

A forecast visual observation of the anthropogenic impact on the pilgrimage places along the Southeast coast of Tamil Nadu, India

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Abstract

The present investigation is focused on the forecasting visual observation of the impact of anthropogenic activity on the pilgrimage places located along the coastal environments in Tamil Nadu, India. Devotees performing the unregulated ritual ceremonies, open defecation, waste materials dumping and local municipality discharging wastewater contamination levels were assessed from direct visual surveillance, and by taking photographs and baseline information collected from five different pilgrimage sites. Results showed that ritual ceremonies, wastewater discharges and debris highly contaminated site-III, and found open defecation at site-I. The lack of coastal regulation, pollution awareness, insufficient sanitation facilities and failure to control the commercial and recreational activities have major deleterious effects on the present and future environments of the coastal areas. This is the first attempt conducted by visual assessment of the coastal pollution in pilgrimage places. The results immensely support the recommendation for proper regulation of ritual activities, arrangement of basic sanitation facilities and prohibition of wastewater discharges to prevent waterborne diseases as well as to strictly follow the regional and national level of coastal regulation policy to protect the biological resources of the Gulf of Mannar marine ecosystems.

Keywords: Shoreline holy places, unregulated ritual impact, Wastewater and Open-defecation, Physiochemical and Microbial pollution, Gulf of Mannar

1. Introduction

Festivals are an integral part of the human life, and unregulated religious festivals by generating degradable and non-degradable waste materials, vigorously affect the environmental qualities and reduce the biological diversities in the foremost pilgrimage places of the coastal ecosystems [1,2,3]. Untreated wastewaters contain a vast amount of toxic chemicals and pathogens that decreases the quality of the entire coastal marine ecosystems[4,5]. The chemical pollution is a main concern in the coastal marine ecosystem, particularly metals causing the bioaccumulation and biomagnification causes major threats in the entire food chain [6,7]. In addition, chemical pollution significantly alters the pH, EC, DO, nutrients, etc. generate toxicity conditions on the seawater and sediments [8]. The pollution impact was decrease of biological resources of the coral reef, sea grass, seaweed and mangroves directly affect food availability and shelter of marine organisms and water clarity [9].

Pathogenic microbial pollution of beach and seawater recreation and consumption of contaminated seafood causes more than 250 million cases of gastroenteritis and respiratory diseases and 5-10 million cases of hepatitis all over the world [10]. In India, a wide range of anthropogenic activities leads to deterioration of the coastal quality and a decrease of the biological resources in the coastal marine ecosystems [11]. People performing different types of ritual ceremonies at pilgrimage places and the rapid development of residential and commercial activities have major deleterious effects on the coastal marine ecosystem [3,12,13]. A number of the authors were reported the seawater and sediment quality in India, but very few authors reported the devotees causing unregulated ritual activities impact in the coastal ecosystem [14,15, 16, 17]. To the best of our knowledge this holistic forecasting visual observation study is the first attempt to assess the impact of anthropogenic activities at pilgrimage places on the southeast coastal ecosystem in India. Therefore, the objective of this research is focused to infer the (1) unregulated religious activity impact, (2) wastewater discharges in the pilgrimage places, (3) open defecation and (4) debris impact in the pilgrimage places located along the southeast coastal regions of Tamil Nadu, India.

2. Materials and methods

2.1 Study area

The visual observation study was conducted at the five different important pilgrimage places in the Southeast coast of Tamil Nadu, India (Fig. 1). Site-I Our lady good health church

(10°40'0.12"N; 79°49'0.12"E), site-II Navagraha temple (10°40'0.12"N; 79°49'0.12"E), site-III Sri RamanathaSwamy temple (09°17'17.16"N; 79°19'2.28"E), site-IV Subramanian Swamy temple (08°29'45.24"N; 78°7'44.76"E) and site-V Kanyakumari Bhagavathi Amman temple (08°9'47.16"N; 77°16'48.36"E). In these pilgrimage places visitors celebrate different types of the ritual ceremonies performed in the coastline environments. Every day, more than two thousand of public and festival season millions of general publics engaged in these pilgrimage places. In addition, the coastal environment wide range of leisure space of sandy, rock and muddy beaches, shallow gradient and mesotidal ranges considerably attract a large number of regional and countrywide level tourists stretched in the five places. The pilgrimage place located in the Gulf of Mannar region is one of the richest marine biodiversity places of the Asian level. The Gulf of Mannar region is occupied by 4,223 species of plants and animals, particularly major economical valuable biological resources of the 15 sea grass species, 181 species of seaweeds, comprising green algae, brown algae, red algae and blue-green algae, 117 coral species, 11 mangrove species, 1147 fish species and endemic species of the dugong is commonly known as sea cow in the coastal marine ecosystem, and its supporting to moral economic level in India [18]

