Section A-Research paper

ENUMERATION AND IDENTIFICATION OF PATHOGENIC POLLUTION INDICATORS AND IMPACT OF SEASONAL CHANGES IN SOUTH EAST COAST, INDIA

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Abstract

In tropical estuaries, there is a dearth of data on the diversity and quantity of bacterial species that may be used as pollution indicators. This is a problem since these estuaries are considered to be particularly sensitive to pollution. In order to accomplish this, we examined the levels of a large number of indicators of pollution that are currently present, as well as the types, numbers, and seasonal shifts of human pathogenic bacteria that are present all along the south eastern coast of India. In addition, we looked at how these factors change over time. In 2019 and 2020, samples were collected from the estuary sections of the rivers in order to get information about conditions before, during, and after the monsoons. The variety and number of microorganisms in near-shore environments may be diminished as a result of discharges from terrestrial drainages, wastewater spillways from residential areas, and other sources.

Keywords: pollution, microbes, seawater, monsoon, season

Introduction

Bay of Bengal (BoB) is supplied with about 2,950 km3 of tropical drainage on a yearly basis. Particularly in the Indian Ocean, where there is a high population density along the coastlines, human pathogen contamination of marine habitats has come to be recognised as a significant ecological threat to human health. This is due to the fact that human pathogens can be transmitted from humans to marine animals. There are a number of illnesses that may be potentially lethal, including cholera, diarrhoea, dysentery, and typhoid fever. Pathogenic bacteria can be the cause of these diseases. If consumers ingest polluted marine items, swim or fish in coastal waters where pathogenic bacteria may be present, or go fishing in such areas, they run the risk of becoming ill (Flemming and Wuertz, 2019). Pathogenic bacteria multiply inside the host, and then are released into the natural environment, leading to the development of zoonoses (Zou et al., 2020).This puts marine life in risk. Consistent monitoring of coastal water is essential in order to discover marine pollution. Particular attention must be paid to coliform and other potentially harmful bacteria. To demonstrate that pollution has a detrimental impact on both human health and marine life, research is very necessary.

Monitoring the microbial load in marine environments is very necessary if one want to guarantee that the water around the shore is suitable for swimming, fishing, and other types of recreational activities. Microbial contamination in coastal waterways is caused by fishing, bathing, commercial usage, domestic and wild animals in tidal zones, and bathing. Fresh-water releases from river systems contaminated with human activity (agribusiness, plantation industry, and urban surface runoff), and fresh-water releases from rivers during the monsoon season all contribute to microbial pollution in coastal waters.

Marine-native illnesses include, for example, bacteria linked to Vibrio, which may result in either fatal or opportunistic infections in humans. Other marine-native diseases include parasites. It is well knowledge that the bacterium known as Vibrio may be the root cause of a broad array of diseases. Combine with either the ingestion of marine meals or the participation in activities that put one in direct contact with marine waters (such as leisure). Awareness the elements that contribute to pollution and disease in a given location requires first gaining an understanding of their spread. Vibrio cholera is common in the coastal waters of areas where cholera is endemic. Additionally, Vibrio cholerae are often discovered in the digestive tracts of copepods that consume phytoplankton. This suggests that an uptick in phytoplankton levels may increase the number of copepods that host the bacterium Vibrio cholerae, which in turn may increase the likelihood of cholera outbreaks among coastal people (Santhaseelan et al., 2022).

The process of determining whether or not water is suitable for human consumption and other recreational uses requires the use of indicator bacteria to a significant degree. Typically, samples of the water itself are used in the process of isolating these microorganisms. Due to the fact that these bacteria are present, there is an increased possibility that additional illnesses, some of which might be potentially hazardous, are also present. Salmonella as well as other indicators of bacterial contamination such as total coliforms (TC), faecal coliforms (FC), Escherichia coli, and enterococci have been total coliforms (TC), faecal coliforms (FC), and enterococci (ENT) (Nagvenkar and Ramaiah, 2009). When doing an analysis of the water's quality, one further factor that is often taken into account is the question of whether or not the water includes bacteria that are heterotrophic. However, bathing water is subject to stricter regulations than other types of water under European Directive 2006/7/CE. If the levels of E. coli and/or ENT in coastal waters are more than 900 CFU/100 ml and/or 330 CFU/100 ml, respectively, it is a sign that these waters should not be used for recreational purposes and should be avoided. These two numbers represent the potential number of CFUs present in 100 mL of a given medium. It is necessary by a number of national laws as well as international requirements for the quality of drinking water that an example of 100 millilitres of water be free of E. coli. These laws and criteria may be found in a number of different countries (WHO, 2004).

It is very essential to have a firm understanding of the geographic distribution pattern of pathogenic bacteria in order to be able to evaluate the possible risk that it presents to the health of humans. On the other hand, there is a scarcity of knowledge on the multiple rivers' contributions of hazardous bacteria to the coast, as well as the bacteria's spread offshore from the coast. This is due to the fact that there is little research done on these topics. The main

purpose of this study is to look at how the weather and seasons affect microbiological parameters in estuaries in 2019 and 2020.

Sample location

In 2019 and 2020, researchers collected samples from the estuary's surface and bottom waters in Parangipettai (S1-S3), Pazhaiyar (S4-S6), Poompuhar (S7-S9), Karaikal (S10-S12) and Velankanni (S13-S15) to determine the number of bacterial species that may be used as pollution indicators (S13-S15). We took 15 samples, each from S1 to S15, at a convergence point with the ocean about 1-2 kilometres inland.

Sample collection

Surface water and bottom water samples were collected in plastic canes from each of the three areas. Hermetically sealed, kept in the dark between 4 and 10 degrees Celsius, and shielded as much as possible from exposure, these sample bottles were also protected from the effects of light and temperature. Storage was kept at a constant temperature and humidity. The region surrounding the estuaries were included in this well planned sampling (Vigneshignesh et al., 2012).

