STUDY AND ANALYSIS OF CHANGE IN WATER QUALITY OF GOMTI RIVER IN SITAPUR AND SULTANPUR AREA

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in Partial Fulfillment of the Requirements

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In

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SUBMITTED BY:

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to the

DEPARTMENT OF CIVIL ENGINEERING

BABU BANARASI DAS UNIVERSITY

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CERTIFICATE

This is to certify that the dissertation entitled **"Study And Analysis Of Change In Water Quality Of Gomti River In Sitapur And Sultanpur Area"** which is being submitted by **Mr. Ashutosh (1170470002)** in partial fulfillment of the requirements for the award of Degree of **Master of Technology in Enviromental Engineering** of the BBD University, Lucknow, is a record of his own work carried out by him under our guidance and supervision. The results embodied in the dissertation have not been submitted for the award of any other Degree or Diploma.

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DECLARATION

I hereby certify that the work which is being presented in this thesis entitled **"Study And Analysis Of Change In Water Quality Of Gomti River In Sitapur And Sultanpur Area"** in partial fulfilment of award of degree of **Master of Technology in Enviromental Engineering** submitted in Department of Civil Engineering, Babu Banarasi Das University, Lucknow is an authentic record of my own work carried under the supervision of **Kamal Nabh Tripathi**, Assistant Professor, BBD University, Lucknow, India.

Date:

Place: Lucknow **(Ashutosh)**

I certify that the above statement made by the student is correct to the best of my knowledge and belief.

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ABSTRACT

According to the U.S. Geological Survey, there are over 332,519,000 cubic miles of water on the planet Earth among which 97% of all the water on Earth is hold by the oceans and contains heavy composition of salt in it and most of the remaining 3% is frozen in the glaciers and icebergs. The atmosphere, rivers, lakes and underground stores hold less than 1% of all the fresh water and this small amount has to provide the fresh water needed to support the Earth's population. River plays a very important role in the life of human beings as well as the other living organisms like animals and plants on the earth. River used to be one of the most important source of clean water during earlier days but nowadays due to the heavy contamination the quality of water of river is decreasing day by day.

In this project work we are going to do analysis of physical and chemical parameters of water of Gomti River in different season at three different locations. The collected samples are analyzed for 8 Physiochemical parameters such as temperature, pH, BOD, DO, COD, Total Hardness, TDS and Alkalinity. The aim of the study is to find out the water quality of the Gomti River of Uttar Pradesh.

Keywords: Gomti River, water quality of River, pH, BOD, DO, Physio-chemical parameters**.**

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Date:

Place: Lucknow **(Ashutosh)**

ABBREVIATION AND SYMBOLS

BOD	Biological Oxygen Demand
DO	Dissolved Oxygen
COD	Chemical Oxygen Demand
RAC	Risk Assessment Code
U/S	Upstream
D/S	Downstream
TDS	Total Dissolved solids
TSS	Total Suspended Solids
Km	Kilometer

CHAPTER I

INTRODUCTION

As the population increasing day by day the demand of water for food production, domestic activities as well as industrial activities also increasing day by day. As we already know that the water is the most essential need for life and over 97% of the water on earth is holds by the oceans is salty and 3% is in frozen state and remaining amount which is approximately near about 1%is considered suitable for living beings on earth. Water is no doubt essential for life but the large quantity of water in the world is polluted due to the excessive contamination and inputs of untreated industrial effluents, household dirty water and sewage water along with farming wastes and decaying materials of human, animals and plants. The quality of water is vital concern for mankind since it is directly linked with human welfare and due to the limited quantity of available water for use, proper management and prevention is very necessary to fulfill the long term requirement and needs of the vast population for daily house hold use and requirements like agriculture etc. The Gomti river is an important river of Uttar Pradesh and it is one of the much known tributary of Ganga river. Gomti river is also known as Adi- Ganga. It contributes about 15% total water flow of Ganga river and Like many other rivers in India Gomti river is also facing many kind of pollution problems due to large level of commercialization and colonization The river Ganga is considered as one of the longest river in India. It has many tributaries and river Gomti is also one among them. Origin of river Gomti takes place from about 50 Km south of the Himalayan hills and about 3 Km east of Pilibhit in Uttar Pradesh. It extends to 900 km through Uttar Pradesh and meets the Ganga River near Saidpur Kaithi. 27 kilometers (17 mi) from Varanasi district. From20 kilometers (12 mi) its origin it meets a small river, the Gaihaaee. Until it reaches Mohammadi Kheri (Lakhimpur district) the Gomti river is in a narrow stream, where it is joined by many tributaries such as the Sukheta, Andhra Chohaand Choha. With the joining of many other tributary like kathina in Mailani and Sarayan in Sitapur district the river is well defined.. Near Jaunpur one of the major tributary the Sai River also joins the Gomti river.

