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Physio-Chemical and Biological Analysis of Gomti River in Lucknow Region

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Abstract: ***River is important for every human being. History shows that important civilization is developed on the bank of River. But due to modern civilization and increase in population, the quality and quantity of river become reduced to assess the quality of Gomti river nine samples were collected at different locations which include upstream and downstream of Lucknow during March, 2017. The sample collected and analysed for 12 physio-chemical and biological parameters such as colour, temp, pH, DO, BOD, COD, Turbidity, Hardness, Chloride, TDS and MPN. The data reveal a fact that the Gomti river in the belt of its origin to upstream of Lucknow has a high self-purification power for pollutants which may be attributed to the nature of wild aquatics, texture and structure of the basement soil of the river. The existence of turning points in a nearby site may partially be elevating the self-purification character of river. After some distance from the upstream of Lucknow the river loss its self-purification power because of low flow rate and large amount of sewerage waste. So that it is necessary to maintain the quality of water of Gomti River.***

Key- words: river restoration, floodplain, Gomti Basin, water quality.

I. INTRODUCTION

Water is one of the most essential requirements of human beings, animals and plants. Therefore, quality of water plays a vital role for their survival. Indian rivers being polluted day-by day due to inputs of untreated industrial effluents, domestic and sewage water along with agricultural wastes and decaying materials of human, animals and plants. Lucknow is the capital city of the Uttar Pradesh. Lucknow is a major metropolitan city of India and the administrative headquarters of Lucknow District and Lucknow Division. It is the eleventh and the most populous city in Uttar Pradesh which is the most populous state of India. Lucknow has always been known as a multicultural city and it flourished as a cultural and artistic hub of North India and as a seat of Nawab power in the 18th and 19th centuries. It continues as an important centre of government, education, commerce, aerospace, finance, pharmaceuticals, technology, design, culture, tourism, music and poetry. Lucknow stands at an elevation of approximately 123 meters (404 ft.) above mean sea level and covers an area of 2,528 square kilometres (976 sq mi). It is surrounded on the eastern side by Barabanki district, on the western side by Unnao district, on the southern side by Rae Bareli and on the northern side by Sitapur and Hardoi. The city is on the north western shore of the Gomti River. It is accessible from every part of India through air, rail and road.

The Gomti River receives pollution load both from the point and nonpoint sources (Srivastava et al 2014). It receives agricultural runoff from its vast catchment area spread over 10 districts directly or through out is course, receives untreated row waste water and industrial effluents through its five major tributaries and more than 40 drains in Lucknow (UPPCB, 2013). Other pollution sources are washing of clothes and animals in the river water. The river also receives industrial pollution load from various industries in the catchment stretch in Lucknow area the local drains. Disposal of domestic and industrial wastes in the river Gomti has become a very serious problem. The quantity of domestic sewage and industrial waste produced in Lucknow is about 325 million litres per day (MLD) according UPPCB, 2013. At present there is only one treatment plant located at Gaughat to receive the sewage from Sarkata, Pata, and Nagaria as well as from Gaughat itself. This treatment plant of 42 MLD capacities has been constructed by National River Conservation Directorate under Gomti action plan for treatment of sewage. Therefore, a major of the sewage is discharged untreated at various places through sewage pumping stations in the river Gomti. The water quality can be affected both by the biological and chemical contaminants. The injudicious disposal of waste effluents may contaminate the water as a translocation of toxic chemicals and many lead to adverse effects on living organisms. The water pollution has direct relationship with physico-chemical parameters if they are found beyond permissible limits (Kumar and Shukla, 2002). Some of these parameters such as nitrate, fluoride, hardness, alkalinity, chloride, temperature, pH, heavy metals etc. are toxic and impose much deleterious effect on public health and

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environment (WHO, 2006, USPA, 2012).

