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EFFECTS OF TROPICAL CYCLONE FANI ON WATER QUALITY IN THE RIVER MAHANADI AND DISTRIBUTARIES

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ABSTRACT

Extremely Severe Cyclonic Storm FANI was the strongest tropical cyclone to strike the Indian state of Odisha since the 1999 Odisha super cyclone. The highest wind speed was 250 km/h. It took place on 3rd and 4th May 2019. The cyclone "FANI" has affected the water supply and distribution in the affected areas of Odisha. It has affected severely three districts Cuttack, Khordha and Puri. Water is considered as most important life supporting natural resource. Two important parameters of water are quantity and quality. Quantity and quality of water both affect human health in different ways. Water quality is the condition of water relative to the requirement of one or more biotic species and human need or purpose .The water should be tested once each year for Total Coliform bacteria, nitrates, total dissolved solids and pH values. The present investigation is aimed at assessing the current water quality standard of the river MAHANADI in terms of physicochemical parameters after the cyclone FANI. The different parameters measured in the present study are pH, DO, Total Hardness, BOD, COD and Total Coliform.

KEY WORDS: Mahanadi, pH, DO, Total Hardness, BOD, COD, Total Coliform

1. INTRODUCTION

The total geographical area of Odisha (1, 55,707 km^2) is divided into eleven river basins covering a geographical area of 1, 50,460 km^2 and minor river basins of 5247 km^2 which drains directly into the Bay of Bengal. Mahanadi is the largest river basin of these (Table- 1).

Table -1: Basin features of the river MAHANADI

Main Features	MAHANADI
Origin	From Amarakantak hills of the Bastar Plateau near Pharsiya village in Chhattisgarh
Basin area (square km)	1,41,134
Basin area in Odisha (square km)	65,628
% to Geographical area of state	42.15
Total length (km)	851
Total length in Odisha (km)	494
Water Resource (Million m^3) (Average)	59155
Water Resource (Million m^3) (75% Dependable)	48732
Per capita water availability (2001, m^3)	3551.06
Major Tributaries	Seonath, Hasdeo, Mand, Ib, Jonk, Ong, Hariharjore, Tel, Jeera
Major Distributaries	Kathajodi, Birupa, Kuakhai, Daya, Bhargavi, Kushabhadra, Devi, Chitrotpala……
Districts covered in Odisha (% geographical area of the state)	Sundargarh (39%), Jharsuguda (100%), Sambalpur (79%), Cuttack (99%), Khordha (98%), Puri (70%), Phulbani (81%), Sonepur (100%), Balangir (100%), Bargarh (100%)…..

Meanwhile, water quality monitoring has been evolving to the latest wireless Sensor network (WSN) based solutions in recent decades. Water is said to be our life because we need it for drinking, bathing, relaxing, fishing and irrigating our crops (Senapati et al, 2018). Besides these we produce hydro energy from water and navigate in it. Water is so much an essential part of our life that ancient civilizations have been developed in almost all river valleys of our country.

With the growth of the modern civilization our life is threatened due to pollution of water both from surface and underground. It has been established that several stomach, liver and skin diseases spread due to polluted water. In our country, especially in the state of Odisha, the scarcity of pure drinking water is so much felt that 50% of urban people and 80% of rural people are affected by water pollution.

Fig.1 Satellite image of cyclone FANI

After the devastating cyclone Fani, the quantum of waste in the three noted districts suddenly scaled up to a new high. According to World Health Organization (WHO) estimates, about 80% of water pollution in developing countries like India is caused by domestic waste (Bhubaneswaran et al, 1999). In India numbers of studies have been carried out to access the water quality in terms of various physicochemical / biological characteristics and heavy metals of surface and ground water at various places (Gleick et al, 1993, Haribhau et al, 2012, Manimaran et al 2012, Parihar et al, 2012 and Patil et al, 2012). The growth in numbers lacking access to safe water and sanitation will be driven in large part by the growth rate of the people living in urban areas.

2. WATER QUALITY ASSESSMENT

The water quality is assessed on use based water quality status (Table-2). According to this concept, out of several uses a water body is put to, the use which demands highest quality of water is termed as Designated Best Use (DBU) and accordingly the water body is designated. In India, water quality is usually assessed in respect of five broad categories as described in the following table.

