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An Assessment of Religious Ceremonies and their Impact on the Physico-Chemical and Microbiological Characterization of Foremost Seawater in Navagraha Temple, Devipattinam, Tamil Nadu, India

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Abstract- The aim of this study is to assess seawater quality and impacts of traditional ritual ceremonies on foremost seashore Navagraha temple. The seawater samples were collected at seven different station and water quality parameters were analyzed on the standard methods. Physico-chemical parameter; pH, electrical conductivity, temperature, total suspended solids, total dissolved solids, total solids, biological oxygen demand, sulphate and microbiological indicators; total heterotrophic bacterial count, total fungal count, total actinomycetes count, and total enteric bacterial count were performed. These results indicated that the water highly exceeds the Indian primary seawater quality standards criteria-II. To prove this hypothesis unregulated celebrations of religious ceremonies are highly polluting the seawater and it cause significant adverse impact on human and marine biota. Our results can provide the potential value for alternative ritual activities and calls for urgent intervention by government management policy on a local and regional support future policy decisions and awareness.

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Abstract- **The aim of this study is to assess seawater quality and impacts of traditional ritual ceremonies on foremost seashore Navagraha temple. The seawater samples were collected at seven different station and water quality parameters were analyzed on the standard methods. Physico-chemical parameter; pH, electrical conductivity, temperature, total suspended solids, total dissolved solids, total solids, biological oxygen demand, sulphate and microbiological indicators; total heterotrophic bacterial count, total fungal count, total actinomycetes count, and total enteric bacterial count were performed. These results indicated that the water highly exceeds the Indian primary seawater quality standards criteria-II. To prove this hypothesis unregulated celebrations of religious ceremonies are highly polluting the seawater and it cause significant adverse impact on human and marine biota. Our results can provide the potential value for alternative ritual activities and calls for urgent intervention by government management policy on a local and regional support future policy decisions and awareness.**

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I. Introduction

Assessment of seawater quality monitoring for the physico-chemical and microbial indicator is essential for protecting the marine ecosystem and human health (Touron *et al.,* 2007). Worldwide, 60% of the marine ecosystem is in polluted condition, and particularly 40% are because of anthropogenic activities (IOC/UNESCO, IMO, FAO, UNDP, 2011). The coastal and marine pollution impacts are more complex and diverse on earth and human beings (UNEP, 2011). In the past few decades, unregulated anthropogenic activities, such as insufficiently treated urban, municipal, domestic, and industrial wastes water discharges are the major deterioration factors in the marine ecosystem (Borja *et al*., 2008; Subramani and Aalbersberg, 2012; Stabili and Cavallo, 2011). These anthropogenic activities have increased the nutrients load, hazardous chemicals, and pathogenic and nonpathogenic microorganisms (Chao *et al*., 2010). These effects naturally induces changes in the numbers of seawater temperature, transparency, water masses, salinity, dissolved carbon dioxide, increased oxygen demand, deposition of organic matter, and pathogenic microbes growing in favorable condition, such as bacteria, fungi, viruses, parasites, and algae (Spatharis *et al*., 2007; Lloret *et al.,* 2008; Oliveira *et al*., 2010). Long-term survival and adaptation of proliferating pathogenic microorganisms have led to deterioration of marine organisms and environmental conditions (Stewart *et al*., 2008; Janelidze *et al.,* 2011). Particularly, costal economic zone for the coral reef 20%, mangroves 30–50%, and sea grass 29% affects global level (Wilkinson, 2008; Nellemann *et al*., 2009).

In addition, human health impacts of the waterborne disease and infections, such as gastroenteritis, hepatitis, respiratory tract infection, ailment, meningitis, ear, eye, nasal cavity infection, etc., are associated with consumption of contaminated seafoods and contacts of coastal materials for recreational activities (Jones and Oliver, 2009; EFSA, 2010; Carrasco *et al*., 2012). Furthermore, treatment of disease caused by pathogenic marine microbes costs 900 million dollars every year. Particularly, 300 million dollars has been spent for gastrointestinal illness caused by beach recreation (Ralston *et al*., 2009). In this situation, many countries are involved in coastal pollution control by monitoring the physico-chemical and microbiological parameters to meet safety levels (Figueras *et al*., 1997; Georgiou and Bateman, 2005). Especially, microbial pollution is monitored by total heterotrophic bacterial counts (THBC), total coliform counts (TCC), total fecal coliform counts (TFC), and fecal streptococci counts (FSC). These indicators

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assessments are effectively useful for the control of coastal pollution (Stevens et al., 2003; Kistemann *et al*., 2002; Baghel *et al*., 2005; Halliday and Gast, 2011). These spatial and temporal variations emphasize as the important factor of the coastal environment quality (WHO, 1998; Thaddeus *et al*., 2010; Marine Water Quality, 2013). Because higher levels of pathogenic bacteria are recorded in coastal environment, a number of waterborne and communicable diseases are caused to human beings (Dada *et al*., 2012; Janelidze *et al*., 2011).

