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Studies on Weather and Water quality Parameters of Manapad Estuary, Tamil Nadu, India

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ABSTRACT: Pollution and environmental stress are being caused by industrial sources, urbanisation, and an expanding population worldwide. As a result, a research was done on the Manapad Estuary in Tamil Nadu, India's weather and water quality factors. According to the findings of the current study, the hottest months were June and September. In 2018, the months of July and August saw the highest wind speeds in Manapad. August and November experience the windiest weather. The month with the most rain was April. The wettest months were January, February, October, and December. May and July both had periods of low pressure. Sea water has a constant appearance, color, and scent throughout the study. Total dissolved solids and electrical conductivity vary across the sampling months of 2018.In the current inquiry, an average pH of 8.01 was recorded in the month of April, and the month of August had the greatest alkalinity levels. The examined months showed a significant variance in hardness, with May and November recording the highest calcium carbonate hardness readings. It was confirmed that the maximum oxygen absorption had occurred in the months of January, April, May, August, October, November, and December. The maximum calcium content was found in November. The highest levels of magnesium were recorded in February in the current research. In the current investigation, the month of October had the greatest sodium concentration. Throughout the course of 2018, there were fluctuations in the levels of potassium, with May recording the greatest levels. The ammonia levels in the Manapad Estuary during 2018 reportedly hit unusually high levels in the months of January, February, and March, according to the current study. There was no change in the amount of nitrite and the nitrate concentration varied significantly between the sampled months in the current study. In the interim, the highest chloride concentrations were found in the months of June and September. The highest sulphate levels were found in the months of January, February, March, April, September, October, November, and December in the current study. In the current investigation, the month of March had the highest concentration of phosphate (mg/l). There were more bacteria than fungi or actinomycetes. In the water samples analysed during the year of 2018, actinomycetes was the least common microbe.

Keywords: Manapad, Estuary, Pollution, Weather, Physicochemical aspects, Microbial parameters.

INTRODUCTION

Monsoonal estuaries are those in India that are influenced by the monsoon season's rainfall (Sarma *et al.,* 2011). When peak flows occur, seasonal runoff into these monsoonal estuaries far outweighs the total volume of the estuary, turning the entire estuary into a river (Sarma *et al.,* 2009). Flow events can significantly affect both primary productivity and biogeochemical processes. Lower phytoplankton biomass is found in some Indian estuaries, including the Cochin Estuary (Gupta *et al.,* 2009); Godavari Estuary; Sarma *et al.,* 2009; Mandovi-Zuari Estuary; Lewis and Wallace 1998) because of excessive turbidity that prevents light from penetrating the water (Sarma *et al*., 2011). Estuaries are crucial for maintaining ecosystem services because they serve as a habitat for a variety of species, as well as a place for enjoyment and transportation (DeSousa *et al*., 1981).

The environmental factors that characterise a given water mass, such as terrain, water velocity and stratification, salinity, oxygen, temperature, and nutrients, also determine the composition of its biota (Prabu *et al*., 2005). They typically exhibit significant seasonal fluctuations in the near shore waters and estuaries depending on the local rainfall, tidal incursions, numerous abiotic and biotic processes, and the amount of fresh water influx affecting the nitrogen cycle of diverse coastal settings (Govindasamy *et al*., 2000).

In their 2016 study, Sharma and Walia (2016) looked into the investigation of the Beas River's water quality indicators in the summer. According to data analysis, the permitted level set by the Bureau of Indian

Standards (BIS), 2012 for drinking water in India was exceeded for cadmium, iron, and other elements.

Estuarine ecosystems are extremely productive systems with a wide range of physico-chemical parameters that are prone to seasonal and daily changes caused by biological and physical processes (Senthilkumar *et al.,* 2002). Salinity may change sporadically because of rain events or daily owing to tidal cycles. Due to photosynthetic, metabolic, and tidal cycles, as well as variations in pH, dissolved oxygen (DO) levels and levels of alkalinity (pH) may also change on a daily basis. Another element that may be more crucial than is widely understood is pH. pH is typically not thought of as a cause for concern because the high quantities of bicarbonate, calcium, and other ions in high-salinity saltwater provide significant buffering capacity against pH fluctuations (Senthilkumar *et al.,* 2002).

