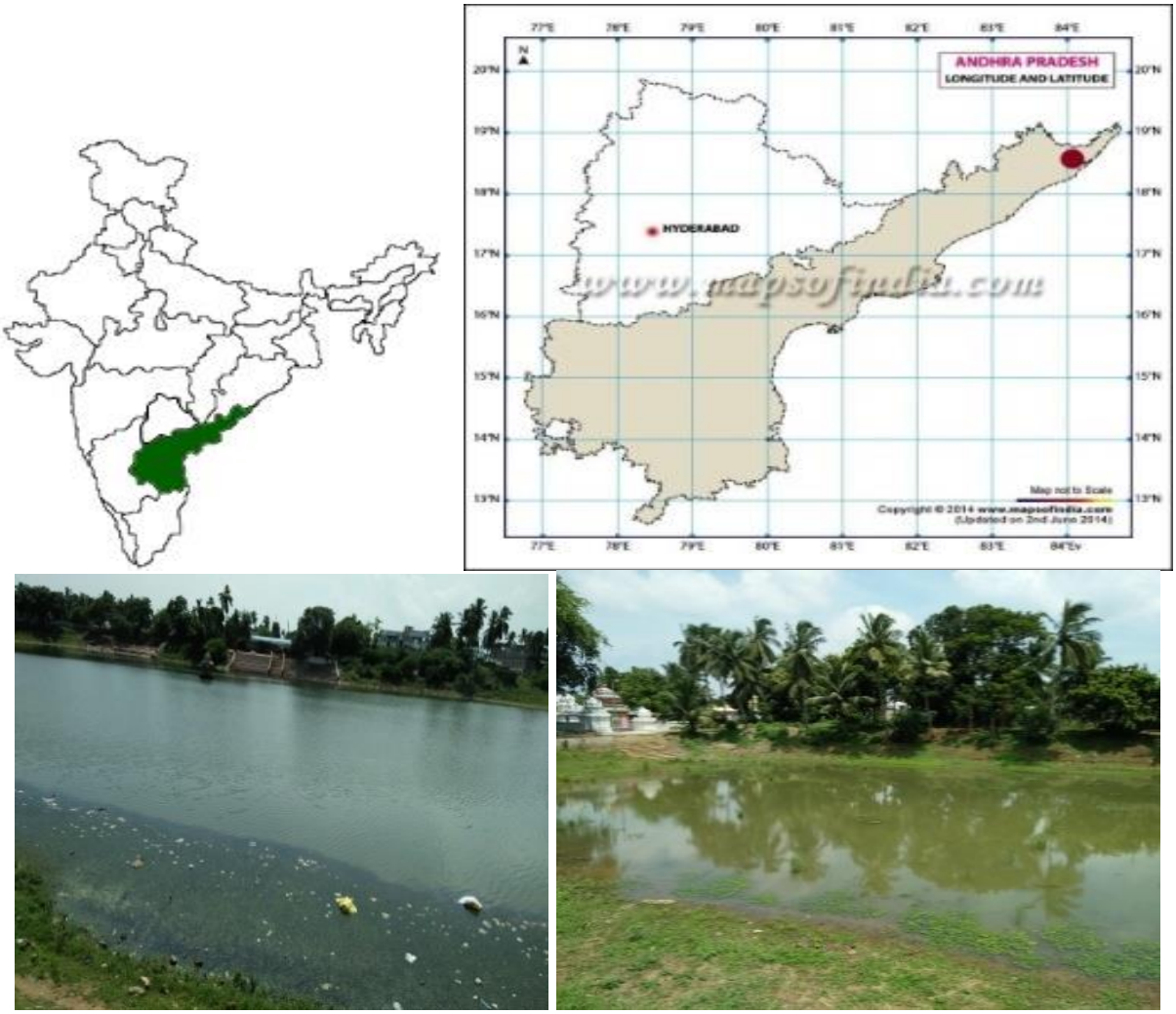

Fig 1: Map and Location of Sri Kurmanadha, Srikurmam & Sri Maninageswar, Kallepalli, Temple Ponds, Srikakulam District, Andhra Pradesh., India

