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Physico-chemical parameter evaluation of water quality around Chandrapur District Maharastra, India

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ABSTRACT

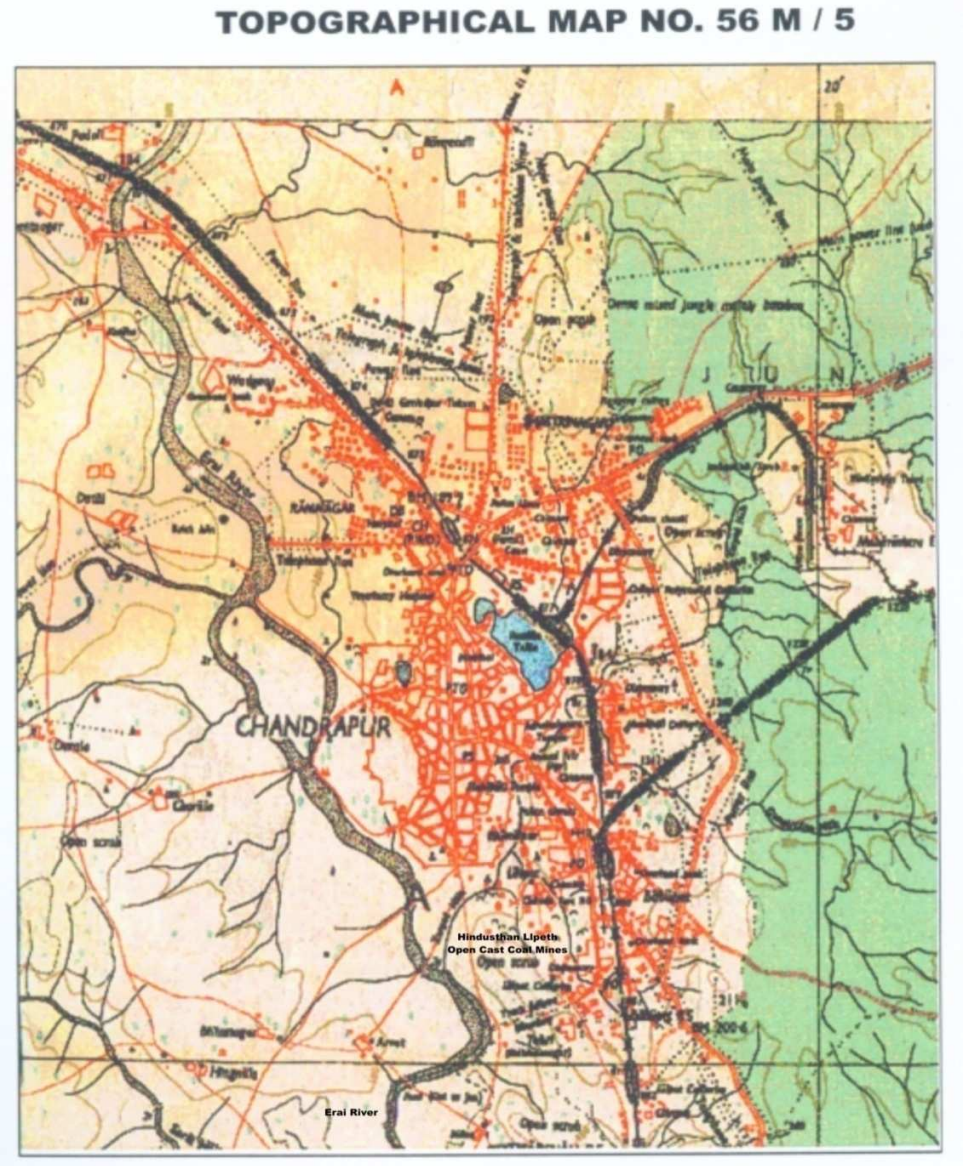
Wardha, Wainganga and Penganga are the major rivers surrounding Chandrapur district. Wardha river flows into the district from western boundary and then flows along the boundaries of Warora, Chandrapur, Korpana, Rajura, Ballarpur and Gondpipari talukas and Penganga and Irai rivers meet the Wardhariver during this course. As Wardha river flows through several industrial active areas of Chandrapur district monitoring of water quality of Wardha river was carried out during September 2011 to August 2012 period to assess the water pollution level. Two sampling stations were selected at downstream of Chandrapur city. Whereas one sampling station upstream were selected .Water samples were collected and analyzed as per standard methods. Parameters such as pH, turbidity were measured in situ during the sampling. Higher values of several physico-chemical parameters indicate the pollution of riverine ecosystem in the study area. Domestic wastes, municipal sewage, industrial effluent from paper and pulp industries as well as agricultural runoffs are directly or indirectly responsible for deterioration of water quality. Statistical analysis including correlation method average values (AV), Standard Deviation (SD), Standard Variance (SV), Standard Error (SE) and 95% confidence limit (CL)were carried out to assess the pollution load. The results revealed that most of the water samples do not meet WHO and BIS water quality standards, while many samples showing severe water quality deterioration.

