Evaluation of Water Quality of Narmada River with reference to Physco-chemical Parameters at Hoshangabad city, MP, India

Sharma Shraddha[1], Vishwakarma Rakesh[2], Dixit Savita[3] and Jain Praveen[4]

[1]Department of Applied Chemistry, Maulana Azad National Institute of Technology, Bhopal, M.P., INDIA
[2]Department of Applied Chemistry, Swami Vivekanand College of Science and Technology, Bhopal, M.P., INDIA
[3]Department of Applied Chemistry, Maulana Azad National Institute of Technology, Bhopal, M.P., INDIA
[4]Centre of IT & Basic Sciences, Madhya Pradesh, Bhoj (Open) University, Bhopal, M.P., INDIA

Available online at: www.isca.in
(Received 26th April 2011, revised 4th May 2011, accepted 16th May 2011)

Abstract

River Narmada is one of the 13 prominent rivers of India, which covers 98,797 sq km of total water-shed area. Narmada is considered to be the lifeline and west flowing river of the state of Madhya Pradesh. The monitoring of water quality of Narmada River was carried out for one year 2007. Four sampling stations were selected at downstream of Hoshangabad city. The water samples collected were analyzed, as per standard methods parameters such as pH, EC, Turbidity were measured in-situ. Raised values of physico-chemical parameters indicate the pollution of riverine ecosystem due to domestic wastes, municipal sewage, industrial effluent from Security Paper Mill (SPM) and agricultural run-off that influence the water quality directly or indirectly. Statistical analysis carried out through correlation method and also evaluates Average values (AV), Standard Deviation (SD), Standard Variance (SV), Standard Error (SE) and 95% Confidence Limit (CL) to assess the pollution load assessment. The results revealed that most of the water samples were below or out of limited; according to the WHO, BIS standards.

key Words: Statistical analysis, Narmada river, Water pollution, River water quality, Hoshangabad city, Physico- chemical analysis.

Introduction

Natural surface water bodies like rivers and streams are subjected to pollution comprising of organic and inorganic constituent [27]. Hoshangabad is the largest cities situated at the bank of river Narmada, which is also a holy place. Narmada is the largest west-flowing river in India and originates from Amarkantak at an elevation of 900m in the Mekhala range of Shadol district, Madhya Pradesh [10]. It is the seventh largest among the fourteen major river basins in the country [11]. The river Narmada drains the catchment between the Vindhyan mountains to the north of the river stretching east-west in general, and the Satpura mountain ranges to the south. It flows through the undulating plains of Hoshangabad about 300m high, dotted with occasional low buttes. . It has a total course of 1312 km and total basin of 98,796,80 sq km Hoshangabad town is situated $22^0 23' 40''$ latitude and $77^0 58' 30''$ longitudes[10]. Hoshangabad city is famous for beautiful "Ghats" along river Narmada. The river is being polluted here by much city sewage along with industrial effluents from Security paper Mill as it provide a cheaper mode of waste disposal. It flows 1,300 km west through the states of Madhya Pradesh and Gujarat in terms of its catchment area[11]. In Narmada river huge quantity of domestic waste, municipal sewage dumped daily in addition to industrial effluents and agricultural run-off. Hence it is

intended to investigate physico- chemical parameters of river water.

Material and Methods

The water samples were collected from the river Narmada water from four selected stations SS1 (Bandhrabhan), SS2 (Naoghat), SS3 (Sethanighat), SS4 (Dongarwara) for a period of twelve months during the year 2007. The river water samples were collected in different sampling bottles as per standard method APHA[2]. The pH, electrical conductivity and turbidity were estimated at sampling sites. The other parameters were measured by the procedure given by APHA in the laboratory[2.16]. The investigation period was divided into two seasons i.e. Pre-monsoon and Monsoon.

