ISSN NO. 2320-5407

Journal homepage: http://www.journalijar.com
Journal DOI: 10.21474/IJAR01

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH

RESEARCH ARTICLE

Physico-Chemical Characteristics of Gomti River at Lucknow Stretch,India.

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Manuscript Info

Manuscript History:

Received: 18 May 2016
Final Accepted: 26 June 2016
Published Online: June 2016

Key words:
Pollutants, B.O.D, Dissolved Oxygen, River Water Pollution

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Abstract

This study was aimed to determine the current status of river Gomti along the Lucknow stretch. Physico-chemical characteristics, level of organic matter, various heavy metals and sewage pollution and their variation has been studied from upstream to downstream of Lucknow. Gaughat is upstream region and Pipraghat is downstream of Lucknow. The samples are taken from upstream to downstream regions of the river. Water samples are subjected to analysis like Total Solids, Total Dissolved Solids, Total Suspended Solid, Conductivity, pH, COD, BOD and DO. Study concluded that large number of drains are responsible for pollution in river Gomti that enter directly into the river carrying untreated industrial and domestic waste. Some other causes are like removal of solid wastes at pumping stations is still manual, sometimes pumping station does not work ,so the sewage waste is by passed directly to the river Gomti or when most of the branch and trunk sewers do not function properly. Study indicates that the water quality has been deteriorated from Gaughat to Pipraghat due to discharge of untreated waste water from about 26 major drains in its entire course. Water of the river Gomti at upstream of Lucknow i.e. Gaughat showed minimum BOD and maximum dissolved oxygen. But due to the presence of 26 drains dissolved oxygen level decreases along its stretch and showed minimum DO at Pipraghat.

Introduction:-

Gomti river is one of the important tributaries of Ganga river which originates from a lake Fulhar Jheel near Mainkot in Madhotanda, Uttar Pradesh. Gomti is an alluvial river, that meets the Ganga river in Ghazipur bordering Varanasi. The river is perennial in nature and is characterized by stagnant flow throughout the year except during the monsoon season when heavy rainfall causes high increase in BOD and decrease in DO. It also results in transportation of sediments along the river. Besides Lucknow, river receives the untreated waste water and industrial effluents from more than 45 drains and there are many tributaries that carry industrial waste from different towns. Some of the stretches of the river looks like a drain due to heavy pollution. Day by day the condition of the river has become worse. Studies showed that the level of dissolved oxygen become lower at many places. Water at Gaughat i.e upstream of Lucknow was good for all beneficial uses but as we go downstream of Lucknow stretch it is severely polluted due to 26 drains resulting in the lowest dissolved oxygen at Pipraghat. The river water is polluted with various heavy metals like copper , chromium, zinc, cadmium, nickel and lead. It is found that there is increase in dissolved oxygen content during the winter season while during summer DO decrease drastically except at Gaughat. River is highly polluted along the Lucknow stretch having high value of BOD and COD during summer and rainy season. Higher concentration of heavy metals were found during rainy season as compared to summer and winter. Due to dumping of garbage along the river bed and disposal of untreated waste, the site of river Gomti showed

increasing trend of turbidity from Gaughat to Pipraghat. Estimates show that 25 nullahs, including Sarkata, Pata nullah, and Wazirganj, pour around 350 MLD of wastewater daily into the Gomti.

Material and method:-

There are total 26 drains consist of 14 drains from Cis-side and 12 drains from Trans-side situated between Gaughat and Pipraghat. Although all these drains are treated at various STP like Daulatganj and Bharwara STP, still they carry contaminated waste of medical, industrial, sewage and domestic.

Sampling sites:-

Wastewater of 26 major drains situated between Gaughat u/s and Piperaghat d/s discharging their waste into river directly. Samples were collected and analysed by Gomti Pollution Control Board from January 2014 to December 2014 from various locations of Gomti river. Number of drains are like Gaughat Drain, Sarkata Drain, Pata Drain, NER U/S, NER D/S, Wazirgang Drain, Ghasiare Mandi Drain, China Bazar Drain, LA-PLACE, Parag Dairy Drain, GH Canal, I.G.Nivas, Jiamau Drain, Lamartenier, Khadra Drain, Mohan Meakin, Daliganj no.1, Daliganj no.2,, Arts college, Hanuman Setu, TGPS, kedarnath, Nishatganj Drain, Baba ka purva, Kukrail Drain and Rahimnagar Drain.