Sample Processing

After being treated with aged saltwater to achieve a salinity of at least 15 PSU, the majority of the media was then subjected to an autoclaving process. The only ingredients required to manufacture TCBS were deionized water and steam sterilisation. All of the plates were prepared and ready to go five days before the samples were collected. Approximately five days prior to the plating technique, three duplicates of 0.1 ml and 0.2 ml water samples were plated on nutrient agar plates. In addition to that, duplicate aliquots of water measuring 0.2 millilitres, 0.3 millilitres, and 0.4 millilitres were placed on each of the selective media. When similar quantities were spread out on plates with a diameter of 90 mm, the medium immediately absorbed them. Except for the plates containing Seawater nutrient agar (SWNA), which were maintained at ambient temperature, all of the plates were stored for 24 to 48 hours at a temperature of 37 degrees Celsius. After about 24 hours of incubation, when abnormally high counts of a single variety of bacteria were identified in any particular medium, samples of cold water were diluted 10- or 100-fold and then looked at again using the spread plating technique. In addition to the counts made on plates, the total viable counts of bacteria were determined for each of the several samples of water that were collected.

RESULTS AND DISCUSSION

Five locations were sampled before, during, and after a monsoon in order to determine the effects of the tides on bacterial populations in a tropical estuary, with each sample lasting between one and three hours. Pre-monsoon surface water at the river mouth had higher TBC than water upstream. Monsoon season reversed. After the rainy season, TBC in surface water increased, while river sediment decreased. Depth-wise salinity stratification impacted the overall viable bacterial count, which was high during the neap tide and low during the spring tide (TVC).

The microbial parameters levels in different water samples in Monsoon 2019, pre monsoon 2019, post monsoon 2019, summer 2019, pre monsoon 2020, post monsoon 2020, summer 2020 were given in Table 1, Table 2, Table 3, Table 4, Table 5, Table 6 and Table 7 respectively.

Table 1: Microbiological parameters levels in different estuary water samples – Monsoon 2019

S.No	Sampling site	Sample nature and other details	Microbiological parameters (CFU/mL)								
			TVC	TC	TS	FC	FS	TV	SA	SH	PA
1	Parangipettai S1	Sea conflueniceng point	187000	12800	1360	1080	220	1800	140	250	390
2	Parangipettai S2	1 km away from sea	106000	5900	940	700	80	1540	110	180	290
3	Parangipettai S3	2 km away from sea	81000	3200	610	480	60	1240	80	130	250
4	Pazhaiyar S4	Sea conflueniceng point	103000	5200	690	510	90	1420	90	180	240
5	Pazhaiyar S5	1 km away from sea	78000	2680	610	320	90	980	80	150	200
6	Pazhaiyar S6	2 km away from sea	64000	1940	480	240	60	810	60	120	150
7	Poompuhar S7	Sea conflueniceng point	88000	3900	680	420	90	1060	80	160	240
8	Poompuhar S8	1 km away from sea	59000	2110	360	220	60	670	80	120	190
9	Poompuhar S9	2 km away from sea	47000	1610	240	160	40	510	50	80	130
10	Karaikal S10	Sea conflueniceng point	208000	18400	3100	1580	240	3100	490	520	640
11	Karaikal S11	1 km away from sea	176000	8100	1670	1240	200	2600	280	340	410
12	Karaikal S12	2 km away from sea	131000	5400	1060	940	120	1760	160	240	330
13	Velankanni S13	Sea conflueniceng point	320000	20100	3400	1860	210	3900	430	540	680
14	Velankanni S14	1 km away from sea	251000	10100	2310	1560	200	3100	220	450	510
15	Velankanni S15	2 km away from sea	194000	5400	2400	1060	190	2710	180	310	380

TVC – Total Viable Count; TC – Total Coliform Count; TS – Total *Streptococci* Count; FC – Fecal Coliform Count; FS – Fecal *Streptococci* Count; TV – Total *Vibrio* Count; SA – *Salmonella* Count; SH – *Shigella* Count; PA – *Pseudomonas* Count

Table 2: Microbiological parameters levels in different estuary water samples – Premonsoon 2019

S.No	Sampling site	Sample nature and other details	Microbiological parameters (CFU/mL)								
			TVC	TC	TS	FC	FS	TV	SA	SH	PA
1	Parangipettai	Sea	96000	6400	940	680	100	1350	100	160	270

	S1	confluenicng point									
2	Parangipettai S2	1 km away from sea	71000	3800	510	390	50	950	70	130	220
3	Parangipettai S3	2 km away from sea	54000	2430	350	280	40	760	50	80	150
4	Pazhaiyar S4	Sea confluenicng point	72000	3600	420	370	40	980	70	110	150
5	Pazhaiyar S5	1 km away from sea	53000	1840	350	200	60	610	60	100	110
6	Pazhaiyar S6	2 km away from sea	54000	1320	250	140	50	490	50	80	90
7	Poompuhar S7	Sea confluenicng point	63000	2710	350	220	60	730	50	80	130
8	Poompuhar S8	1 km away from sea	41000	1490	240	140	30	400	50	70	100
9	Poompuhar S9	2 km away from sea	29400	1080	160	110	30	320	30	60	70
10	Karaikal S10	Sea confluenicng point	138000	7200	1030	810	130	2160	220	290	370
11	Karaikal S11	1 km away from sea	112000	4800	870	610	110	1740	140	220	270
12	Karaikal S12	2 km away from sea	91000	3300	610	480	80	1320	90	140	210
13	Velankanni S13	Sea confluenicng point	224000	8200	1980	1120	150	2920	280	340	480
14	Velankanni S14	1 km away from sea	176000	6200	1540	840	120	2260	170	260	330
15	Velankanni S15	2 km away from sea	137000	3700	1070	590	110	1910	100	190	260

