International Journal of Engineering Sciences & Research Technology

(A Peer Reviewed Online Journal)
Impact Factor: 5.164

IJESRT

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

IJESRT
INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

AN EVALUATION/ CRITICAL REVIEW OF MAJOR STREAMS POLLUTING OR DROPPUNG RAPTI RIVER IN GORAKHPUR CITY SUPPORTED BY RECOMMENDING MEASURES FOR SUITABILITY OF RIVER WATER AS WATER SUPPLY SOURCE

Ajai Kumar Rai*, Dr. Brajesh Mishra
* Assistant Professor, Department of Civil Engineering, ITM, Gorakhpur, UP, India
Senior Engineer, UPSSCL, Lucknow, U.P.,India.

DOI: 10.5281/zenodo.8394837

ABSTRACT

Water is the basic necessity in almost all type of cooking, washing&daily routine activities for healthy life but everyone is involved intentionally or unknowingly in activities creating water pollution.The soil condition particularly agricultural fields containing excess fertilizers/pesticides /harmful constituents responsible for soil contamination and both biodegradable / non-biodegradable wastes thrown or lying on the ground in the course of river/drains/streams are the human activity causes of river pollution and shares the maximum contribution in context to river water pollution in addition to the natural causes for water pollution such as earthquake,landslide,flood,T-Sunami,volcanic eruption etc. Disposal of domestic waste at the banks of water bodies or solid waste disposed at the sides of roads and streets though contains smaller quantity of the pollutants/contaminants but plays a big role in the pollution of first strata water & river water through surface drains or city sewers dropping intoriver.The present evaluation study is concerned not only with the problems in the implementation of measures adopted to control the river water pollution but also the statistical /comparative analysis of the five main city sewer streams/river water quality in light of parameters length of stream, dropping discharge per day, potential hydrogen (pH), biochemical oxygen demand(BOD),chemical oxygen demand(COD), total suspended solid(TSS),total Coliform (T Coli.)

KEYWORDS: Water Pollution, Rapti River, Water Quality Assessment or Control Parameters ,Gorakhpur

1. INTRODUCTION

India may be regarded as land of rivers due to faith of its people in river and location of major cities along the banks of river including capital Delhi on the bank of river Yamuna. Gorakhpur city situated on the bank of river Rapti is second important city of eastern Uttar Pradesh after Varanasi in context to population, facilities of education, health and location features to connect the different parts of the country (Headquarter of NE Railway).The origin of the Rapti/Rohin river at an elevation of approximately 3050 m is the Himalyan region in Nepal(In between western Dhaulagiri &Mahabharat Range) known as Asian Water Tower due to major rivers of Asia i.e. Ganga, Brahmputra, Yamuna originating from the same region. The following figure shows the network of the rivers originating from the foot hills of Himalayan hill range i.e Nepal &Uttarakhand flowing in the eastern Uttar Pradesh.

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

Fig1: Eastern UP Main River (Originated from Nepal &Uttarakhand) Network

In comparison with rivers originating from other locations or sources, the sediment generation and transportation is much more observed as four-fifth of the sediment is generated by Himalayan regions due to highest elevation resulting steep slope in the river bed responsible for soil erosion or sediment particles increase in river flowing. In addition to this intense rainfall, snow and snowmelt water intercepting during the course of the river resulting high sediment much more than silt carrying capacity of the rivers speciallyin monsoon season. High sediment in river creates various basic problems such as erosion of banks, river route changes through blockage by silt depositing, reduction in quality of water and more contribution towards the water pollution elements grasping from soil as well as transportation of chemical pollutants. The eroded sediments from the mountainous regions supports both ways i.e. quantity wise and quality wise for alluvial deposits consisting of sand, silt and clay in the tarai and plain regions at the time of flash flood resulting in fertile land.