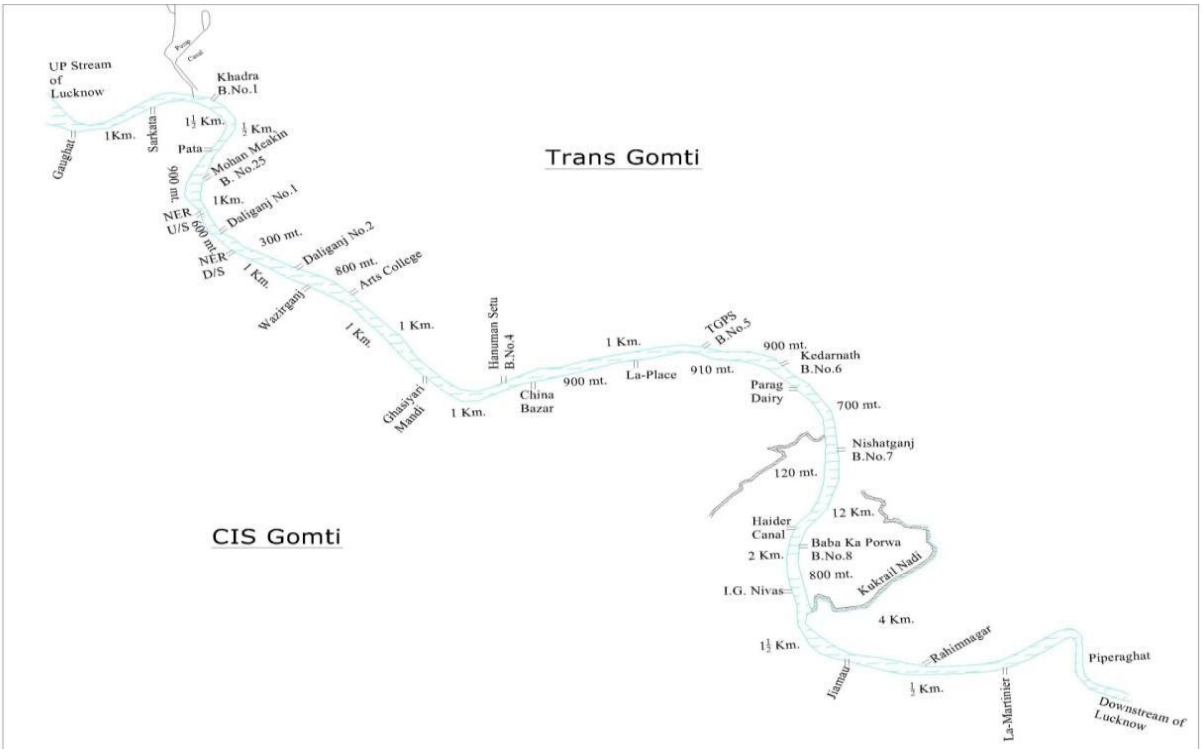

Figure 1:- Sampling Locations in Lucknow city

Table 1:-Drains and their discharges (Source: Lucknow Nagar Nigam)

Cis-Gomti drains (13 Nos.)	Average dry weather flow in mld.
Gaughat drain	1.0
Sarkata	18.0
Pata	18.0
NER Upstream	0.3
NER downstream	0.5
Wazirganjj	13.0
Ghasyari Mandi	10.0
China Bazar	2.0
La-Place	1.0
Jopling road	1.0
G.H.Canal	78.0
Jiamau	-

La-Martiniere	0.5
Trans- Gomti drains (12 Nos.)	**Average dry weather flow in mld.**
Mahesh ganj	-
Rooppur khadra	0.5
Dyer Meakin	3.0
Daliganj No.1	8.0
Daliganj No.2	1.0
Art college	0.5
Hanuman Setu	0.5
TGPS	1.0
Kedar Nath	2.0
Weshatganj	1.0
Kukrail	20.0
Baba ka purwa	-

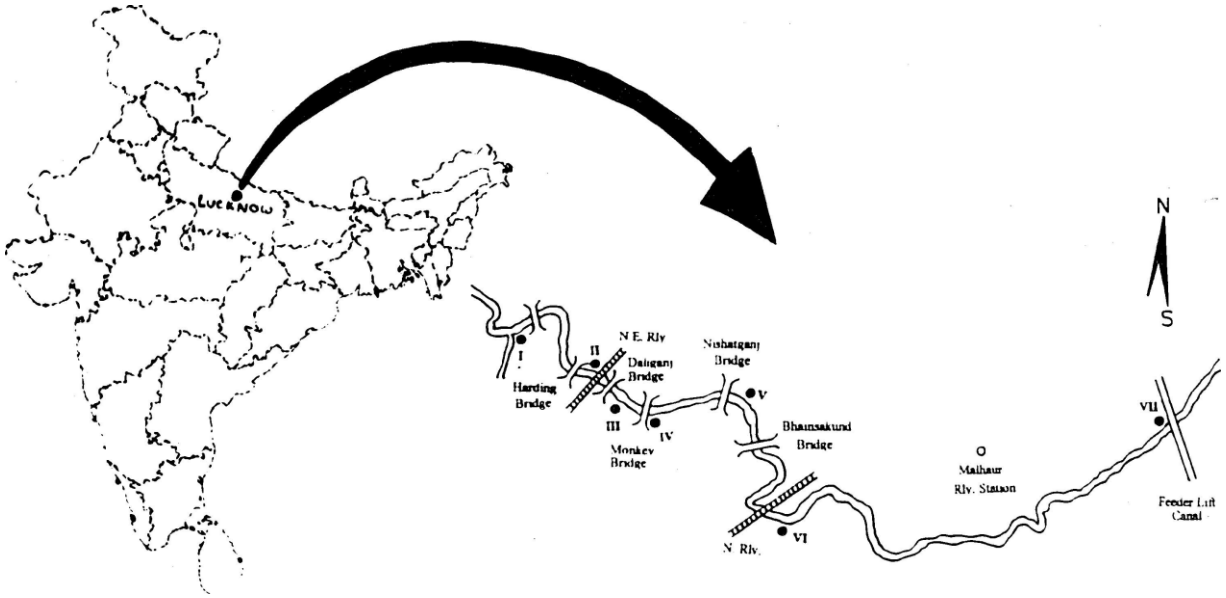

Figure 2:- Segment showing drainage of the Gomti river, *Source: U.P.Jal Nigam and Gomti Pollution Control Board*