Through man-made activities like the discharge of domestic sewage and industrial effluents into estuaries, which has led to a significant decline in the population of shallow water fish and the disappearance of numerous flora and fauna, the health status and biological diversity of Indian estuarine ecosystems are deteriorating day by day (Kumar and Achyuthan 2007). Because of bioaccumulation processes, heavy metal contamination in the marine environment gets into the food chain and poses major risks to human and environmental health. Heavy metals like Zn, Pb, Cr, Co, Cu, Ni, and Cd have accumulated in marine animals like fish, prawns, crabs, and mussels (Kumar and Achyuthan 2007).

Therefore, an effort was made to research the weather, physical and chemical characteristics, and microbiological factors in the Manapad estuary in South Tamil Nadu, India, from January to December 2018.

MATERIALS AND METHODS

Description of study area. Manapad is a coastal village in far-southern Tamil Nadu, India. It is situated in the Gulf of Mannar Biosphere Reserve and is 11 kilometres from Tuticorin and 12 kilometres south of Tiruchendur (GOMBR). Near Manapad, there are a lot of coastal communities where fishing is the primary industry.

Weather Report. The weather report for the Manapad estuary for the months of January through December 2018 was gathered from the website https://www.worldweatheronline.com/lang/es/manapad-point-weather-history/tamil-nadu/in.aspx. It included the minimum and maximum temperatures, wind speed, rainfall, humidity, cloud cover, and pressure. The statistics were gathered on the fifteenth day of every month.

Estimation of Physicochemical parameters. Samples of water were taken from January to December 2018. For the purpose of analysing the nutrients in surface water, clean polyethylene bottles were used to collect the samples, which were then promptly transferred to the lab and maintained in an ice box. The method described in APHA was used to assess a variety of physicochemical parameters, including appearance, colour, odour, total dissolved solids, electrical conductivity, pH, alkalinity as $CaCO_3$, hardness as $CaCO_3$, oxygen absorption, calcium, magnesium, sodium, potassium, ammonia, nitrite, nitrate, chloride, sulphate, and phosphate (American Public Health Association (APHA), 1992).

Estimation of Microbial parameters. Serial dilution and pour plate procedures were employed to estimate the water's microbial parameter. The procedures were carried out under rigorous aseptic guidelines and with a focus on safety. To count the number of bacteria, Zobell Marine Agar was employed. For the estimation of fungi, modified Malt Extract Agar was usedand modified Starch Caesin Agar was used to isolate actinomycetes.

The microbiological count was performed using Standard Microbiological Criteria techniques. The instruments employed were as precise as they could be. AR grade chemicals were employed. When sampling, all necessary precautions were taken to prevent contamination. The number of colony forming units (CFU/ml) per millilitre of water was used to express the microbial population. The formula CFU/ml = (Number of microbial colonies × dilution factor) / Volume of culture plate was used to determine the CFU/ml of microorganisms.

RESULTS AND DISCUSSION

Weather report. The weather report of Manapad estuary during the period of January 2018- December 2018 was given in Table 1.

Table 1: Weather report of Manapad estuary during the period of January 2018- December 2018.