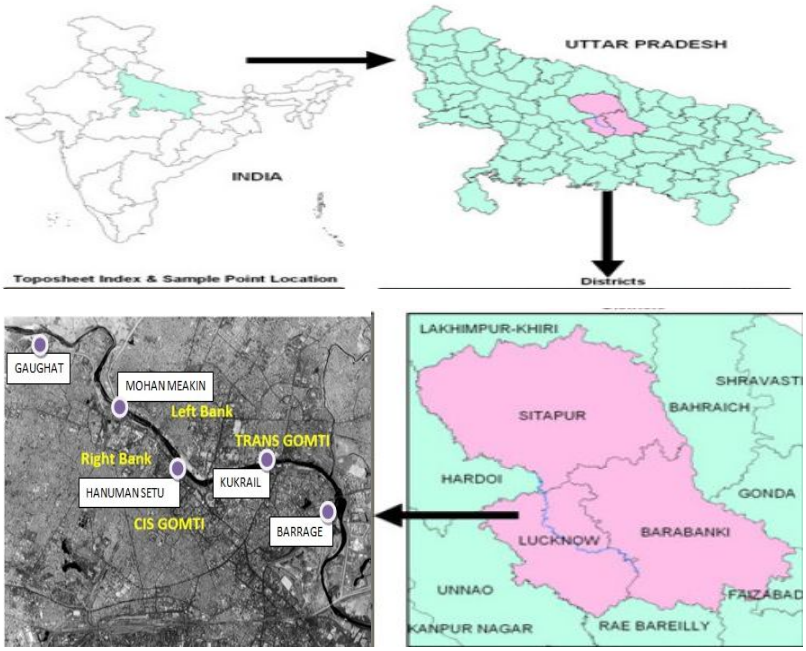

Fig. 1: Study Area of Gomti River

Table. 1 Locations of sampling sites

S.no	Sampling points	Longitude	Latitude	Sample name
1	Neemsar	80°28'44.8"E	27°20'46.1"N	S-1
2	Kantaniya	80°47'57.7"E	27°11'28.7"N	S-2
3	Dubagga	80°52'30.1"E	26°54'08.9"N	S-3
4	Gaughat.	80°53'51.6"E	26°53'16.1"N	S-4
5	Mohan Meakin	80°55'07.3"E	26°52'18.6"N	S-5
6	Hanuman Setu.	80°56'20.7"E	26°51'34.7"N	S-6
7	Kukrail Nala.	80°58'01.7"E	26°51'34.8"N	S-7
8	Gomti barrage.	80°56'01.7"E	26°50'46.1"N	S-8
9	Males mau	81°00'56.2"E	26°49'03.6"N	S-9

II. OBJECTIVE

A. The main objectives of study are

1) To identify the water specific problems in Gomti river.
2) To identify the causes of presence of pollutants in the river i.e. presence of any industry, disposal of wastage etc.
3) To analyses the physicochemical and biological characteristics.
4) To formulate the corrective measures to improve the quality of water.

III. LITERATURE REVIEW

According to Srivastava et al., (2011) drains are the main source of water pollution especially for rivers flowing within the city carries industrial effluent, domestic waste, sewage and medicinal waste results in poor water quality. The extent to which these

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drains pollute the water quality of river Gomti in Lucknow city. Study of water quality of the river Gomti of Jaunpur City was carried out by Yadav et al. (2012).

Mishra and Mishra (2008) carried out physico-chemical studies on the river Gomti and observed that the high concentration of DO, BOD, COD and MPN were noticed in water and concentration of these parameters increased from 2006 to 2008, while DO was found below the detectable limit. COD and TDS value were also observed to increase day by day due to increase in quantity of industrial effluents and sewage being discharged in the river, the level of DO also falling rapidly due to increase in BOD and COD.

Singh et al. (2005) carried out a study on a 630 km stretch of river Gomti, to study the distribution of heavy metals in sediments and the partitioning of their chemical species between five geochemical phases (exchangeable fraction, carbonate fraction, Fe/Mn oxide fraction, and organic fraction) using Tessier's analytical sequential extraction technique. Most fractions in the sediments associated with the carbonate and the exchangeable fractions were between 11 and 30% except in a few cases where it was more than 50%. According to the Risk Assessment Code (RAC), the sediments having 11–30% carbonate and exchangeable fractions are at medium risk. The concentrations of cadmium and lead at mid Lucknow, Pipraghat, Sultanpur U/S and Sulthanpur D/S are between 31 and 50%. They thus pose a high risk to the environment. Since the concentrations of cadmium and lead at Neemsar (Cd 56.79%; Pb 51%) are higher than 50%, the RAC as very high. In most cases, the average metal concentrations were lower than the standard shale values.