The river Gomti enters Lucknow after travelling approximately around 240 km. For about 12 km going through the city it supply its water to most of the places of the city. Situated on the northern western shore of Gomti river and surrounded by Barabanki from eastern side and Unnao from western side, Rae Bareli by the southern side and Sitapur - Hardoi by northern

side is the Lucknow city which has elevation of 404 ft. (123 m) above sea level. The city covers an area of 2,528 square kilometers. In addition to Lakhimpur kheri, Sultanpur and Jaunpur, Lucknow is also among 15 of the most prominent town of the river catchment basin.

CHAPTER II

REVIEW OF LITERATURE

Singh et al (2005) carried out a study to know 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. on Gomti River

Mishra and Mishra (2008) the high concentration BOD, COD, DO and MPN were noticed in water during his studies on physio-chemical parameters of Gomti River and the level concentration of these parameters got increased from 2006 to 2008 while DO was found the detectable limit. Due to rapid increase in the quantity of sewage and industrial waste value of COD and TDS also increasing day by day.

Srivastava et al (2011) carried out a study in which he found out the main source of water pollution for rivers in cities are drains they flow within city with industrial effluent ,sewage and domestic waste which pollutes the water and the quality of water becomes poor

Kumar et al (2013) caried out a water test in order to know the water quality of river Gomti in Lucknow and found that 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. The river is highly polluted due to discharge of domestic and industrial waste through several drains. The increase in value of chloride, nitrate and total hardness were also due domestic discharges. Increased concentration of heavy metal in water at Parag, Daligaj, Mohan meakin and Monkey Bridge area

Purushottam Trivedi (2016) carried out water samples for testing from different location of Gomti river in order to perform analysis of physiochemical charachtrerstics of water, residues of pesticide and heavy metals in water of Gomti river and the result revealed that river water was contaminated with HCH, DDT, alachlor, heptachlor and butachlor at hanuman sethu and gomati bairaj which may contribute to toxicity in the ecosystem of the river.

Ali et al (2016) carried out water samples for testing from 7 location of Gomti river to assess the Quality of River Gomti in Lucknow in terms of Water Quality Index and cause of pollution. The sample collected and analyzed for 10 physio-chemical parameters such as pH, DO, EC, BOD, Total Hardness, Calcium, Magnesium, Chloride, Alkalinity and TDS. The Assessment of Water Quality Index using Weighted Arithmetic Method revels that the quality of River Gomti is detoriating while entering into Lucknow city due to the discharge of huge quantity of sewage through different drain into River Gomti. The quality of river water was moderately polluted at the entrance of the city (Manjhi Ghat and Water intake point) and pollution at this point is mainly found due to some industrial as well as domestic discharge into

Kumar and Banergee (2016) carried out the water test in order to compare the water quality of river Gomti in Lucknow city during pre-monsoon and post monsoon season. 10 samples were taken from different regions of Gomti river in Lucknow. 7 physio chemical parameters were analyzed.

Rahman et al (2016) performed a water test on water samples collected form various district of Uttar Pradesh in order to perform physiochemical analysis of Gomti river during the season of summer , winter and rainy season. The results obtained by them is most of all parameters are within permissible limits except pH, BOD and DO. The test revealed that the Gomti River was highly polluted and the water quality is not now in safe limit for human, flora and fauna.