India is surrounded by coastline to about 8085 km. It is playing a pivotal role in the people population, social, economic, cultural, and religious activities. These regions have a wide range of anthropogenic activities, which have considerable adverse impacts on the marine ecosystem (Nobi *et al*., 2010). Especially, the religious activities have contributed significant part of the coastal pollution because most of the religious ceremonies are conducted in the nearby water bodies (AHEC, 2011). Degradable and non-degradable materials, such as flowers, milk, curd, vegetables, gee, coins, idols, ashes of departed ones, and body hairs are the major pollutants in water bodies; every day, 10,000-50,000 people take ritualistic mass bathing (Marale *et al*., 2010). In addition, approximately, 60,000 human cremated dead bodies and about 15,000 incomplete burnt dead human and animal bodies annually dumped in the holy water bodies (Mishra *et al*., 2009). These types of religious activities have been vigorously affecting the aquatic environment, which cause communicable disease for human being and aquatic organisms (Semwal and Akolkar, 2006; Vinay *et al*., 2005; Bhatnagar and Sangwan, 2009; Sangeeta and Savita, 2011; Sharma and Bhadula *et al*., 2012). Given this situation, this study focuses on the devotees using ablution pond and toward offshore seawater spatial variation of physico-chemical and microbial behaviors compared with the Indian primary water quality criteria for class SW-II waters for bathing, contact water sports, and commercial fishing standard. Output obtained in this study result provides baseline information on coastal pollution identification, valuable suggestion for ritual ceremonies regulation, the waterborne and communicable disease prevention, and management strategies for the resolution by the local authorities.

II. Description of the Study Area

Thilakeswara temple, popularly known as Navagraha temple, is an important venerated pilgrim centre and much remembered and quoted in the cultural heritage and history of India and devotees come from all over India and abroad. This is an ancient temple existing from the time of epic battle of Ramayana. The exact location of the temple comes in Devipattinam village, Ramanathapuram district of Tamil Nadu (Figure 1). It is the only temple situated in the sea (Bay of Bengal) at about approximately 100 m away from the shore, built for the holy Navagrahas. The worship place is located exactly at a latitude of $9.47'97^0$ N and longitude of $78.89'57^0$ E. The temple consists of nine stone pillars representing nine celestial planets (deities); various worshipping rituals are performed in the form of offering coins, nine grains, and flowers in the sea, and many take a holy bath in the ablution pond to escape from the adverse effects caused by the planets (as per Hindu religious basis). Hence, the devotees frequently visit the place, and sometimes the number of population may touch even 3000 approximately. The place is heavily congested with the people during festival time, and particularly, its number highly increases at the time of the festival periods, such as new moon day of January and February months. Puja is a religious ceremony, and for Navagrahas, people offer nine varieties of grains, such as paddy, wheat, dal varieties, pulses, Dil, etc. in nine stones. Devotees have the deep belief that worship will relieve their sufferings and sins of previous birth. Therefore, it's also these coastal regions having potentiality for fishing and aquaculture practices with no other pollution source other than people intervention. This is the main intention, using the physico-chemical and microbial tools, we made a study towards sanitary aspects of those people who are coming from various part of the country.