Key words: River water quality, statistical analysis, Wardha River, Water pollution, Chandrapur city, Physico-chemical analysis, industrial pollution.

INTRODUCTION

Water also known as blue gold, one of the most precious natural resources is responsible for life on Earth as, evolution of life and development of human civilization could not have been possible without water. All great civilizations of the world therefore evolved around rivers. Rapidly increasing population indiscriminate urbanization and unplanned industrialization along the rivers as well as in the catchment areas have put tremendous stress on water resources and their quality. Indiscriminate discharge of industrial effluent in rivers has been a common phenomenon leading to sever depletion of water quality and aquatic life. The examination of water quality is therefore necessary to assess its quality as well as to find out source of pollution , which ultimately helps in planning the water quality management such studies helps to find out whether water is suitable for specific industrial purpose, and if not, to choose the most effective treatment strategy; to determine the extent of pollution and to suggest a possible remedy; to determine the efficiency towards natural purification when sewage and industrial

wastes are discharged into water courses; and to ascertain the effect of rainfall on water quality, Primary assessment of water pollution level in the natural environment has therefore been of great concern to the Scientists, Environmentalists and Engineers as it also help assessing adverse effects on human beings and environment .[1,2,3]



The selected area is drained by major tributaries of the Godavari, one of the most important rivers for southern region of India. The three rivers in the study area namely Wardha, Wainganga and Penganga are major tributaries to river Godavari and therefore water quality of these rivers can have complex impacts on major rivers. The Penganga River, flowing along part of the western boundary, merge into the Wardha river near Ghugus town. It further flows in NW–SE direction and finally merging in to the Wainganga River at the south eastern corner of the district where it completely drain out.

The Waingangā River is the main river which flows along the border of the Chandrapur and Gadchiroli district. The Wardha River is the only perennial river and having the longest river course as compared to the other two major rivers. One of the main tributaries of the Wardha river is Erai river, rises in the northern part of Warora tehsil which flows along south side of Chandrapur covers distance about 80 km and merges in to wardha River. The Penganga flowing along western border takes east west course and then joins the Wardha River at Ghugus [13].

EXPERIMENTAL SECTION

The water samples were collected from the Wardha river at three different selected stations SS1 (Wada),SS2(Ghugus),SS3 (Ballarpur) over a period of twelve months during the year September 2011- August 2012. The river water samples were collected in different sampling bottles as per standard methods mentioned in literature (Standard methods for the examination of water and waste water APHA,AWWAWPEC 19th edition, New York1998). The pH and turbidity were measured and estimated at sampling sites by using water analysis kit (systronic).The other parameters were measured by the procedure given by APHA in the laboratory. The investigation period was divided into three seasons that are pre-monsoon, monsoon and post-monsoon

RESULTS AND DISCUSSION

PH: pH is an important parameter in evaluating the acid base balance of water. The pH values of water at sewage discharge points are usually higher than that of the river water. The graphical representation of change in pH values is shown in Fig. 1. The BIS (Bureau of Indian Standards) limits for drinking water is in the range of 6.5 -8.5.[6,10,11] The pH of Wardha river water samples in pre-monsoon season was found to be in the range 7.5 to 8.0 for monsoon season in the range of 8.2 to 8.9 and for post monsoon 7.4 to8.3 as shown in Fig 1 and Table1-3, along with concentration of average value with 95% CL value was found to be 7.8±0.17, 8.48±0.882, 7.9±0.323 in pre-monsoon, monsoon and post-monsoon season respectively. pH showed negative correlation with total hardness (-0.3900), total solids (-0.34330), iron (-0.277) in pre-monsoon and monsoon season, pH also shows negative correlation with fluoride (-4.54), iron (-1.0707), dissolved oxygen (-0.9050) and positive correlation with other physico- chemical parameters which are given in Table 4-6.

In the present investigation a pattern of pH change was noticed Mentioned three seasons shows pH values tillted towards alkaline which indicates the alkaline nature of water might be due to high temperature that reduces the solubility of carbon dioxide. The photosynthetic activity of dense phytoplankton causes higher pH value in samples.
TURBIDITY: Turbidity of water is an important parameter, which influences the light penetration inside water and thus affect the aquatic life. The graphical representation of turbidity values for collected water samples are shown in Fig. 2. The turbidity value of water sample of Wardha river in pre-monsoon monsoon and post monsoon were observed in the range of 20.2- 28.2, 35 - 69 , 20 - 44,NTU respectively along with average value of 95%CL was found to be 124 ±2.9, 51.75 ±12.02, 30.5 ±8.5 respectively (Table 1-3). Turbidity shows negative correlation with chloride(-1.9468), total hardness (-1.4702), total solids (-1.4997) and fluoride (-1.2475)in pre- monsoon, dissolved oxygen (-1.6351) in monsoon and post-monsoon season. Positive correlation was found with other physico-chemical parameters which are given in Table 4-6.

Monsoon season shows higher turbidity values due runoffs. It carries many particles like sand, clay slits, agricultural runoffs etc.