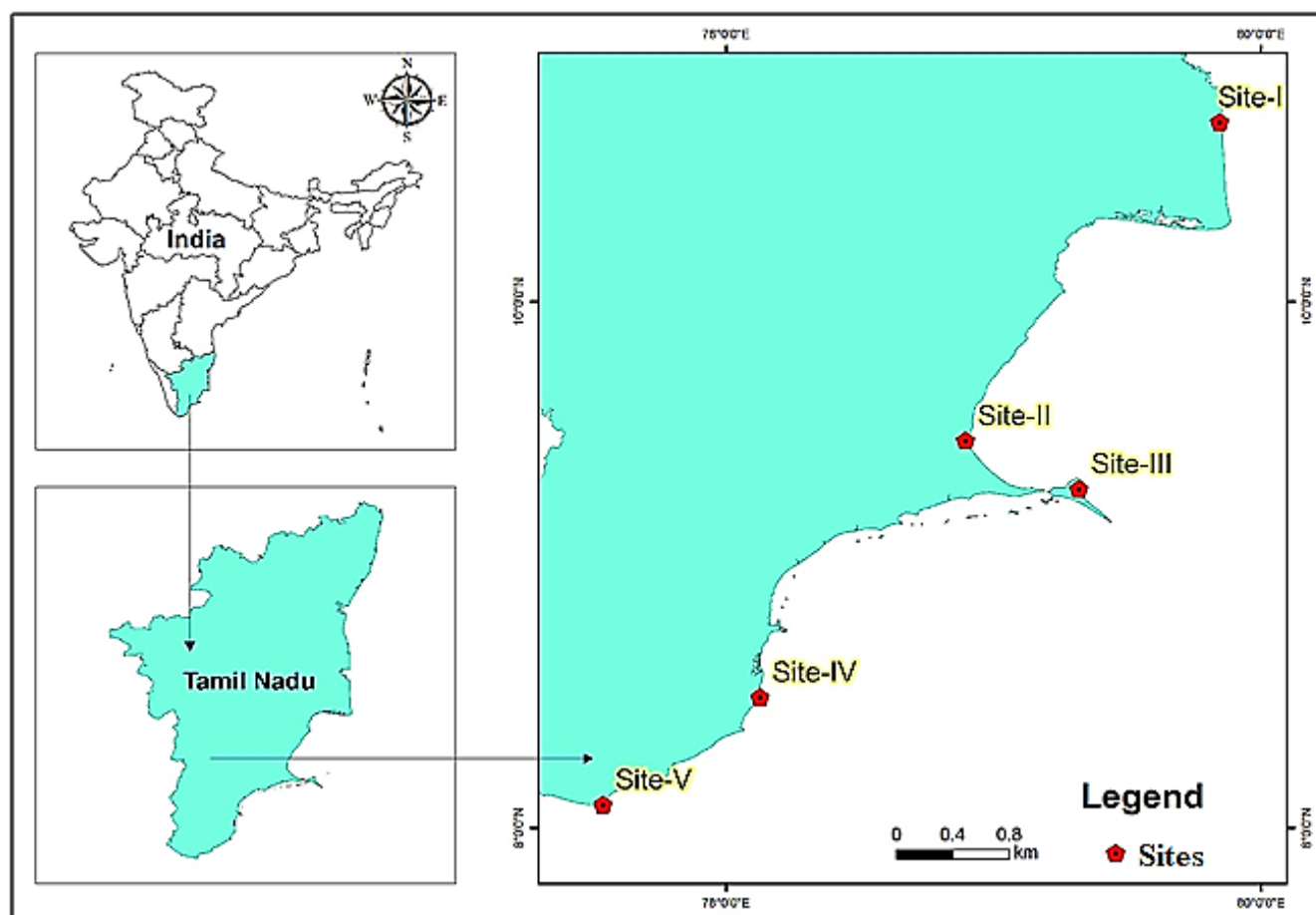


Fig. 1. The map showing these study sites.

