

Determination of Waste Water Quality from Sewer Systems of Aurangabad City of Maharashtra (India)

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ABSTRACT: Aurangabad city is one of the fastest growing cities in Asia. The generated raw sewage in the city is directly discharged into the river system via various nalas. In Aurangabad, most of the areas have partial drainage facilities in form of open drains (nala). Pollution of surface and ground water due to sewage is a major problem due to rapid urbanization growth. Overall untreated sewage discharges a major cause of water pollution. To decide the capacity of sewage treatment plant and its efficiency, there is a need of accurate baseline data of waste waters quality and quantity. Therefore; present work has undertaken the assessment quality of sewage generated in Aurangabad city. The aim of this study was to determine the pollution level of waste water in 11 nalas drained in different areas of Aurangabad city and to study its diurnal variation in Physico-chemical parameters term. The parameters temperature, pH, electric conductivity, dissolved oxygen, biological oxygen demand, chemical oxygen demand, total suspended solids etc. were determined and recorded. The study was in the period of Pre-monsoon season & Post-monsoon season 2012. All these values are crossing the standard limits of World Health Organization (WHO) recommendations for wastewater discharge. There is diurnal variation in the disposal of sewage quantity and quality.

KEYWORDS: sewer systems, Physico-chemical parameters, nalas, Aurangabad, Sewage water.

I. INTRODUCTION

The rapid growth of human population or migration of people, rapid industrial activity, indiscriminate use of natural resources, our quest for material comforts and new lifestyles demanding a variety of products and amenities, have led to degradation of environmental quality “the environmental pollution” which has become global phenomenon, On the onset pollution by itself and its impacts are large and specifically. The magnitude of growing water pollution is a major global problem and like other developing countries.

Water contamination has raised to a degree of no revival and treatment, getting warning situation in India (Mehta., 2014). But it is neither feasible nor even desirable to slow down the pace of development. Then, what we have to do for, under the recent conditions, where we have to manage our development and industrial activities in such a manner that the least possible harm is done to our environment. An important aim of this strategy is to arrange the regular monitoring and control of environmental quality (Khambete et al., 2004). The water bodies get polluted due to the discharge of effluents from the human, domestic, industries activities, and soil contamination besides the dumping sites and agricultural drainage. These factors result in the deterioration of water quality of the various water bodies (Rai et al., 2012). From rural areas to urban areas have increased domestic effluents while industrial development in metro and non-metro cities. Rivers play a important role not only to serve the purpose of water supply for agricultural, industrial, domestic and power generation but also utilized for the disposal of sewage and industrial waste and therefore put under tremendous pressure (Subin and Husna, 2013) To preserve the health of unsuspecting

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South Africans and maintain the integrity of the environment, it is imperative to regularly and consistently monitor the quality of municipal wastewater effluent prior to discharge into the receiving environment. (Igbinoso and Okoh, 2009).

The use of waste water for irrigation is a way of disposing of urban sewage water with several advantages. Waste water contains a lot of nutrients which make the crop yield increase without any fertilizers. The Aurangabad city is covered by several water resources like Kham river, Harshul lake, Salim Ali lake, and outlet of ponds from nearby of rural areas. Hence sometimes it receives agricultural run-off in some proportion, the disposal of waste, burning offside fuels, discharge of domestic wastes, hospitals and industrial effluents from small scale industries which are located nearby the bank of the rivers. Hence the rivers and outlet of ponds are converted into nalas. Untreated sewage discharge not only damage to aquatic flora and fauna but also harmful to human health and life that used for drinking and domestic purpose in the downstream areas of the river (Neelesh Shrivastava et al., 2012).

The study has been carried out to assess and monitor the quality of municipal waste water of Aurangabad city, therefore; a continuous seasonal assessment carried out from different sites of Aurangabad city.

II. MATERIAL AND METHODS

Study Area:

Aurangabad city from Marathwada region of Maharashtra states was selected for monitoring the waste water quality of sewer system. Aurangabad is a headquarter of Marathwada region of Maharashtra state with historic background. Aurangabad is situated at latitude 19° 53' 59" north and longitude 75° 20' east the city established on the banks of the Kham River. Topographically it is located in the valley region between the Chauka hills on the north and Satara hills on the south. The valley has a breadth of about 15 km and opens towards the east which has facilitated for the extension and development of the new settlement. Ajantha and Ellora caves have put the city on the tourist map of the world. It is the cultural, religious, educational and industrial centre. The average altitude of the city is about 581 m above mean sea level. Aurangabad is one of the rapidly growing cities in Asia. Presently it comes in DMIC (Delhi – Mumbai Corridor Project) of Government of India, and under this state government plan develops the industrial area in Shendra-Bidkin belt in Aurangabad.