IV. RESEARCH METHODOLOGY

Water quality is a complex subject, which involves physical, chemical, hydrological and biological characteristics of water and their complex and delicate relations. In Lucknow city, from Gaughat upstream to Gomti barrage, 26 drains are discharging about 500 MLD wastewater into the river Gomti. Out of these 26 drains, 3 drains viz: Nagaria, Sarkata and Pata are discharging waste water after proper treatment at sewage treatment plant located at Daulatganj. Mohan Meakine Ltd. has its own effluent treatment plant (ETP). The remaining 23 drains were discharging their waste waters directly into the river Gomti without any treatment, until Bharwata S.T.P came into being used. Thus, the river Gomti (at Lucknow) water seems to look less vulnerable to pollutants, but the reality is that we have a loads to issues to sort out right from Gaughat to Gomti barrage.

A. Testing for Various Water Quality Parameters of collected water sample

It is very essential and important to test the water before it is used for drinking, domestic, agricultural or industrial purpose. Water must be tested with different physic-chemical parameters. Selection of parameters for testing of water is solely depends upon for what purpose we going to use that water and what extent we need its quality and purity. Water does content different types of floating, dissolved, suspended and microbiological as well as bacteriological impurities. Some physical test should be performed for testing of its physical appearance such as temperature, colour, etc., while chemical tests should be perform for its BOD, COD, dissolved oxygen, hardness and other characters.

Table.2 BIS Drinking Water Quality Standards

Parameters	Drinking Water Quality Standards (IS: 10500)	Maximum Allowable Limit
Temperature (˚C)	18	22
pH	6.5-8.5	9.2
Dissolved Oxygen (mg/l)	--	
B.O.D. (mg/l)	--	
C.O.D. (mg/l)	250	
Turbidity (NTU)	5	10
Hardness (mg/l)	75	115
Chloride (mg/l)	250	1000
Total Dissolved Solids (mg/l)	500	2000
MPN coliform/100ml	0	

V. DATA ANALYSIS AND RESULTS

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The data collected by sampling at various locations are analysed and the results are discussed here for various water quality parameters.

Table.3 Result Regarding Various Water Quality Parameters of Gomti River

	NEEMSAR (S-1)	KANTANIA (S-2)	DUBAGGA (S-3)	GAUGHAT (S-4)	MOHAN MEAKIN (S-5)
COLOUR	Colourless	Colourless	Colourless	Colourless	colourless
ODOUR	Odourless	Odourless	Odourless	Odourless	odourless
TEMP.	18.5	19	19.5	19.7	19.4
pH	6.9	7.2	6.4	8.3	6.8
DO	1.4	78	.81	0.8	0.9
BOD	18	21	23	30	28
COD	320	280	265	155	220
Turbidity	4.00	8.6	12.3	20.0	18.6
Hardness	126	139	141	159	162
Chloride	178	184	174	140	180
TDS	310	425	450	380	560
MPN	3200	3500	3800	3600	4000

Continued (Table 3)

	HANUMAN SETU (S-6)	KUKRAIL NALA (S-7)	GOMTI BARRAGE (S-8)	MALESMAU (S-9)
COLOUR	colourless	Turbid	Colourless	Turbidity
ODOUR	odourless	Odourless	Odourless	Odourless
TEMP.	19.6	19.2	19.8	19.2
pH	7.4	7.9	8.1	8.3
DO	1.0	0.8	1.2	.9
BOD	24	29	32	30
COD	240	210	180	160
Turbidity	15.7	20.9	26.7	23.00
Hardness	154	170	169	168
Chloride	179	158	130	134
TDS	640	530	406	580
MPN	5000	4600	4800	5000

A. PH

pH data obtained by digital pH meter as mentioned in Table.3 are presented in Fig.1, which depicts the variations during the monitoring periods.