Results and Discussion

Studies of physico – chemical characteristics of river Narmada water suggests that the various parameters depending upon the hydrochemistry of the study area and also the waste water released from the different nallas. Different aspects of water and waste water have been studied by many workers such as physico-chemical characteristics of sewage entering into the river[1.3.4.5.7.8.9.12.17.22]. The Physical factors contributing the great role in water quality such as Temperature, pH and Turbidity water level and intensity of illumination is also an important factor to maintain the water quality[6.18.19.25.30]. The pH of water is directly related to carbonate and bicarbonate ions present in it, which is closely associated with CO_2 pressure and the ionic strength solution and altering the pH values change the quality of water have been activities in the aquatic solutions. The Biochemical oxygen demand is of great importance in water quality assessment[14.15]. The results achieved during the course of present study are tabulated in tables 1 to 4. The results are demonstrated by the minimum and maximum values, average values and statistical evaluations i.e. Standard Deviation (SD), Standard Variance (SV), Standard Error (SE), 95% Confidence Limit (CL) of the parameters of Narmada river water are presented in table 1 to 2 and description of correlation coefficient (r) of river water samples is presented in table 3 to 4. The result of physico-chemical properties obtained during present study was found fluctuated with the standard values of water quality given by World Health Organization[29], BIS (Bureau of Indian Standards) to categories the sites according to their pollution load.

pH: pH is an important parameter which is important in evaluating the acid-base balance of water. The pH value of water at sewage discharge points were usually lower than that of the river water[23.24], also reports similar results in case of river Ganga. The BIS (Bureau of Indian Standards) limits of pH for drinking water are 6.5-8.5. The pH of Narmada river water samples in Pre monsoon season was found to be in the range 7.7 to 8.9 and in Monsoon 7.6 to 9.9 as shown in fig.1, along with concentration of average value with 95% CL was found to be 8.55 ± 0.91in Pre-monsoon and 8.85 ± 1.45 in Monsoon respectively. pH showed negative correlation with Turbidity (r = -0.4232), Ca hardness (r = -0.4404), Chloride (r = -0.4433), Phosphate (r = - 0.9847), DO (r = -0.4045) in Pre-monsoon and in Monsoon pH showed negative correlation with Turbidity (r = -0.7770), Ca hardness (r = -0.7070), Sulphate (r = -0.2760), Chloride (r = -0.7040), Phosphate (r = - 0.9040), DO (r = -0.4060) and positive correlation with other physico-chemical parameters which are given in table 3 and 4.

Electrical Conductivity (EC: EC measurement is an excellent indicator of TDS, which is a measure of salinity that affects the taste of potable water[27]. The Electrical Conductivity of water sample of Narmada River in Pre monsoon and Monsoon was observed to be in the ranges of 373-462 and 272-364 μmhos/cm, as shown in fig.2 respectively. This conductivity of average value of 95% CL was found to be 400.5 ± 65.87 and 298.7 ± 69.52 μ mhos/cm respectively. EC showed negative correlation with Turbidity (r = -0.7508), Ca hardness (r = -0.7610), Sulphate (r = -0.3159), Chloride (r = -0.7515), Phosphate (r = -0.4270), DO (r = -0..6799) in Pre-monsoon and in Monsoon EC showed negative correlation with Turbidity (r = -0.9770), Ca hardness (r = -0.7810), Sulphate (r = -0.4600), Chloride (r = -0.8000),

Phosphate (r = - 0.4350), DO (r = -0.5440) and positive correlation with Mg Hardness, Nitrite which are given in table 3 and 4.

Turbidity: Turbidity of water is an important parameter, which influences the light penetration. The turbidity values of Narmada river water sample in Pre monsoon and Monsoon was found to be in the range of 12.11- 13.0 and 21.7-29.64 NTU as shown in fig.3, along with the concentration of a average value with 95% CL was found to be 12.6 ± 0.58 and 27.24 ± 5.92 N.T.U. respectively. Turbidity showed negative correlation with Mg Hardness (r = -0.4957), Nitrite (r = -0.8025) in Pre-monsoon and in Monsoon Turbidity showed negative correlation with Mg Hardness (r = -0.9830), Nitrite (r = -0.6920) and positive correlation with Sulphate, Chloride, Phosphate and DO which are given in table 3 and 4.