Table 2:- Water quality of Gomti river

		jan	feb	mar	april	may	june	july	aug	sept	oct	nov	dec
Dadhnamu-ghat Sitapur	DO (mg/l)	10.9	11.2	11.3	8.4	8.5	7.0	5.8	7.5	7.5	8.4	10.2	9.6
	BOD (mg/l)	2.5	2.4	2.6	2.9	2.7	2.9	2.7	2.7	2.5	2.6	2.7	2.6
	Total Coliform (MPN/ 100 ml)	1700	2200	2600	3900	2200	1100	1300	1700	1300	940	940	790
Manjhighat, Lucknow	DO (mg/l)	10.9	10.8	9.4	-	-	6.8	5.5	5.6	6.0	7.9	8.5	9.3
	BOD (mg/l)	2.8	2.8	2.9	-	-	3.1	2.9	3.0	2.9	2.8	2.9	2.9
	Total Coliform (MPN/	2400	2800	3200	-	-	2800	2200	2400	2300	2200	2100	2000

	100 ml)												
Gaughat (u/s of lko)	DO (mg/l)	10.4	10.5	9.1	7.8	6.6	6.5	5.2	5.3	5.7	7.6	8.3	9.0
	BOD (mg/l)	3.1	3.2	3.4	3.8	3.5	3.3	3.2	3.4	3.2	3.3	3.2	3.1
	Total Coliform (MPN/ 100 ml)	3500	4000	4700	5400	4900	3500	3200	3500	3300	2800	2400	2200
Kudyaghat	DO (mg/l)	9.5	8.6	7.4	-	-	5.1	4.3	4.8	4.9	6.3	7.2	7.8
	BOD (mg/l)	3.6	4.0	4.4	-	-	4.6	4.2	4.5	4.4	4.2	4.0	3.8
	Total Coliform (MPN/ 100 ml)	4900	7000	9400	-	-	17000	9200	9400	7900	7000	6300	4900
Mohan meakin	DO (mg/l)	8.1	6.5	5.9	-	-	4.3	3.5	3.8	4.2	5.4	6.0	6.3
	BOD (mg/l)	4.8	5.0	5.6	-	-	6.0	5.5	6.0	5.5	5.2	5.4	5.2
	Total Coliform (MPN/ 100 ml)	$17x 10^3$	$21x 10^3$	$22x 10^3$	-	-	$34x 10^3$	$32x 10^3$	$26x 10^3$	$21x 10^3$	$17x 10^3$	$14x 10^3$	$14x 10^3$
Nishatganj drain	DO (mg/l)	6.0	4.7	4.1	-	-	2.4	2.3	2.5	2.4	2.7	2.9	2.7
	BOD (mg/l)	6.6	7.0	7.8	-	-	8.0	7.0	8.0	7.5	7.0	7.5	7.0
	Total Coliform (MPN/ 100 ml)	$49x 10^3$	$70x 10^3$	$94x 10^3$	-	-	$70x 10^3$	$79x 10^3$	$94x 10^3$	$79x 10^3$	$70x 10^3$	$63x 10^3$	$46x 10^3$
U/S barrage	DO (mg/l)	4.8	3.6	3.2	-	-	1.9	1.8	1.6	1.8	1.5	1.7	1.5
	BOD (mg/l)	7.5	8.5	9.0	-	-	9.5	9.0	9.5	9.0	8.5	9.5	9.0
	Total Coliform (MPN/ 100 ml)	$70x 10^3$	$94x 10^3$	$110x 10^3$	-	-	$110x 10^3$	$94x 10^3$	$110x 10^3$	$94x 10^3$	$94x 10^3$	$79x 10^3$	$70x 10^3$
Pipraghat	DO (mg/l)	4.7	4.3	2.5	1.8	2.0	1.8	1.6	2.1	2.4	1.8	1.0	2.8
	BOD (mg/l)	8.5	9.0	10.0	8.6	9.0	10.5	10.0	10.5	9.4	9.8	10.0	9.0
	Total Coliform (MPN/ 100 ml)	$110x 10^3$	$130x 10^3$	$140x 10^3$	$94x 10^3$	$110x 10^3$	$140x 10^3$	$140x 10^3$	$130x 10^3$	$110x 10^3$	$110x 10^3$	$94x 10^3$	$79x 10^3$
Bharwara	DO (mg/l)	2.5	1.2	1.0	-	-	1.3	0.7	1.2	0.7	1.2	1.0	0.9