Gupta et al, (2017) (Physio-Chemical and Biological Analysis of Gomti River in Lucknow Region) carried out a test on nine samples from different locations which include upstreamand downstream of Lucknow during March, 2017 and found that the DO, TSS, TDS, nitrate, and other parameters at some of the sites were beyond permissible limit,

The sample collected and analysed for 12physio-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.

Singh et al (2017) perform a test in order to study the water quality of Gomti River of Lucknow and its effect on human health and the result they found is Cd, Cr, Zn, Cu, Ni, Mo, Se and Fe content were noticed in beyond the permissible value among all station

CHAPTER III

METHEDOLOGY

3.1 PHYSICAL WATER QUALITY PARAMETERS

The physical characteristics of water are assessed in terms of color, odour, temperature, and . Quantative or qualitative measurement of these characteristics is necessary for the assessment of water quality

3.1.1 SOLIDS:

The solids found in water typically include silt and clay from riverbanks or lake bottoms and organic matter and microorganism from natural or anthropogenic sources. Solids can be classified by their size, state, chemical characteristics and by their size distribution. On the basis of size, solids can be classified as non-volatile or volatile on the basis of their chemical characteristics.

Solids aesthetically displeasing and provide adsorption sites for chemical and biological agents. The removal of solids is of great concern in the production of clear safe drinking water, in the process industries and wherever a water of high quality is required..

3.1.2 TURBIDITY:

Clarity is the first thing that is noticed about water. Turbidity is the measure of the extent to which light is either absorbed or scattered and may be present due to erosion of colloidal material from soil, vegetable fibers, microorganism etc. turbidity measurement is very useful in defining drinking water quality as turbid water apart from giving an unpleasant look, also interferes with various unit operations involved in water treatment.

3.1.3 TEMPERATURE

Temperature, one of the most important parameters in natural surface water system affects a number of important water quality parameters. Chemical and biochemical reaction rates increases with increases in temperature. While the solubility of gases decreases with

increases in temperature, the temperature of surface water governs to a large extant the biological species present and their rate of activity.

3.1.4 ODOUR:

Odours associated with water originate from the presence of decaying organic matter or in case of mineral spring, the reduction of sulphates to H2S gas by bacteria. Odour may also rise due to presence of microorganisms. In general odour wise most commonly be found in surface water as decaying organic matter may accumulates in bottom deposits large enough to provide suitable condition for the anaerobic bacteria that produces gases. Sources of organic include plant debris, dead animals and microorganism and waste water discharges. Consumers find odour aesthetically displeasing and may prefer to use tasteless, odourless water. Odour produced by organic substances may pose more than a problem of simple aesthetics, since some of those substances may be carcinogenic.

3.1.5 COLOR:

Pure water is colorless but water may become colored as a result of colloidal suspension. However many of the colors associated with water are not true color. True colors results from dissolved materials most often organics.

Most color in natural water results from dissolved tannins extracted from decaying plant materials. Many industrial wastes are colored and if not properly treated can impact color to the receiving streams. Colored water is not aesthetically accepted. Moreover highly color water is unsuitable for laundering, dying, papermaking, beverage manufacturing, dairy production and other food processing, textiles and plastic production.

3.2 CHEMICAL WATER QUALITY PARAMETERS-

The Chemcial characteristics of water are assessed in terms of TDS, TH , Ph and Alkalinityand like physical paramters. qualitative measurement of these characteristics is aslo necessary for the assessment of water quality.

3.2.1 HYDROGEN ION CONCENTRATION (pH):

The pH value of water is measure of its alkalinity or acidity. More accuracy sated the pH is a measure of the hydrogen ion concentration in water.

Mathematically this is the logarithm to the base 10 of reciprocal of the hydrogen ion concentration of pure water. Thus a pH value of 7 indicates neutral solution, neither alkaline nor acidic. A pH less than 7 indicates an acidic solution indicates the presence of carbonate of calcium and magnesium and a pH value of 8.5 or above usually indicates appreciable exchangeable solution.