Calcium Hardness: Calcium is an important micronutrient in an aquatic environment Hardness of the river water is of considerable significance in connection with the discharge of the sewage and industrial effluent containing pollution, as indicated by variations in the concentration of the hardness of the water[20]. The concentration of Ca Hardness in Narmada river water sample in Pre monsoon and Monsoon was found to be in the range of 330-353 mg/L and 370-396 mg/L as shown in fig.4, along with the concentration of a average value with 95% CL was found to be 343± 15.7 and 384 ± 17.8 mg/l respectively. Calcium Hardness showed negative correlation with Mg Hardness (r = -0.5126), Nitrite (r = -0. 8117) in Pre-monsoon and in Monsoon Calcium Hardness showed negative correlation with Mg Hardness (r = -0.8010), Nitrite (r = -0.3010) and positive correlation with Sulphate, Chloride, Phosphate and DO which are given in table 3 and 4.

Magnesium Hardness: Magnesium as co factor for various enzymatic transformations within the cell especially in the trans-phosphorylation in algal, fungal and bacterial cell[28]. The concentration of Mg Hardness in Narmada river water sample in Pre monsoon and Monsoon was found to be in the range of 185-316mg/l and 196-293 mg/l as shown in fig.5, along with the concentration of a average value with 95% CL was found to be 235 ± 98.098 and 223 ± 74.39 mg/L respectively. Magnesium Hardness showed negative correlation with Chloride (r = -0.5017), Phosphate (r = -0. 4703), DO (r = -0.4063) in Pre-monsoon and in Monsoon Magnesium Hardness showed negative correlation with Sulphate (r = -0.4880) Chloride (r = -0.8190), Phosphate (r = -0. 4320), DO (r = -0.5710), and positive correlation with Nitrite, Sulphate in Pre-monsoon and only Nitrite in Monsoon which are given in table 3 and 4.

Nitrite: In general, increase downstream the pollution input gives a sufficient indication of the deteriorating quality of water due to entry of wastewater in river. Similar findings have been reported by Shah and Rai[20.21] .The concentration of Nitrite in Narmada river water sample in Pre monsoon and Monsoon was found to be in the range of 0.063-0.093 mg/l and 0.083-0.089 mg/l as shown in fig.6, along with the concentration of a average value with 95% Cl was found to be 0.071 ± 0.023and 0.086 ± 0.0041 mg/L. The BIS (Bureau of Indian Standard) suggested the limit of phosphate is 0.1mg/L. Nitrite showed negative correlation with Sulphate (r = -0.3850) Chloride (r = -0.8032), Phosphate (r = -0.4544), DO (r = -0.7378) in Pre-monsoon and in Monsoon Nitrite showed negative correlation with Chloride (r = -0.3300), Phosphate (r = -0. 3390), and positive correlation with Sulphate in Monsoon which are given in table 4.

Phosphate: The increased application of fertilizers, use of detergents and domestic sewage greatly contribute to the heavy loading of phosphorous in the water[13]. The BIS (Bureau of Indian Standard) suggested the limit of phosphate is 0.1mg/l. The concentration of Phosphate in Narmada river water sample in Pre monsoon and Monsoon was found to be in the range of 0.16-0.19 mg/L and 0.19-0.28mg/L as shown in fig.7, along with the concentration of an average value with 95% CL was found to be 0.17 ± 0.02 and 0.22 ± 0.07 mg/L respectively. Phosphate showed positive correlation with DO (r = 0.5477) in Pre-monsoon and (r = 0.0736)in Monsoon, which are given in table 3 and 4.

Sulphate: Sulphate is widely distributed in nature and may be present in natural waters. The main source of sulphur is the rocks present near the water-bodies and biochemical action of anaerobic bacteria. The concentration of Sulphate in Narmada river water sample in Premonsoon and Monsoon was found to be in the range of 325-449 mg/l and 415-493 mg/l as shown in fig.8, along with the concentration of a average value with 95% Cl was found to be 362.5 ± 92.36and 442.75± 55.035 mg/l respectively. Sulphate showed negative correlation with Phosphate (r = -0.060) in Monsoon and Sulphate showed positive correlation with Chloride, Phosphate and DO in Pre-monsoon and Chloride, DO in Monsoon which are given in table 3 and 4.