	BOD (mg/l)	10.0	11.5	13.0	-	-	12.0	13.0	12.0	12.5	12.0	12.0	11.5
	Total Coliform (MPN/ 100 ml)	110x 10^3	140x 10^3	170x 10^3	-	-	170x 10^3	210x 10^3	140x 10^3	130x 10^3	110x 10^3	110x 10^3	94x 10^3
Jaunpur (d/s Gomti)	DO (mg/l)	7.8	8.0	7.8	7.8	7.7	7.4	7.5	7.4	7.2	7.5	7.9	8.2
	BOD (mg/l)	3.2	3.4	3.6	3.8	3.5	3.1	3.0	2.5	3.0	3.4	3.5	3.7
	Total Coliform (MPN/ 100 ml)	17x 10^3	14x 10^3	11x 10^3	17x 10^3	17x 10^3	14x 10^3	17x 10^3	21x 10^3	17x 10^3	17x 10^3	17x 10^3	17x 10^3
Before meeting Ganga, Varanasi	DO (mg/l)	8.0	8.1	8.0	8.0	7.8	7.6	7.7	7.5	7.2	7.5	8.1	8.4
	BOD (mg/l)	3.0	3.2	3.3	3.4	3.3	2.9	2.5	2.3	2.8	3.2	3.2	3.4
	Total Coliform (MPN/ 100 ml)	11x 10^3	9.4x 10^3	8.0x 10^3	9.0x 10^3	9.0x 10^3	8.0x 10^3	9.0x 10^3	17x 10^3	14x 10^3	13x 10^3	14x 10^3	14x 10^3

Source : Gomti Pollution Control Board(2014)

TABLE 3:- Classification according to water quality (IS:2296-1982)

	A	B	C	D	E
DO mg/l (min)	6	5	4	4	-
BOD mg/l (max)	2	3	3	-	-
Total coliform(MPN/100 ml) mg/l (max)	50	500	5000	-	-
Total dissolved solid mg/l	-	-	-	-	2100

Category A: suitable for drinking after disinfection
Category B: suitable for bathing
Category C: suitable for drinking after treatment and disinfection
Category D: suitable for fisheries
Category E: suitable for irrigation, industrial cooling
Source : Gomti Pollution Control Board(2014)

Results and Discussion:-

The water quality of Gomti river at Lucknow stretch are shown in the table:2. The total stretch is divided into number of reaches: Gaughat to Kudyaghat , Kudyaghat to Mohan Meakin, Mohan Meakin to Nishatganj drain, Nishatganj drain to Upstream barrage, Upstream barrage to Pipraghat. Pollution of River Gomati has taken place due to disposal of sewage from various drains due to which water quality has deteriorated. Various water quality parameters of river Gomati has been discussed below.

Dissolved oxygen (DO):-

The stretch of Gomti river from Gaughat to Pipraghat showed decreasing trend of dissolved oxygen. Gaughat showed the maximum content whereas Pipraghat showed the minimum. The DO at Gaughat is maximum because the water at this site is least polluted from industrial, sewage and domestic waste. However, when river reaches the Gomti barrage and Pipraghat, it gets heavily polluted due to discharges from various cis and trans drains emptying into the river round the year which is shown in figure no.7,8. During rainy season dissolved oxygen decreases as compared to summer and winter as in rainy season runoffs from the agricultural fields and industries directly enter into the river without any treatment. From figure no.3, at Gaughat , the water of the river is clean and no turbidity has been found. The water at Kudyaghat is slightly polluted due to the discharge from drains. It can be referred from

figure no.4, the content of dissolved oxygen is sufficient enough so that the fishes can survive here. The dissolved oxygen level at Mohan Meakin during the winter and summer seasons is high as compared to the rainy season because of the heavy runoff. At this sampling location dissolved oxygen level decreases because of the pollution from drains and industries. At Nishatganj drain sampling location there is heavy depletion of dissolved oxygen because of the higher BOD level. This sampling site is almost at the middle of the city, therefore sullage content is high. This variation of DO is shown in figure no.6. The Gomti barrage constructed at downstream end of the town impounds most of the sewage entering the river. This also stops the river from flowing. The flow will become stagnant and there is high depletion of dissolved oxygen.

Biological oxygen demand (BOD):-

Increasing trend of BOD was observed from upstream to downstream sites of Lucknow. Decomposition of organic matter is largely an aerobic process, so the demand and requirement of oxygen increases resulting decrease in the dissolved oxygen, thereby increasing BOD and COD. Lower value of BOD at Gaughat was found because of the negligible pollution at the upstream site which is shown in figure no.3. BOD content was found to be complementary to the DO values for entire stretch which can be referred from the figures given below. Detergents used by the washemen leads to increase in the phosphate content in the river water that causes growth of algae. Algal growth in water resulted in lowering of DO due to which the demand of oxygen increases which leads to the decomposition of organic matter incomplete. The content of BOD increases from Nishatganj drain to Pipraghat due to heavy disposal of industrial wastes which is shown in figures 6,7 and 8. At Nishaganj the sullage content is very high because of the disposal of household wastes.