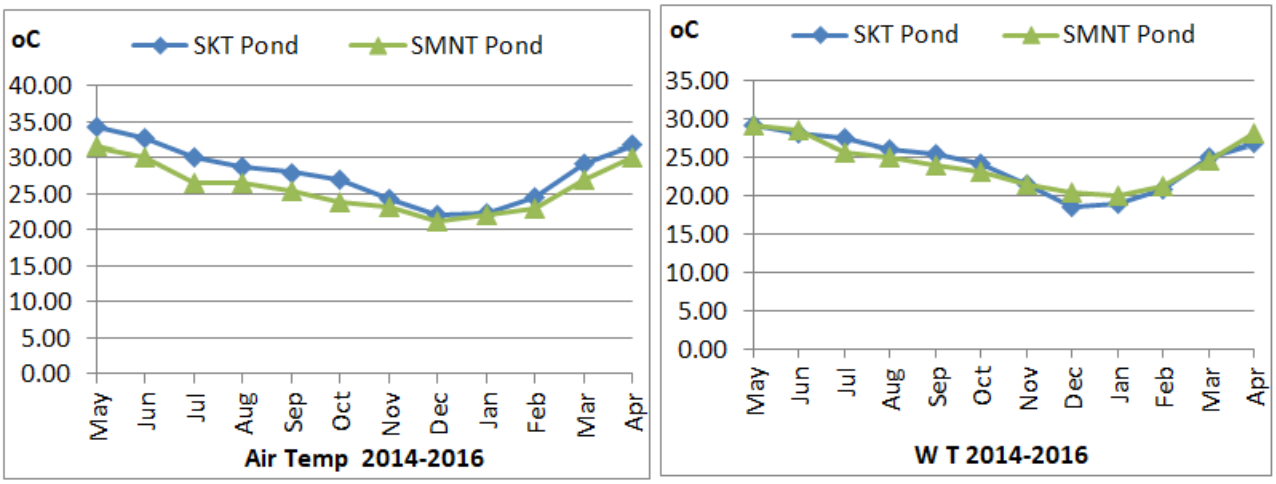

Fig 2 (A &B). Seasonal changes in Physical features of Sri Kurmanadha, Srikurmam & Sri Maninageswara, Kallepalli, Temple Ponds, Srikakulam District, A. P