Chloride: Main sources of chloride in river waters are sediments, sewage and trade and industrial effluents, if present. Sewage bring with urine, which is rich in chloride content i.e. 4500-5000 ppm chloride 45/. The BIS (Bureau of Indian Standard) suggested the standard of chloride is 250 mg/l. The concentration of Chloride in Narmada river water sample in Premonsoon and Monsoon was found to be in the range of 270-289 mg/l and 320-342 mg/L as shown in fig.9, along with the concentration of a average value with 95% CL was found to be 280.25 ± 13.0 and 332 ± 14.9 mg/l respectively. Chloride showed positive correlation with Phosphate (r = 0.5762), DO (r = 0.9942) in Pre-monsoon and in Monsoon Chloride also showed positive correlation with Phosphate (r = 0.3729), DO (r = 0.9211).

Dissolved Oxygen: Dissolved oxygen in natural and waste water depends on the physical, chemical and biological activities in the water body. The WHO (World Health Organization) suggested the standard of DO is >5.00 mg/l. The concentration of DO in Narmada river water sample in Pre monsoon and Monsoon was found to be in the range of 4.2-4.5 mg/L and 4.1-4.6 mg/L as shown in fig.10, along with the concentration of a average value with 95% CL was found to be 4.35 ± 0.21and 4.3 ± .034 mg/L respectively.

Conclusion

This study provides an informative data and helps to understand the contamination of wastewater in river Narmada and the influences the ecology of river Narmada. The major source of pollutants are local anthropogenic activities, agricultural runoff and by industrial effluent. In the present study it was found that physico- chemical characteristics of a few of the river water samples crossed the maximum permissible limit, due to heavy mixing of effluent waste and domestic sewage it was noticed that the physico-chemical parameters indicates balance of the river Narmada was disturbed. The study concluded that due to discharge of untreated sewage into the Narmada, the water quality of Narmada has been severely deterioted and the potable nature of water is being lost.

References

1. Agrawal I.C. and Srivastava H.C., Pollution Survey of major drains discharged into river Ganga and Yamuna at Allahabad., *Instn. Pub. Lic. Hlth. Engrs.,* TS III-39, TS III-48, **(1984)**

2. APHA, Standard method for the examination of water and waste water. APHA, AWWA, WPEC, 19th edition, New York, **(1998)**

3. Arora H.C., Routh T., Chattopadhyaya S.N., and Sharma V.P., Survey of sugar mill effluent disposal part II, A comparative study of sugar mill effluent characteristics, *India J. Environ. Hlth.,* **16(3),** 233-246 **(1974)**

4. Bandy J.T.,Water characteristics, *J. Wat. Poll. Cont. Fed.,* **56(6)**, 544-548 **(1984)**

5. Basu A.K., Studies in effluents from pulp paper mill and its role in bringing the physico-chemical changes around several discharge point in the Hoogly Estuary, *Indian J. Int. Eng.,* **46,**108-116 **(1966)**

6. Butler J.L., Temperature relation in shallow turbid pools, *Proc. Okla. Acad. Sci.,* **43**, 90-95 **(1963)**

7. Ciaccia L., Water and Water Pollution Hand book, Mercel Dekker, Inc. New York, **3**, 801-808 **(1972)**

8. Dakshini K.M.M. and Soni J.K., Water quality of sewage drains entering Yamuna in Delhi, *Indian J. Environ. Hlth.,* **21**, 354-360 **(1979)**

9. Ganpati S.N. and Chacko P.I., An investigation of the river Godavari and the effects of the paper mill pollution at Rajamundry, *Proc. Indo-Pac. Fish Counc, Madras Meeting Sec. II and III,* 70 **(1951)**

10. Gazetteer of Hoshangabad, Govt. of India, Madhya Pradesh, **(1979)**

11. Ghosh T.K., Shakila B. and Kaul S.N., Protection of ecologicaliy sensitive areas: origin of rivers and upper catchment areas, *J. of Indian Association for Enviro. Management,* Vol. **31**, 59-64 **(2004)**

12. Goel P.K. and Trivedi R.K., Some considerations on sewage disposal to fresh water and resultant effects, *Poll. Res.* **3**, 7-12 **(1984)**

13. Golterman H.L., Physiological Limnology Elsveri Scientific Publication Co. N.Y. 489 **(1975)**

14. Hannan H.H., Young W.C. and Mathew J.J., Nitrogen and Phosphorous dynamics in three central Texas impoundments, *Hydrobiologia,* **40**, 121-129 **(1972)**