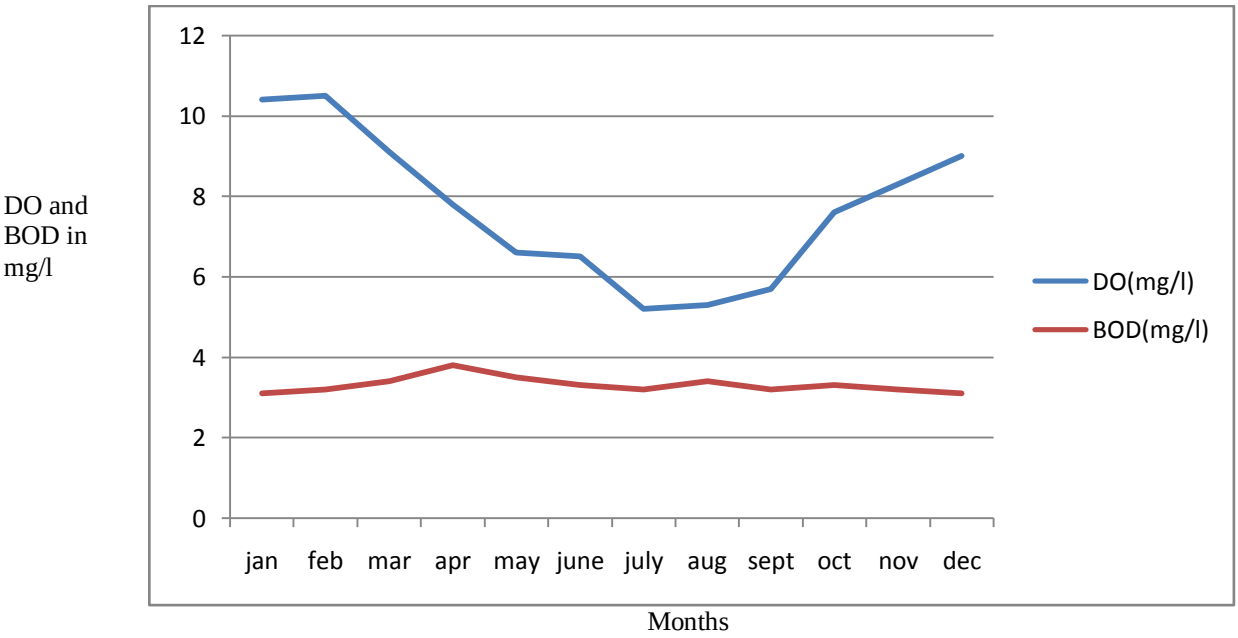

Figure 3:- Variation of DO (mg/l) and BOD (mg/l) measured at Gaughat (upstream of Lucknow) (2014)

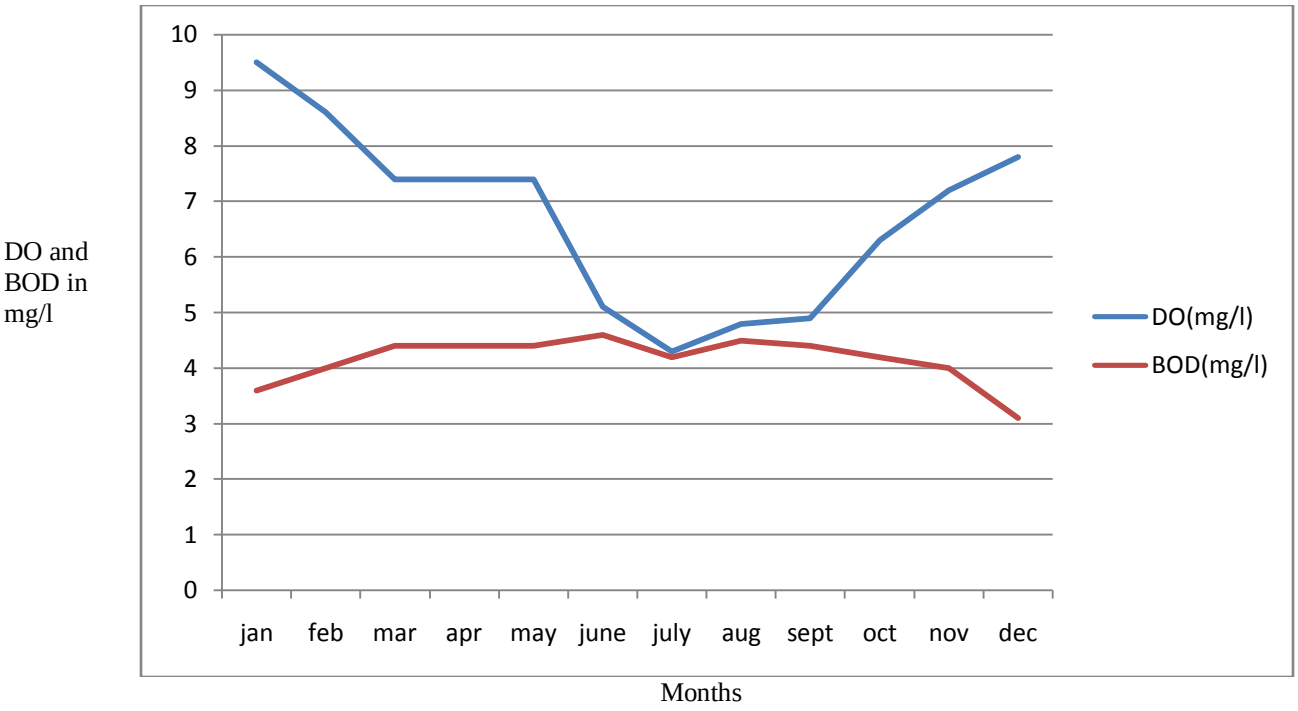

Figure 4:- Variation of DO (mg/l) and BOD (mg/l) measured at Kudyaghat (2014)