Month	Temperature (°C)		Wind	Rain	Humidity	Cloud	Pressure
	Minimum	Maximum	km/h	Mm	%	%	mb
January	24	30	21 NE	0.5	72	34	1012
February	25	31	26 NE	1.3	72	33	1015
March	27	32	11 S	1.4	68	15	1010
April	28	32	9 S	14.8	70	26	1009
May	29	33	14 SSE	5.0	67	21	1007
June	28	35	26 WSW	0.0	60	42	1009
July	28	33	29 WSW	0.0	58	34	1006
August	27	30	32 WSW	1.6	67	66	1008
September	28	34	17 SSW	2.2	61	21	1009
October	27	30	15 SSW	4.0	72	32	1011
November	27	32	11 SSW	2.1	70	15	1009
December	25	31	18 ENE	0.8	71	16	1011

NE: North East; S: South; SSE: South and South East; WSW: West and South West; SSW: South and South West; ENE: East and North East

The collection of coastal meteorological and oceanographic data by coastal observatories is crucial for understanding regional processes. The results of the current study's temperature show that the months of June and September were the hottest. According to oceanographers, the shallow depth in the Gulf of Mannar that allows heat to penetrate faster may be the cause of the temperature increase (Tejonmayam, 2019). According to the current study, the wind speed in Manapad in 2018 was at its highest in the months of July and August and at its lowest in the months of March, April, and November. The reports of Jyothibabu *et al*. (1993), which state that the surface winds in the Gulf of Mannar are light from March to April (Pre-Monsoon) period, provide strong support for the current study. The vast Western Ghats mountain range, which runs along India's southwest coast, and the Knuckles mountain range, which is located in south-central Sri Lanka, have a wind tunnelling effect, which may be one of the reasons why the surface wind in the Gulf of Mannar is always stronger than that in its neighbouring regions.

According to Nimalanathan and Rajamanickam (2006), the coastal plains of the Gulf of Mannar region typically experience significant wind speeds. According to surveys conducted in 2018 by Suribabu and Neelakantan (2018), the windiest months are August and November, respectively because Gulf of Mannar is tropical and both the southwest and northeast monsoons have an impact on the region. Between January and December of 2018 there was a significant variation in rainfall in the study's area. In contrast to Suribabu and Neelakantan (2018), April saw the highest amount of rainfall. According to our research, the months of January, February, October, and December had the highest humidity levels.

According to the findings of the current investigation, unusually low pressure was seen in the months of May and July, with reported pressures of 1007 mb and 1006 mb, respectively. According to Suribabu and Neelakantan (2018) reports, the wind force near Pamban causes unpredictable tides. They added that the Gulf of Mannar region had rapid ocean currents. While the sea is quiet in September and tranquil from June to August, it is highly turbulent from April to August. Around a half metre is the local tidal amplitude (Suribabu and Neelakantan 2018). The current study reveals that Manapad in the Gulf of Mannar was experiencing extreme heat even as constant sea breeze increased humidity levels along coastal Tamil Nadu. This claim is confirmed by a team from the National Centre for Coastal Research, who discovered that corals developed as submerged reef structures as part of a restoration operation in the area have bleached due to an increase in sea surface temperatures during their routine underwater inspections (Tejonmayam, 2019).

Estimation of physical parameters. Table 2 lists the physical characteristics of water taken from the Manapad Estuary between January 2018 and December 2018. Throughout the course of the study, sea water has a consistent appearance, colour, and smell. The sampled months of 2018 show variations in total dissolved solids and electrical conductivity.

Table 2: Physical parameters of water of Manapad estuary during the period of January 2018- December 2018.

MONTH	Appearance	Colour	Odour	Total Dissolved solids (mg/l)	Electrical Conductivity (Micro mho/cm)
January	Clear	Colourless	None	16609	24790
February	Clear	Colourless	None	16543	24561
March	Clear	Colourless	None	16543	24691
April	Clear	Colourless	None	16881	25061
May	Clear	Colourless	None	22190	33120
June	Clear	Colourless	None	21000	32150
July	Clear	Colourless	None	20000	30165
August	Clear	Colourless	None	21000	31560
September	Clear	Colourless	None	23000	31850
October	Clear	Colourless	None	16850	25650
November	Clear	Colourless	None	16350	24680
December	Clear	Colourless	None	16980	24950