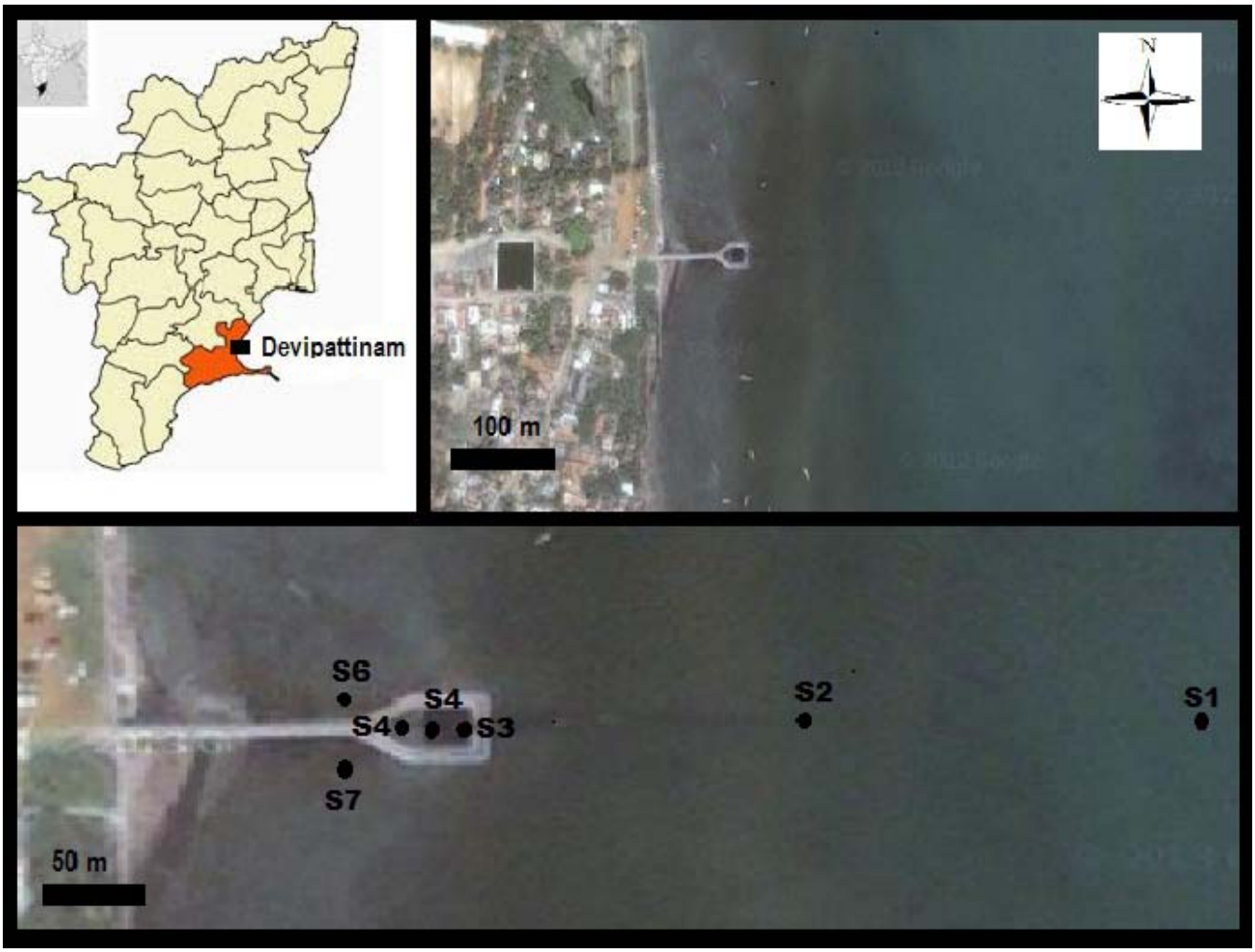


Figure 1 : Aerial photos of sample sites depicted and along the around Devipattinam Navagraha temple coastal environment (available from google.com

III. Materials and Methods

a) Sample collection

Seawater samples were collected from seven different station of ablution pond towards offshore at 1 and 2 km coastal zones near Navagraha temple. Water samples were collected at 30 cm depth in sterile plastic bottles, placed in cooling boxes, and immediately transferred to the laboratory according to the standard methods of APHA, 1998.

b) Physico-chemical parameters analysis

pH, temperature, and electrical conductivity (EC) were measured using water analysis hand meters and temperature measured using a standard mercury-filled centigrade thermometer. Samples were stirred gently, and stable readings were recorded. Total suspended solids (TSS) were determined by filtering seawater 1.2 μm using Millipore GF/C filter paper method; for determining total dissolved solids (TDS) and total solids (TS), hot air oven 105°C 8 h method was applied (Sahu *et al*., 2013). Biological oxygen demand (BOD) and sulphate (SO_4) were measured using standard APHA method.

c) Microbiological parameters analysis

The seawater total heterotrophic bacteria populations were counted (THBC) by pour plate method using the nutrient agar medium. Seawater sample of 0.1 ml was taken with a sterile micropipette and directly poured on the nutrient agar medium plates. All the plates were incubated at 37°C for 24 h. Furthermore, same procedure as mentioned was followed for measuring total fungal count (TFC) by Rose bengal agar medium plate. The plates were incubated at 28°C for 72 hours. Total actinomycetes populations were counted (TAC) by pour plate method. Samples of 0.1 ml were poured into the Kenknight agar medium. The plates were incubated at 28 ± 2°C after 96 h. Total enteric bacterial populations were counted (TEBC) from 0.1 ml sample poured on the (Eosin Methylene Blue Agar) EMB agar medium. The plates were incubated at 37°C for 24 h. (all media were purchased from HI-MEDIA