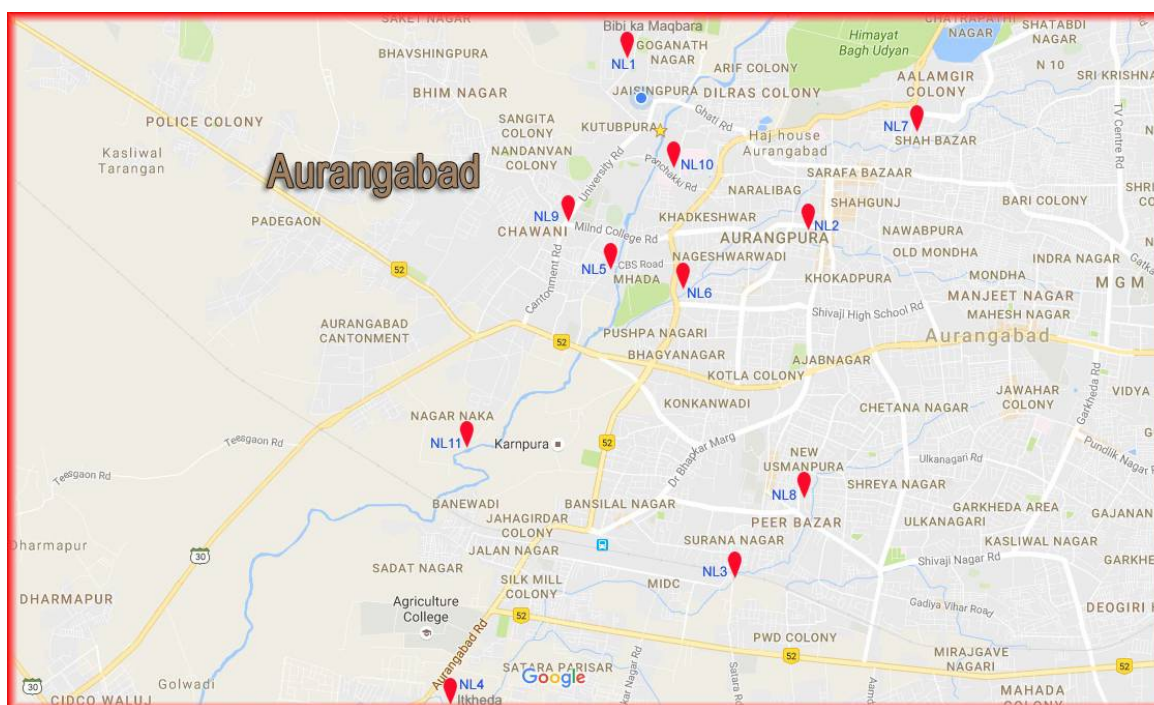


Figure 1: Map of Aurangabad city shows the sampling sites

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Sampling sites & Methods of Sampling:

Eleven sampling sites were selected for study work as follows: near Maqbara (NL1), Aurangpura nala (NL2), near railway station (NL3), Itkheda nala on Paithan road (NL4), near bus stand nala (NL5), Nirala bazaar nala (NL6), shah bazaar nala (NL7), Osmanpura nala near police station (NL8), chhavani nala (NL9), near Panchakki (NL10), near nagar naka (NL11). These sites were places from where the reach up to the Kham river. Sewage samples are collected from the eleven sites at the centre of the nalas channel about 40-50 cm below the surface, to prevent the collection of oils, surface impurities, etc. Before sampling, bottles were rinsed with 0.1N chromic acid, then washed twice with distilled water. A separate sample was collected in the plastic bottle to analyse and measure the Dissolved oxygen (DO). During sample collection hand gloves and mask were used for safety. The water samples were analysed to determine their physicochemical parameters. This analysis was done according to APHA (2000).