3.2.2 TOTAL DISSOLVED SOLIDS

The material remaining in the water after filtration for the suspended solids analysis is considered to be dissolved. Dissolved solids are the term generally associated with fresh water system and consists of inorganic salts, small amount of organic matter and dissolved material. The principle organic anions dissolved in water include the carbonates, chlorides, sulphates and the principle cations are sodium, potassium, calcium and magnesium. Excessive dissolved solids are objectionable in drinking water because of possible physiological effects, unpotable mineral tastes. The water with TDS less then 600mg/l is considered good for drinking purposes and water TDS more than 1200mg/lb is considered un potable, [40].

3.2.3 ALKALINITY

Alkalinity is defined as the quantity of ions in water that will react to neutralize hydrogen ions. Alkalinity is most entirely due to bicarbonate and carbonate and hydroxide ions in the water, usually in association with calcium, magnesium, sodium and potassium. Alkalinity can exit in water below the neutral point of PH 7.0. because the relationship between alkalinity, CO 2 and PH value.

3.2.4 TOTAL HARDNESS

Hardness is defined as the concentration of multivalent metallic cations in solution. At super saturated condition the hardness cations will react with anions in water to form a solid precipitate. Hardness is classified as carbonate hardness and non-carbonate hardness depending upon the anions with which it associates. The hardness that is equivalent to the alkalinity is

termed as carbonate hardness, with any remaining hardness being called non-carbonate hardness. Carbonate hardness is sensitive to heat and precipitates readily at high temperature.

3.2.5 DISSOLVED OXYGEN

The various gases which may get dissolved in water due to its contact with atmosphere or the ground surface may be nitrogen, methane, hydrogen sulphide, carbon di oxide and oxygen.

The concentration of oxygen gas in river water is important. Oxygen gas is generally absorbed by water from the atmosphere; Algae and other tiny plant life of water also give oxygen to the water, but are being consumed by unstable organic matter for their oxidation. Hence, if the oxygen present in water is found to be less than its saturation level, it indicates presence of organic matter and consequently making the water suspicious. Dissolved oxygen is required for the respiration of aerobic microorganisms as well as all other aerobic life forms. However oxygen is slightly soluble in water. The rate of biochemical reactions that uses oxygen levels tends to be more critical in summer because the stream flows are usually lower and thus the total quantity of oxygen available is also lower. The presence of dissolved oxygen in wastewater is desirable because it prevents the formation of noxious odors. The presence of oxygen in water in dissolved form is necessary to keep it fresh and sparkling. Dissolved oxygen is also important to aquatic life because detrimental effect can occur when DO levels drop below 4-5 mg/L, depending upon the aquatic species. Oxygen levels that remain below 1-2 mg/L for few hours can result in dying of fishes.

3.2.6 BIOLOGICAL OXYGEN DEMAND

The extent of oxygen consumed by the organic matter present in water sample is known as Biochemical Oxygen demand (BOD). The BOD of raw water will indicate the extent of organic matter present in the water. If sufficient oxygen is present in water, the useful aerobic bacteria production will flourish and cause the biological decomposition of waste and organic matter, thereby reducing the carbonaceous material from the water. The amount of oxygen required in the process until oxidation gets completed is known as BOD. Polluted waters will continue to absorb oxygen for many months, till the oxidation gets completed and it is not practically possible to determine this ultimate oxygen demand. Hence the BOD of water during the first five days at 20 0 C. The dissolved oxygen is measured after the period of incubation. The difference between the original oxygen content and the residual oxygen content will indicate the oxygen consumed by the water sample in five days. If BOD of water is zero it means that

no oxygen is required and thus no organic matter is present. The extent of pollution of sewage and other industrial wastewater is also measured by determining the values of their BOD.

3.2.7. CHEMICAL OXYGEN DEMAND

Chemical oxygen demand (COD) is a measure of the oxygen consumed when organic matter is broken down chemically rather biologically. It is measure of non-biodegradable organics present in the waste water. It is a measurement of pollutants in natural and wastewaters to assess the strength of discharged water such as industrial effluent waters and sewage. It is normally measured in both municipal and industrial wastewater treatment plants and gives an indication of the efficiency of the treatment process.