15. Hutchinson G.E. and V.T. Bower., Adirect demonstration of phosphorous in a small lake, *Proc. Nat. Acad. Sci.,* **33**, 148-153 **(1947)**

16. Kodarkar M.S., Methodology for water analysis, Ind. Asso. Aquatic Biologist, Hyderabad **(1992)**

17. Kothandaraman V., Thergaonkar V.P., Koskij T. and Ganapati S.V., Physico chemical and biological aspects of Ahmedabad Sewage, *Environ. HIth*., **5**:356-363 **(1963)**

18. Matkar L.S. and Gangotri M.S., Physico-chemical analysis of sugar industrial effluents, *J. Indl. Polln.* Cont., **18(2)**, 139-144 **(2002)**

19. Prasad R.R., Priliminary observations on the temperature gradients and light penetration in the upper 200 feet of water of the Bay of Bengal, *Proc. Indian Acad. Sci.,* **36**, 61-69 **(1952)**

20. Rai H. Limnological observation on the different rivers and lakes in the Ivory Coast, *Hydrobiologia,* **44(213),** 301-317 **(1974)**

21. Shah A.R., Physico-chemical aspects of pollution in river Jhelum (Kashmir) during 1981-83, Book Ecol. and Pollu. of Indian Rivers, (Ed Trivedi R.K.) Ashish Pub. House New Delhi (1),163-207 **(1988)**

22. Sharma K.D., Lal N. and Pathak R.D., Water quality of sewage drains entering Yamuna at Agra, *Indian J. Environ. Hlth.,* **23(2)**, 118-122 **(1981)**

23. Shukla B.D., Suresh C., Tripathy R., Deep Kumari V. and Pande V.S., Physico-chemical and biological characteristics of river Ganga from Mirzapur to Ballia, *Indian J. Envrion. H1t,* **31(3)**, 218-227 **(1989)**

24. Sikander M., Ecology of river Ganga in Varanasi with special reference to pollution Ph.D. Thesis, B.H.U., Varanasi, **(1987)**

25. Sivakumar A.A., Arunadevi P., Aruchami M., Studies on water quality of the river Ambarapalaym, Coimbatore district, Tamil Nadu. *Nature Env. Polln. Techno*, **2(3)**, 305-308 **(2003)**

26. Steemann N.E. and Hansen V.K., Light adoptation in marine phytoplankton

pollutions and it inter relation with temperature, *Physiol. Plant.,* **12**, 353-370 **(1959)**

27. Unnisa S.A. and Khalilullah M., Impact of industrial pollution on ground and surface water quality in the Kattedan industrial area, *J. of Indian Association for Enviro. Management*, **31**, 77-80 **(2004)**

Wetzel R.G., Limnology. W.B. Saunders Co., Philadelphia USA 743 **(1975)**

28. WHO, Recommendations, Water and Sanitation. Guidelines for Drinking Water Quality, Vol.1. Geneva: WHO **(1984)**

29. Young F.N. and Zimmerman J.R., Variation in temperature in small aquatic situation, *Ecology,* **37**, 609-611 **(1956)**

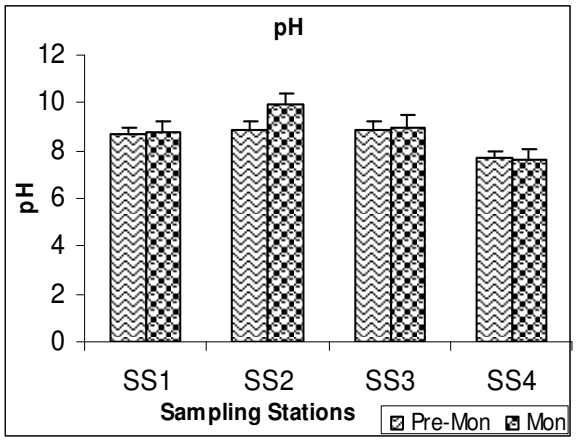

Fig-1: Graph showing variation in pH Concentration at different sampling stations