2.2 The visual observation of coastal pollution

Coastal pollution levels were assessed by direct visual surveillance, photographs and baseline information collected during the month of January-December 2015 at the five sites. The observation work started in the early morning and at until sunset. Four major pollution sources were identified (1) religious ceremonies; (2) wastewater discharges; (3) open defecation and (4) Debris.

2.3 Observation of religious ceremonies

Pollution level was visually observed during different types of ritual ceremonies; holy bathing (Devotees population density) and puja ceremonies using degradable and non-degradable materials (Millet, semolina, corn, rice, sorghum, paddy, wheat, pulses, vegetables, flowers, fruits,

banana leaf, cloth, milk, curd, ghee, coins, idols, camphor, ashes of departed ones and body hairs). Information related to ritual ceremonies were collected by the devotees and priest in the five sites.

2.4 Assessment of the wastewater discharges

The wastewater discharges pollution level was monitoring the number of canals and wastewater discharges pipeline connection counted on along the shoreline environment and improper designs of the wastewater treatment plant discharges of the untreated wastewater approximate level information collected from the water treatment plant (WTP) operator and shoreline store employees and fisherman.

2.5 Estimation of the open defecation

Fecal pollution was estimated by measuring the fecal pellets level (including those from the wild and pet animal population), counting the toilets and monitoring the management of sanitation facilities at the shoreline environment of the five sites.

2.6 Estimation of the waste debris

The debris pollution level was increased by the devotees by throwing ritual materials and tourist people lifted materials such as paper, plastic and steels on the beach and seawater environment. A number of the dust pins were counted in a shoreline environment at the five sites.

3. Results and Discussion

3.1 Ritual ceremonies impacts

The highest level of ritual pollution was observed at site-III and the lowest level at site-I (Fig. 2 & Table. 1). Increased amounts of degradable and non-degradable ritual materials offered by devotees affected the temperature, pH, EC, suspended solids, DO and nutrient levels in the seawater [17,19,20]. Increased suspended solids (>1000 mg/l) resulting increased turbidity level, which interfering with light penetration, resulting decrease of photosynthesis processes in the plankton population in coastal marine ecosystems [21,22,23,24]. Inadequate pasteurization process of raw milk offering was >100 cfu/ml of coliform bacteria and a mixture of the organic load may deplete the oxygen level (<5 mg/l) in seawater pushing to intolerant of depressed oxygen will either die or try to avoid the most of the coastal organisms and increased the mortality rates in coastal ecosystem ([25,26,27,28,29]. The mass level of holy bathing was exceeded the standard

permissible limit (SPL) indicator levels of the heterotrophic bacteria (>61 cfu/ml⁻³) (SPL 100 cfu/ml), total coliform bacteria (>57 cfu/ml⁻²) (SPL <100 cfu/100) and total *Enterococcus* bacteria (>41 cfu/ml⁻²) (SPL 100 CFU/100 mL) in seawater [3,26,30]. Idol immersion increased the heavy metal concentration Cr 0.05 mg/l (SPL 0.1 mg/l), Pb 0.45 mg/l (SPL 0.01 mg/l), Ni 0.17 mg/l (SPL 3 mg/l), Hg 0.78 mg/l (SPL 0.01 mg/l), As 0.5 mg/l (SPL 0.02 mg/l), Si 3.82 mg/l, 0.35 mg/l, Mg 10.0 mg/l and Ca 68.4 mg/l (SPL 75 mg/l), causing serious adverse effects in coastal organisms and affects human health [23,31,32,33,34]. Trampling behavior of millions of people often disturb and destroy seabirds and turtles; affecting nesting and feeding, reducing parental care of highly vulnerable eggs, thereby affecting the biological diversity of the coastline environment [35,36].



Fig. 2. The photography evidence of the ritual ceremonies impacts in the coastline environment.

Table 1. The ritual ceremonies impacts on the coastal quality status in the five sites.