Table 2: Use Based Classification

Class	Use
A	Drinking water source without conventional treatment but after disinfection
B	Organized outdoor bathing
C	Drinking water source with conventional treatment followed by disinfection
D	Fish culture and wild life propagation
E	Irrigation, industrial cooling or controlled waste disposal

Parameters for the above classifications are grouped in three categories.

i) Simple parameters(sanitary surrounding, general appearance, color, smell, transparency, presence of fish and insects)

ii) Regular monitoring parameters and

iii) Special parameters to be monitored when need or apprehensions arise.

The requirements in respect of regular monitoring parameters for different classes are given in the following Table-3.

Table 3: Standards for regular monitoring parameters

Parameters	**Requirements**		
	Excellent	Desirable	Acceptable
pH	7.0-8.5	6.5-9.0	6.5-9.0
DO	6-8	6-9	5-9
Total Hardness	70-120	60-120	60-140
BOD(mg/L)	Below 2	Below 5	Below 8

*Concentrations of all parameters are in mg/L except pH.

The present study aims at detecting the quality of water of the river Mahanadi in respect of physicochemical parameter studies.

3. WATER QUALITY MONITORING PARAMETERS

Fresh water, a scarce natural resource, is subjected to diverse uses for sustenance of human civilization. Conscious use of water in a sustainable manner can overcome the concerns of water availability and quality to maximum extents. Water quality monitoring is an integral part of the water resource management plans. Monitoring comprises all activities to obtain information with respect to the water system, types of water use i.e. in stream use or abstractive use, nature of the source such as surface water (rivers, lakes), ground water or sea water, quantifying the pollution load, identifying the polluting sources. The following water quality parameters are monitored at all locations of the river Mahanadi.

a. Physical parameters: Temperature, pH, Alkalinity, Total suspended solids (TSS).
b. Indicators of organic pollution: Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Ammoniacal (Ammonium + Ammonia) - Nitrogen, Total Kjeldahl Nitrogen (TKN), Free Ammonia – Nitrogen.
c. Bacteriological parameters: Total Coliform and Fecal Coliform.
d. Mineral constituents: Total Dissolved Solids (TDS), Boron, Total hardness, Calcium, Magnesium, Sodium, Potassium, Chloride, Fluoride, Sulphate.
e. Nutrients: Nitrate (Nitrate + Nitrite) – Nitrogen, Phosphate – phosphorous.
f. Metals: Chromium (Cr), Iron (Fe), Nickel (Ni), Copper (Cu), Zinc (Zn), Cadmium (Cd), Mercury (Hg), Lead (Pb).

Season Description

Water quality data of the river Mahanadi has been described in terms of seasonal values with respect to the cyclone Fani. The seasons are defined as follows:

Pre Monsoon (PRM): May, June.

Monsoon (M): July, August.

Post Monsoon (POM): September, October.

4. METHODS AND PROCEDURES OF INVESTIGATION

The entire area of Odisha was thoroughly studied and locations of the river Mahanadi were earmarked. Water samples from strategic locations of the three identified districts were collected. Seasonal water quality analysis was done with respect to physical, chemical and biological parameters. Physical properties of water quality include temperature, conductivity and turbidity. Chemical characteristics involve parameters such as pH, total hardness, BOD, COD, heavy metals, pesticides, alkalinity and dissolved oxygen. Biological indicators of water quality include algae and phytoplankton. Contaminated water may contain other pathogens (micro-organisms that cause illness) that are more difficult to test for. Therefore these indicator bacteria are useful in giving us a measure of contamination levels. Impairments of these can be observed as impacts to the flora and fauna with a given water body.

One litre capacity of air tight polypropylene sampling bottles were taken for collecting the water samples. The bottles were sterilized before the collection of samples. The bottles were rinsed with the proposed collected water samples and the water samples were collected from different strategic locations of the river Mahanadi and its distributaries covering the three districts i.e., Cuttack, Khordha and Puri. The temperature of the different water samples was determined at the site by the sensitive Red Mercury Thermometer, just after collecting the water samples. pH of the water samples were determined by the field pH meter as well as the laboratory pH meter. The Dissolved Oxygen (DO) content was measured by the standard Winkler's alkali Iodide –azide method. The total hardness was measured by EDTA complexometric titration method. The BOD test was carried out by the standard dilution method. The COD was estimated by titrating the experimental sample against standard potassium dichromate solution. Most Probable Number (MPN) technique was adopted to find out Total Coliforms in the sample.