Rapti river basin consists of 331Km in the mountainous region in the form of foothills of Himalaya in Nepal whereas 451 Km in the plain and Tarai regions of north-eastern UP districts. Rapti river covering the left bank of Ghaghara, which is also the left bank tributary of Ganga,covers the basin area of almost all north eastern districts of UP from Baharaich in the West to Ballia in the east.It is diverted by about hundred kilometer west by Dundwa Sub range of Shivalik hill range before forming their course southward parallel to Ganga river.The details of tributaries of Rapti river after its entry in the Indian continent are shown in Table 1as follows:

Table 1-Tributaries of Raptiriver in India

Name of River / Stream	Details
BurhiRapti	Rises from Balarampurdistrictflowingalmost parallel to Rapti river upto the border of Siddharth Nagar District and then joins the Rapti River near Naugarh in SiddharthNagar.ArrahaNala combined with Chharihawanala is the prominent tributory of BurhiRapti.The major tributory of BurhiRapti is Banganga, which emerges from Nepal tarai region and flows in the middle of Bansi town dividing the town Bansi as east and west joins the BurhiRapti in southern direction after kakrahi in East Siddharth Nagar. The effluent sreamsBhaklainShrawsti,Kain in Tulsipur ,Parasi and Sikri in Bansi acts as the tributaries of BurhiRapti/Bangaga.BurhiRapti flow is supported by several local sreams through enhancement of basin areas such as Jamwar,Arrah,Kunhara,Ghoghietc
Suwawan Stream	This stream originating in western portion of Balrampur flowing near Balarmpur city giving the impression of a narrow lake followed by nala form except rainy season, when it takes the form of deep river ,ends at the border of Siddharth Nagar meeting Rapti.
Ami River	Originates in SantKabir Nagar ends in Bansgao Tehsil of Gorakhpur by meeting Rapti river
Rohini	Originating source of this river is the foothills in Nepal near Chaurangikhola.Kauria block of the GorakhurDristrict is the basin area of this river as the entry point in the district is Campeerganj whereas end point where it meets Rapti river is Domingarh.

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

Taraina	Tarainanala is local stream developed during rainy season near Unaula within Gorakhpur District passing through Bhenry Tal where it find its direct way due to south east direction to meet Rapti river.
Tura,Pharendand,Gaura	Tura and Pharend are small streams flowing through the Ramgarh forest and north of piparaich respectively in almost in parallel way meets the Gauranala in the south of the city .Gauranala runs parallel to Raptiriver with the discharge of tura and pharendnala combined with overflow of Ramgarh and NarhariTals to a considerable distance .

2. LITERATURE REVIEW

Causes of Sediment Generation

Water in river flows from higher elevation to lower elevation causing supply of potential energy due to difference in elevation between the starting and end of the river.Depending upon the potential energy, a network consisting of different channels and valleys forms supported by aquatic (zone of green, lush &water loving vegetation) and riparian habitats(living or located on the banks of river or water body).The excess potential energy is naturally utilized by river in shaping the landscape and moving forward i.e formation of the course of the river and excess is dissipated through contact of potential water from banks, formation of ripples, water turbulence and erosion at meander bends.

Adverse Effect of Sediments in River Water

Though sediment generation depends upon the various controllable and uncontrollable factors such as climate, temperature, soil or vegetation type and weathering /erosion rates of soil or rock but every river flows with a particular silt carrying capacity. If the incoming silt is more than silt carrying capacity silt deposition takes place at the bed of the river while in case of low silt entry the erosion of the bed occurs.If neither scouring nor silting is taking place a river is said to be equilibrium and regarded as ideal condition of the flow. The silting and scouring both are problematic for a river as silting reduces the depth of the river while scouring increases the roughness of the river bed ultimate result is the change in the velocity of river flow encouraging overflow or erosion or changes in the banks of river. Every river has tendency to change their path with time .discharge flowing ,climate& local conditions, hence its management is more complicated and no specific technique can be applied for all rivers.