TVC – Total Viable Count; TC – Total Coliform Count; TS – Total *Streptococci* Count; FC – Fecal Coliform Count; FS – Fecal *Streptococci* Count; TV – Total *Vibrio* Count; SA – *Salmonella* Count; SH – *Shigella* Count; PA – *Pseudomonas* Count

Table 3: Microbiological parameters levels in different estuary water samples – Post monsoon 2019

S.No	Sampling site	Sample nature and other details	Microbiological parameters (CFU/mL)								
			TVC	TC	TS	FC	FS	TV	SA	SH	PA
1	Parangipettai S1	Sea confluenicng point	112000	7800	1030	760	130	1520	120	170	300
2	Parangipettai S2	1 km away from sea	82000	4200	630	470	80	1060	90	160	250
3	Parangipettai S3	2 km away from sea	66000	2610	410	350	60	940	60	100	180

4	Pazhaiyar S4	Sea confluenicng point	83000	4200	510	420	80	1140	90	140	160
5	Pazhaiyar S5	1 km away from sea	64000	2160	400	220	70	790	70	110	130
6	Pazhaiyar S6	2 km away from sea	57000	1680	290	160	60	580	60	100	100
7	Poompuhar S7	Sea confluenicng point	71000	2940	420	260	80	970	60	100	150
8	Poompuhar S8	1 km away from sea	48000	1620	290	150	60	510	60	80	120
9	Poompuhar S9	2 km away from sea	33000	1240	180	130	50	400	50	70	100
10	Karaikal S10	Sea confluenicng point	176000	8600	1560	1140	180	2710	180	330	460
11	Karaikal S11	1 km away from sea	145000	5700	1140	860	130	1880	150	260	330
12	Karaikal S12	2 km away from sea	101000	4600	890	610	100	1480	120	170	250
13	Velankanni S13	Sea confluenicng point	281000	10100	2530	1610	200	3500	390	450	620
14	Velankanni S14	1 km away from sea	205000	9100	1840	1240	170	2940	240	380	490
15	Velankanni S15	2 km away from sea	159000	5400	1340	780	130	2260	150	270	350

TVC – Total Viable Count; TC – Total Coliform Count; TS – Total *Streptococci* Count; FC – Fecal Coliform Count; FS – Fecal *Streptococci* Count; TV – Total *Vibrio* Count; SA – *Salmonella* Count;SH – *Shigella* Count; PA – *Pseudomonas* Count

Table 4: Microbiological parameters levels in different estuary water samples – Summer 2019

S.No	Sampling site	Sample nature and other details	Microbiological parameters (CFU/mL)								
			TVC	TC	TS	FC	FS	TV	SA	SH	PA
1	Parangipettai S1	Sea confluenicng point	120000	9800	1100	920	110	1700	120	210	340
2	Parangipettai S2	1 km away from sea	89000	4900	720	560	70	1240	100	160	260
3	Parangipettai S3	2 km away from sea	72000	2900	480	390	40	1010	60	110	210
4	Pazhaiyar S4	Sea confluenicng point	85000	4400	550	450	50	1220	80	150	200
5	Pazhaiyar S5	1 km away from sea	68000	2360	480	220	70	800	70	130	160
6	Pazhaiyar S6	2 km away from sea	55000	1700	320	180	50	670	50	100	120

7	Poompuhar S7	Sea conflueniceng point	72000	3300	510	310	70	960	60	110	160
8	Poompuhar S8	1 km away from sea	48000	1810	280	170	30	490	50	90	140
9	Poompuhar S9	2 km away from sea	35000	1300	200	140	30	380	30	60	100
10	Karaikal S10	Sea conflueniceng point	176000	13800	2200	1020	160	2500	290	380	460
11	Karaikal S11	1 km away from sea	135000	6600	1020	900	160	2000	160	260	380
12	Karaikal S12	2 km away from sea	108000	4500	840	720	90	1510	100	180	270
13	Velankanni S13	Sea conflueniceng point	266000	9800	2400	1400	150	3200	310	430	540
14	Velankanni S14	1 km away from sea	204000	8100	1800	1300	170	2700	190	340	370
15	Velankanni S15	2 km away from sea	161000	1100	1500	990	160	2300	130	240	310

TVC – Total Viable Count; TC – Total Coliform Count; TS – Total *Streptococci* Count; FC – Fecal Coliform Count; FS – Fecal *Streptococci* Count; TV – Total *Vibrio* Count; SA – *Salmonella* Count; SH – *Shigella* Count; PA – *Pseudomonas* Count

Table 5: Microbiological parameters levels in different estuary water samples – Premonsoon 2020

S.No	Sampling site	Sample nature and other details	Microbiological parameters (CFU/mL)								
			TVC	TC	TS	FC	FS	TV	SA	SH	PA
1	Parangipettai S1	Sea conflueniceng point	101000	5500	1080	620	140	1290	120	150	270
2	Parangipettai S2	1 km away from sea	76000	4000	550	410	80	990	80	150	240
3	Parangipettai S3	2 km away from sea	60000	2830	420	300	80	820	70	90	160
4	Pazhaiyar S4	Sea conflueniceng point	88000	4000	470	430	90	1130	100	120	140
5	Pazhaiyar S5	1 km away from sea	64000	1930	350	270	70	760	80	100	100
6	Pazhaiyar S6	2 km away from sea	60000	1530	300	180	70	490	80	100	90
7	Poompuhar S7	Sea conflueniceng point	69000	2610	320	250	100	1080	60	90	150
8	Poompuhar S8	1 km away from sea	48000	1690	290	160	80	510	50	80	110
9	Poompuhar	2 km away	33400	1200	230	120	60	380	50	80	100