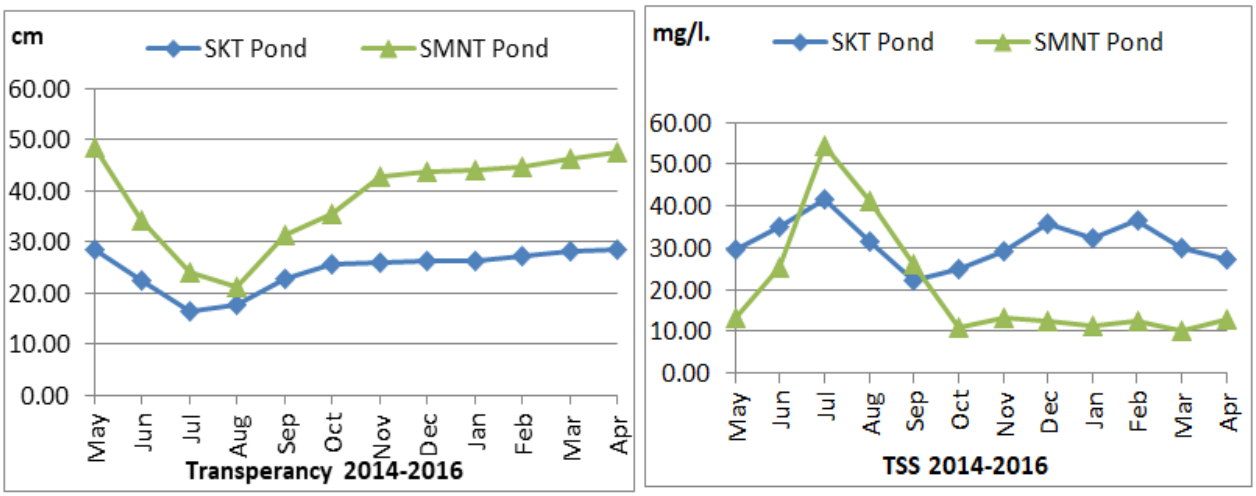

Fig 3 (A &B): Seasonal changes in Physical features of Sri Kurmanadha, Srikurmam & Sri Maninageswara, Kallepalli, Temple Ponds, Srikakulam District, A. P

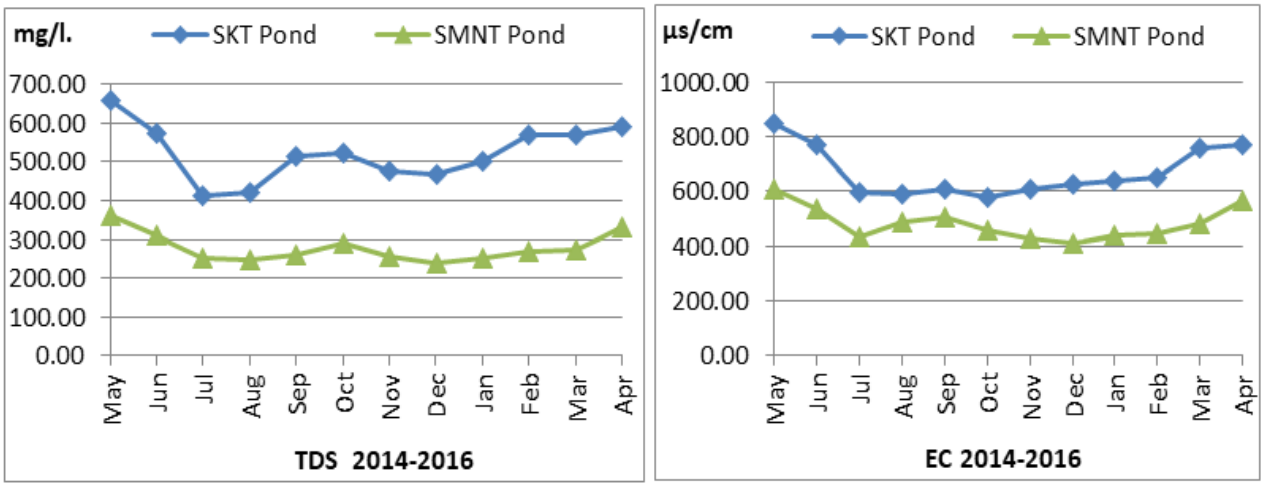

Fig 4 (A &B): Seasonal changes in Physical features of Sri Kurmanadha, Srikurmam & Sri Maninageswara, Kallepalli, Temple Ponds, Srikakulam District, A. P