	Ritual ceremony	Offering materials	Quality	
			Beach	Sea water
Site I	Holy bathing	NP*	NP	**
Site II	Holy bathing and Pujas	Flower, fruits, oil, millet, semolina, corn, rice, sorghum, paddy, wheat and pulses,	NA	*
Site III	Holy bathing and Pujas	Millet, semolina, corn, rice, sorghum, paddy, wheat, pulses, vegetables, flowers, fruits, coconut, banana leaf, cloth, <i>milk, oil, curd, ghee, coins, idols, camphor, ashes of departed ones and body hairs</i>	*	*
Site IV	Holy bathing and pujas	Millet, rice, flowers, fruits, vegetable, fruits, banana leaf, <i>milk, curd and ghee</i>	***	**
Site V	Holy bathing and pujas	Fruits, banana leaf, milk, <i>curd, ghee, flowers and cloth</i>	***	**

Site-I Our lady good health church, Site-II Navagraha Temple, Site-III Sri Ramanatha swamy temple, Site-IV Subramanian swamy temple, Site-V Kanyakumari Bhagavathi Amman temple.

*** Good; ** Average; * Poor; NP-Not performed; NA-Not accessed

3.2 Wastewater impacts

Maximum level of wastewater discharges was observed at the site-III and lowest level was site-V (Fig. 3 & Table. 2). Wastewater discharge resulted in black color, bad-odor, high turbidity, floating debris, litter and visually observable human fecal stools in the seawater. The absence of the water treatment plants in hotels, small industries and residential areas generates wastewater that is directly discharged into channels and pipelines at pilgrimage places along the seawater in the site-III. The wastewaters contain heavy metals, oil and grease, insecticides, pesticides, PAHs, steroids, surfactants, nutrients, pharmaceutical, personal care products and pathogens. These compounds cause biochemical and immunochemical responses and functional changes at cellular levels of filter feeder organisms of the benthic communities [8,37,38,39,40]. Particularly, fecal pathogens such as *Escherichia coli*, *Salmonella*, *Shigella* and *Klebisella*, contaminated up to 30 cm of sediment environment and accumulated highly in the benthic biological communities increasing mortality and morbidity rates in the coastal marine ecosystem [41]. A recent report

showed that untreated wastewater released by villages and residential areas surrounding the Sri Ramanatha Swamy temple decreased the 8.9% (32 km²) coral reef system in the Gulf of Mannar marine ecosystem of India [42,43].



Fig. 3. The photography evidence of the wastewater discharges in the coastline environment.

Table 2. The wastewater pollution status in the five sites.

	Wastewater discharges (100-1000 lit/ day)		No. of wastewater treatment plant	Coastal quality status
	No. of canals	No. of pipelines		
Site I	1	0	0	**
Site II	0	0	0	***
Site III	0	3	1	*
Site IV	0	1	0	**
Site V	0	0	0	***

*** Good; ** Average; * Poor

3.3 Open defecation impacts

Minimum level of open defecation feces pollution was observed at the site-V and maximum level observed at the site-I (Table 3). Insufficient sanitation facilities such as latrines and bathrooms, aged and improper maintaining resulted in open defecation of millions of people causing an increased level of fecal pathogens at site-I. The fecal pellet was contaminated 3 m² patch of undisturbed beaches, and high traffic area bacterial sized particle translocation on average 1.6 m in just 4 h in the recreational beaches [44]. The human feces contain 10⁹ to 10¹¹ g⁻¹ level of fecal coliform bacteria, *Enterococci* bacteria and viruses were contaminated in the beach and seawaters [45,46]. In addition, offering of ritual food materials and dumping of waste material attracted the residential and wild animals causing deposition of fecal pellet by dogs (10⁹-10¹⁰) cows and birds (1.77 × 10⁸), gull (1.77 × 10⁸), geese (1.28 × 10⁵) per gram fecal pathogens changed the temperature, pH, salinity, nutrient deficiencies, sunlight and predation in beach and seawater environments [47,48,49]. Direct surface contact of contaminated seawater on skin, eyes and mucous membranes, as well as inhalation and ingestion by holy bathing caused diarrhea, dysentery, jaundice, typhoid, cholera, liver and gastrointestinal disorders in bathers. In addition, pregnancy outcomes, such as increases in low birth weights, preterm births, stillbirths, and spontaneous abortions were increased in pilgrims, tourists and nearby dwellers [50,51,52,53,54].