In the current investigation, the water is clear, colourless, and odourless, all of which indicate that there is no visual pollution. The total dissolved solids (mg/l) of the water collected from the Manapad estuary between January 2018 and December 2018 showed the highest total dissolved solids (23000 mg/l) and lowest total dissolved solids (16350 mg/l) in the months of September and November, respectively. According to the Jeyageetha *et al.* (2015). investigation at a particular Tuticorin Thermal Power Station (TTPS) plant, the maximum and minimum values were reported in August and November, respectively. The current analysis corroborated their findings. Early research (Tyler *et al.,* 2003; Sabaka *et al.*, 2016) frequently presupposed that the electrical conductivity of the ocean was uniform. But there is also evident that there was no credible global description or gridded data set of the observed ocean conductivity (Kuvshinov *et al.,* 2006). The months of May and June were the ones with the highest electrical conductivity of water taken from the Manapad estuary. 33120 Micro mho/cm and 32150 Micro mho/cm, respectively, were recorded as the electrical conductivity for these months. Seasonal variation is thought to have an impact on the electrical conductivity of in situ sea water as a function of its pH

(Nwoye *et al.,* 2014). Seasonal variation is a result of climatic change, which is also seen in the current study.

Estimation of chemical parameters. Table 3 lists the chemical characteristics of water taken from the Manapad Estuary between January 2018 and December 2018.

Table 3: Chemical parameters of water collected from Manapad estuary during the period of January 2018-December 2018.

Parameters	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
pH	7.79	7.95	7.99	8.01	6.76	6.85	6.65	6.75	6.89	7.35	7.56	7.89
Alkalinity as $CaCO_3$ (mg/l)	4750	5700	4760	4800	6000	5250	5300	6500	5450	5650	4800	4780
Hardness as $CaCO_3$ (mg/l)	10000	9856	8500	10000	15000	12000	11650	12000	9560	11550	15000	10000
Oxygen absorbed (mg/l)	2	1.6	1.6	2	2	1.6	1.6	2	1.6	2	2	2
Calcium (mg/l)	2700	2500	2200	2300	3100	2600	2500	2500	2500	2200	3200	2700
Magnesium (mg/l)	1080	1760	720	785	1680	1570	1550	1550	1080	1680	850	1260
Sodium (mg/l)	1300	850	1300	1300	310	1200	1100	1100	1210	1850	1250	1300
Potassium (mg/l)	23	22	23	36	45	23	23	25	22	25	22	21
Ammonia (mg/l)	1.28	1.28	1.28	1.06	0.8	1.21	0.8	1.23	1.21	0.9	1.19	1.21
Nitrite (mg/l)	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Nitrate (mg/l)	10	10	10	12	14	12	14	10	12	10	12	14
Chloride (mg/l)	5500	5300	4500	5450	7000	6500	6000	5450	6500	4500	5300	5400
Sulphate (mg/l)	206	206	206	206	29	56	80	175	206	206	206	206
Phosphate (mg/l)	0.16	0.16	0.26	0.18	0.16	0.16	0.16	0.16	0.16	0.18	0.16	0.16

Sundararajan *et al*. (2018) investigated the pH of the water in the Gulf of Mannar regions and discovered that one of the sites they tested had a maximum pH of 8.48. In the current investigation, a minimum pH of 6.65 was observed in July 2018 and a maximum pH of 8.01 was reported in the month of April. The highest alkalinity was found in the month of August (6500 mg/l), and the lowest alkalinity was found in the month of January (4750 mg/l). The presence of domestic waste and the lack of normal tidal action, which would have had a flushing and dilution effect on dissolved constituents as well as bicarbonates, which could increase alkalinity levels, may have contributed to the higher total alkalinity values recorded in summer regardless of the season (Dattatreya *et al.,* 2018).