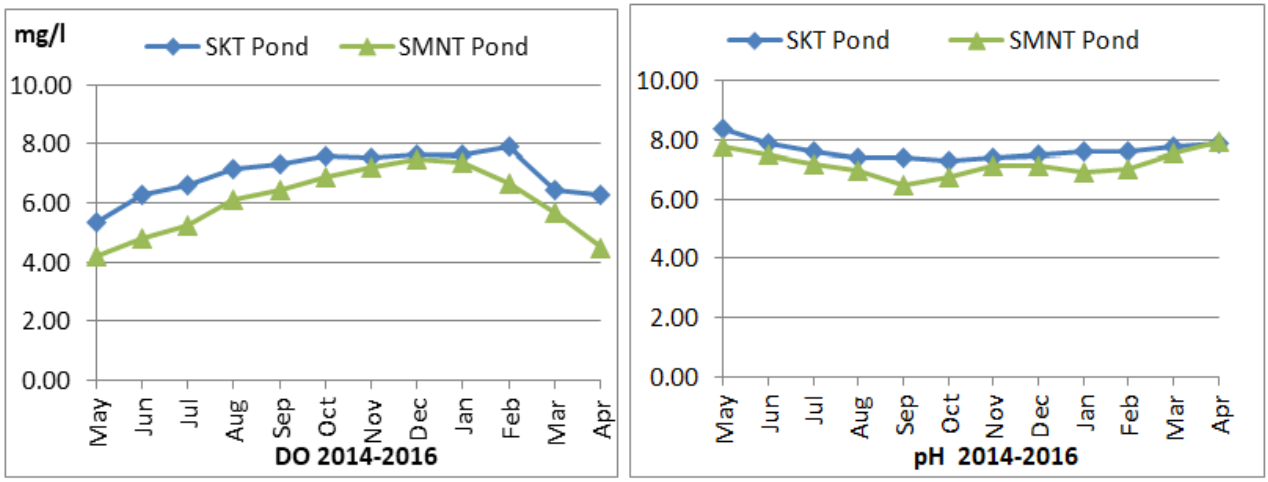

Fig 5 (A &B): Seasonal changes in Physical features of Sri Kurmanadha, Srikurmam & Sri Maninageswara, Kallepalli, Temple Ponds, Srikakulam District, A. P

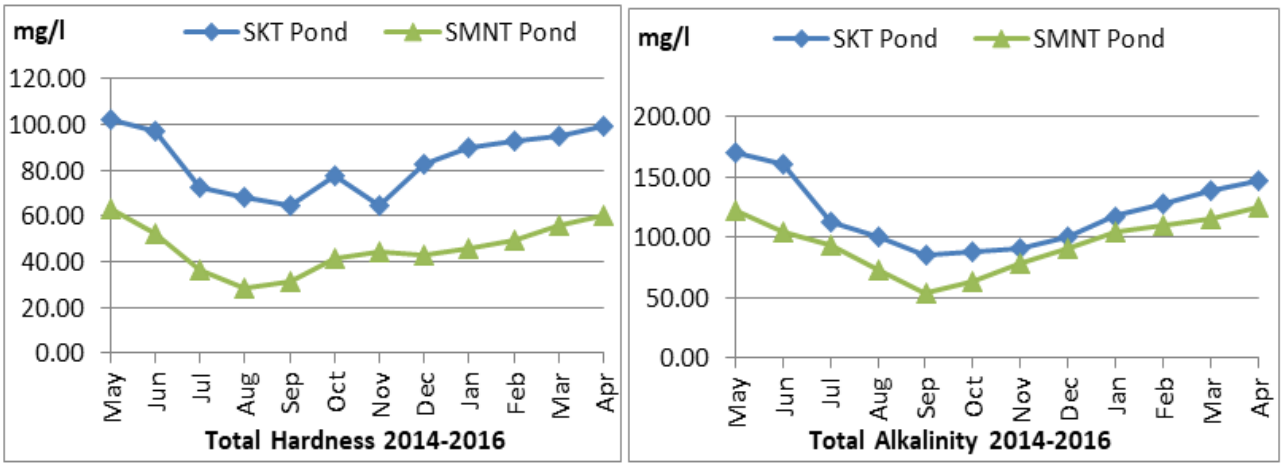

Fig 6(A &B): Seasonal changes in Physical features of Sri Kurmanadha, Srikurmam & Sri Maninageswara, Kallepalli, Temple Ponds, Srikakulam District, A. P