CHLORIDE: Main sources of chloride in river water are from industrial effluents, agricultural run-off, pesticides, insecticides etc if present. Sewage with urine is rich in chloride content of about 4500-5000 ppm. The BIS standard for chloride is 250mg/l. The graphical representation of chloride concentration variation is shown in Fig. 3. The concentration of chloride in Wardha river water sample in pre monsoon, monsoon and post monsoon was found to be in the range of 248-255, 116-350, 155-182 mg/l respectively along with concentration of average value with 95% CL value was found to be251 ±11.3, 182.75±95.00, and 168±10.7 mg/l respectively given in Table 1-3. From Table 4-6 it will be more clear that Chloride shows negative correlation with fluoride (-1.2433) and dissolved oxygen(-1.3764) in monsoon season samples whereas positive correlation with other physico- chemical parameters.

The higher content of chlorine in water bodies in various seasons is due to animal origin like human faeces and sewage inflow from various industries which contain pesticides, polychlorinated biphenyls (PCBs) . Chloride increases with the increasing degree of eutrophication.

TOTAL HARDNESS: Hardness of water is a measure of the soap consuming capacity of water. Hard water also has harmful health impacts and also directly affects many industrial process including boilers. A positive relation between total hardness, alkalinity and anion present in water samples [9,12]The graphical representation of total hardness in present water samples are shown in Fig. 4. The amount of total hardness (Table 1-3) in Wardha river water samples in pre-monsoon, monsoon and post-monsoon season was found to be in the range of 230-360, 196-

305, 348-400 mg/l along with concentration of average value with 95% CL value was found to be 282 ±48, 237.75±43.38, 376.25±19.55mg/l respectively. Total hardness shows negative correlation with Fluoride (-1.3121), dissolved oxygen (-1.4182), in pre monsoon. Fluoride (-1.1435), dissolved oxygen (-1.7589), in monsoon and shows positive correlation with other physico- chemical parameters which are given in Table 4-6.

In a present study the waste water is associated with mines, paper and pulp industry, and iron steel industry. So the waste from these industry contains calcium, magnesium, zinc manganese etc. The hardness of post monsoon period shows higher values as compare to premonsoon and monsoon.

TOTAL SOLIDS: The graphical representation of total solids present in water samples are shown in Fig. 5.The concentration of total solids in Wardha river water sample in pre- monsoon, monsoon and post-monsoon was found to be in the range of 260- 360, 480- 510, 350- 431 mg/ along with concentration of average value with 95% CL value was found to be 283±13.5, 495±11, 385±29 mg/l respectively given in Table 1-3. Total solids shows negative correlation with Fluoride (-1.4231), iron (-2.6726) in pre-monsoon. Fluoride (-1.4402), dissolved oxygen (-1.4324) in monsoon, and shows positive correlation with other physico- chemical parameters which are given in Table 4-6.
Total solids (TS) mean total suspended solids (TSS) and total dissolved solids (TDS).The TS are composed of carbonates. Bicarbonates, chlorides, phosphates, calcium magnesium, sodium, potassium, manganese, organic matter, salts and other particals. The effect of presence of TS is due to silt and organic matter. The maximum value of TS was recorded in monsoon season. Which reflect the more pollution.

FLUORIDE: High fluoride intake over a period of time can lead to fluorosis. Excess fluoride intake with inadequate food supplement is responsible for dental and skeletal fluorosis, which is a serious health concern in many areas of the world. The sources of fluoride are mainly geogenic, but significant contribution from industrial effluents is also reported. NEERI reported higher concentration of fluoride in water samples from several parts of Chandrapur district are contaminated with higher concentration of fluoride. The graphical representation of fluorides present in water samples are shown in Fig. 6. The concentration of fluoride in Wardha river water sample in pre-monsoon, monsoon and post-monsoon was found to be in the range of 0.12-0.2, 0.2- 0.5, 0.18- 0.22 mg/l along with concentration of average value with 95% CL value was found to be 0.2±0.04, 0.27±0.26, 0.25±0.147mg/l respectively reported in Table 1-3. Fluoride shows negative correlation with iron (-0.9705) in pre-monsoon and shows positive correlation with other physico- chemical parameters which are given in Table 4-6.These low values of fluoride in river water infer that source of fluoride in study area may be mainly geogenic.

The study shows less values of fluoride concentration because surface water contains less than 0.5mg/lit fluoride. In monsoon the value is 0.27mg/lit.

IRON: Iron is one of the most important constituent of blood in human and other living organism. Iron is an essential element for human nutrition and metabolism but in excess quantities results in toxic effect like hemochromatosis in tissues. The maximum permissible limit of iron in drinking water is 0.3 ppm.[(12)]The graphical representation of iron present in water samples are shown in Fig. 7. The iron concentration in Wardha river water sample in pre-monsoon, monsoon and post-monsoon was found to be in the range of 0.28- 0.40, 0.54-0.60, 0.30-0.45 mg/l along with concentration of average value with 95% CL value was found to be 0.27±0.01, 0.24±0.01, 0.19±0.05mg/l respectively. Iron shows negative correlation with dissolved oxygen (-1.3867) in monsoon and shows positive correlation with other physico- chemical parameters which are given in Table 4-6.