According to Vilas and Ashwinova (2015), the Sunderban Mangrove ecosystem's total hardness ranged from 1800 to 9200 mg/l. Total hardness was found to range from 680 to 6800 mg/l along the Pichavaram mangrove forest, according to Mariappan *et al*. (2015). In contrast, there was a significant variation in hardness across the studied months, which was determined by the presence of calcium carbonate. Maximum calcium carbonate hardness measurements of 15,000 mg/l were made in the months of May and November, and the lowest measurements of 8500 mg/l were made in the month of March. The current investigation reveals that there were no significant differences between the sampled months of January to December in the oxygen absorbed report for the year 2018. The oxygen absorption ranges from 1.6-2 mg/l. The dissolved oxygen content varied between 2.7 mg/L and 5 mg/L during the study period, according to studies by Dattatreya *et al*. (2018).

The calcium content of the water drawn from the Manapad Estuary varied from January to December according to the study's sampling period. The month of November recorded the highest calcium concentration (3200 mg/l). Similarly, the coastal region of the Kudankulam Nuclear Power Plant was studied by Govindaraju *et al*. (2011) who found that the calcium level was high, at about 3300 mg/l. The findings of Govindaraju *et al*. (2011) are consistent with those of this investigation. The magnesium observed in February of the present study was 1760mg/l, which is in agreement with the work by Arasamuthu *et al*. (2017) where magnesium levels were 1250, 1204, and 1271 mg/l, respectively along the Tuticorin coast in the Gulf of Mannar in southeast India.

In the current investigation, the highest sodium concentration was found in the month of October, where it reached 1850 mg/l. In contrast, reports of Khan (2020) reported very high concentrations above 7000mg/l in various parts of Thoothukudi Harbour. The amount of potassium varied throughout the course of the year 2018, with the highest potassium (45 mg/l) recorded in the month of May and the lowest potassium (21 mg/l) recorded in the month of December.When Khan (2020) investigated the potassium levels in Thoothukudi Harbour at several sites, he discovered that the fishing harbour there has 247 mg/l of potassium, the outer harbour contains 233 mg/l, and the new harbour contains 258 mg/l.

According to the current study, the Manapad Estuary's ammonia levels during 2018 reached extremely high

levels in the months of January, February, and March, with a measured ammonia concentration of 1.28 mg/l. In contrast, ammonia concentrations in the study area ranged from 3.9 g/l to 19.8 g/l, according to Dattatreya *et al*. (2018)'s research. Manju *et al*. (2012) found that the mangrove habitats along the Kerala Coast had nitrite concentrations ranging from 0.15 to 0.99µM. According to Muthuraman *et al*. (2019), nitrite levels were found to range between 0.25 µmol/l and 0.75µmol/l at Threspuram and 0.14µmol/l and 0.56µmol/l at Kayapattinam. In contrast to all of these research, the current study found that the nitrite concentration stayed constant throughout 2018 and the water's nitrite concentration was 0.03 mg/ml. In the case of seawater, nitrate is typically regarded as a limiting nutrient for primary production (Muthuraman *et al.,* 2019). In the current study, there were significant differences in the nitrate content between the sampled months. The months of May, July, and December had the highest nitrate content (14 mg/l), whereas January, February, March, August, and October had the lowest nitrate concentration (10 mg/l).

According to Khan (2020) study, the month of May had the highest chloride content, with a total of 7000 mg/l of chloride observed in Thoothukudi Harbour. In the interim, the months of June and September had chloride concentrations exceeding 6500 mg/l. In the current study, the months of January, February, March, April, September, October, November, and December had the highest levels of sulphate (mg/l). 206 mg/l of sulphate were recorded over these months. Rainwater runoff, sewage waste, soil, fertilisers, decomposing plant and animal debris, and the breakdown of sulphate-rich effluents from the husk retting grounds may all have an impact on the elevated concentration of sulphate that is noticed throughout the winter season (Rajmohan *et al.,* 2016). The largest amount of phosphate (mg/l) in the current study was found in the month of March (0.26mg/l), whereas the lowest phosphate concentration, 0.16 mg/l, was started in the remaining months: January, February, May, June, July, August, September, November, and December. Therefore, it can be said that there are no signs of contamination of this kind in the Manapad Estuary in 2018.