5. RESULTS AND DISCUSSION

The cyclone Fani has badly affected the water quality status of different rivers of Odisha including Mahanadi. In order to examine the water quality status of the river Mahanadi, a thorough study has been conducted throughout from May 2019 to October 2019.

The variation of different water parameters in different seasons are described as follows.

<u>Pre Monsoon</u>

In the month of May and June pH of water samples were varied between 7.8 to 8.3. The DO of water samples were varied between 7.8 mg/ l to 9.5 mg/l. The total hardness of water samples were varied from 60-72 mg/l. BOD of water samples were varied from 1.5 to 2.3 mg/l. The COD values were varied from 9.8 mg/l to 12.5 mg/l. The Total Coliform values were varied from 61.0 MPN/100 ml to 96.3 MPN/100 ml.

Monsoon

In the month of July and August pH of water samples were varied between 8.1 to 8.8. The DO of water samples were varied between 8.0 mg/l to 9.8 mg/l. The total hardness of water samples were varied from 66-80 mg/l. BOD of water samples were varied from 1.8 to 2.7 mg/l. The COD values were varied from 15.4 mg/l to 18.2 mg/l. The Total Coliform values were varied from 108.5 MPN/100 ml to 180.2 MPN/100 ml.

Post Monsoon

In the month of September and October pH of water samples were varied between 7.3 to 7.9. The DO of water samples were varied between 7.5 mg/l to 9.0 mg/l. The total hardness of water samples were varied from 58-70 mg/l. BOD of water samples were varied from 1.3 mg/l to 2.0 mg/l. The COD values were varied from 8.7 mg/l to 11.2 mg/l. The Total Coliform values were varied from 30.2 MPN/100 ml to 60.5 MPN/100 ml.

The Data of the parameters measured is given in the following tables.

Table – 4: Seasonal Average Values of pH

Sample	PRM	M	POM
S1	7.8	8.1	7.3
S2	8.0	8.3	7.5
S3	7.9	8.4	7.7
S4	8.2	8.7	7.9
S5	8.3	8.8	7.8

Table – 5: Seasonal Average Values of DO in mg/l

Sample	PRM	M	POM
S1	7.8	8.5	8.3
S2	8.4	8.0	7.5
S3	9.3	9.3	8.7
S4	9.5	9.0	9.0
S5	8.9	9.8	7.9

Table – 6: Seasonal Average Values of Hardness in mg/l

Sample	PRM	M	POM
S1	64	66	68
S2	60	72	58
S3	69	69	70
S4	67	80	65
S5	72	77	63

Table – 7: Seasonal Average Values of BOD in mg/l

Sample	PRM	M	POM
S1	1.8	1.8	1.5
S2	2.1	2.7	1.3
S3	2.3	2.0	1.7
S4	1.9	2.4	1.8
S5	1.5	2.3	2.0

Table –8: Seasonal average values of COD in mg/l

Sample	PRM	M	POM
S1	9.8	15.4	8.7
S2	10.4	16.8	9.1
S3	11.6	16.1	10.3
S4	12.5	17.5	11.2
S5	12.0	18.2	10.9

Table –9: Seasonal average values of Total Coliform in MPN/100 ml.

Sample	PRM	M	POM
S1	61.0	108.5	36.0
S2	87.5	130.7	45.3
S3	81.7	150.0	30.2
S4	96.3	180.2	50.7
S5	75.8	165.3	60.5

6. CONCLUSION

Cyclonic events occur periodically and cause broader environmental impacts which are of concern. Water quality assessment of the river Mahanadi and its distributaries during the period of May 2019 to Oct 2019 is discussed. Water quality assessment is done on the basis of use based classification, biological assessment and wholesomeness. The river didn't conform to class-A (drinking water source without conventional treatment but after disinfection) because of high total coliform bacterial counts. It also didn't conform to class-B (bathing water quality) with respect to coliform bacterial counts. Coliforms are a broad class of bacterial found in our environment including feces of man and other warm blooded animals.