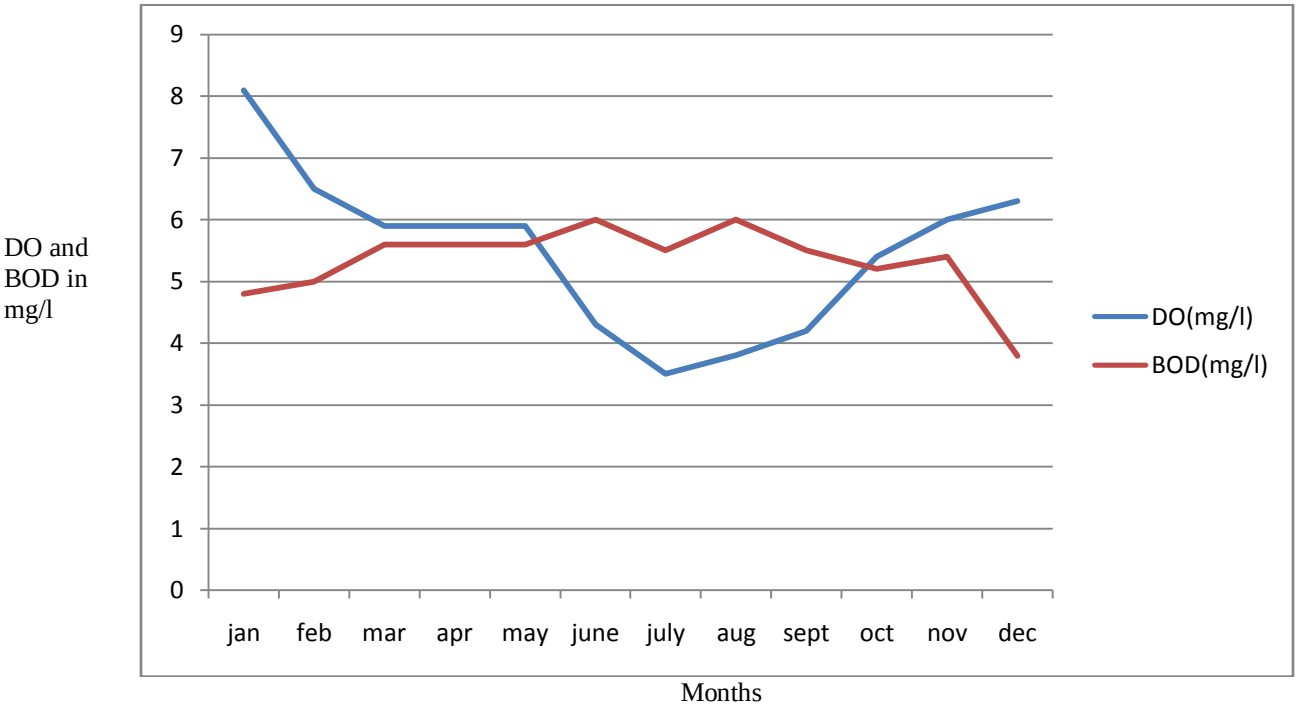

Figure 5:- Variation of DO (mg/l) and BOD (mg/l) measured at Mohan meakin(2014)

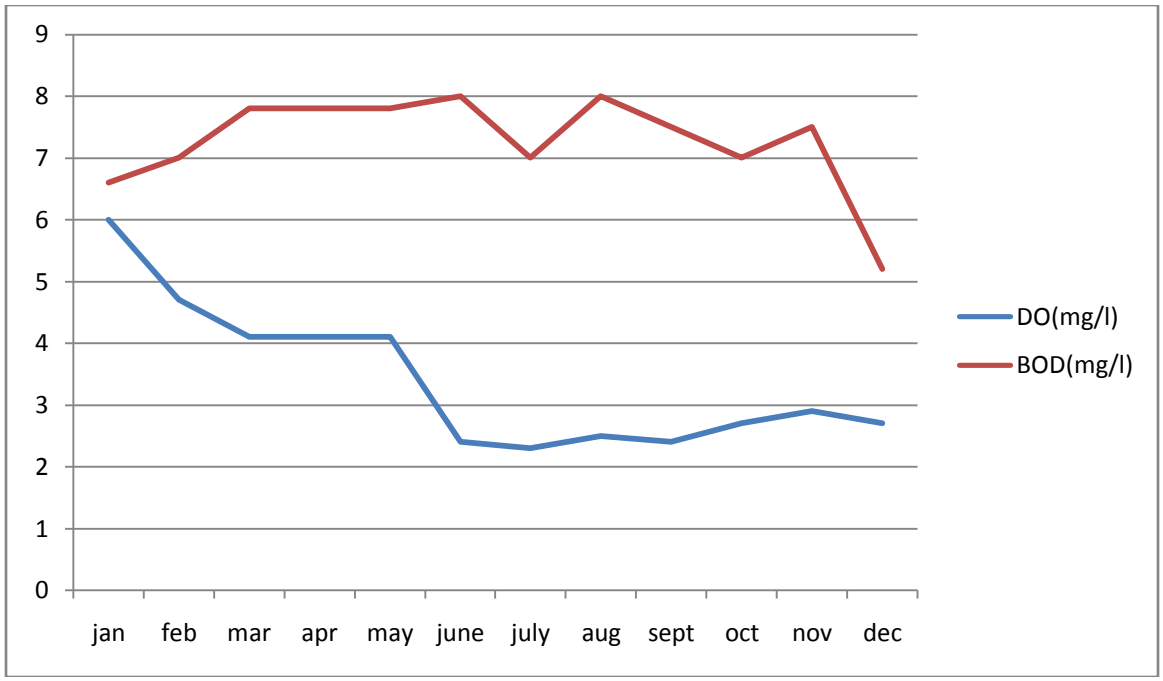

Figure 6:- Variation of DO (mg/l) and BOD (mg/l) measured at Nishatganj drain(2014)