Laboratories Pvt. Ltd India). All samples were done in triplicate; mean value and averages obtained for microbes densities values were expressed as colony-forming units all samples.

d) Statistical analysis

Statistical analysis was performed using statistical package 'SPSS software version 17'. Data are presented as the Pearson correlation test was performed for physico-chemical parameters and microbial indicators.

IV. Results and Discussion

The results of our study concluded that religious ceremonies highly affect seawater. This study highlights the presence of ubiquitously distributed waterborne disease causing pathogenic enteric bacterial species in seawater. In India, this study is one of the first to evaluate relationships between coastal environment and religious ceremonies activities affecting seawater. The contaminating factors were assessed when comparing with Indian primary water quality criteria of class SW-II waters for bathing, contact water sports, and commercial fishing standards (Anonymous, 2001).

a) Assessment of physico-chemical pollution indices parameters

The measurement of temperature of seawater in seven stations showed slight variations. The temperature ranged from 29.0 to 33.0 °C (Fig. 2a). There was not an appreciable change in the temperature (Leifer, 1988; Solic and Krstulovic, 1992;). The natural pH of seawater ranges from 7.5 to 8.5. Anthropogenic activities and other natural disorders affect seawater pH values to below pH 7.5 and above pH 8.5 (Jayakumar, 2013). pH 7.7 value was recorded in the station 5 and pH 8.3 value was recorded at station 2. The inshore location had basic condition 7.87, 7.83, 7.76, 7.91, and 7.98 at ablution pond zones when compared with offshore environment seawater (Fig. 2b). This might be attributable to the offering of organic materials. The fluctuation of the hydrogen ions concentration has directly affected the marine biotas (WHO, 1989; Kalita *et al*., 2006; Umamaheshwari, 2010; Sharma *et al*., 2012). The EC values showed small changes in the seven sampling station (Fig. 2c). The inshore ablution pond station showed 18.83, 18.87, 18.85, 18.87, and 18.86 mS/cm. The obtained results matched with the findings of Mehta (2013). The measurement of TSS ranged minimum of 3160 mg/l at station 1 and maximum level 8920 mg/L at station 6 (Fig. 2d), TDS minimum level of 34,880 mg/l and maximum level of 38,400 mg/l were recorded station 5 (Fig. 2e), TS minimum value ranged from 38,040 mg/l in station 1 and maximum value to 45,480 mg/l in station 6, respectively (Fig. 2f). Solid particles were highly recorded at the ablution pond and nearby station zones because of mass bathing, offering vegetables, flowers, garlands etc highly promoted the solid particles (Mathur *et al*., 2008). The excess level of solids particles in aquatic environment caused various stresses, such as increasing oxygen demand, low-nitrification rate, and promoted propagation of pathogens. In addition, low level of solid particles reduces light penetration into seawater, and it affects the primary production of algae, macrophytes, and sea grasses and its direct damage reduces fish growth rate and causes fish diseases in the marine ecosystem (Klontz *et al*., 1985, Liltved and Cripps, 1999). These solid particles are transported to the offshore environment which led to many serious deleterious effects affecting the seawater and benthic environment biological species diversity (Kim and Yur, 2004). Especially, this coastal region immensely supports the rich and diverse fauna like corals, sea anemones, mollusks, sea cucumbers, starfishes, and sea urchins, and it also serves as feeding and nursery habitat for endangered species, such as dugong, turtles, and many commercial and recreationally important fishes (Manikandan *et al*., 2011). Therefore, water quality protection is more crucial in this region. The measurements of BOD values observed ranged from 13 mg/l to 26 mg/l. Minimum range values were observed in the offshore station, and maximum level values were observed in the inshore ablution pond station (Fig. 2g). Several authors have reported that religious activities highly promoted the organic load in the aquatic environment because of which more amount of oxygen depleted in the aquatic environment (Kulshrestha and Sharma, 2006; Kaur, 2012). BOD measurement of inshore water showed that aquatic environment is highly affected. This measurement is major prime factor affecting water quality (McCoy and Olson, 1986; Singh *et al*., 1999; Parashar *et al*., 2003; Sangeeta and Savita, 2011). The sulphate showed minimum range of 2715 mg/l recorded from station 1 and maximum range of 3201 mg/l recorded at station 7 (Fig. 2h). The physico-chemical parameters results showed strong correlation as observed with solid particles in ablution pond stations zones (shown in the Table 1).