Sample Analysis

All the nalas of city carry sewage and openly dispose of untreated sewage in Kham River which one of the notified river and sub river of the Godavari river. Samples have collected and analysed in pre and post monsoon of the year of 2012. Temperature and pH parameters measured at sampling site directly. Other Physico-chemical parameters like dissolved oxygen(DO), hardness (TH), biochemical oxygen demand (BOD), chemical oxygen demand (COD), electrical conductivity (EC) oil and grease, total suspended solids (TSS), total dissolved solids (TDS), chloride ions (Cl⁻), phosphate(PO₄), nitrate (NO₄) were analyzed in the laboratory and the methodology has adopted from APHA (2000) and Trivedi and Goel, (1986)

Seasonal Sampling

Municipal wastewater was collected during pre-monsoon in the month of May-June 2012 and post monsoon in the month of September-October 2012 from eleven sampling stations which cover the entire Aurangabad city. The surface water quality changes from season to season and is easily polluted. For this purpose, samples were collected from different nalas throughout the year on a monthly basis. Samples were collected in clean plastic bottles, labelled properly and brought to the laboratory for analysis.

III. RESULTS AND DISCUSSION

The results of this study are presented in the table No.1 & 2 and the values listed for various parameters are the values obtained for months collected from 11 sampling sites.

Table 1: Physico-Chemical parameters of samples collected in month of May –June 2012(Pre- monsoon)

Parameters	Sampling Sites (nalas)										
	NL1	NL2	NL3	NL4	NL5	NL6	NL7	NL8	NL9	NL10	NL11
Temp.	30.0	32.0	29.1	32.0	32.8	30.2	30.0	31.2	29.7	30.6	31.6
pH	8.02	9.1	9.3	8.9	8.6	9.4	9.0	8.9	8.7	8.5	8.3
Electric conductivity	1535	1950	1536	1869	1705	1690	1790	1603	1405	1470	1392
Dissolved Oxygen	0.8	0	0	0.6	0.4	0	0	0	0.7	0	0
Biological Oxygen Demand	35	86	91	55	45	89	81	78	40	64	72
Chemical Oxygen Demand	76	210	281	149	110	250	201	168	91	236	260
Total suspended Solids	35	220	234	229	78	248	241	220	44	92	96
Total Dissolved Solids	740	850	826	851	720	896	780	795	711	797	795

All the parameters value in mg/L except Temperature= °C and EC = µs/cm

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Table 2: Physico-Chemical parameters of samples collected in month of September –October 2012 (Post monsoon)

Parameters	Sampling Sites (nalas)										
	NL1	NL2	NL3	NL4	NL5	NL6	NL7	NL8	NL9	NL10	NL11
Temp.	28.6	26.8	27.8	28.0	30.1	31.0	30.0	29.4	28.6	27.4	26.3
pH	8.1	8.4	8.6	8.2	8.1	8.3	8.5	8.8	8.1	8.9	8.8
Electric conductivity	1578	1780	1605	1590	1586	1588	1566	1570	1409	1558	1590
Dissolved Oxygen	0.1	0	0.1	0	0.2	0.8	0.5	0.8	0.9	0	0.7
Biological Oxygen Demand	30	65	78	49	41	76	71	67	33	54	63
Chemical Oxygen Demand	71	141	166	108	93	164	161	139	78	121	131
Total suspended Solids	141	255	261	259	151	263	256	249	144	150	158
Total Dissolved Solids	728	780	745	765	680	650	750	735	732	746	748
Chloride	141	166	145	153	151	147	149	148	146	151	150
Total Hardness	310	344	312	265	300	305	311	340	245	320	330
Phosphate	0.293	0.396	0.223	0.330	0.240	0.174	0.160	0.189	0.187	0.178	0.229
Nitrate	1.08	1.09	1.05	1.07	1.03	1.08	1.05	1.06	1.07	1.08	1.04
Oil & Grease	1.2	0.9	2.6	2.1	1.8	0.8	2.0	2.1	2.0	1.2	1.3

All the parameters value in mg/L except Temperature= °C and EC = μ S/cm

During the pre-monsoon the study its diurnal variation in Physico-chemical properties of sewage sample along with quantity generated. During the study period (Pre-monsoon season May-June 2012 & Post-monsoon season September-October 2012) the study was conducted. The parameters of water viz, temperature (°C), pH, electric conductivity (μ S/cm), biological oxygen demand (BOD) (mg/L), chemical oxygen demand (COD) (mg/L), total suspended solids (TSS) (mg/L), total dissolved solids (TDS) (mg/L), dissolved oxygen (DO) (mg/L), chloride (Cl⁻), phosphate (mg/L), nitrate (mg/L), total hardness (TH) (mg/L), etc. were studied. In pre-monsoon, the temperature was ranging from 29.1 to 32.8°C and 26.3 to 31.0°C in post monsoon.