The water quality also didn't conform to class-C (drinking water source after conventional treatment and after disinfection) with respect to BOD. The water quality is also deteriorated due to high coliform bacteria which may be attributed to the in stream activities on the river.

Following the cyclone nearly three-quarters of the samples analysed did not conform to World Health Organisation (WHO, 2017) guideline values for safe drinking-water in terms of chlorine residual, total and faecal coliforms, and turbidity. Turbidity and total coliform levels significantly increased from pre-cyclone levels, which were likely due to the large amounts of silt and debris entering water-supply sources during the cyclone (Kulkarni, 2020). The alkaline nature of water is the result of alkaline municipal waste and due to the formation of carbonates in water. In order to restore river water quality intact we must set up the septic tank of each household and the overflow of the septic tanks should be connected to the common drain carrying waste water. The waste water should be treated in the sewage treatment plant consisting of the grit chamber, primary clarifier, aeration tank and secondary clarifier (Ranjan et al, 2012). The result of the outlet should satisfy the general waste water discharge to inland surface water. Better co-ordination between and response from local water and health authorities would also have been beneficial.

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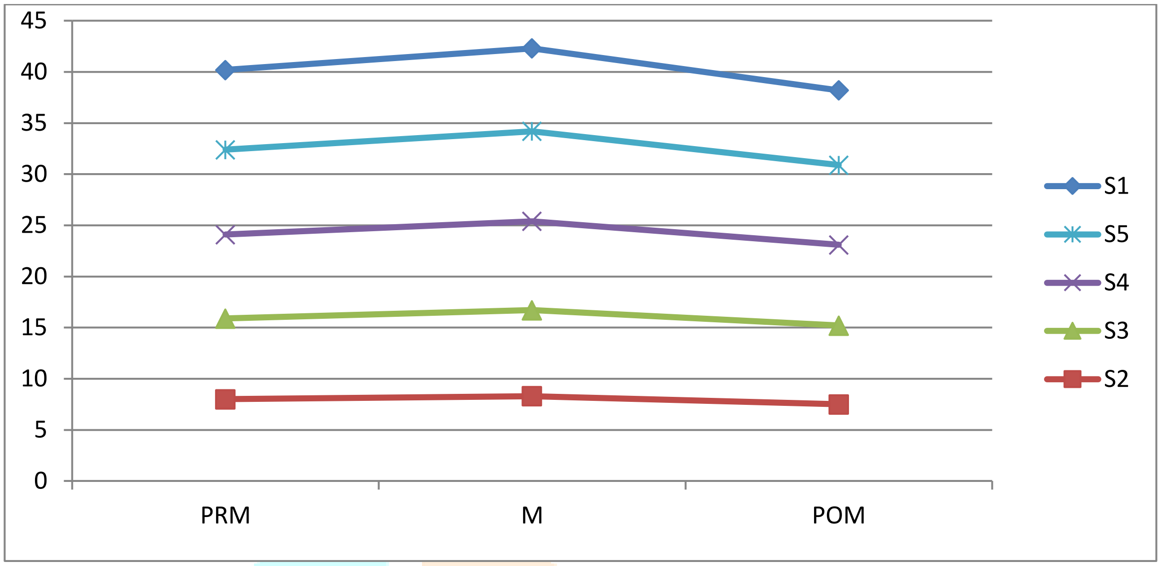