Fig.2a

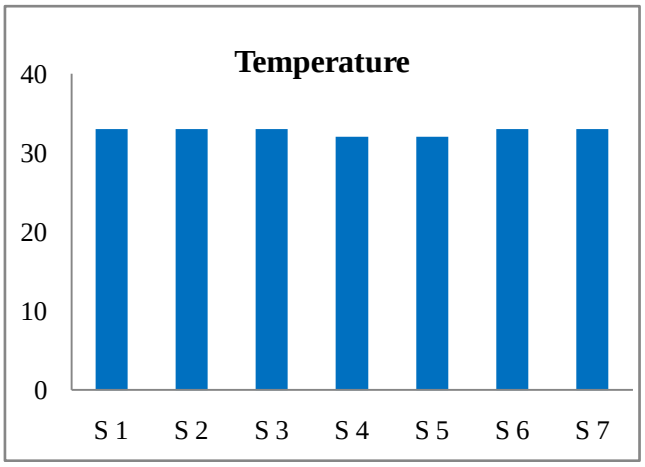
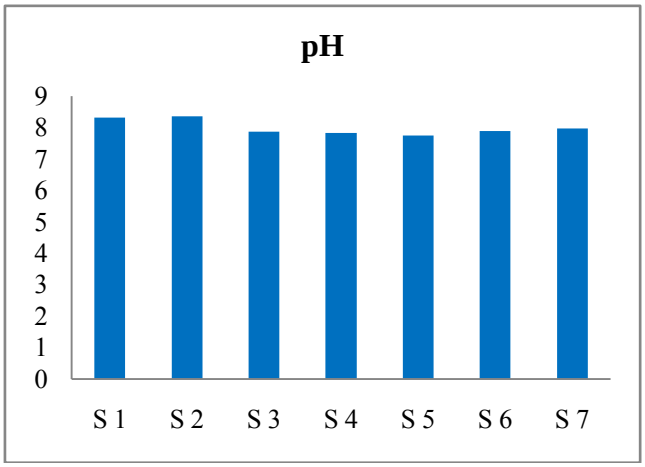


Fig.2b



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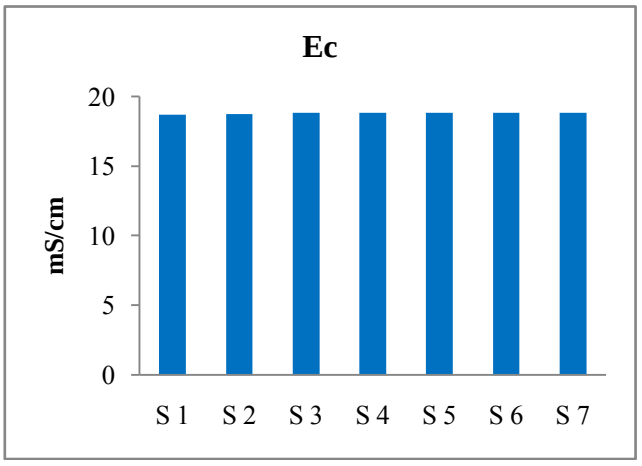

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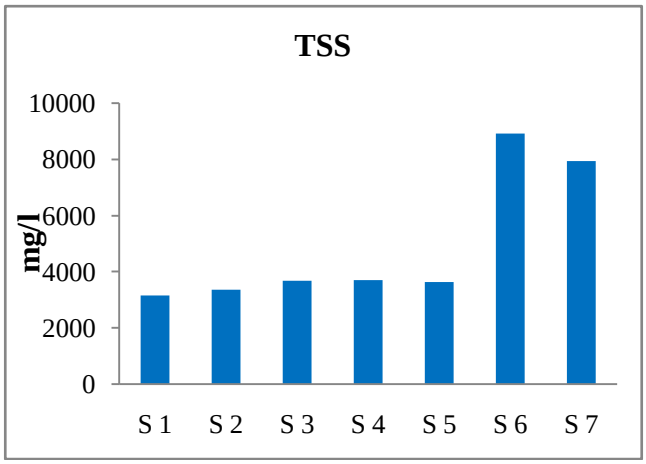