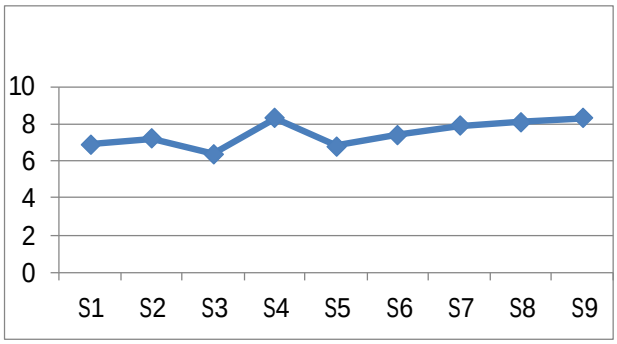

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Fig. 1 Variation in pH

A review of pH data with respected to primary water quality criteria prescribed by Environment Protection Act,1986 in terms of pH required in the range 6.5-8.5 for class-A water .The river in the whole stretch of Lucknow represents that the ph variation is within the normal limits and the river water quality is not affected by pH. As the variation shows pH is low at the Dubagga (S-3)and Mohan Meakin (S-5) location represent that industrial and domestic discharge at this place which also affect the taste of water at that place.

B. Temperature

The temperature of river water at various sampling locations, which was measured by using mercury thermometer, is summarized in Table-3 and the variation shown in fig. 2. It is found that variation of temperature ranges between 19.2˚C and 19.8 ˚C. As per the standards, the temperature should not 40˚C in any section of the stream within 15 meter downstream from the effluent outlet. Thus it is reflect that the temperature variation is within the normal limits and the river quality is not affected by thermal pollution.

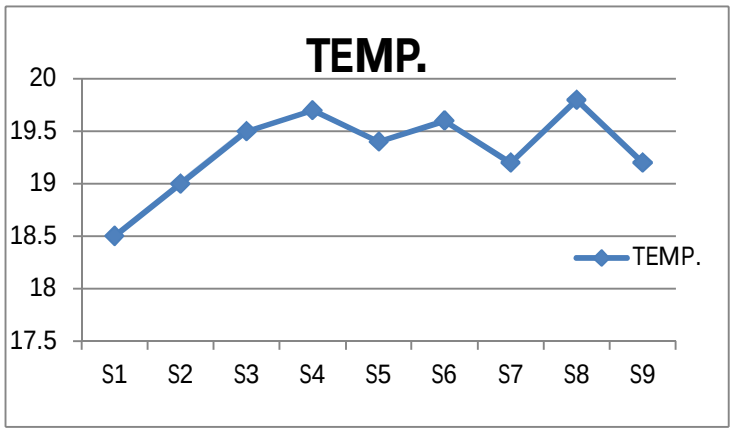

Fig. 2 Variation in Temperature

C. Turbidity

Turbidity was measured by using Nephalo-turbidity meter, and the data are summarized in Table 3. As per the primary water quality criteria for class-B waters the turbidity should not exceed 30 NTU. The variation as shown in Fig. 3 reflects that there are certain effluent is added up to the river stream. The deterioration in water quality in terms of turbidity is problematic situation in the river as the high value affect the transparency of water and thereby, affecting healthy functioning of river ecosystem due to poor transmission of sunlight up to the full depth of river. At point S-1 and S-8 there is huge variation in turbidity which represents the sewage and sludge disposal which are affecting the aesthetic appearance of water at that place.

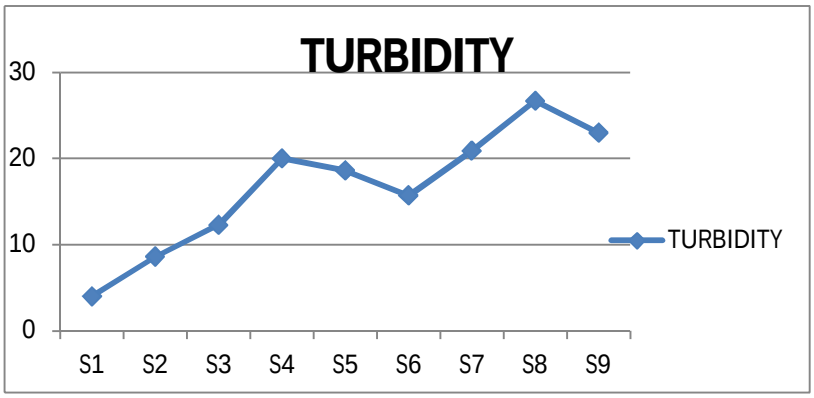

Fig.3 Variation in Turbidity

D. Colour

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A glance at Table 3 incorporating colour data observed visually reflects that the river water possess noticeable colour different from natural colour at Kukrail (S-7), where it was found to be turbid. Thus it represents that near this point the discharge of industrial effluent is merged into the river.