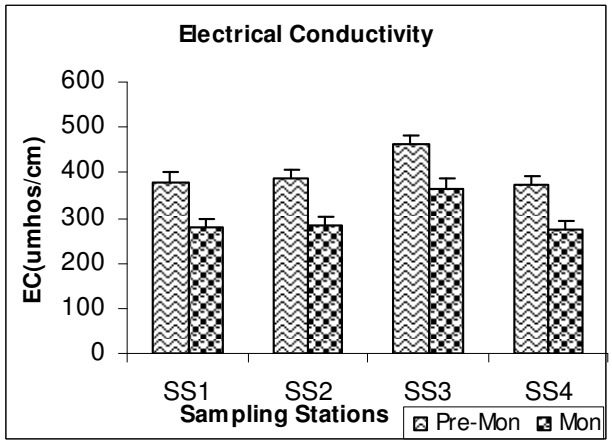

Fig-2: Graph showing variation in Electrical conductivity Concentration at different sampling stations

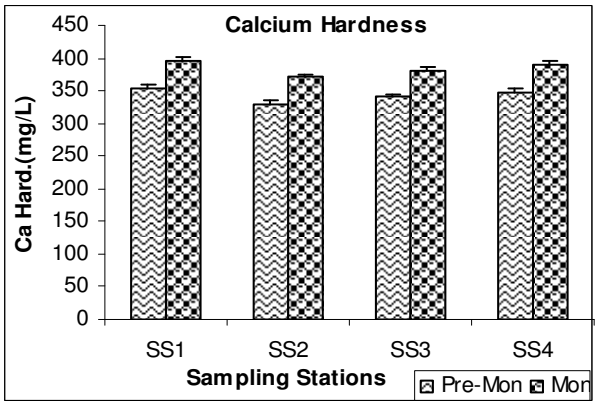

Fig-3: Graph showing variation in Turbidity Concentration at different sampling stations

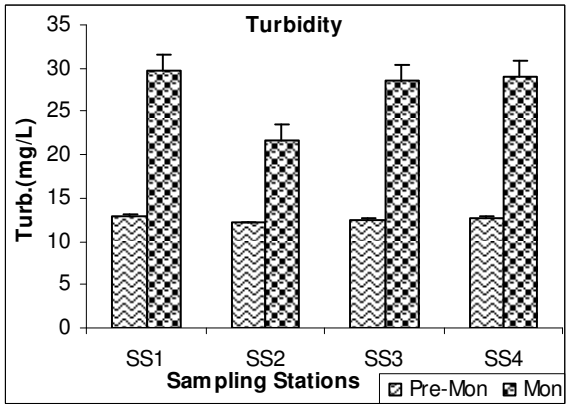

Fig-4: Graph showing variation in Calcium Hardness Concentration at different sampling stations

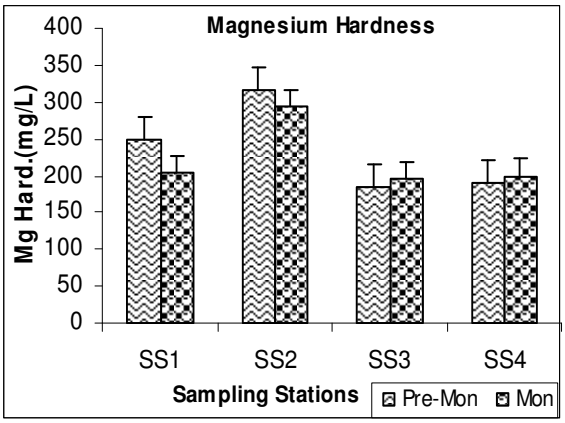

Fig-5: Graph showing variation in Mg Hardness Concentration at different sampling stations

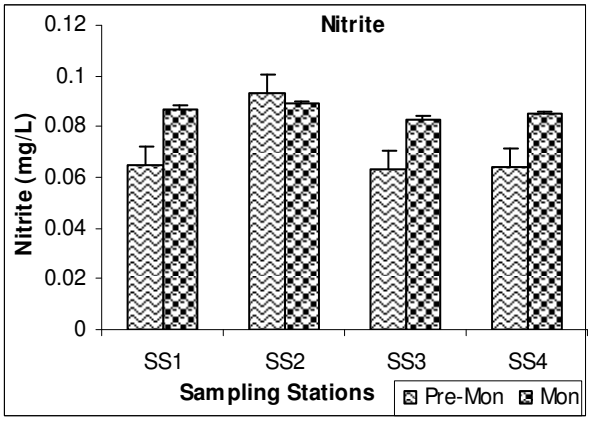

Fig-6: Graph showing variation in Nitrite Concentration at different sampling stations