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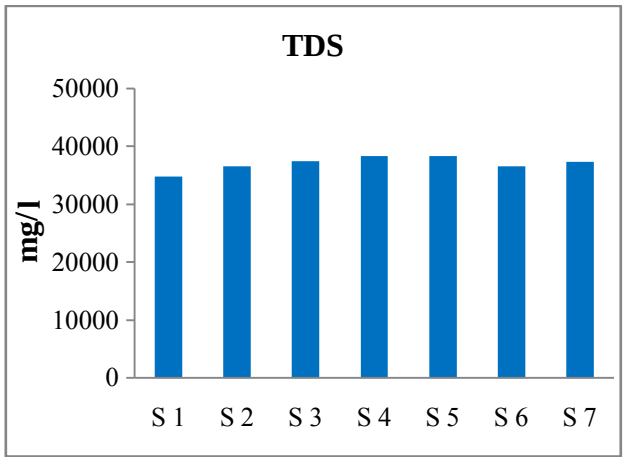

Fig.2f

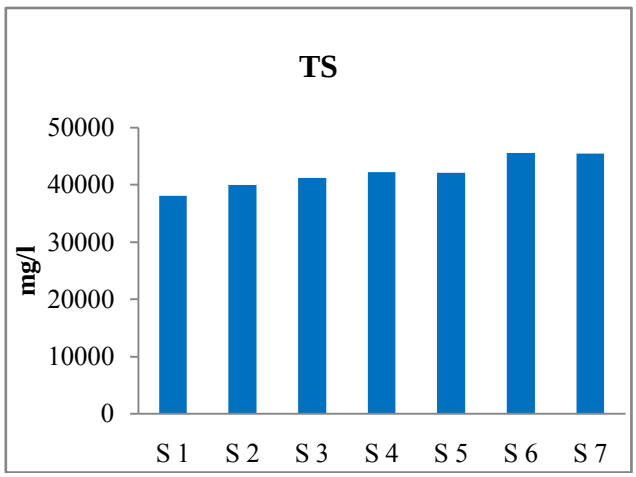

Fig.2g

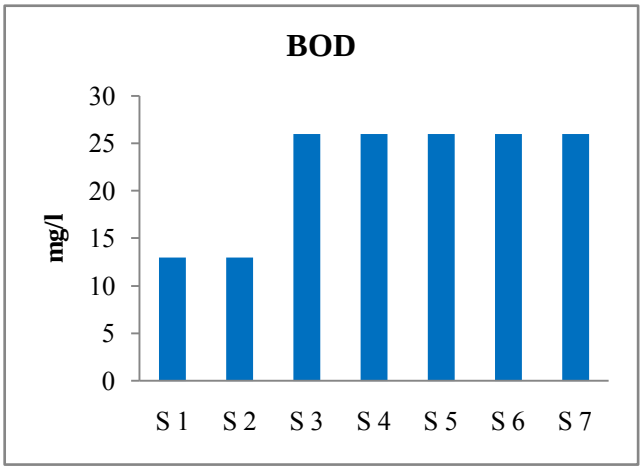

Fig.2h

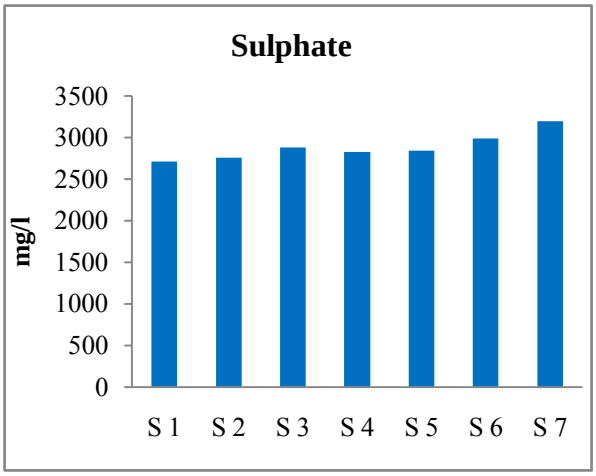

Figure 2 : Spatial variation of physico-chemical parameters in seven station seawater samples