	S9	from sea									
10	Karaikal S10	Sea conflueniceng point	161000	2500	610	1060	170	2760	150	320	480
11	Karaikal S11	1 km away from sea	144000	4400	1160	690	130	2110	160	300	300
12	Karaikal S12	2 km away from sea	104000	4300	740	500	110	1500	130	190	260
13	Velankanni S13	Sea conflueniceng point	242000	9800	2280	1470	220	3620	380	420	650
14	Velankanni S14	1 km away from sea	190000	8200	1750	930	130	2660	270	380	490
15	Velankanni S15	2 km away from sea	155000	8700	1090	490	100	2150	150	260	360

TVC – Total Viable Count; TC – Total Coliform Count; TS – Total *Streptococci* Count; FC – Fecal Coliform Count; FS – Fecal *Streptococci* Count; TV – Total *Vibrio* Count; SA – *Salmonella* Count; SH – *Shigella* Count; PA – *Pseudomonas* Count

Table 6: Microbiological parameters levels in different estuary water samples – Post monsoon 2020

S.No	Sampling site	Sample nature and other details	Microbiological parameters (CFU/mL)								
			TVC	TC	TS	FC	FS	TV	SA	SH	PA
1	Parangipettai S1	Sea conflueniceng point	117000	6900	1170	700	170	1460	140	180	310
2	Parangipettai S2	1 km away from sea	87000	4400	670	490	110	1100	100	160	280
3	Parangipettai S3	2 km away from sea	72000	3010	480	370	100	1000	80	110	200
4	Pazhaiyar S4	Sea conflueniceng point	99000	4600	560	480	130	1290	120	150	160
5	Pazhaiyar S5	1 km away from sea	75000	2250	400	290	90	940	110	120	130
6	Pazhaiyar S6	2 km away from sea	63000	1890	340	200	80	580	90	110	110
7	Poompuhar S7	Sea conflueniceng point	77000	2840	390	290	120	1320	70	110	180
8	Poompuhar S8	1 km away from sea	55000	1820	340	170	110	620	60	90	150
9	Poompuhar S9	2 km away from sea	37000	1360	250	140	80	460	70	80	140
10	Karaikal S10	Sea conflueniceng point	199000	5600	1430	1390	220	3310	290	360	600
11	Karaikal S11	1 km away	177000	5300	1140	940	150	2250	230	340	380

		from sea									
12	Karaikal S12	2 km away from sea	114000	3900	1020	630	130	1660	190	220	310
13	Velankanni S13	Sea confluenicng point	299000	11700	2830	1960	270	4200	550	530	810
14	Velankanni S14	1 km away from sea	219000	11100	2050	1330	180	3340	290	500	670
15	Velankanni S15	2 km away from sea	177000	10300	1360	840	120	2500	160	340	460

TVC – Total Viable Count; TC – Total Coliform Count; TS – Total *Streptococci* Count; FC – Fecal Coliform Count; FS – Fecal *Streptococci* Count; TV – Total *Vibrio* Count; SA – *Salmonella* Count; SH – *Shigella* Count; PA – *Pseudomonas* Count

Table 7: Microbiological parameters levels in different estuary water samples – Summer 2020

S.No	Sampling site	Sample nature and other details	Microbiological parameters (CFU/mL)								
			TVC	TC	TS	FC	FS	TV	SA	SH	PA
1	Parangipettai S1	Sea confluenicng point	125000	8900	1240	860	150	1640	140	200	340
2	Parangipettai S2	1 km away from sea	94000	5100	760	580	100	1280	110	180	280
3	Parangipettai S3	2 km away from sea	78000	3300	550	410	80	1070	80	120	220
4	Pazhaiyar S4	Sea confluenicng point	101000	4800	600	510	100	1370	110	160	190
5	Pazhaiyar S5	1 km away from sea	79000	2450	480	290	80	950	90	130	150
6	Pazhaiyar S6	2 km away from sea	61000	1910	370	220	70	670	80	120	120
7	Poompuhar S7	Sea confluenicng point	78000	3200	480	340	110	1310	70	120	180
8	Poompuhar S8	1 km away from sea	55000	2010	330	190	80	600	50	100	150
9	Poompuhar S9	2 km away from sea	39000	1420	270	150	60	440	50	80	130
10	Karaikal S10	Sea confluenicng point	199000	9100	1780	1270	200	3100	220	410	570
11	Karaikal S11	1 km away from sea	167000	6200	1310	980	180	2370	180	340	410
12	Karaikal S12	2 km away from sea	121000	5500	970	740	120	1690	140	230	320
13	Velankanni S13	Sea confluenicng	284000	11400	2700	1750	220	3900	410	510	710

		point									
14	Velankanni S14	1 km away from sea	218000	10100	2010	1390	180	3100	290	460	530
15	Velankanni S15	2 km away from sea	179000	6100	1520	890	150	2540	180	310	410

TVC – Total Viable Count; TC – Total Coliform Count; TS – Total *Streptococci* Count; FC – Fecal Coliform Count; FS – Fecal *Streptococci* Count; TV – Total *Vibrio* Count; SA – *Salmonella* Count; SH – *Shigella* Count; PA – *Pseudomonas* Count