E. Odour

Odour data generally collected by direct smelling presented in Table3.The odour of river water was found odourless at every sampling point which represents there is no aesthetic problem regarding the odour of the river water.

F. Total Dissolved Solids

Total dissolved solids measured at various sampling locations are mentioned in Table 3 and the variation shown in Fig.4.It is revealed that the Total Dissolved Solids values show peaking tendency at Mohan Meakin (S-5), Hanuman Setu (S-6) and Malesmau (S-9). This also indicates the effect of industrial waste water discharged into the river and the impact on flora and fauna.

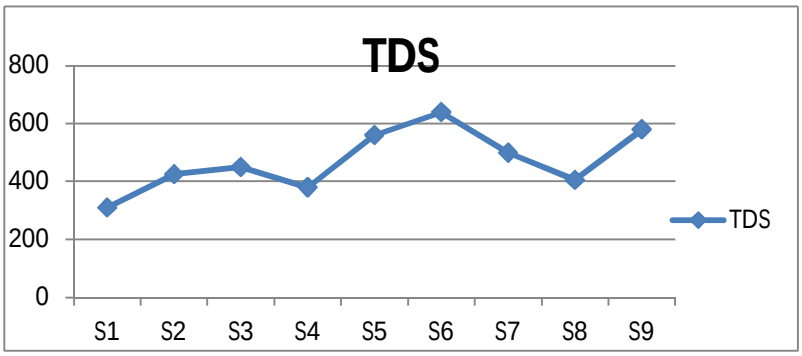

Fig. 4 Variation in Total Dissolved Solids

G. Dissolved Oxygen

The dissolved oxygen data pertaining to various sampling locations are given in Table 4.1 and the variation is depicted in Fig.5. Looking at primary water quality criteria it is revealed that a minimum of 6.0 mg/l D.O. content is necessary for Class-B and Class-C waters. It is also known that not less than 3.5 mg/l of D.O. is necessary at any time for the protection of aquatic life. D.O. at every point is quite less than the permissible value. This necessitates the implementation of an action plan to restore Class-A water quality in the entire stretch of the river.

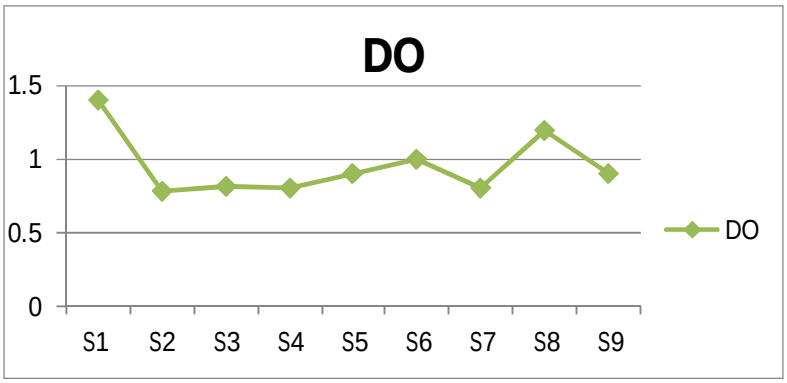

Fig.5: Variation in Dissolved Oxygen

H. Biochemical Oxygen Demand

The Biochemical Oxygen Demand data presented in Table 4.1 and the depicted in Fig. 4.6 reveal that at all the sampling point

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B.O.D. alarming higher values and maximum at the point Gomti Barrage i.e. 32 mg/l. This indicates the discharge of biodegradable organic matter through industrial waste water stream in the river owing to which the fall in D.O. level may also be attributable. As per norms B.O.D. of Class-A waters should not be more than 2.0 mg/l. As against this successively high value of B.O.D. in river water indicate severe organic pollution in river. At Gomti Barrage (S-5) the B.O.D. value seems to be maximum that represents the more discharge of bio-degradable organic matter at this point.