The NL5 recorded highest seasonal value of temperature i.e 32.8°C in May 2012. The observed values of temperature indicate that the municipal wastewater quality would be certainly affected by this parameter. Among the various water parameters, the temperature is one of the most important parameters having more influence on the biotic communities and effect on dissolved oxygen. The high temperature in water reduces the value of dissolved oxygen in the water.

The pH value was ranging from 8.2 to 9.4 in pre-monsoon and 8.1 to 8.9 in post monsoon, this leads to the municipal wastewater was alkaline in nature in pre-monsoon, The values of pH were within the accepted range. The similar result

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was recorded by (Paula Popa et al. 2012), where they were working on the study of physico-chemical characteristics of waste water in an urban agglomeration in Romania. Post monsoon seasons within the permissible limits of pH for irrigation, but sampling site NL6 was highest in alkalinity. In pre-monsoon 1405 to 1950 $\mu\text{S}/\text{cm}$ for electric conductivity, in post monsoon 1558 to 1605 $\mu\text{S}/\text{cm}$, the high value in EC indicates that there is high quantity of ions in the water.

The dissolved oxygen content was ranged from 0 to 0.8 mg/L in summer and 0 to 0.9 mg/L in the post-monsoon season. Many times in summer it was zero, indicating the presence of higher organic matter in it.

The BOD of sewage samples was determined during pre-monsoon season and recorded values from 35 to 91 mg/L, the highest BOD recorded was 91 mg/L at sampling site NL3, and in post-monsoon, it was ranging from 30 to 78 mg/L, minimum noted at site NL1. In pre-monsoon chemical oxygen demand observed between 76 to 281 mg/L and 71 to 166 mg/L in post monsoon season. The COD of sewage was found maximum up to 281 mg/L at NL3 which indicates the pollution load in it. This result is similar to the study of (Sukumaran et al, 2008). The BOD and COD have an inverse relation with DO value in water and they are significant and important to aquatic organisms to survive (Goel, 1997).

Total suspended solids were ranging from 35 to 234 mg/lit in pre-monsoon season and 141 to 263 mg/L in post monsoon season. In pre-monsoon total dissolved solids were found 711 to 896 mg/L whereas 728 to 780 mg/L in post monsoon season. TDS value was reported maximum up to 896 in summer at sampling site NL6 mg/L, this value indicates the presence of dissolved mineral like salts and organic matters in it. Similar work was achieved by (Lokhande et al ,2012), when they studied the physico-chemical parameters of waste water effluents generated from Taloja industrial area of Mumbai, India. The observations of sewage sample collected from different areas were found similar to that of data produced by (Patil et al., 1983; Jayalakshmi et al., 2011; Wolfgang et al., 2012). The results of the quality study in this investigation of sewage indicate high values of hardness TDS. The absence of oxygen indicates high organic matters found in it.

In pre-monsoon chloride noted from 151.4 to 220 mg/L and 141 to 166 mg/L in post monsoon whereas in pre-monsoon between 0.248 to 0.716 for phosphate and 0.78 to 0.396 in post monsoon.

Total hardness of the selected sampling sites was noted in pre and post monsoon in between 310 to 390 mg/L and 245 to 344 mg/L, the high value of hardness indicates the high value of magnesium and calcium ions present in water.

Nitrates value observed from 1.04 to 1.09 mg/L in pre-monsoon and from 1.03 to 1.09 mg/L in post monsoon, in pre-monsoon oil and grease was ranges 1.7 to 3.8 mg/L and 0.9 to 2.6 mg/L in post monsoon.

All these values are crossing the standard limits of World Health Organization recommendations (WHO) for wastewater discharge. There is diurnal variation in the disposal of sewage quantity and quality. The obtained results indicate that the water of Kham River at all the sites are slightly polluted which can be attributed to the regular discharge of domestic sewage in it.

During the present study, the site NL2 has maximum pollution load whereas site NL9 recorded of minimum pollution level during both pre and post monsoon. The maximum values at site NL2 may be due to the presence of several types of suspended solids, human-made religious activities, effluents from many resources, disposal of solid wastes. Grey water discharge from domestic waste at residential properties.