Factors Affecting River Water Pollution

As far as river water quality is concerned, all measures are subjected to some limitations depending upon the localized conditions such as relief, basin area, geology of the area, rainfall, humidity, runoff &temperature, however the cleaning of the river through prohibition of entry of raw effluent & untreated industrial waste has been given due importance and many government policies and regulations are enforced to keep the river water quality for various uses required for the survival of human or living beings.

Importance of water in context to survival of life is well known to all. Dumping of industrial waste is the major source of river water pollution.The other minor sources agricultural effluents, radioactive wastes and thermal pollution are responsible for polluted ground water. The soil condition particularly agricultural fields containing excess fertilizers/pesticides /harmful constituents responsible for soil contamination and both biodegradable / non-biodegradable wastes thrown or lying on the ground in the course of river/drains/streams are the natural causes of river pollution and shares the maximum contribution in context to river water pollution. As the radioactive wastes return to the biosphere is harmless, its deep &safe permanent burial beyond the catchment area of the river must be ensured. Thermal pollution plays an important role in the real practical pollution problem in context to river water as the waste material either in the form of industrial waste or waste material thrown or disposed on the surface of the earth comes in contact with natural water, cooling or heating actions takes place resulting the new form of backwater ejected by the waste material not only changes the constituents of natural water but also the oxygen level of the natural water and disastrous effect on the ecosystem/environment is produced.

Methods of Purifying Water

Traditional methods of purifying water i.e. boiling & filtering (charcoal, ceramic and sand) has limitations to its use in context to purify river water in terms of effective cost, practical applicability on so large scale and condition of water to be treated. Hence for treating so far recent developed techniques Reverse

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

Osmosis(RO),Ultra Violet Light(UV) and Ultra Violet Filtration (UFS) are being implemented for quality upgradation of river water. As all the techniques, which are in developing stage , has ability to reduce some degree of pollution, hence trials of mixed techniques combining old &recently developed depending upon site and water quality condition is being adopted/trialed. In RO purifying process, a RO membrane which consists of fine pores that trap dissolved chemicals and germs in water is used while in UV process, water is passed through a chamber for getting exposed with ultraviolet rays enabling deactivation of microorganisms. The most effective technique

UF process big membrane with bigger pore size (from 0.01 microns to 0.1 microns) than RO is used for removing effectively pathogenic organisms, turbidity and physical impurities.

Both RO &UV techniques gives better results in their own way and used in case of high & low TDS level respectively. The difference between UV &UF water purification techniques lies in fact that former requires electricity, running water or flowing water and optimum pressure for filtering action whereas the same is not needed for later one. UF techniques blocks/removes bacteria andviruses whereas in UVs techniques deactivation of waterborne disease causing bacteria, viruses and pathogens takes place, The water treated using UF technique provides additional benefit of mud and turbidity removal; Bioremdiation technique may be defined as environmental cleaning, managing &purifying system using biological agents like algae, fungi, bacterial, plants and its enzymes &microbes .This technique survives through natural process and well known adopted technique for the treatment of polluted soil capable of complete removing of all the undesirable polluted / toxic elements from the soil. Bioremediation system adopted for improving the river water quality may prove success as trial technique due to similarity of soil pollution and water pollution in context to the quantity of oxygen requirement and PH value.

3. REVIEW OF RAPTI RIVER/CITY SEWERS POLLUTION PROBLEMS

All Indian River water pollution problems is faced from last five decades and besides the claims of cleaning the rivers by government agency the problem is becoming severe and increasing at an alarming rate and no permanent solution is still achieved.

Disposal of Raw/Untreated Water of City Sewers

According to Nagar Nigam official sources, there are eighteen numbers of city drains carrying dirty waters of different localities is dropped into Domingarh, Rapti River, RamgarhTaal and Rohin River. Out of eighteen only 11drains are connected to STP whereas the dirty water of seven drains is directly dropped without treatment. In the rainy season these city sewers dirty water is spread over more than one dozen wards located near the bandhs of rapti river and get filled with dirty water ultimately resulting the disturbance /problem in routine activities of people residing in these wards almost each year and every heavy rainfall activity. Though some regulators are established in these areas but their full capacity utilization is not achievable as they were established almost several years before and most equipment have completed the design period.