Table 3. The open defecation pollution status in the five sites.

	No. of toilet shoreline environment		Open defecation
	Free toilet	Payable toilet	
Site I	0	0	Very High
Site II	1	0	Low
Site III	0	3	Low
Site IV	2	2	low
Site V	0	2	Low

3.4 Debris impacts

The lowest quantity of debris pollution was observed at site-V and highest quantity observed at site-III (Fig. 4 & Table. 4). High level of unregulated ritual and commercialized activity resulted in huge amounts of debris, such as ritual materials and packaging, spoons, carry bags, water buckets, bottles and caps, soft drink cans, sneaks bucket covers, children toys, confectionary wrappers, balloons, cigarettes and cigarette holders, at site III. A recent statistic demonstrated that devotees generated per day 300,000 kg solid waste of biodegradable (organic, paper and textile) and non-biodegradable waste (plastics, glass and metals) in 12.3 km in pilgrimage places surrounding the terrestrial and aquatic environments [55]. The debris spread and accumulate in the beaches, washing up on high and low tide activities through entering in the seawater, and land runoff of the heavy rainfall, heavy wind speed and ocean currents were spread the offshore coastal marine ecosystems [56,57]. The floating debris in the offshore environment settles in sediment benthic zones and was ingested by marine organism mistaking the plastics for foods [58]. This blocked the digestive tract and reduced feeding activity due to a false sense of satiation, internal injury, causing starvation and death of coastal organisms such as tunas, squid, toothed whales, fishes, reptiles, seabirds, fur seals, turtles and mammals [59,60,61]. The plastic debris containing toxic chemical compounds such as phthalates, bisphenol A (BPA) and styrene monomers causes endocrine disruption, mutagenicity and carcinogenicity in marine organisms [62,63,64,65]. In addition, cigarette filters association of metals such as Al, Fe, Mn, Cu, Zn, Pb, Ag, Cd, Co, Cr, Mo, Sb, Sn and U may cause the bioaccumulation of these toxic metals in humans

through consumption of contaminated seafood can lead to serious adverse effects such as prostate cancer, breast cancer, sperm count decreases, miscarriage, obesity and diabetes testicular dysgenesis syndrome [66,67,68].



Fig. 4. The photography evidence of the debris pollution in the coastline environment.

Table 4. The debris pollution status in the five sites.

	No. of dust pin	Sources of debris			Quality	
		Ritual activity	Commercial activity	Recreational activity	Beach	Seawater
Site I	0	Low	High	High	Poor	Average
Site II	1	High	Moderate	Low	NA*	Poor
Site III	1	High	High	Moderate	Poor	Poor
Site IV	1	Moderate	Moderate	Moderate	Average	Average
Site V	1	Low	Low	Moderate	Good	Good

*Not Assessed.

4. Conclusion

The present study demonstrated that unregulated anthropogenic activities highly affected the coastal quality and human health in the pilgrimage places. Based on the results following insight into the notions to four ways of instruction as suitable for control of the coastal pollution; (i) Ritual ceremonies; given the separate arrangement of compactable and recollecting ritual materials at a small level of artificial seawater pond construction in a shoreline environment best ways to reduce the ritual pollution; (ii) The capable of full efficient wastewater treatment plant construction and renovation is moral support to control of wastewater pollution; (iii) Increase the sanitation facilities and properly maintaining the good hygienic infrastructure of bathroom and latrine facilities and mobile toilets; control the fecal pollution and last (iv) Restrict the usage of the plastic cups and carries bags in the shoreline stores and hotels and increase the dust pin counts will decrease the debris pollution. The present investigation easily gives the immediate solution, prevent the short and longtime impact of the coastal and human health, and create the coastal pollution awareness, supporting to the enrichment of the flora and fauna population of the Bay of Bengal and Palk Bay regions. Overall, our study suggested the risk of wastewater toxic chemical levels, ritual materials, debris and fecal pellets associated microbial, and organic and inorganic

compound contamination in the pilgrimage places situated along the south east coast of Tamil Nadu.

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