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Statistical Analysis

Table 3: Descriptive Statistics for Physico-Chemical parameters of pre and post monsoon sewage water samples

Parameters	Pre monsoon					Post monsoon				
	Mean	Median	SD	Min	Max	Mean	Median	SD	Min	Max
Temp	30.84	30.60	1.16	29.10	32.80	28.55	28.60	1.47	26.30	31.00
pH	8.79	8.90	0.42	8.02	9.40	8.44	8.40	0.30	8.10	8.90
EC	1631.36	1603.00	185.95	1392.00	1950.00	1583.64	1586.00	84.15	1409.00	1780.00
DO	0.23	0.00	0.33	0.00	0.80	0.37	0.20	0.37	0.00	0.90
BOD	66.91	72.00	20.38	35.00	91.00	57.00	63.00	16.83	30.00	78.00
COD	184.73	201.00	71.05	76.00	281.00	124.82	131.00	33.82	71.00	166.00
TSS	157.91	220.00	87.30	35.00	248.00	207.91	249.00	56.86	141.00	263.00
TDS	796.45	795.00	57.65	711.00	896.00	732.64	745.00	37.13	650.00	780.00
Chloride	178.00	178.60	23.60	151.40	220.00	149.73	149.00	6.34	141.00	166.00
TH	361.00	361.00	26.44	310.00	395.00	307.45	311.00	29.77	245.00	344.00
Phosphate	0.46	0.42	0.17	0.25	0.72	0.24	0.22	0.07	0.16	0.40
Nitrate	1.06	1.06	0.02	1.04	1.09	1.06	1.07	0.02	1.03	1.09
Oil & Grease	2.72	2.80	0.69	1.70	3.80	1.64	1.80	0.58	0.80	2.60

All the parameters value in mg/L except Temperature= °C and EC = µs/cm

Table 4: Pearson correlation for Physico-Chemical parameters of selected sewage water samples of pre monsoon season

Parameters	Temp	pH	EC	DO	BOD	COD	TSS	TDS	Chloride	TH	Phosphate	Nitrate	Oil & Grease
Temp	1												
pH	-0.1755	1											
EC	0.4500	0.4963	1										
DO	0.0050	-0.5046	0.1038	1									
BOD	-0.1543	0.7497	0.2896	-0.8992	1								
COD	-0.1754	0.5002	0.0215	-0.8727	0.8686	1							
TSS	-0.0373	0.8596	0.6365	-0.5829	0.8226	0.5566	1						
TDS	0.0259	0.6662	0.4654	-0.5423	0.7493	0.6905	0.7907	1					
Chloride	0.0477	0.1172	-0.2742	-0.7785	0.6143	0.6422	0.2664	0.3564	1				
TH	-0.324	0.7692	0.3694	-0.435	0.7679	0.6061	0.8046	0.8411	0.2141	1			

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	8			8									
Phosphate	0.677 4	- 0.426 2	0.274 0	0.191 0	- 0.224 8	- 0.202 0	- 0.224 1	- 0.061 6	- 0.0629	- 0.203 3	1		
Nitrate	0.738 7	- 0.114 0	0.250 1	0.030 9	- 0.230 6	- 0.341 7	- 0.189 2	- 0.196 3	0.0932	- 0.431 5	0.4131	1	
Oil & Grease	0.207 9	0.208 1	0.255 0	- 0.633 2	0.625 9	0.748 7	0.482 5	0.666 4	0.4586	0.498 6	0.1529	- 0.230 4	1

The table of the correlation coefficient is showing the range of association presents between two variables. The greater (mod) value of coefficient indicates a good relationship between two parameters. There is a direct relationship found between two parameters on increase or decrease of the single parameter the other will also change (Patil and Patil, 2010). The relationships between the parameters in the form of scatter diagrams are given in figure 4. The regression analysis carried out to relate DO, BOD, COD, pH, and total suspended solids etc. The correlation coefficient between COD with BOD, DO with BOD, DO with COD, TSS with pH and TH with TDS is established which give correlation coefficient $r = 0.8686$, $r = -0.8992$, $r = -0.8727$, $r = 0.8596$ and $r=0.8411$ respectively, showing a very good correlation. Whereas the same analysis was carried out for post-monsoon season and the respective outputs are as follows: The correlation coefficient between COD with BOD, DO with BOD, DO with COD, TSS with pH and TH with TDS is established which give correlation coefficient $r = 0.9937$, $r = 0.1449$, $r = 0.1229$, $r = 0.1361$ and $r=0.1528$ respectively.