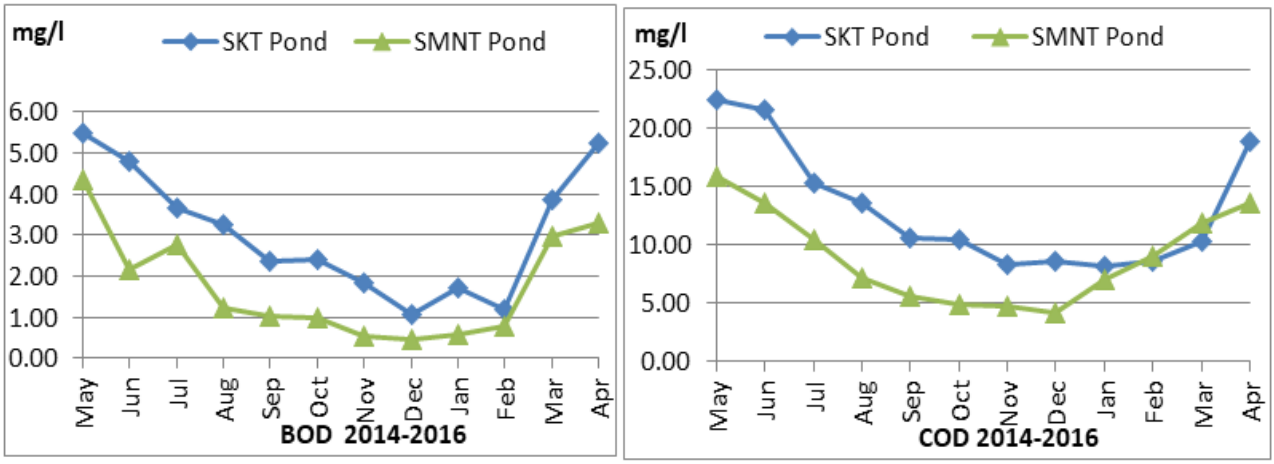

Fig 7(A &B): Seasonal changes in Physical features of Sri Kurmanadha, Srikurmam & Sri Maninageswara, Kallepalli, Temple Ponds, Srikakulam District, A. P

Correlation Matrix (Pearson's Correlation matrix)

In the correlation studies of Sri Kurmanadha and Sri Maninageswara temple ponds were during May 2014 to April 2016 (Table 2A & B). Temperature showed strong positive correlation with COD (r=0.91, (r=0.88), BOD (r=0.96, (r=0.89) and negative correlation with dissolved oxygen (r=-0.91) (r=-0.97). A good synchronization between temperature and dissolved oxygen, i.e. a significant inverse relationship was reported (Aba Mustapha 2013). Electrical conductivity showed significant positive correlation with TDS (r=0.85, 0.89), and negative correlation with DO (r= -0.82, r=-0.84). Similar reports were made by Jyotsna *et al*., (2016). TDS showed positive correlation with pH (r=0.77, r=0.72), and total hardness (r=0.81, 0.78). Similar observations were recorded by Srinivasulu and Damodharam (2016) and Jyotsna *et al*., (2016). pH showed positive correlation with COD (r=0.77, r=0.84), total alkalinity (r=0.94, r=0.86), total hardness (r=0.81, r=0.84), and negative correlation with DO (r= -0.87, r=-0.77). Similar correlation reports were recorded by Tidame and Shinde (2012) and Amarendr *et al*., (2016). Dissolved oxygen showed negative correlation with COD (r= -0.88, r=-0.93), BOD (r= -0.95, r=-0.93) (Sharma *et al*., 2011 and Ajayan *et al*., 2013). Chemical oxygen demand showed positive correlation with BOD (r= 0.92, r=0.91) and total alkalinity (r= 0.75, r=0.79). The similar results were made by Naik *et al*., (2017). Biological oxygen demand showed positive correlation with total alkalinity (r= 0.74, r=0.63) (Shib Abir 2014). Total Alkalinity showed positive correlation with total hardness (r= 0.90, r=0.87). Similar findings were noticed by Baruah and Kakati (2012).

Table 2 A & B: Correlation Matrix among the physical variables of Sri Kurmanadha, Srikurmam and Sri Maninageswara, Kallipalli, Temple Ponds, A.P., India, during May 2014 to April 2016.