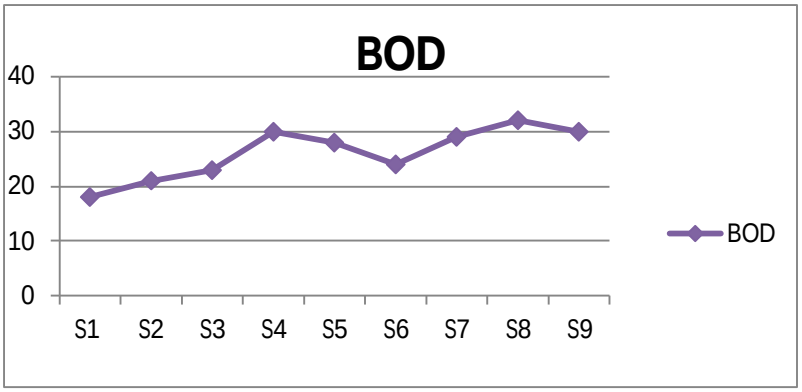

Fig.6 Variation in Biochemical Oxygen Demand

I. Chemical Oxygen Demand

C.O.D. data incorporates in Table.3 and depicted in Fig.7 represents the fluctuation in the values. Notably the C.O.D. for discharging sewage and trade effluent into stream is prescribed to be less than 250 mg/l. The values were found to be below norms but attention to manage the pollution load joining the river is needed. C.O.D. seems to be maximum at Hanuman Setu (S-6) which represents the sewage disposal at this point seems to be more and beyond the acceptable limit.

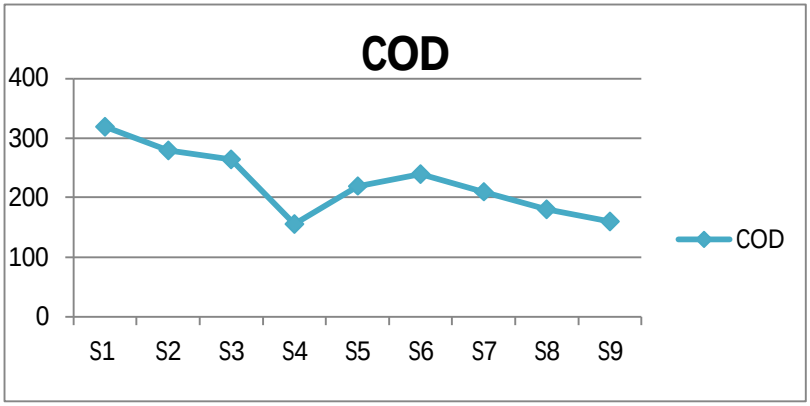

Fig. 7 Variation in Chemical Oxygen Demand

J. Chloride

The chloride data in Table-3 and depicted in Fig.8.A review of the Fig. reveals that there is no abrupt variation in the chloride concentration at any sampling locations.Even though minor variation are noticeable in time and space. At sampling location S-5 and S-6 i.e. Mohan Meakin and Hanuman Setu, the higher values for chloride seems to be appear which affecting the desirable water quality parameter.

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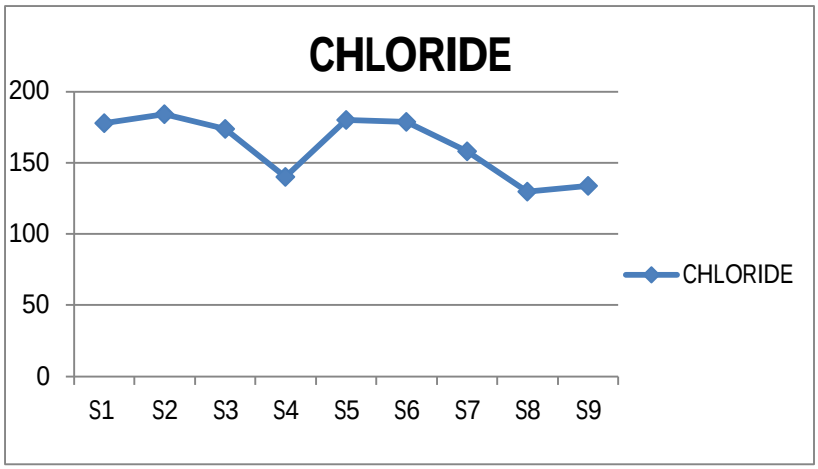

Fig. 8 Variation in Chloride

K. Hardness

The hardness data in Table-3 and depicted in Fig.9.A review of the Figure reveals that there is abrupt variation in the hardness concentration at some sampling locations. Even though minor variation is noticeable in time and space. Such variations are generally caused due to the industrial and municipal effluent discharged into the river. At Kukrail (S-7) and Gomti Barrage (S-8) the higher concentration of hardness seems to be appear which generally represents the heavy industrial and municipal disposal at these locations.