Fig.1: Seasonal Variation of pH at different locations

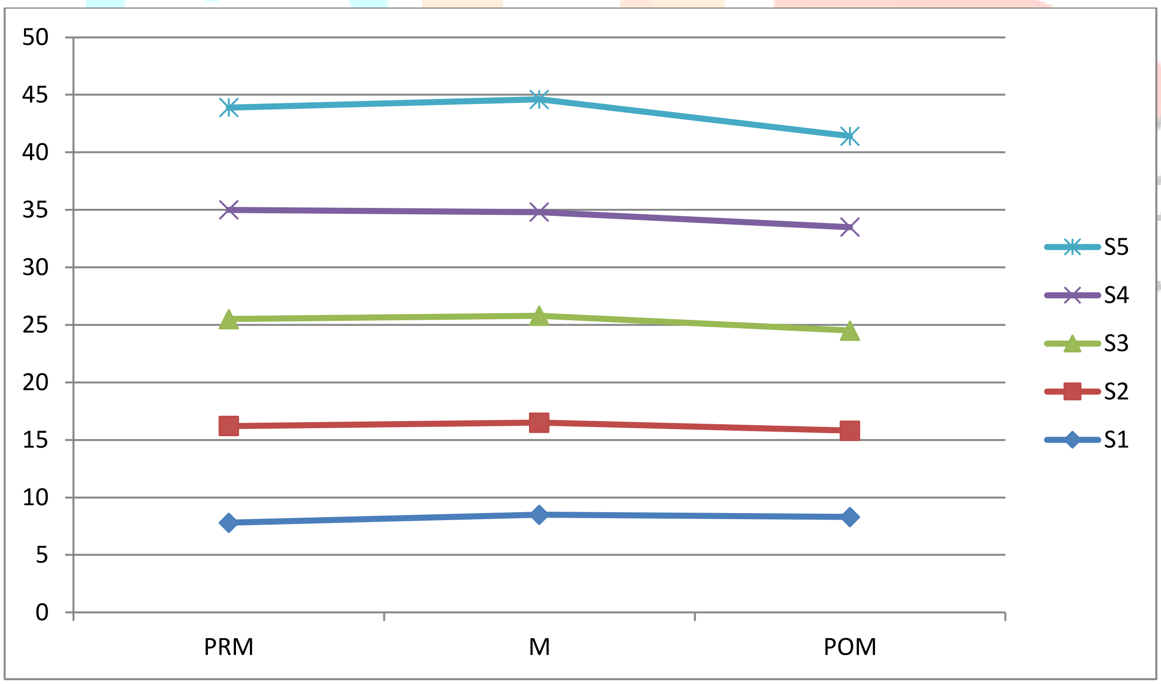

Fig.2: Seasonal Variation of dissolved oxygen (DO) at different locations

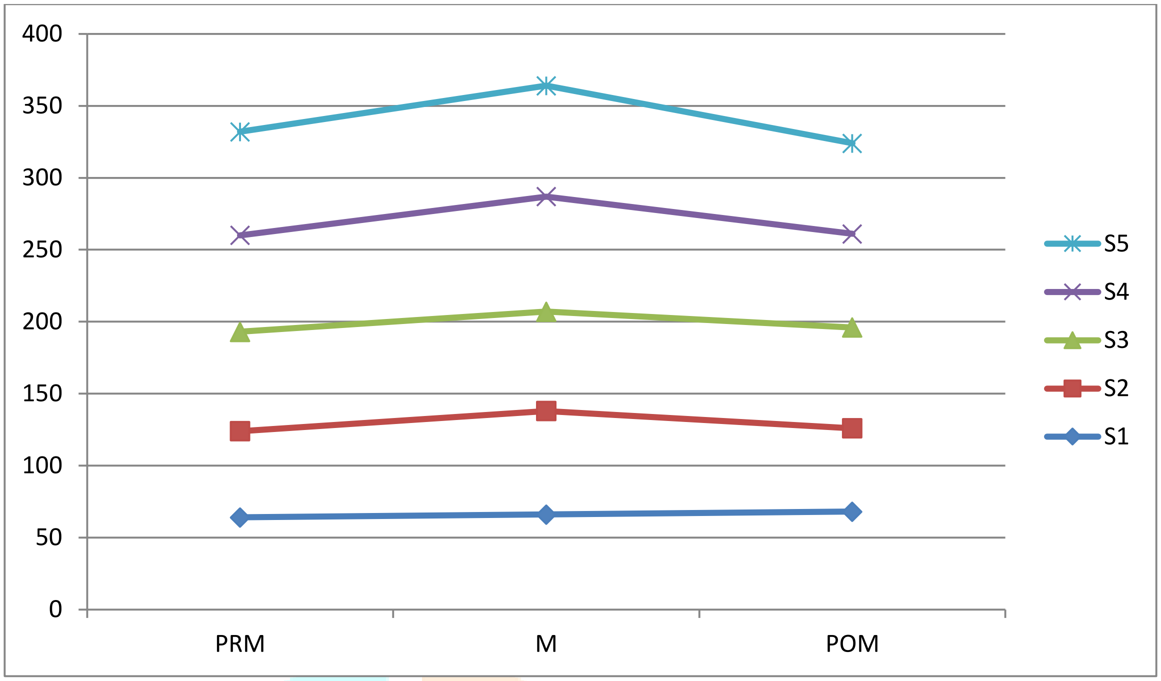