Table1 : Pearson correlation analysis based on physico-chemical parameters and microbial indicators correlation test

	pH	EC	Temp	TSS	TDS	TS	BOD	SO_4	THBC	TFC	TAC	TEBC
pH	1											
EC	-.908**	1										
Temp	.594	-.426	1									
TSS	-.255	.546	.349	1								
TDS	-.815*	.791*	-.722	-.011	1							
TS	-.597	.848*	-.014	.891**	.444	1						
BOD	-.960**	.966**	-.400	.467	.763*	.764*	1					
SO_4	-.420	.665	.210	.845*	.297	.893**	.639	1				
THBC	-.360	.645	.128	.828*	.308	.884**	.577	.976**	1			
TFC	-.514	.772*	.032	.873*	.348	.941**	.710	.937**	.954**	1		
TAC	-.154	.452	.340	.924**	.014	.836*	.379	.922**	.930**	.873*	1	
TEBC	-.267	.507	.194	.720	.232	.753	.483	.953**	.967**	.870*	.896**	1

***. Correlation is significant at the 0.01 level (2-tailed).*
**. Correlation is significant at the 0.05 level (2-tailed).*

b) Assessment of microbial pollution load indicators

Preliminary step of microbial pollution assessment was monitored with the specificity of selected microbial indicators in the study area. The microbial pollution was immense which showed high value for the selected indicators (Sato *et al*., 2005). The measurements of THBC indicators showed highest numbers observed as 603 cfu/0.1 ml at the station 7 and lowest level 105 cfu/0.1 ml as observed in station 1. This obtained result showed that there is consistently unbelievable increase in the level of THBC counts in ablution pond station (Fig. 3a). Recent studies have shown links between the religious activities and aquatic environment recorded from observations for the total heterotrophic bacteria counts (Mishra *et al*., 2009). The measurement of TFC showed highest number of 47 cfu/ml at station 7 and 3 cfu/ml lowest level recorded at station 1 (Fig. 3b). Monitoring fungal organism has crucial role of sea organisms and human health impacts associated with coastal environment recreational places (WHO, 1998). Global population of 20–25% has been affected with fungal disease infections (Havlickova *et al*., 2008). Particularly, sea and other natural surface water recreational contacts have caused many infections in skin, keratinized tissues, such as nails, fur, and hair piodermiae, and inner organs, such as digestive organs, brain, lungs illness, and urogenital tract infections which are possible even without previous mechanical injury (Milan *et al*., 2005; Boutiba *et al*., 2012). The measurement of TAC at offshore station showed lowest

level of 17 cfu/0.1 ml and highest level of 104 cfu/ml were observed at station 7 (Fig. 3c). Actinomycetes colonies grown well in organic, and other waste materials accumulated environment. This immensely supports that the most of the waste materials decomposes because of which immobilization of mineral nutrients in organic matter occurs. In addition, it also plays a significant role for the protection of the physical and chemical process in the marine ecosystem (Goodfellow and Haynes, 1984; Baskaran *et al*., 2011). The measurement of TEBC lowest levels were recorded in offshore station 1 as 15 cfu/0.1 ml and highest level for the station 7 recorded as 425 cfu/0.1 ml (Fig. 3d). This data supports similar observations as reported for other studies while investigating the highly populated enteric bacteria attributable to the religious activities in aquatic environment (Bhatnagar and Sangwan, 2009). Here, enteric bacterial assessment was significant in parts of the public health and coastline biosphere. Some studies in India indicated that devotees' religious activities causes number of waterborne and other communicable diseases from enteric bacteria polluting pilgrimage places (Pandey *et al*., 2005; Semwal and Akolkar, 2006; Saini *et al*., 2009) Because of everyday holy bathing and other contacts from polluted ablution pond environment. It may lead to the transmission of waterborne disease and infection spread among human beings through seafood. In India, 21% of the diseases are water-related (Srikanth, 2009). In addition, 80% global level of all disease and infections are spread through pathogenic materials contaminating in water and food (Tayo *et al*., 2011). Especially, pathogenic enteric bacterial species of Salmonella, Vibrio, and Escherichia coli O157:H7 contaminating seawater are responsible for the food-borne disease outbreaks in worldwide (Velusamy *et al*., 2010). These regions are seafood-productive ecosystem, and 22% of Tamil Nadu state is fishing on these polluted environments (Johnson *et al*. 2013). The Pearson correlation test showed a positive correlation for the religious activities affecting seawater physico-chemical quality and microbial indicators (except for the some parameters; shown in the Table). The observed seawater physico-chemical and microbial parameters results exceeded the maximum permissible limit of Indian primary class SW-II quality standard values. These types of religious activities are highly affecting the ablution pond seawater and nearby coastal zone.