Name of the Parameter	AT	WT	Tra	Ec	TDS	pH	DO	TA	TH	TSS	COD	BOD
AT	1.00											
WT	0.98, 0.0.99	1.00										
Tra	- 0.14	-0.31	1.00									
Ec	0.67	0.51	0.51	1.00								
TDS	0.49	0.33	0.73	0.85	1.00							
pH	0.69	0.54	0.38	0.95	0.77	1.00						
DO	-0.91	-0.84	-0.05	-0.82	-0.55	-0.87	1.00					
TA	0.66	0.51	0.35	0.94	0.76	0.94	-0.78	1.00				
TH	0.39	0.20	0.60	0.86	0.81	0.81	-0.54	0.90	1.00			
TSS	-0.10	-0.12	-0.38	-0.05	-0.33	0.11	0.00	0.22	0.15	1.00		
COD	0.91	0.86	-0.10	0.72	0.49	0.77	-0.88	0.75	0.50	0.06	1.00	
BOD	0.96	0.90	-0.02	0.76	0.51	0.76	-0.95	0.74	050	-0.09	0.92	1.00

Name of the Parameter	AT	WT	Tra	Ec	TDS	pH	DO	TA	TH	TSS	COD	BOD
AT	1.00											
WT	0.99	1.00										
Tra	-0.01	-0.10	1.00									
EC	0.91	0.87	0.19	1.00								
TDS	0.81	0.78	0.44	0.89	1.00							
pH	0.72	0.68	0.48	0.61	0.72	1.00						
DO	-0.97	-0.97	-0.00	-0.84	-0.78	-0.77	1.00					
TA	0.46	0.39	0.63	0.42	0.56	0.86	-0.56	1.00				
TH	0.50	0.43	0.82	0.56	0.78	0.84	-0.53	0.87	1.00			
TSS	0.20	0.27	-0.88	-0.09	-0.30	-0.17	-0.26	-0.30	-0.60	1.00		
COD	0.88	0.84	0.26	0.78	0.79	0.04	0.93	0.79	0.73	0.04	1.00	
BOD	0.89	0.87	0.19	0.77	0.77	0.12	-0.93	0.63	0.63	0.12	0.91	1.00

Note: AT- Air Temperature (^{0}C), WT-Water Temperature (^{0}C) Tra-Transparency (cm), EC- Electrical Conductivity (µs/cm), TDS-Total Dissolved Solids (mg/l), pH, DO (mg/l), TA- Total Alkalinity (mg/l), TH- Total Hardness (mg/l), TSS- Total Suspended Solids (mg/l), COD- Chemical Oxygen Demand (mg/l), BOD- Biological Oxygen Demand(mg/l).

CONCLUSION

The present observations revealed that the comparison between Srikurmanadha and Srimaninageswar temple ponds water status ranges from mesotrophic in rainy to near eutrophication in summer of Srikurmanadha temple pond and at the same time oligotrophic to slightly pollute in Srimaninageswara temple pond as per SWQS (IS 229:19926). These temples are different in pollution status, first one is receiving more pollutants from pilgrims and villagers and second one is only by villagers and angiosperm plants. If the unwanted human activities not regulated in both temples by the temple authorities, it might be leads to spoil the water. Not removing the suspended solids and angiosperm plant debris are continued in the pond, later on turn to breeding grounds of mosquitoes and other pathogenic organisms. It is gradually change in future the pond would catch eutrophication. Proper sanitation measures would be taken by temple authorities, village elders or village authorities immediately. The environmental awareness programs to public care and temple authorities are essential to keep the water body clean and safe. Arranging dust beans, plastic collection, mike announcements in holydays may be given successful results. These ponds bunds are so wide, they support to develop a walk- path, growing of sacred plants and beautiful land scalping for enhancing the beauty of the temple, village and attract a lot of nature- lovers and increase the temples revenue.

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