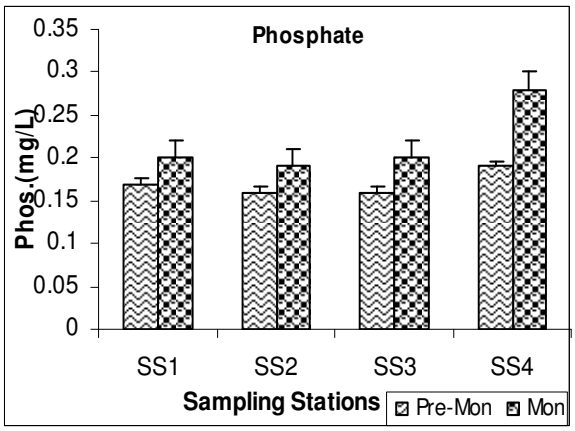

Fig-7: Graph showing variation in Phosphate Concentration at different sampling stations

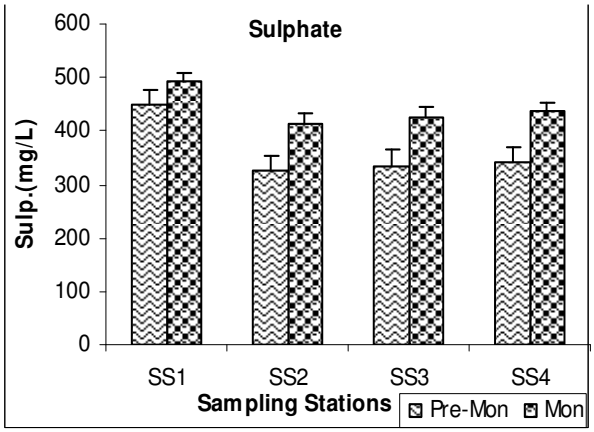

Fig-8: Graph showing variation in Sulphate Concentration at different sampling stations

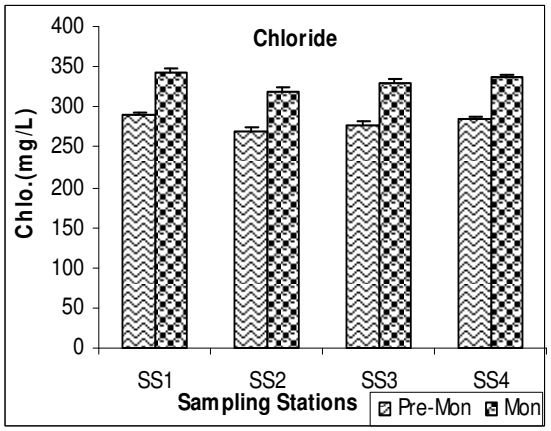

Fig-9: Graph showing variation in Chloride Concentration at different sampling stations

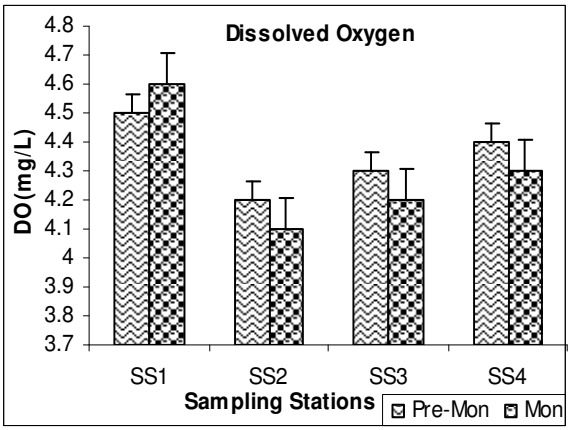

Fig-10: Graph showing variation in DO Concentration at different sampling stations

Table-1: Statistical evaluation for physico-chemical parameters of Narmada river water samples in Pre-monsoon