3.3 MATERIALS AND METHODS

Water quality is a multifarious subject, which involves physical, chemical, hydrological and biological characteristics of water and their complex and delicate relations. 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 exclusively depends upon for what purpose we going to use that water and what level we need its quality and purity. Some physical test should be performed for testing of its physical properties like temperature while chemical tests should be performed for its BOD, COD, dissolved oxygen, hardness and other characteristics. Gomati River, also called Gomti, tributary of the Ganges (Ganga) River, central Uttar Pradesh state , Northern India. The River goes for a distance of about 900 km, passing through Uttar Pradesh finally to join River Ganges in Ghazipur.Different cities that are located along the banks of the River Gomti are Sultanpur, Lucknow, Jaunpur and Lakhimpur Kheri, Barabanki and these are the main cities that are prominent in the region, out of the total 15 cities in the catchment land. The Gomti River catchment area is of about 25,800 km2 The three-sampling site were selected for quantitative analysis of the physicochemical parameter in water column of the Gomti River and The sample are taken in the month of May 2018(Pre – monsoon) and November 2018 (Post – monsoon) The selected sites are,

Site1. Dadhnamau Ghat, Sitapur (100 km upstream from Lucknow city).

Site2.Gaughat, Lucknow: Upstream of the Lucknow city near the water supply in take point from River.

Site3. Gola Ghat ,Sultanpur (About 12 km upstream of the Sultanpur city.

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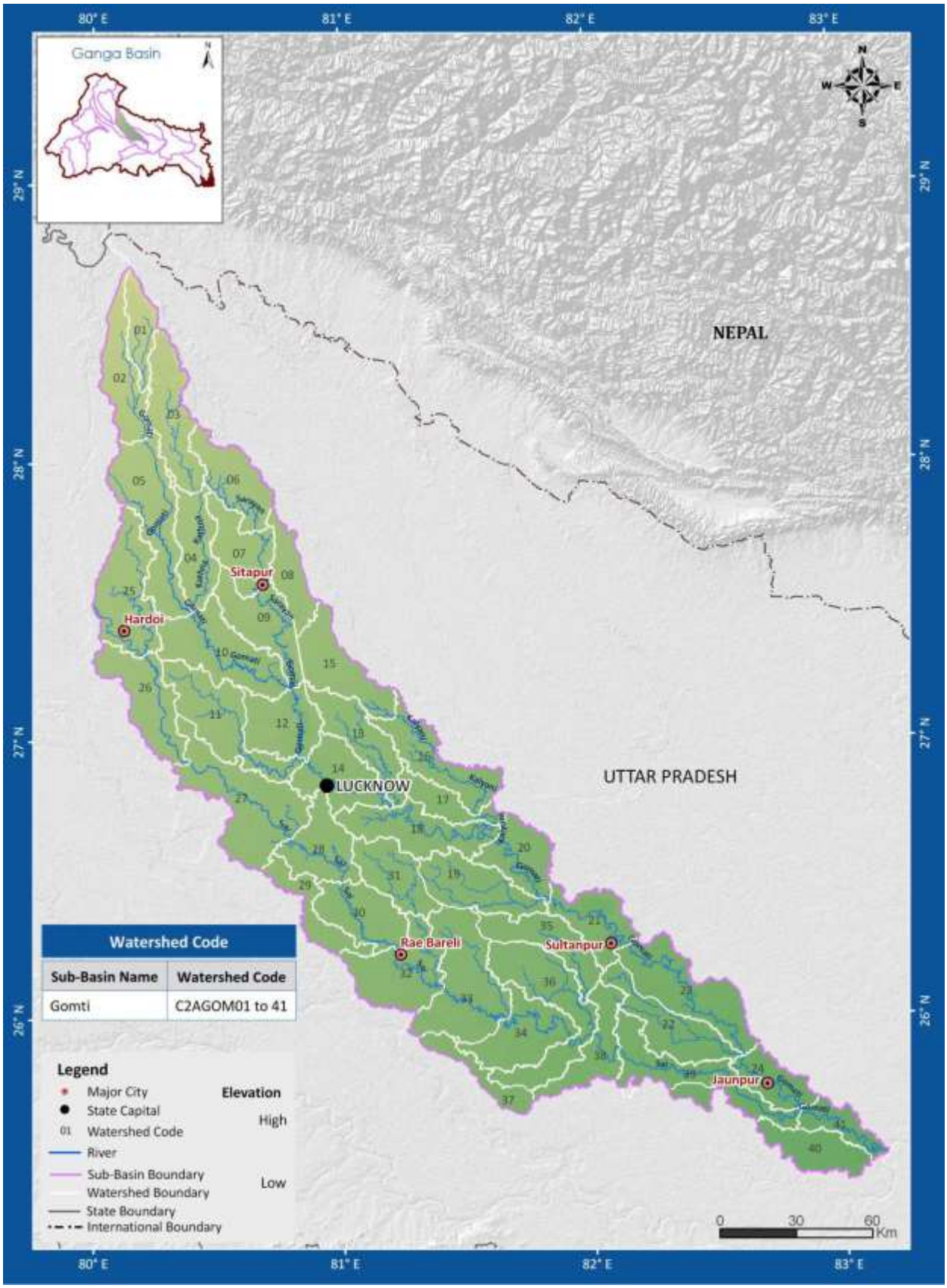