Fig. 9: Variation in Hardness

L. M.P.N.

M.P.N. data incorporates in Table 3 and depicted in Fig.10 represents the fluctuation in the values. As per the requirements for the Primary Water Quality Criteria for Class-A waters M.P.N. of total coliform/100 ml observed to the much higher at all the sampling locations this also reveals the bacteriological quality of river water is not good. It may therefore, be restored to that proper disinfection of treated effluents should be incorporate in the treatment system of the industry.

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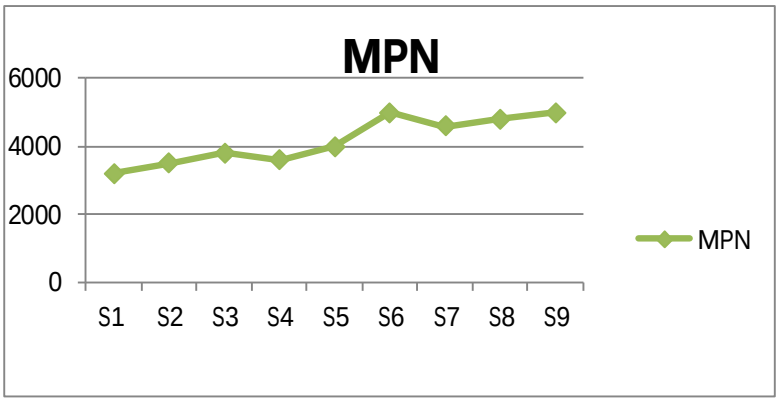

Fig.10 Variation in M.P.N.

Thus it is realized that Gomti river is severely victimized by anthropogenic pollution of industrial origin at many point along its length and a scientifically planned waste management program is needed to be implemented urgently. Based on the results and discussion the recommendations and conclusion are presented below.

Table 4: Maximum and Minimum Concentration of Gomti River (March 2017)

Parameters	Maximum	Minimum
Temperature	19.8	18.5
pH	8.3	6.4
Dissolved Oxygen	1.4	0.78
B.O.D.	32	18
C.O.D.	320	155
Turbidity	26.7	4.00
Hardness	170	126
Chloride	184	130
Total Dissolved Solids	640	310
MPN	5000	3200

VI. CONCLUSION

The data reveal a fact that the Gomti river in the belt of its origin to upstream of Lucknow has a high self-purification power for pollutants which may be attributed to the nature of wild aquatics, texture and structure of the basement soil of the river. The existence of turning points in a nearby site may partially be elevating the self-purification character of river. After some distance from the upstream of Lucknow the river loss its self- purification power because of low flow rate and large amount of sewerage waste. So that it is necessary to maintain the quality of water of Gomti River.

Prevention of pollution in rivers and other water bodies is a high priority cost in the country. The indiscriminate discharge of treated or untreated industrial waste water into rivers as rendered degradation of water quality of many major rivers and the efforts are being made for the last three decades to restore them as clean rivers. Over the years, many industrial clusters have cropped up on the bank of medium and small rivers too. This results in additional pollution load in joining rivers, which are already facing the menace of pollution.

The assessment of water quality parameters at five sampling sites selected along the stretch of river affected directly by industrial effluent discharged has yield it some very useful interferences as mentioned below:

A. The DO, TSS, TDS, nitrate, nitrite and other parameters at some of the sites were beyond permissible limit, water was polluted and is not suitable for beneficial uses without conventional treatments.

B. The river is highly polluted due to discharge of domestic and industrial waste through several drains.

C. The increase in value of chloride, turbidity and total hardness were also due domestic discharges.

D. Increased concentration of water quality parameters in water at Parag, Daligaj, Mohan Meakin and Monkey Bridge area could

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be due to high discharge of water from catchment area, industries and various drains.

E. The parameters like pH, Turbidity, Colour, Odour, Total Dissolved Solids, Chloride also confirm a severe deterioration in river water quality.

F. The biological examination of river water in respect of Total Coliform/100 ml at various sampling location has confirmed that the river water is unfit for direct consumption, bathing or any other domestic use.

G. It is also found that, due to lack of sincere and serious approach towards the treatment and disposal of industrial waste water by industries the condition is worsening day by day.