Fig.3: Seasonal Variation of hardness at different locations

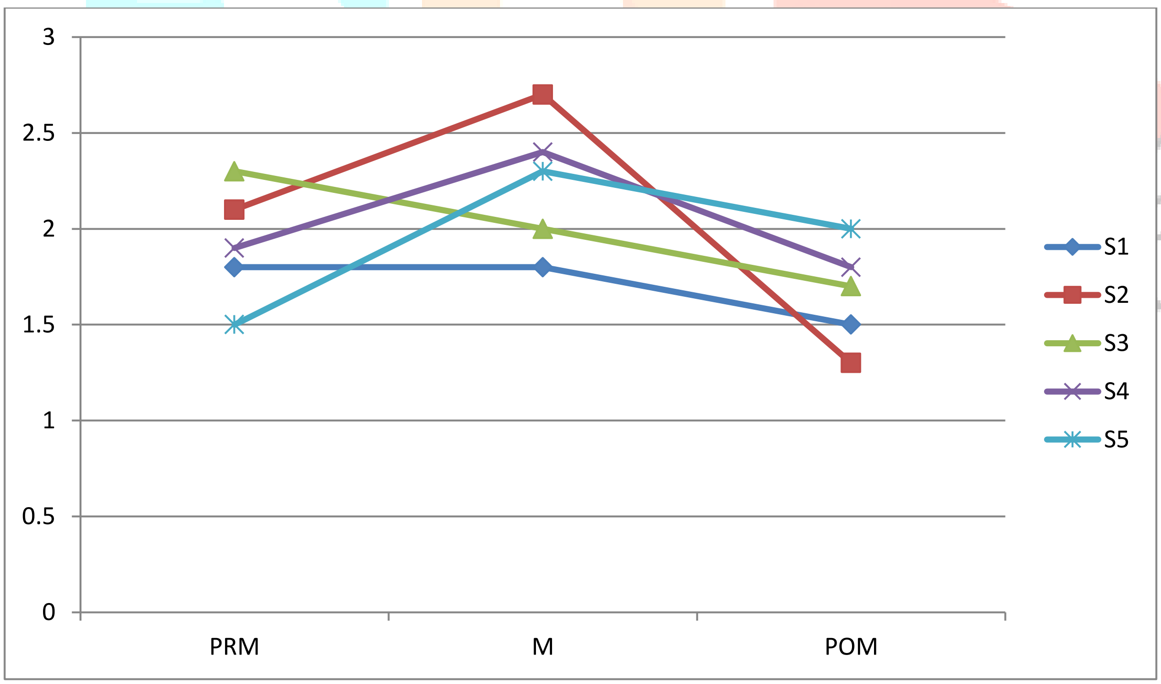

Fig.4: Seasonal Variation of BOD at different locations