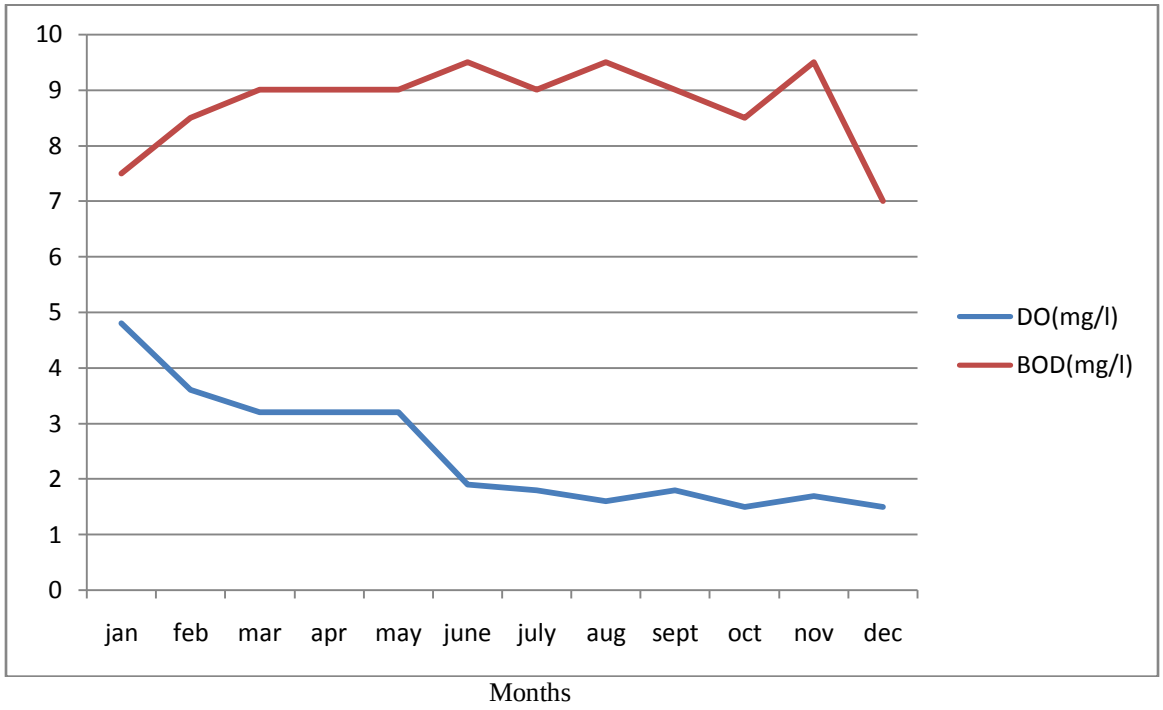

Figure 7:- Variation of DO (mg/l) and BOD (mg/l) measured at Upstream barrage(2014)