Parameters	pH	Elec. cond.	Turb.	Ca Hard.	Mg Hard.	Nitrite	Sulphate	Cl	Phosphate	DO
AV	8.55	400.5	12.6	343	235	0.07125	362.5	280	0.17	4.35
S E	0.29	20.698	0.18	4.94	30.825	0.00726	29.022	4.09	0.01	0.06
S D	0.57	41.396	0.36	9.88	61.65	0.01452	58.043	8.18	0.01	0.13
S V	0.33	1713.7	0.13	97.7	3800.7	0.00021	3369	66.9	0	0.02
Min	7.7	373	12.1	330	185	0.063	325	270	0.16	4.2
Max	8.9	462	13	353	316	0.093	449	289	0.19	4.5
AV± CL (95.0%)	8.55 ± 0.91	400.5 ± 65.871	12.6 ± 0.58	343 ± 15.7	235 ± 98.098	0.0712 ± 0.02310	362.5 ± 92.36	280 ± 13.0	0.17 ± 0.02	4.35 ± 0.21

Table-2: Statistical evaluation for physico-chemical parameters of Narmada river water samples in Monsoon

Parameters	pH	Elec. cond.	Turb.	Ca Hard.	Mg Hard.	Nitrite	Sulphate	Chloride	Phosphate	DO
AV	8.85	298.75	27.2	384	223	0.086	442.75	332	0.22	4.3
S E	0.46	21.846	1.86	5.58	23.377	0.001291	17.293	4.69	0.02	0.11
S D	0.91	43.691	3.72	11.2	46.755	0.002582	34.587	9.38	0.04	0.22
S V	0.83	1908.9	13.8	125	2186	6.67E-06	1196.3	88	0	0.05
Min	7.68	272	21.7	370	196	0.083	415	320	0.19	4.1
Max	9.9	364	29.6	396	293	0.089	493	342	0.28	4.6
AV±CL (95.0%)	8.85 ± 1.45	298.75 ± 69.522	27.2 ± 5.92	384 ± 17.8	223 ± 74.397	0.086 ± 0.004109	442.75 ± 55.035	332 ± 14.9	0.22 ± 0.07	4.3 ± 0.34

Table-3: Correlation coefficient values among the physico-chemical parameters of Narmada river water samples in Pre monsoon

Parameters	pH	Elec. cond.	Turb.	Ca Hard.	Mg Hard.	Nitrite	Sulphate	Chloride	Phosp.	DO
pH	1									
Elec.cond.	0.3826	1								
Turb.	-0.4232	-0.7508	1							
Ca Hard.	-0.4404	-0.7610	0.9997	1						
Mg Hard.	0.4913	0.9269	-0.4957	-0.5126	1					
Nitrite	0.3975	0.9966	-0.8025	-0.8117	0.8987	1				
Sulphate	0.0849	-0.3159	0.7983	0.7839	0.0581	-0.3850	1			
Chloride	-0.4433	-0.7515	0.9997	0.9998	-0.5017	-0.8032	0.7880	1		
Phosphate	-0.9847	-0.4270	0.5578	0.5724	-0.4703	-0.4544	0.0893	0.5762	1	
DO	-0.4045	-0.6799	0.9948	0.9928	-0.4063	-0.7378	0.8407	0.9942	0.5477	1

Table-4: Correlation coefficient values among the physico-chemical parameters of Narmada River water samples in Monsoon

Parameters	pH	Elec. cond.	Turb.	Ca Hard.	Mg Hard.	Nitrite	Sulphte	Chloride	Phosp.	DO
pH	1									
Elec.cond.	0.7593	1								
Turb.	-0.7770	-0.9770	1							
Ca Hard.	-0.7070	-0.7810	0.8965	1						
Mg Hard.	0.7609	0.9995	-0.9830	-0.8010	1					
Nitrite	0.5406	0.8303	-0.6920	-0.3010	0.8118	1				
Sulphate	-0.2760	-0.4600	0.6256	0.8675	-0.4880	0.0784	1			
Chloride	-0.7040	-0.8000	0.9101	0.9993	-0.8190	-0.3300	0.863	1		
Phosphate	-0.9040	-0.4350	0.4345	0.3845	-0.4320	-0.3390	-0.060	0.3729	1	
DO	-0.4060	-0.5440	0.7045	0.9259	-0.5710	-2E-15	0.9904	0.9211	0.0736	1