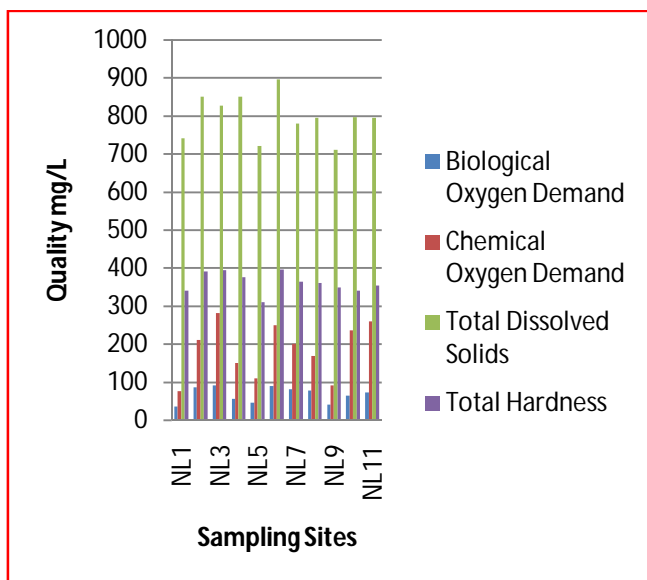


Figure 2: Graph showing the some of physico chemical parameters during pre-monsoon.

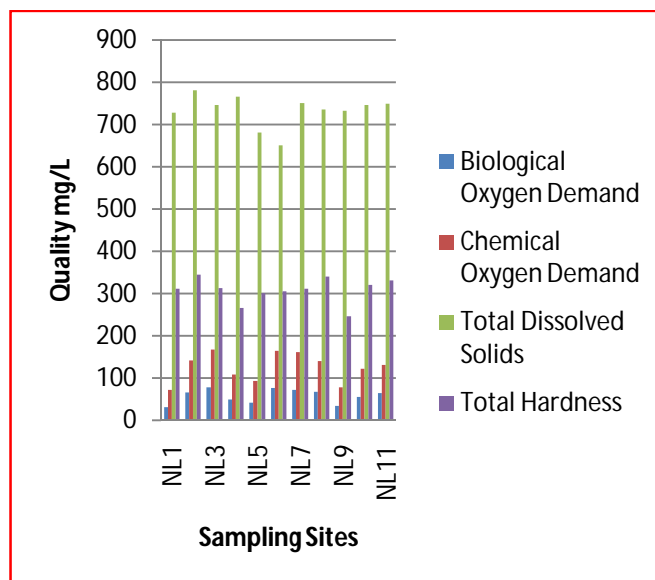


Figure 3: Graph showing the some of physico chemical parameters during post-monsoon

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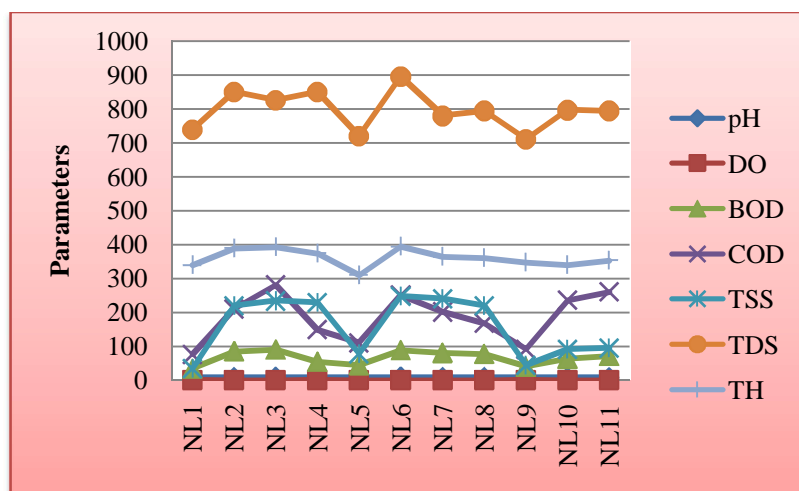


Figure 4: Scatter diagram of highly correlated parameters during pre-monsoon

IV. CONCLUSION

A comparative analysis of water samples of Sewage water at different sampling sites for the pre and post monsoon seasons carried out by taking some important parameters like pH, total dissolved solid, TSS, dissolved oxygen, chloride, nitrate, phosphate, BOD, COD and hardness. The physicochemical analysis of sewage water samples concluded that the sewage quality at all the sampling site (NL1 –NL11) is above the permissible limit which may affect the water quality of Kham River All the sewage inlets will make the water acceptable for drinking and for other purposes. Some parameters need to be attention before using such as TDS, DO and BOD. The study shows during post monsoon season that quality of sewage water is slightly improved.

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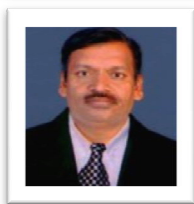
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