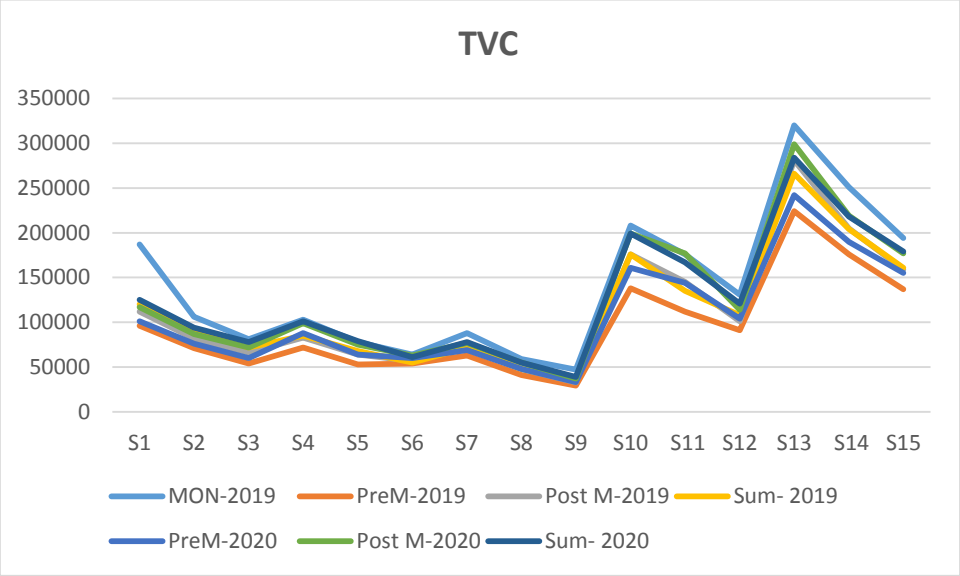

Fig.1: TVC – Total Viable Count in water samples from estuaries

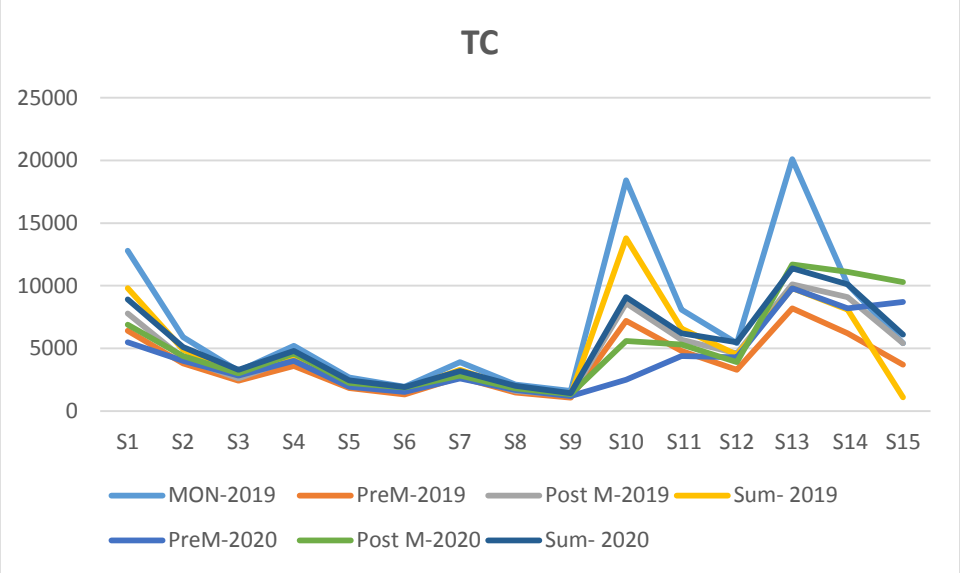

Fig.2: TC – Total Coliform count in water samples from estuaries

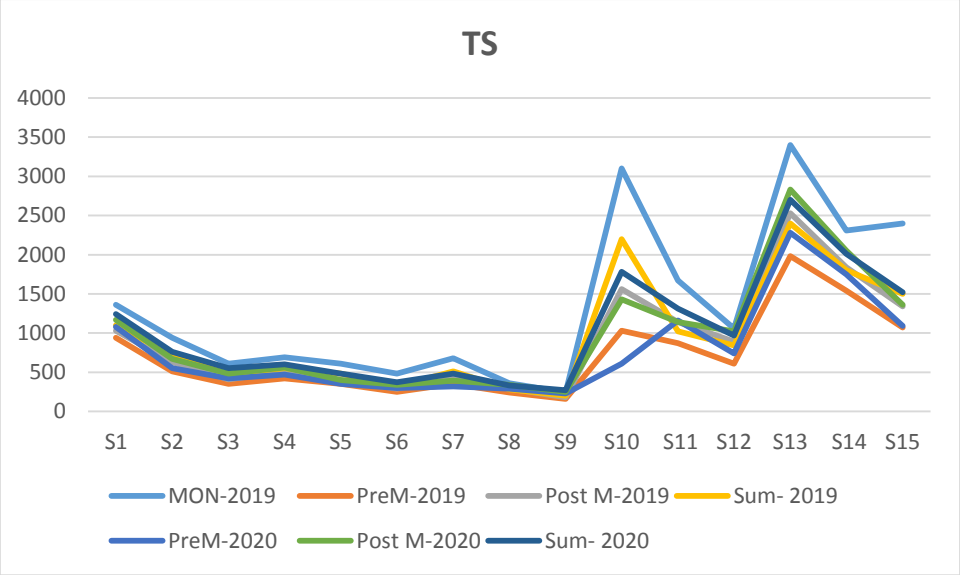

Fig. 3: TS – Total Streptococci Count in water samples from estuaries

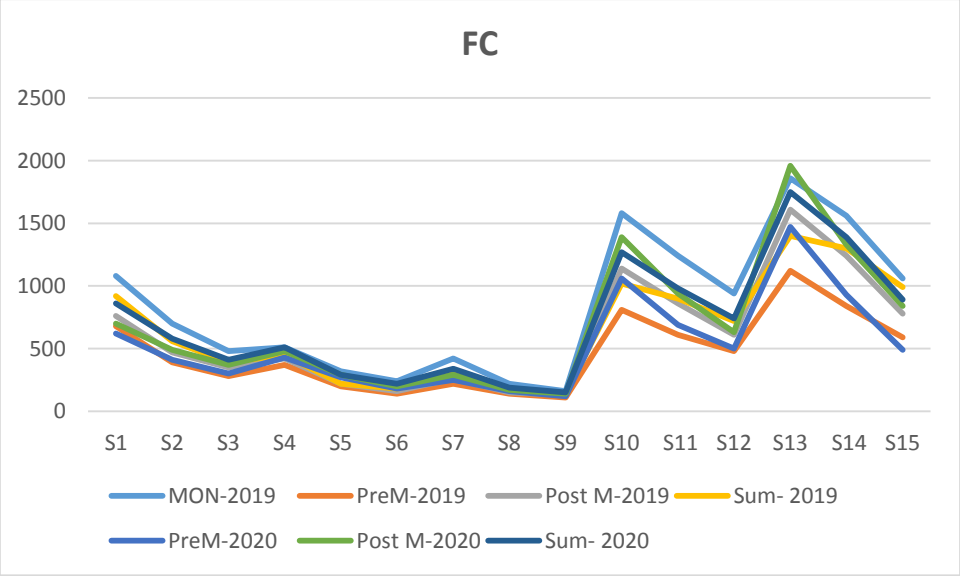

Fig. 4: FC – Fecal Coliform Count in water samples from estuaries

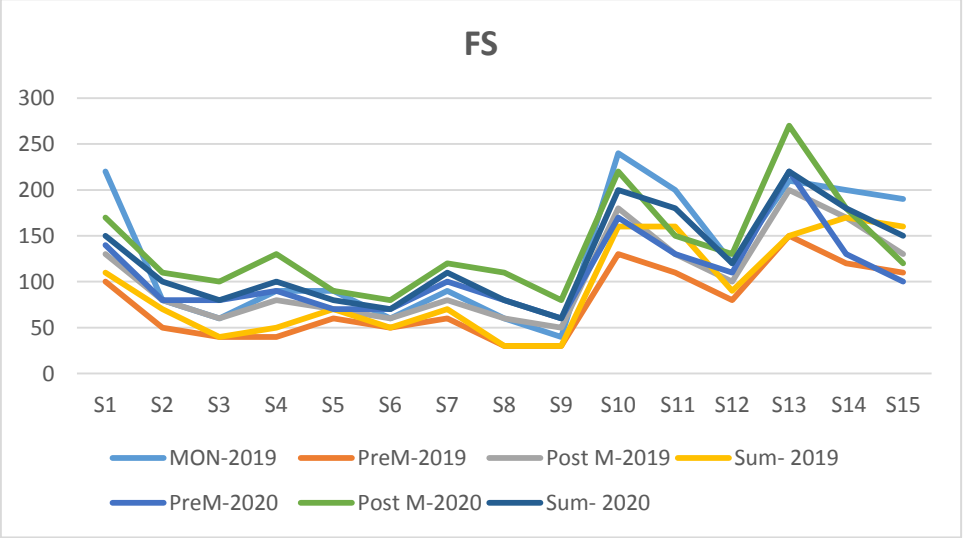

Fig. 5: FS – Fecal Streptococci Count in water samples from estuaries

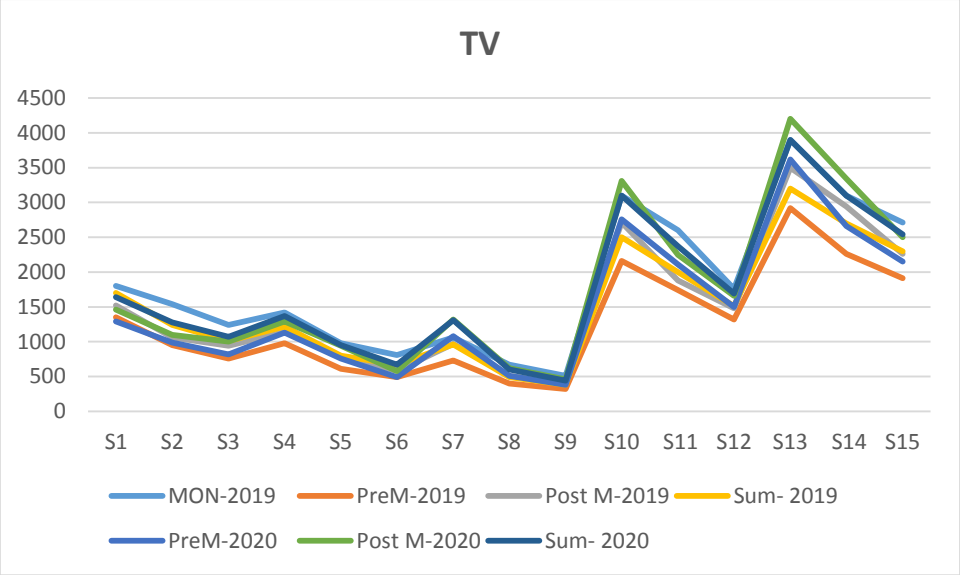