Estimation of Microbial parameters. The microbes (Bacteria, Fungi, and Actinomycetes) from the water samples taken from the Manapad Estuary between January and December 2018 were counted, and their enumeration is shown in table 4. More bacteria were present than fungus or actinomycetes. In comparison to bacteria, fungi had a higher population, while actinomycetes was the least prevalent microorganism in the water samples examined during the year of 2018.

Table 4: Microbial parameters of water in Manapad estuary during the period of January 2018 to December 2018.

Month	Bacteria (CFU/ml) at 10^{-4} dilution	Fungi (CFU/ml) at 10^{-3} dilution	Actinomycetes(CFU/ml) at 10^{-2} dilution
January	36.66±2.516	01.66±0.577	03.33±0.577
February	50.00±2.645	08.33±1.527	13.33±2.516
March	35.66±3.055	02.66±1.527	02.33±1.527
April	30.00±4.000	02.33±0.577	01.66±1.154
May	39.66±3.511	05.00±1.000	06.66±0.577
June	22.66±2.516	01.00±1.00	00.66±1.154
July	14.66±2.081	01.66±0.577	01.33±0.527
August	40.00±3.000	06.33±0.577	09.33±1.527
September	23.66±1.527	01.33±0.577	03.33±0.577
October	27.33±2.516	02.33±0.577	06.00±1.000
November	30.33±4.041	03.00±1.000	09.00±1.000
December	33.66±1.154	03.66±0.577	07.66±0.577

Each value is the mean (±SD) of three observations

Water and sediment make excellent culture media for a wide variety of microorganisms (Helen *et al.,* 2014). In the current investigation, the bacterial population peaked in February at 50×10^4 CFU/ml. With 14.66×10^4 CFU/ml, the bacterial population was at its lowest in the month of July. Land wash off from various sources after rainfall is to blame for the greater densities of THB population (Hatha *et al.,* 2008) and faecal coliform (Shehane *et al.,* 2005; Metcalf, 1982). According to Comeau *et al.* (2016); Tisthammer *et al.* (2016), marine fungus are present throughout the ocean, including the water column. In the current investigation, February had the highest fungal population (8.33×10^3 CFU/ml). June saw the lowest level of fungal activity (1.00×10^3 CFU/ml. In five sampling stations over two different seasons and 83 species from water samples. Sivakumar *et al.* (2006) reported that the distribution of fungi in Muthupettai mangroves along the East coast of Tamil Nadu was studied in terms of species diversity, seasonal variation, and frequency of occurrence. Although earlier reports of marine actinomycetes were thought to be the result of runoff from the land, molecular (Moran, *et al.,* 1995; Urakawa *et al.,* 1999) and conventional methods (Mincer *et al.,* 2002) have demonstrated that actinomycetes do exist in the marine environment. In the current study, the actinomycetes population peaked in the months of February and August (13.33×10^2 CFU/ml and 09.33×10^2 CFU/ml, respectively). In the months of June (00.66×10^2 CFU/ml) and July (01.33×10^2CFU/ml), the actinomycetes population was at its lowest.

CONCLUSIONS

Based on the results, it can be said that the Manapad estuary has a little pollution impact.

FUTURE SCOPE

The Manapad estuary's wellbeing can be improved or maintained by implementing the following recommendations: Plastics and other solid trash, including rotting fish, should not be dumped; To protect the priceless estuarine and coastal resources, people should be made aware of the need to prevent coastal pollution; reducing the overuse of chemical pesticides and fertilisers in agricultural lands; Regular environmental monitoring should be done to establish baseline data on the estuary's condition, which would be helpful for good management techniques for the sustainable use of estuarine resources as well as for any remedial action that might be required.

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