Fig 1 : Gomti river basin

Fig 2: Dhadhnamau Ghat ,Sitapur

The process of sampling involves some process which are as follows –

- Plan for sampling
- Labelling of sample
- Storing of sample
- Sample testing

Sampling of collected samples has been done according to the steps as shown in fig 2. First step is selection of sites for the collection of the samples. In this process we decide the best suitable sites for the collection of the samples. After selecting the sites, the sample is collected from the selected sites. Second step is the process of labelling in which we label down the plastic bottles that contains the samples from different sites so that we can easily identify the sample is from which site.

After the process of labelling, the samples were taken out to the lab in a proper storage kit and then at the lab the testing of the samples take place. In this process different tests are performed in order to evaluate different physio chemical parameters like temperature, pH, BOD, DO, COD, Total Hardness, Alkalinity and TDS. It is very necessary to perform the testing process within the time limit of 24 hr. of sample collection to find out the exact result.

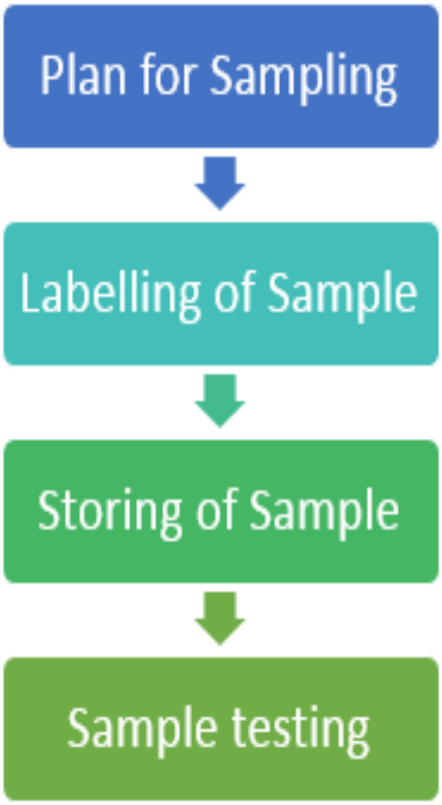

Fig:3 Process of Sampling

Collection of water sample:-

In the present study, seasonal variations in physical and chemical parameters of Gomti River were studied. The sampling was taken in pre monsoon season May 2018, and Post monsoon season 2018. The sample was collected from below the water in plastic bottles and stored for further analysis. The samples were analysed for 8 different physicochemical parameters namely Temperature, pH, Total dissolved solids (TDS), Total Hardness(TH), Alkalinity, , Biological oxygen demand(BOD),Chemical oxygen demand (COD), Dissolved oxygen (DO).