Fig. 6: TV – Total Vibrio Count in water samples from estuaries

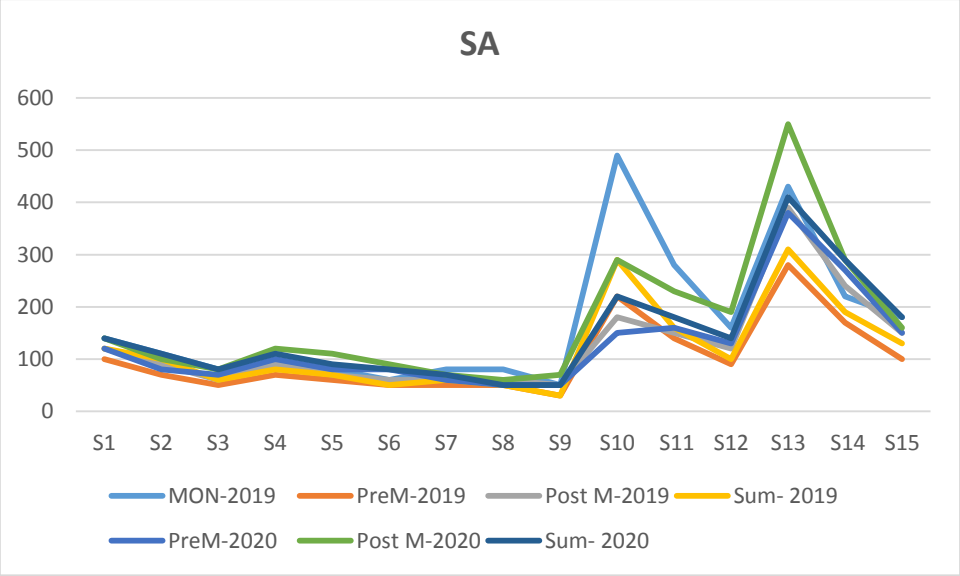

Fig. 7: SA – Salmonella Count in water samples from estuaries

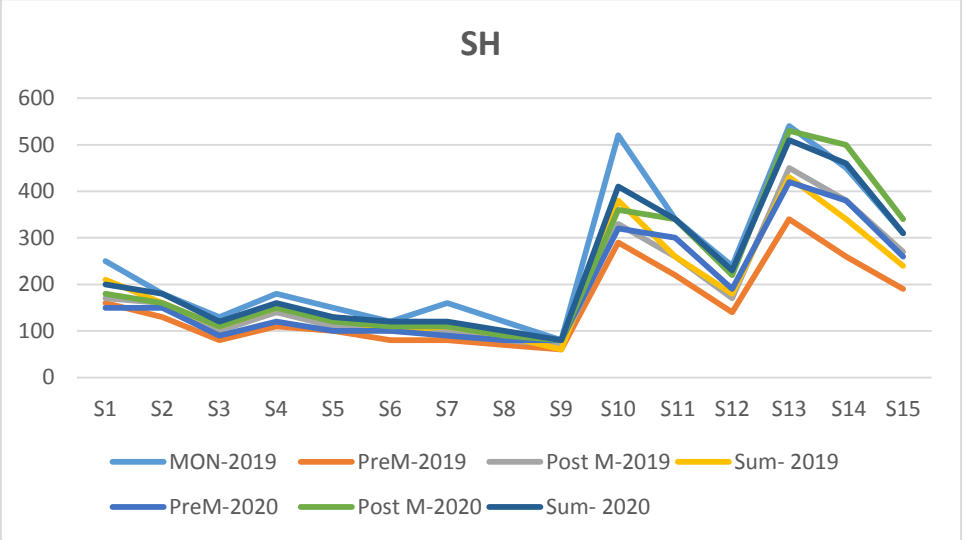

Fig. 8: SH – Shigella Count in water samples from estuaries

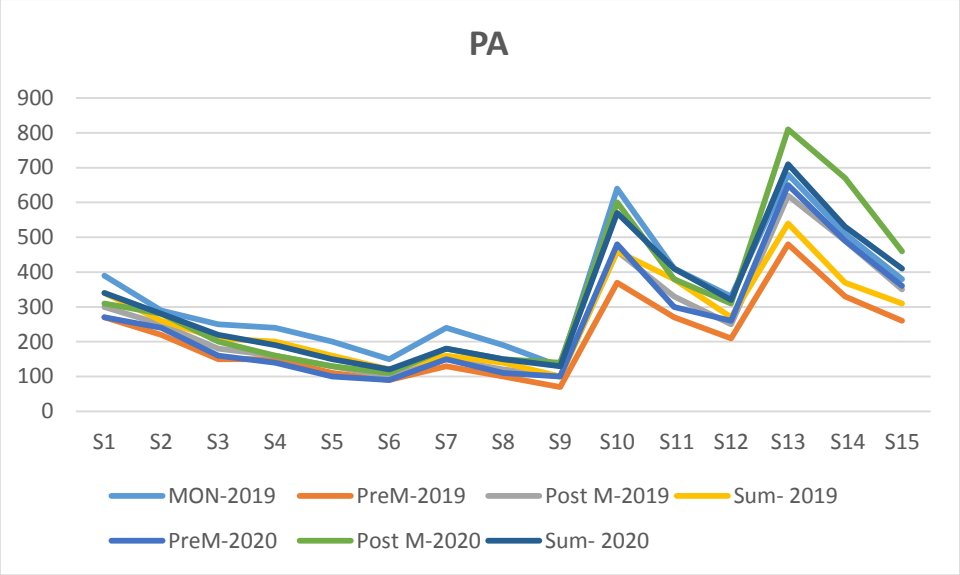

Fig. 9: PA – Pseudomonas Count in water samples from estuaries

The total viable count of colony forming units present in the sample throughout the seasons from 2019 to 2020 at Velankanni (S13, S14 & S15) was high and Poompuhar (S7, S8 & S9) was low when compared to other areas (Fig.1). The average TVC present in an average obtained from monsoon-2019, pre monsoon-2019, post monsoon-2019, Summer- 2019, Pre monsoon- 2020, Post monsoon-2020 and Summer- 2020. The analysis shows that TVC was highest during monsoon and lowest during pre monsoon of 2019. Total coliforms present in Velankanni was high throughout the seasons while Poompuhar records the lowest CFU/ml. Total coliforms found in parangipettai and Karaikkal were moderataely high followed by Pazhaiyar. The average count of TC increased in monsoon of 2019 and records lowest count in Pre monsoon of 2019.