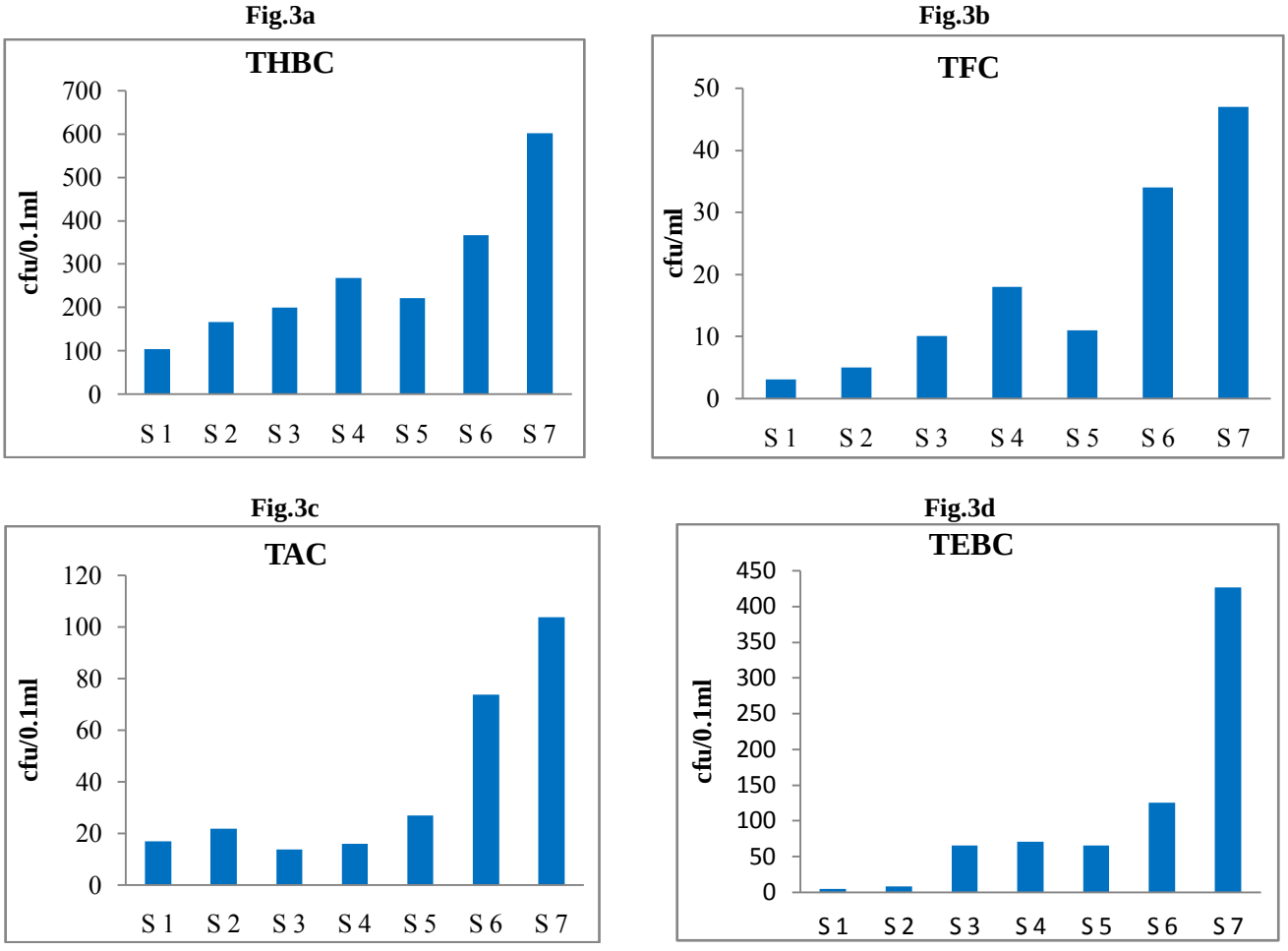

Figure 3 : Spatial variation of microbial indicator in seven station seawater samples

V. Conclusion

The present findings clearly revealed that the devotees conducting ritual ceremonies highly affects the physico-chemical and microbial characters of the seawater in Devipattinam, Navagraha temple. Pathogenic microorganisms affecting humans are found significantly high in the ablution pond locations. The contaminated holy ablution pond seawater is obviously unfit for human beings usage according to the category of Indian seawater II standard. Furthermore, ritual bathing is not recommended in that water. In addition, this coastal zone is the marine fisheries sector in Tamil Nadu state. Hence, ritual ceremonies practice should be regulated. This study plays a crucial role for ensuring coastal quality management and provides prevalent information to prevent the waterborne disease to human beings. Hence, the government must implement some strict effective regulations and monitoring methods and impart in parts of coastal zone.

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