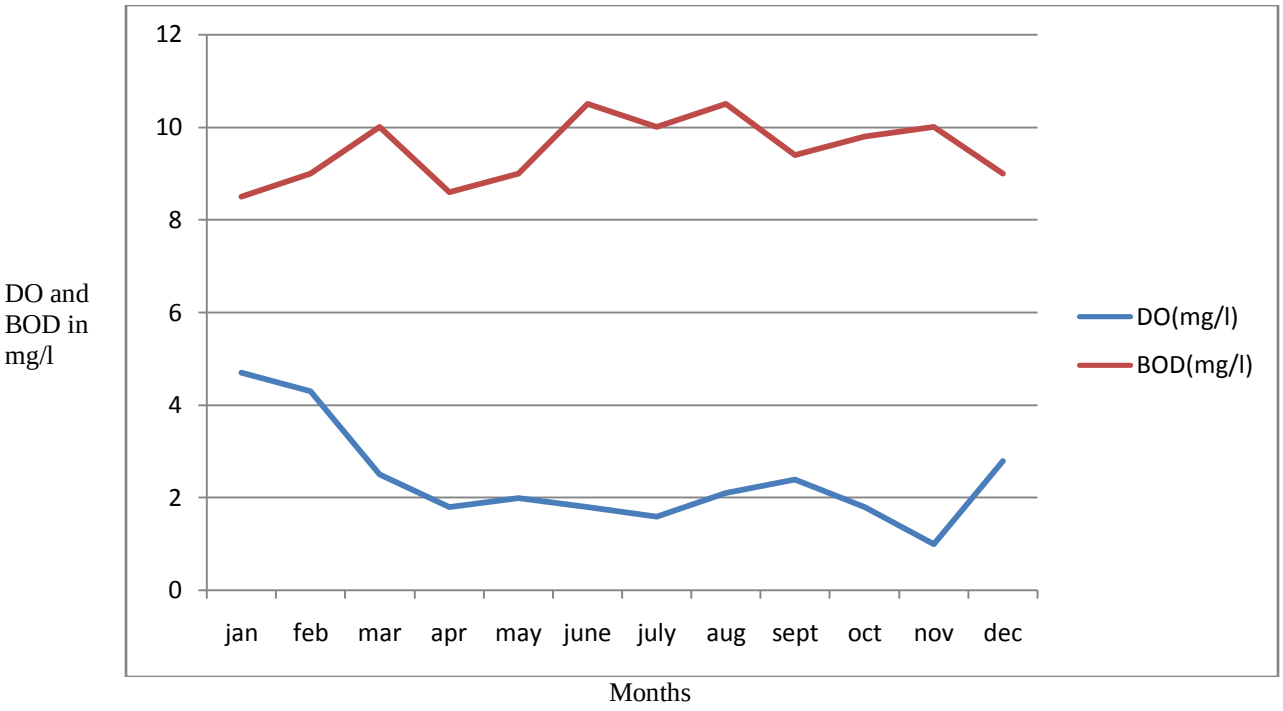

Figure 8:- Variation of DO (mg/l) and BOD (mg/l) measured at Pipraghat (downstream of Lucknow) (2014)

Chemical oxygen demand (COD):-
The sites of Gomti river from Gaughat to Pipraghat also showed an increasing trend in COD. The demand of oxygen for the decomposition of biodegradable and non biodegradable organic matter increases from upstream to downstream. COD content was to be higher at Upstream barrage and Pipraghat sites.

pH:-
The pH is an important indicator of the water quality and the extent of the pollution in the river water. The sites from Gaughat to Nishatganj showed significantly decreased pH values. During the month from December to May, Gomti becomes highly polluted because the flow of river becomes minimum in dry weather as compared in monsoons. This was reported by the U.P. State Pollution Control Board in 1995. PH value becomes high due to the heavy runoff from industries, agricultural fields and other contaminated sites during the rainy season. It has been observed that pH of water gets drastically changed with time due to temperature changes, exposure to air and biological activity.

Total Solids (TS):-
Study showed that there are significantly higher values of total solids in post monsoon season and lower in pre monsoon season. Due to high runoff from industrials and agricultural fields during the rainy season, total solids have been increased. It has been studied that Pipraghat and Upstream barrage showed higher total solids concentration as compared to other sampling sites because of the heavy industrial and sewage pollution.

Total Dissolved Solids (TDS):-
In water, total dissolved solids are composed mainly of carbonates, bicarbonates, chlorides, phosphates and nitrates of calcium, magnesium, sodium, potassium and manganese, organic matter, salt and other particles. Study revealed that there are slightly higher values in post monsoon season which may be due to accumulation of carbonates. Its concentration is maximum at downstream of Lucknow as compared to other sampling sites.

Total suspended solids (TSS):-
The analysis showed higher values of suspended solids at Lucknow i.e. Mohan Meakin, Upstream barrage, Piperaghat. It might be due to presence of high organic matter. The total suspended solids are composed of carbonates, bicarbonates, chlorides, phosphates and nitrates of calcium, magnesium, sodium, potassium, manganese,

organic matter, salt and other particles. Higher values of suspended solids were found in post monsoon which might be due to run off from many bathing ghats, drain water discharge, industries, agricultural fields and garbage dump sites. Study showed lower values during winter and summer seasons.

Conductivity:-
Increasing levels of conductivity and cations are the products of decomposition and mineralization of organic materials. Due to dilution with rain water higher value was found at Mohan Meakin and Pipraghat during rainy season.

Hardness:-
Sulphates and chlorides of the metal caused permanent hardness in water. Carbonate and bicarbonate are also responsible for the temporary hardness. As the presence of organic matter increases, the level of dissolved oxygen decreases thereby increasing the concentration of carbon dioxide which gives more carbonate which when combine with calcium and magnesium ion gives hardness to the water . The sites of Gomti from Gaughat to Pipraghat showed the increasing trend in hardness. The reason behind this may be the use of soaps and detergents by washer men at various ghats, also because of high alkalinity in nearby drains, discharge of the domestic wastes through the drains and acid wastes. Increase in dissolved solids also increases the hardness as dissolved solids are composed of mainly carbonates, bicarbonates, phosphates etc of calcium and magnesium.

Conclusion:-
Study revealed that water quality of Gomti river was found to be more polluted at the downstream of the stretch as compared to the other sampling sites. Physico-chemical and microbiological quality of Gomti river was poor, unsafe and not acceptable for any purpose . The level of all the indicators are above the standards which are the serious concern for the ecology of the river. The deterioration of water was due 26 drains along its stretch. Various industrial waste, agricultural waste and domestic wastes are the main cause of increasing urbanization and population resulted in the increase in generation of waste that is being discharged into the river. It leads to increase in the content of heavy metals that results in pollution of river water. Due to huge amount of organic and inorganic matter, river lost its self purification nature, resulting higher bacterial growth. That is why it is very necessary to treat the waste coming from industries and other sources before merging into the river so that the aquatic as well as human life may not get affected.

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