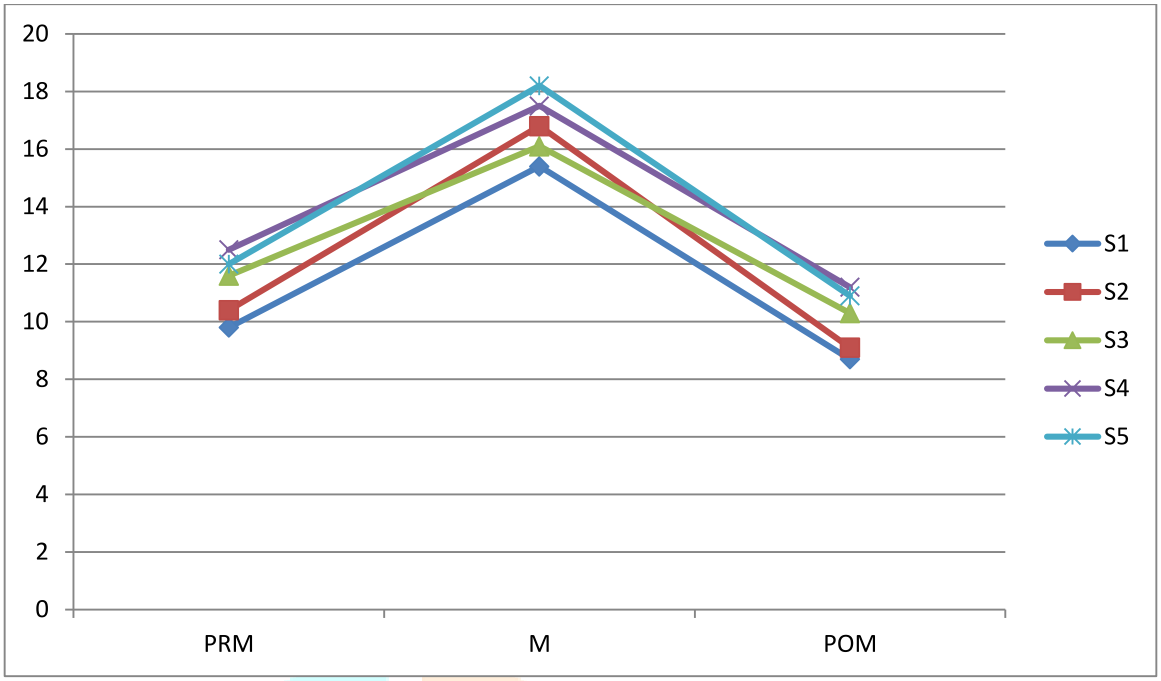

Fig.5: Seasonal Variation of COD at different locations

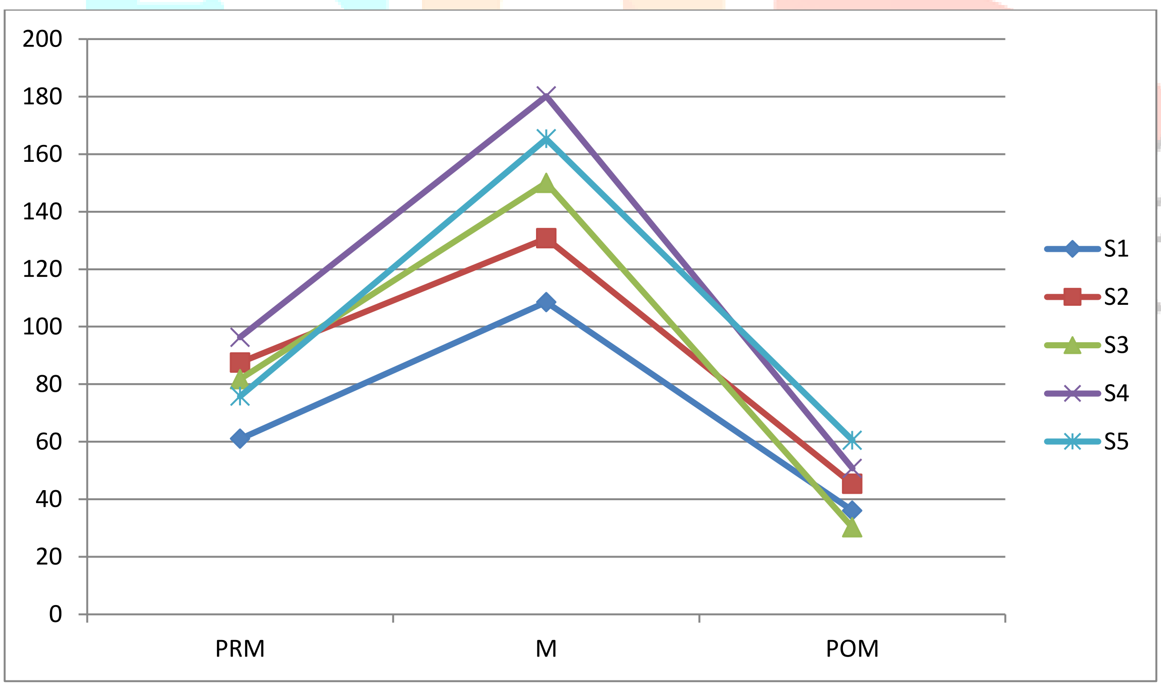

Fig.6: Seasonal Variation of Total Coliform at different locations