The study area is surrounded by iron and steel industry so the effluent contains iron industry waste which is hazardous to human health.

DISSOLVED OXYGEN: Dissolved oxygen content in natural and waste water depends on physical, chemical and biological activities in the water bodies. The WHO (World Health Organization) suggested the standard of DO is >5.00 mg/l. The graphical representation of DO present in studied water samples are shown in Fig. 8. The concentration of DO in Wardha river water sample in pre-monsoon, monsoon and post-monsoon was found to be in the range of 0.28-0.34,0.54-0.60,0.30- 0.45 mg/l, along with concentration of average value with 95% CL value was found to be 0.33±0.04 , 0.57±0.11 0.37±0.1 mg/l respectively, given in Table 1-3.

Process water in paper mills contains a lot of sugars and lignocellulose, which support the growth of bacteria ,mold and some yeast .Effluent from agricultural runoff contains large amount of toxic wastes rich in ammonia-nitrogen,

urea , nitrate phosphate which support the growth of algae, yeast, and cyanobacteria. Cellulolytic bacteria such as Klebsiella pneumonia and Enterobacter have been isolated from spent water from paper and pulp industries. The occurrence of these microbes in the effluents lead to excessive oxygen demand loading and also disturb the ecological equilibrium of the receiving waters with much loss of aquatic life and intense consequences.

NITRATES: The pollution input gives a sufficient indication of the deteriorating quality of water due to entry of waste water in river .Similar findings have been reported by Shah and Rai. The concentration of nitrate in water sample in pre-monsoon, monsoon and post-monsoon was found to be in the range of 0.07-0.02, 0.08 -0.10, 0.17-0.20 mg/l,along with concentration of average value with 95% CL value was found to be 0.0712±0.02, 0.086±0.00410, 0.17±0.02mg/l respectively, given in Table 1-3.

Table 1: Statistcal evaluation for physico-chemical parameters of Wardha river water sample in pre monsoon

Parameter Studied	pH	Turbidity	chloride	Total hardness	Total solids	Iron	fluoride	D.O.	nitrate
AV	7.8	24	251	282	283	0.2	0.17	0.33	0.0712
SE	0.09	1.475	5.75	24.32	6.91	0.005	0.02	0.02	0.00726
SD	0.18	2.95	11.5	48.64	13.82	0.01	0.04	0.04	0.014
SV	0.032	8.70	132.25	236.84	190.99	0.0001	0.0016	0.0016	0.00021
Min	7.5	20.2	248	230	0.12	0.19	0.12	0.28	0.063
Max	8.0	28.2	255	360	0.2	0.20	0.2	0.40	0.093
AV ±CL 95%	7.8 ±0.17	124 ± 2.88	251 ± 11.27	282 ± 47.66	283 ±13.54	0.27 ±0.0098	0.2 ±0.039	0.33 ±0.039	0.0712 ±0.02

Table 2: Statistical evaluation for physico-chemical parameters of Wardha river water sample in monsoon

Parameter Studied	pH	Turbidity	chloride	Total hardness	Total solids	Iron	fluoride	D.O.	Nitrate
AV	8.48	51.75	182.75	237.75	495	0.24	0.27	0.57	0.086
SE	0.45	6.135	48.47	22.135	5.59	0.007	0.068	0.03	0.001291
SD	0.90	12.27	96.94	44.27	11.18	0.014	0.136	0.060	0.0025
SV	0.82	150.55	9397.6	1960.18	125	0.0002	0.01	0.003625	0.066
Min	8.2	35	116	196	480	0.22	0.2	0.54	0.083
Max	8.9	69	350	305	570	0.26	0.5	0.60	0.089
AV ±CL 95%	8.48 ±0.88	51.75 ± 12.024	182.75 ±95.0012	237.75 ±43.3846	495 ±10.9564	0.24 ±0.013	0.27 ±0.26	0.57 ±0.11	0.086 ±0.00410

Table 3: Statistical evaluation for physico-chemical parameters of Wardha river water sample in post monsoon

Parameter Studied	pH	Turbidity	chloride	Total hardness	Total solids	Iron	fluoride	D.O.	nitrate
AV	7.9	30.5	168	376.25	385	0.19	0.25	0.37	0.17
SE	0.165	4.32	5.46	9.975	14.59	0.027	0.075	0.05	0.01
SD	0.33	8.64	10.93	19.95	29.18	0.055	0.15	0.10	0.01
SV	0.11	74.75	119.5	398.18	851.5	0.003	0.022	0.010	0
Min	7.4	20	155	348	350	0.18	0.16	0.30	0.16
Max	8.3	44	182	400	431	0.22	0.5	0.45	0.19
AV ±CL 95%	7.9 ±0.323	30.5 ± 8.465	168 ±10.7016	376.25 ±19.551	385 ±28.59	0.19 ±0.053	0.25 ±0.147	0.37 ±0.098	0.17 ±0.02