Physicochemical analysis:-

The parameters like Temperature, pH, TDS, Alkalinity, Total hardness, BOD, COD, DO were analyzed by using APHA, (1999) standard procedures. Total dissolved solid (TDS) was determined gravimetrically by evaporating a known amount of volume. pH was determined by digital pH meter. Temperature was measured by thermometer. Dissolved oxygen (DO) was measured by Azide modification titrimetric method. Chemical oxygen demand (COD) was determined by Open reflux methods. Biological oxygen demand (BOD) was determined by 5 days BOD test. Hardness of water was determined by EDTA titrimetric method.

Phenolphthalein as an indicator at pH 8.3. Alkalinity was also determined by titrimetric method. The results obtained by different tests carried out on physicochemical properties of River water samples comprises with the World Health Organization (WHO, 2008), Bureau of Indian Standard (BIS, 2004) specified for drinking water.

Fig 4: Collection of water sample from River

CHAPTER IV

RESULT AND DISCUSSION

The water samples were analyzed for physicochemical characteristics. Total of seven physicochemical parameters were analyzed namely pH, TDS, TSS, DO, BOD, COD and Total Hardness (TH), in the present study. Physicochemical properties of River Gomti variation in different months and at three different locations sites were recorded during the pre monsoon and post monsoon season.

Sampling sites:- For the process of water testing and sample collection of Gomti river 3 sites were selected which are as follows.

Sample no.	**Location of sampling**	**Co-ordinates of locations (Latitude/ Longitude)**
Sample 1	Dadhnamau Ghat, **Sitapur** (100 km upstream from Lucknow city)	27.464655 , 80.400262
Sample 2	Gaughat , **Lucknow** (upstream of the Lucknow city)	26.531611, 80.535165
Sample 3	Gola Ghat **,Sultanpur** (About 12 km upstream of the Sultanpur city).	26.270573, 82.078686

Table 1: Sampling location with co-ordinates

Pre monsoon season: - The first water sample was taken in the month of May 2018 in order to test and analyse the change in physiochemical properties and parameters of water like Temperature, Ph, DO, BOD, COD, TH, TDS, Alkalinity of water in summer or pre monsoon season. The test results are shown below in the table

S. NO.	PARAMETERS	SAMPLE (1)	SAMPLE (2)	SAMPLE (3)
1	Temperature ^{o}C	33.5	33	32.7
2	pH	7.40	7.85	7.65
3	DO(mg/l)	10.4	7.8	10.1
4	BOD (mg/l)	3.6	4.3	4.6
5	COD (mg/l)	16.0	20.5	15.2
6	Total Hardness (mg/l ($CaCO_3$)	200	223	216
7	Alkalinity (mg/l $CaCO_3$)	230	198	210
8	T.D.S. (mg/l)	453	665.3	465

Table 2: Test result of water sample collected in May 2018

Post Monsoon season:- The second water sample was taken in the month of November 2018 in order to test and analyse the change in physiochemical properties and parameters of water like Temperature, Ph, DO, BOD, COD, TH, TDS, Alkalinity of water in winter or post monsoon season. The test results are shown below in the table

S. NO.	PARAMETERS	SAMPLE (1)	SAMPLE (2)	SAMPLE (3)
1	Temperature ^{o}C	21	20	22.3
2	pH	7.33	7.90	7.26
3	DO(mg/l)	11.2	8.2	10.4
4	BOD (mg/l)	3.5	4.4	4.0
5	COD (mg/l)	14.4	21	15.5
6	Total Hardness (mg/l ($CaCO_3$)	155	210	173
7	Alkalinity (mg/l $CaCO_3$)	233	195	215
8	T.D.S. (mg/l)	354	646	396

Table 3: Test result of water sample collected in November 2018

RESULT:-

Temperature

In Pre monsoon season the highest value of temperature was found at Dadhnamau Ghat, Sitapur which is $33.5^{0}C$ and the lowest value of temperature was found in Gola Ghat ,Sultanpur

which is 32.7^{0}C while the temperature of Gaughat , Lucknow slighty lower then Dadhnamau Ghat, Sitapur with the temperature of 33^{0}C. In post monsoon season the highest value was found in Gola Ghat ,Sultanpur which is 22.3 and the lowest value of temperature was found in Gaughat , Lucknow which is 20^{0}C. Weather condition and atmospheric temperature are mainly responsible for the change in temperature of river water.