Table 8: Average number of microbiological parameters levels in different estuary water samples

	MON-2019	**PreM-2019**	**Post M-2019**	**Sum-2019**	**PreM-2020**	**Post M-2020**	**Sum-2020**
TVC	139533.3	94093.33	112200	112933.3	106360	124466.7	125200
TC	7122.667	3871.333	4796.667	5091.333	4212.667	5131.333	5432.667
TS	19910	10670	13460	14400	11640	14430	15370
FC	824.6667	465.3333	610.6667	644.6667	525.3333	681.3333	704.6667
FS	130	77.33333	105.3333	94	108.6667	137.3333	125.3333
TV	1813.333	1260	1512	1512	1483.333	1735.333	1735.333
SA	168.6667	102	126	120	128.6667	170	146.6667
SH	251.3333	154	192.6667	196.6667	188.6667	226.6667	231.3333
PA	335.3333	214	266	268	260	326	314

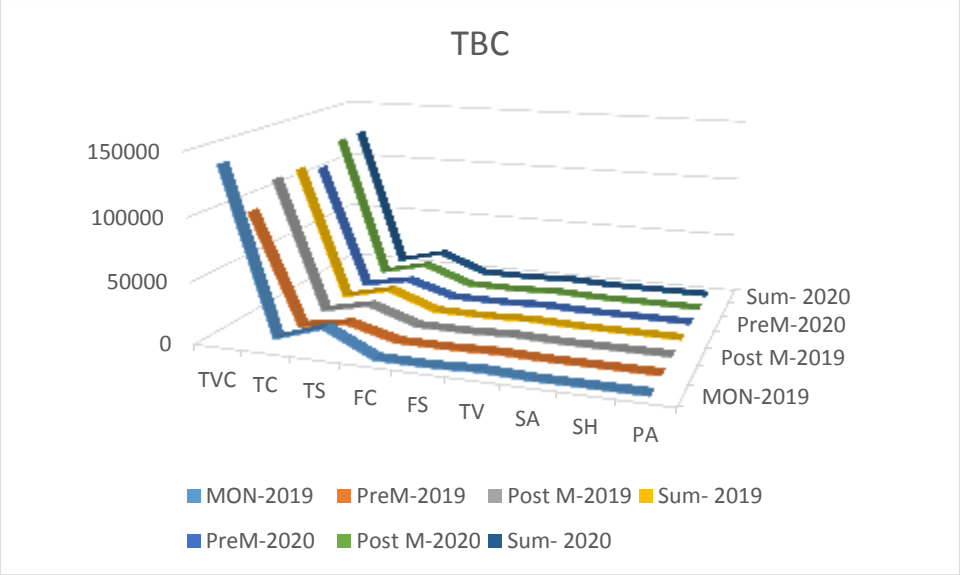

Fig. 10: Average number of microbes in water samples in all seasons

TS – Total Streptococci Count occurs in the estuaries of Velankanni followed by Karaikkal were considerably high throughout the monsoon seasons. TS found to get increased in monsoon 2019 and decreased in pre monsoon of 2019 (Fig. 10). The estuary in Pazhaiyar was found to be low in all seasons (Fig. 3).

Fig.4 depicts FC – Fecal Coliform Count in estuary water samples from Velankanni and Karaikkal were increased when compared to samples from other estuaries. Pre monsoon of 2020 recorded high average of FC whereas low during summer 2019. The findings shows that the samples collected from the sea confluencing point during all the seasons were low on comparing with other two sampling stations (Table 1-7).

From Table 1-7, we found that FS – Fecal Streptococci Count (Fig.5), TV – Total Vibrio Count (Fig.6), SA – Salmonella Count (Fig.7), SH – Shigella Count (Fig.8) and PA – Pseudomonas Count (Fig.9) shows similar results. The water samples collected from Velankanni followed by Karaikkal yielded high number of microbial colony forming units per millilitre. Pazhaiyar and Poompuhar records less number of CFU/ml shows that it has low pollution. Parangipettai records moderate number of microbial counts in all seasons. Fig. 10 shows that pre monsoon of 2019 recorded lesser number of FS, TV, SA, SH and PA.

Salmonella and other markers of bacterial contamination such as total coliforms (TC), faecal coliforms (FC), Escherichia coli, and enterococci have been total coliforms (TC), faecal coliforms (FC), and enterococci (ENT) (The World Health Organization and The Organization for Economic Co-operation and Development, 2003). When analysing the quality of the water, one more element that is often taken into consideration is whether or not the water contains heterotrophic bacteria.

The total viable count (TVC) of water and sediment samples was found to be at its maximum during the monsoon season and at its lowest after the rains ceased falling. This was determined via scientific research and it was revealed that the TC, FC, TS, and FS ranges were all bigger during the monsoon than they were during any other season, which is in line with the tendency that was demonstrated with TVC. It was discovered that both the Cuddalore fishing port and the Pondicherry fishing harbour had very high levels of all bacterial indices. This was discovered while comparing the two fishing ports to one another.

The enormous human populations and ongoing illegal settlement operations in each of these places might be a contributing factor in this phenomenon (Vignesh et al., 2016; Kumarasamy et al., 2009).

An investigation was conducted to determine the degree to which total coliforms, faecal coliforms, and enterococci can accurately predict the presence of Salmonella in marine environments. We discovered the ideal mix of sensitivity and specificity for predicting the presence of Salmonella based on the indicator cut-off values of Enterococci (Efstratiou et al., 2009). At the vast majority of sample locations, an increase in the number of VC and PA was seen during the monsoon season. At the vast majority of sample locations, an increase in the number of VC and PA was seen during the monsoon season. According to the CFU counts, it would seem that human faeces, as opposed to animal waste or any other kind of pollution, was the primary source of the contamination in the regions where testing were carried out (Korajkic et al., 2018).

CONCLUSION:

The water in estuaries all around the south eastern coast of India has been analysed, and the results reveal that microbial pollution will continue to be present in the water throughout 2019 and 2020. The maximum level of microbial colonies was reported in Velankanni and Karaikkal, while Pazaiyar and Poompuhar recorded the lowest amount of microbial colonies. Alterations in the seasons contributed, in their own way, to the presence of microbes in the water. The summer of 2019 has shown a lower incidence of colonies, whereas the monsoon of 2019 has shown an increased occurrence of colonies. The most significant contributors to pollution are industry's usage of resources and human activity.

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