Table 4: Correlation coefficient values among the physico-chemical parameters of Wardha river water sample in Pre monsoon

Parameter Studied	pH	Turbidity	chloride	Total hardness	Total solids	Fluoride	Iron	D.O.	Nitrate
pH	1								
Turbidity	0.0581	1							
chloride	0.9569	-1..9468	1						
Total hardness	-0.3900	-1.4702	1.7056	1					
total solids	-0.3433	-1.4997	1.9336	1.4439	1				
Fluoride	0.9798	-1.41131	1.0783	-1.3121	-1.4231	1			
Iron	-0.277	0.9860	1.6035	0.53881	-2.6726	-0.9705	1		
D.O	1.5431	1.5140	1.7920	-1.4182	0.9296	1.3699	0	1	
Nitrate	0.3975	0.0849	-0.8025	-0.8117	0.8979	-0.6942	0.56	-0.52	1

Nitrates represent the final product of the biochemical oxidation of ammonia. Monitoring of nitrates in drinking water supply is very important because of health effects on humans and animals. The maximum nitrate content was might be due to leaching of nitrate from nearby agricultural field.

Table 5: Correlation coefficient values among the physico-chemical parameters of Wardha river water sample in monsoon

Parameter Studied	pH	Turbidity	chloride	Total hardness	Total solids	Fluoride	Iron	D.O	Nitrate
pH	1								
Turbidity	1.2611	1							
chloride	1.3539	1.3144	1						
Total hardness	1.1618	1.4977	1.3146	1					
total solids	1.168	1.5075	1.3163	1.5806	1				
Fluoride	-4.54	-1.2475	-1.243	-1.1435	-1.4402	1			
Iron	-1.0707	1.410	0.2087	1.2598	1.4142	0.0940	1		
D.O	-0.9050	-1.6351	-1.376	-1.7589	-1.4324	1.1066	-1.387	1	
Nitrate	-1.021	-1.512	-1.630	-1.354	0.0321	0.0562	-1.587	0.075	1

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

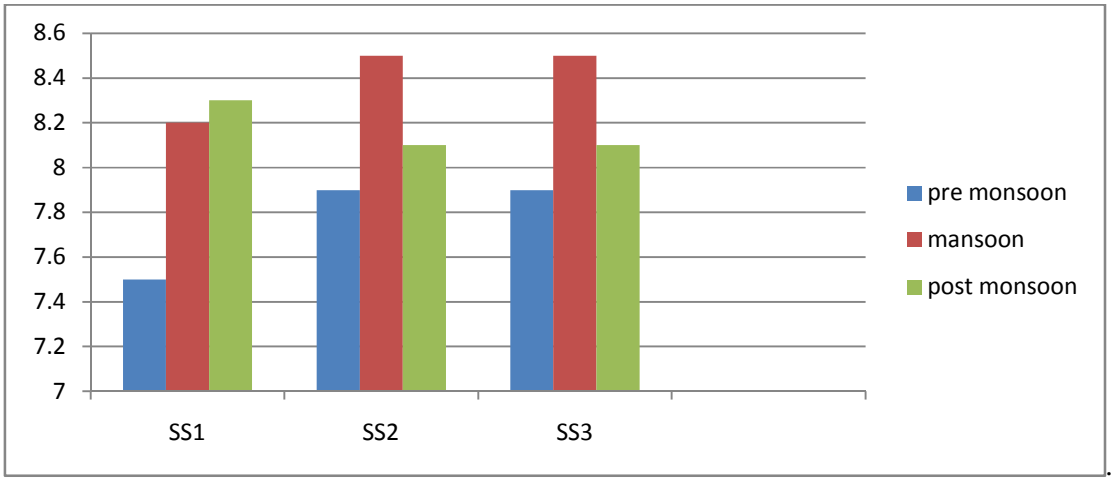


Fig-2: Graph showing variation in Turbidity Concentration at different sampling stations