It is realize that urgent steps are needed to restore the water quality and regenerate the aquatic ecosystem in the river. This necessitates, on one hand, adequate treatment and disposal of industrial effluents, drains and regular monitoring of the river water to ensure that the 'River remains a River' throughout its length. This can materialized with a coordinated effort of government agencies, industrial units, local bodies and public, at large. This should go a long way toward saving Gomti River from fury of pollution.

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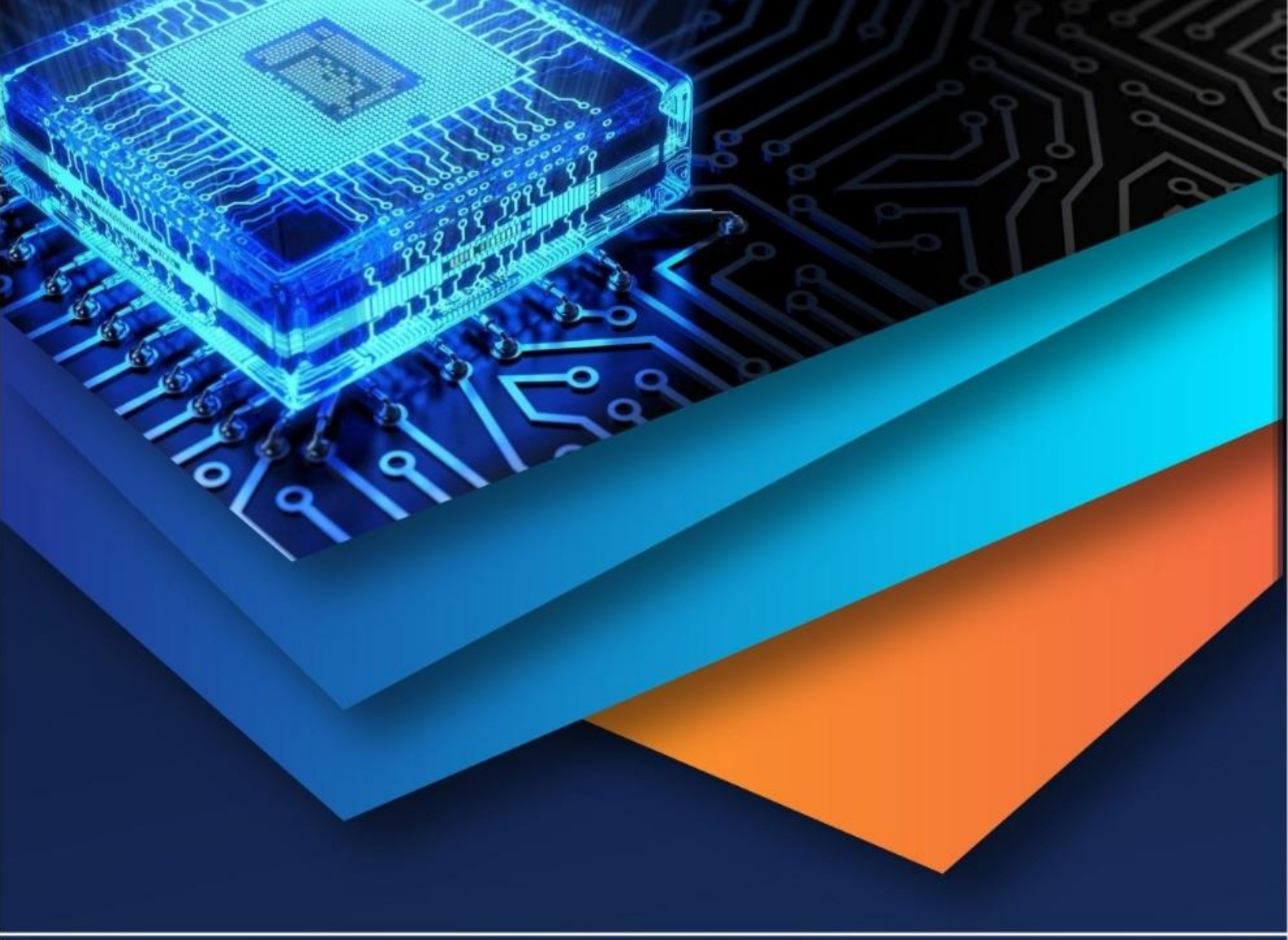

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