Ph:-

In pre monsoon season the highest value of pH was was found at Gaughat , Lucknow which is 7.85 and the lowest value of temperature was found in Dadhnamau Ghat, Sitapur which is 7.40. In post monsoon season the highest value of pH was again found in Gaughat , Lucknow which is 7.90 and the lowest value of ph was found in Gola Ghat ,Sultanpur which is 7.26 .Factors like Waste Water including water from sewage dumped in the river and other factors like acid rain etc are basically responsible for alteration in the value of Ph.

Dissolved oxygen

In pre monsoon season the highest value of dissolved oxygen was found in Dadhnamau Ghat, Sitapur which is 10.4 mg/l and the lowest value of dissolved oxygen was found in Gaughat , Lucknow which is 7.8 mg/l followed by Gola Ghat ,Sultanpur with the DO value of 10.1mg/l. In post monsoon season the highest value of DO was found in Dadhnamau Ghat, Sitapur which is 11.2 mg/l and the lowest value was found in Gaughat , Lucknow which is 8.2 mg/l.

Biological Oxygen Demand

In the pre monsoon season the highest value of BOD was found at Gola Ghat ,Sultanpur which is 4.6 mg/l and the lowest value of BOD was found at Dadhnamau Ghat, Sitapur which is 3.6 mg/l. In post monsoon season the highest value was found at Gaughat , Lucknow which is 4.4mg/l while the lowest value of BOD is Dadhnamau Ghat, Sitapur with the BOD value of 3.5 mg/l. BOD is basically used to find the amount of organic materials in water.

Chemical Oxygen Demand (COD)

In the pre monsoon season the highest value of COD was found at Gaughat , Lucknow which is 20.5 mg/l and the lowest value of COD was found at Gola Ghat ,Sultanpur which is 15.2 mg/l. In post monsoon season the highest value was found at Gaughat , Lucknow which is 21 mg/l while the lowest value of COD was found at Dadhnamau Ghat, Sitapur with the COD value of 14.4 mg/l. The lower value of COD in the water indicates the less amount of pollution present in the water and the high amount of COD indicates the high amount of pollution in the water.

Total Hardness

In the pre monsoon season the highest value of total hardness was found at Gaughat , Lucknow which is 223 mg/l and the lowest value of total hardness was found at Dadhnamau Ghat, Sitapur which is 200 mg/l. In Winter season the highest value was found at Gaughat , Lucknow which is 210 mg/l while the lowest value was found at Dadhnamau Ghat, Sitapur with the value of 155 mg/l. Factors which are responsible for the alteration in hardness of water in rivers are discharge of domestic wastes from industries and discharge of waste water containing contents of soaps and detergents etc.

Alkalinity

In the Summer season the highest value was found at Dadhnamau Ghat, Sitapur which is 230 mg/l and the lowest value was found at Gaughat , Lucknow which is 198 mg/l. In Winter season the highest value was again found at Dadhnamau Ghat, Sitapur which is 233 mg/l while the lowest value was found at Gaughat , Lucknow with the value of 195 mg/l. Alkalinity is basically a measure of the water's ability to neutralize acidity.

Total Dissolved Solids (TDS)

In the Summer season the highest value of total dissolved solids was found at Gaughat , Lucknow which is 665.3 mg/l and the lowest value of total hardness was found at Dadhnamau Ghat, Sitapur which is 453 mg/l. In Winter season the highest value was found at Gaughat , Lucknow which is 646 mg/l while the lowest value was found at Dadhnamau Ghat, Sitapur with the value of 354 mg/l.