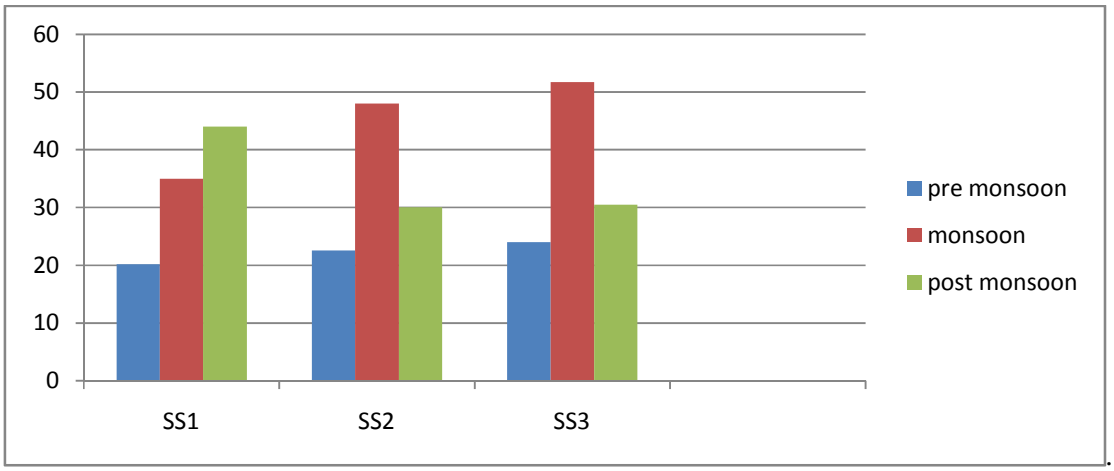


Table 6: Correlation coefficient values among the physico-chemical parameters of Wardha river water sample in post monsoon

Parameter Studied	pH	Turbidity	chloride	Total hardness	Total solids	Fluoride	Iron	D.O.	nitrate
pH	1								
Turbidity	1.2611	1							
chloride	1.3539	1.3144	1						
Total hardness	1.1618	1.4977	1.3146	1					
total solids	1.168	1.5075	1.3163	1.5806	1				
Fluoride	-4.54	-1.2475	-1.243	-1.1435	-1.4402	1			
Iron	-1.0707	1.410	0.2087	1.2598	1.4142	0.0940	1		
D.O	-0.9050	-1.6351	-1.376	-1.7589	-1.4324	1.1066	-1.387	1	
Nitrate	-0.852	-1.235	-1.3258	-1.647	0.325	0.7458	-1.256	-1.74	1

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

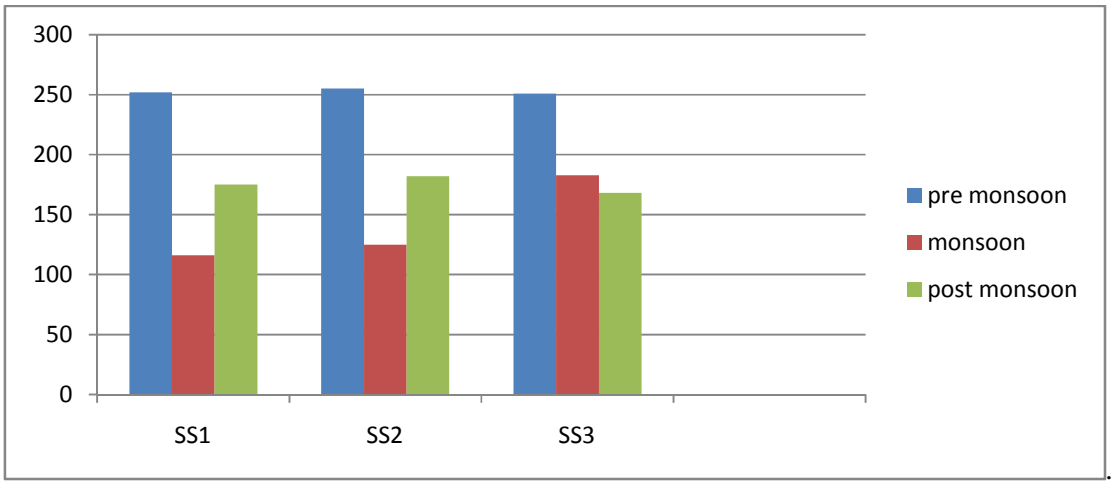


Fig-4: Graph showing variation in Total Hardness Concentration at different sampling stations

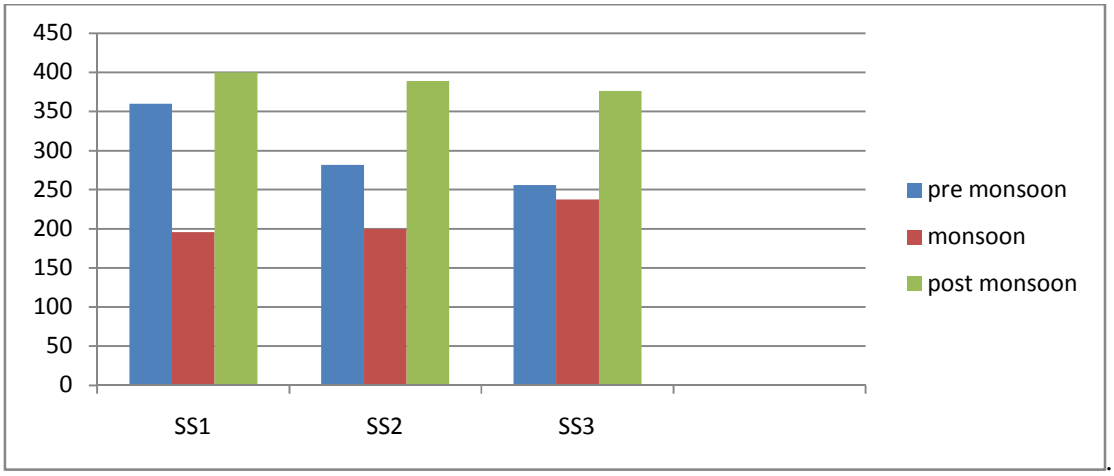


Fig-5: Graph showing variation in Total Solids Concentration at different sampling stations

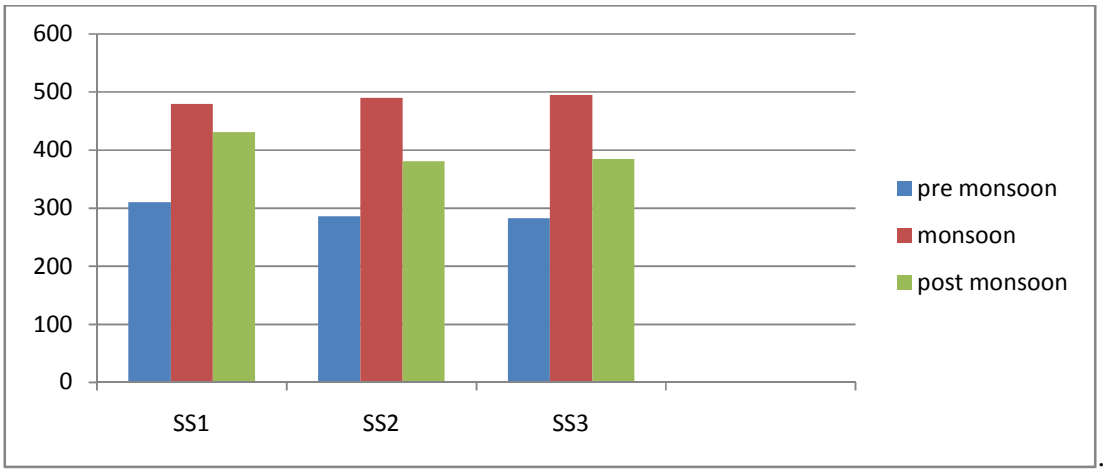


Fig-6: Graph showing variation in Fluoride Concentration at different sampling stations

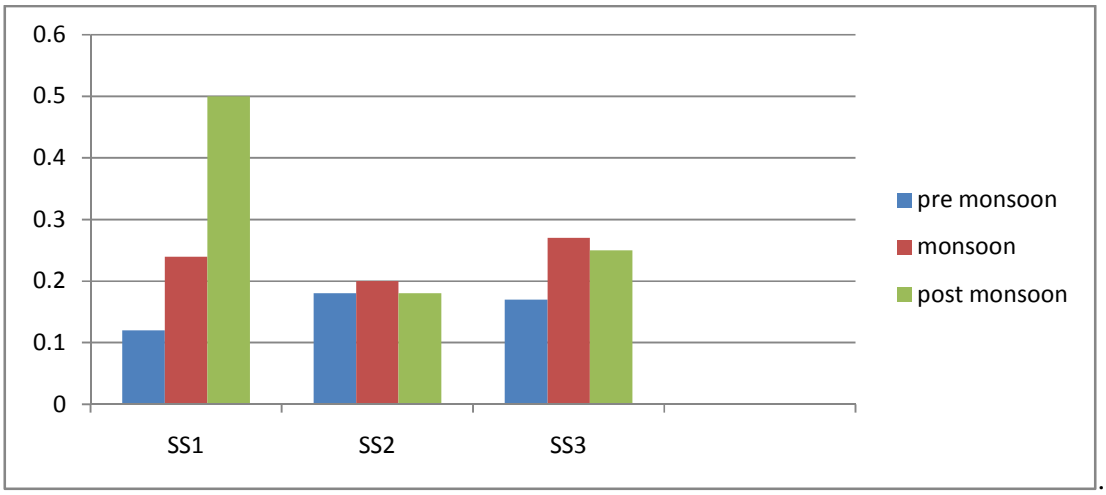


Fig-7: Graph showing variation in Iron Concentration at different sampling stations

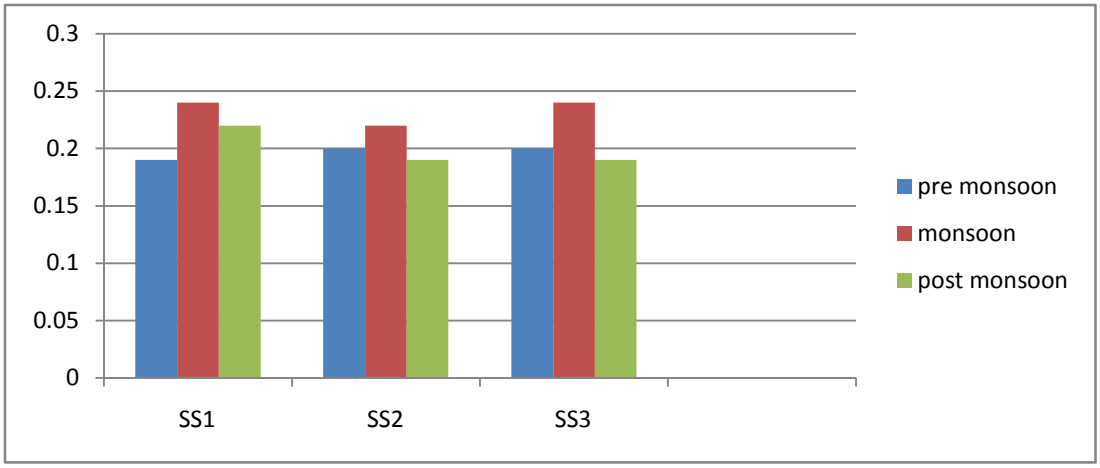


Fig-8: Graph showing variation in D. O. Concentration at different sampling stations

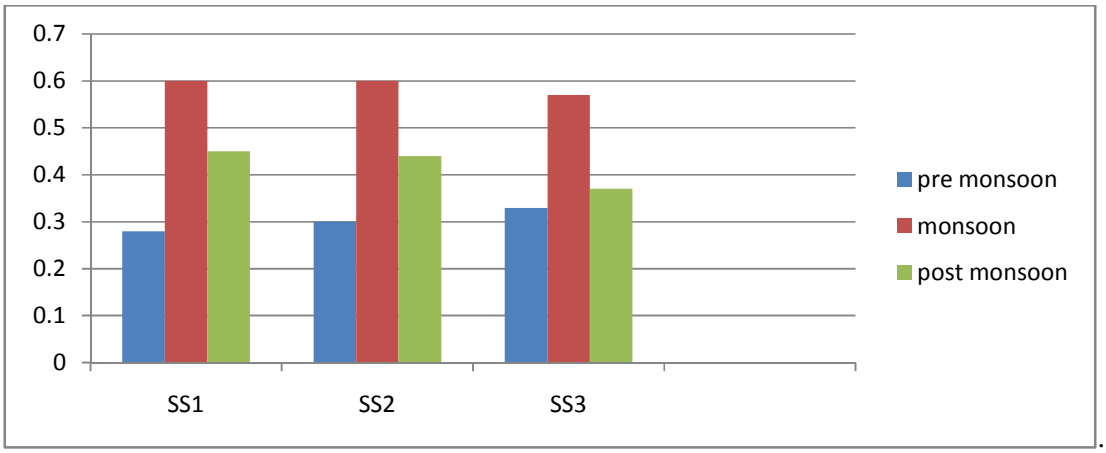
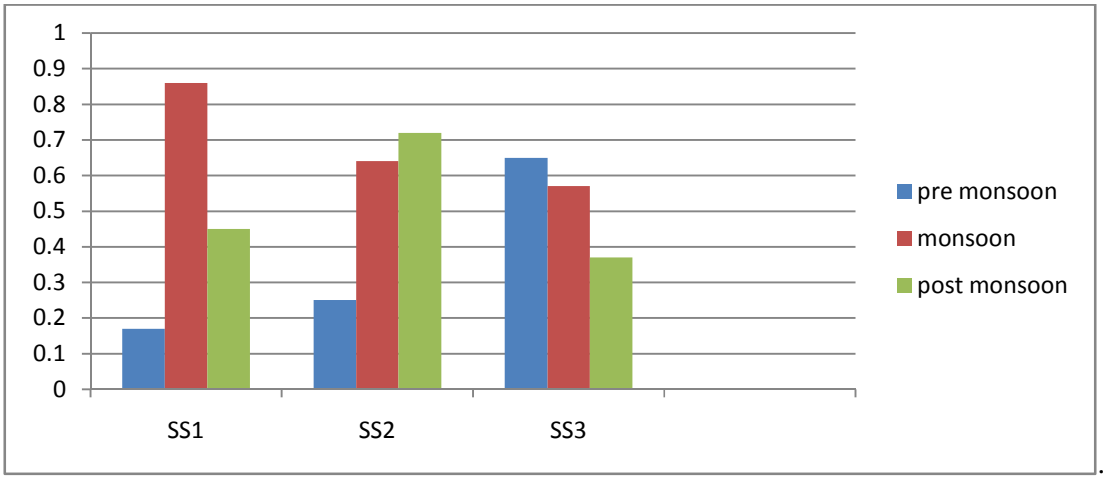


Fig-9: Graph showing variation in Nitrate Concentration at different sampling stations



CONCLUSION

This study provides an informative primary data on water quality parameters and helps to understand the contamination of Wardha river water and its possible influence on the the ecological system. The major sources of pollutants are local anthropogenic activities, agricultural runoff containing fertilizers, pesticides, insecticides and industrial effluent containing toxic chemicals in higher amount. In the present study it is our efforts to evaluate many physico-chemical parameters and its characteristic behavior of a river water samples in different seasons and different sampling stations. Many values of parameter crossed the maximum permissible limit, due to heavy discharge of effluent waste and domestic sewage in the river basin indicating deterioration of Wardha river water quality. The study suggested immediate need to take extensive water quality monitoring studies and to find the remedial measures to protect this important natural water sources in the study area

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