Inadequate Solid Waste Disposal

The solid waste disposal practice in Gorakhpur city lies in very haphazard way and the practice of dumping of household solid waste in open plots/area and at the bank of lakes /tals shows symbols of habitual practice continued from the past resulting the ground water pollution as well as surface water pollution, hindrance in smooth flow of drains/sewers and above all flowing of streets/road as nala or filled with dirty water in case of frequent heavy rain each and every year in monsoon season.

Failure of Implementation of Action Plans for Cleaning/Treating City Sewer Waters

Though many attempts and plans for cleaning these sewers/nalla has been made by nagarnigam, but these were either only partially completed or failed and no plan/attempts has been reported as complete success. Prominent upon which are:

- Plan for making Rapti river pollution free through MBR technique-In this technique dirty water of sewers/ nallah has is to be passed through the different tanks constructed following the specifications of MBR technique. The membrane provided in tanks will clear the dirty water in the same way as in water is cleared in ROs.These tanks must be equipped with pumps, equipments provision for removing harmful constituent through bacteria/ protozoa and microfiltration or ultra filtrationequipments. The plan is still pending in context to financial approval/implementation

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

- For cleaning of dirty water streams meeting at Takiyaghat in Raptiriver,U.P. government executed agreement with National Environmental Engineering Research Institute for about 6 crores and NEERI Team excavated a large pit for collecting dirty water as planning was to clarify the water through water hyacinth/plants and pouring limestone pieces (kankar).But suddenly the NEERI team left the site thus resulting the end of the plan for cleaning water at Takiyaghat. This is perhaps due to one or more of the following reasons:
  - ***(i) The flow incoming in the tank is from all sides and chances of uncontrollable situation in context to entry &exit seperation of the flow in and out in the tank may arise in future.***
  - ***(ii) The desired depth of the pit for storing the dirty water in the tank pit for purifying or treating is restricted either by water table or the river water top surface level/bed level. As the average ground water table in the stretch of Domingarh to Rajghat varies from 3.60m below ground level (Pre-monsoon) to 1.50m below ground level (Post- monsoon)***
  - ***(iii) The selected site has depth, area or discharge limitations.***
  - ***(iv) Chances of mixing of stored dirty water with Rapti river water exists.***

  However meeting of these nalas at Takiyaghat needs to be separated and dropping point /STP of each nala should be carried out by diverting the alternative route and different dropping point in Raptiriver.
- A joint project between two up government departments nagarnigam&jalnigam were started almost three years before for treating the sewer water flowing in nallahas through sewer treatment plant at different locations taking five nallahas as representative sample accounting 52.55 crorelitres dirty water falling in rapti/rohinrtvers. In this regard,a STP of 30 croreslitres capacity was to be established at NetajiSubhashchandra Bose Nagar, for which nagarnigam in principally agreed to provide 6 acres of land to Jalnigam for STP and reserve availability of further 6acres is kept by nagarnigam for future expansion/additional STP establishment .It was claimed that this plant will capable of cleaning the sewer/dirtywater of 21 wards of Gorakhpur City currently falling in RohinRiver.This project coverage includes not only connection three nallahasi.e.Stepping Stone School Nallah,BaragadawaGaonJalanNala, Mahesara-MohripurNala&Stepping Stone School Nala with STP but also connecting approx.190 Km sewer line related to 45 thousand residences consisting of 1.75 lakh population.But still after three years this project is yet to start in terms of execution/establishment of Sewer Treatment Plant and partially sewer line has been laid in incomplete and ineffective active status.
- Two nos STP with total capacity of 45 MLD(15MLD at MahadewaJharakhandi&30 MLD at Sahara State) working near Ramgarh Lake is found to be ineffective in most of the times in the year especially in monsoon season as their working is governed by logical control subjected to programmable,

4-RESEARCH METHODOLOGY

After identification of status of Rapti river water pollution ,causes of water pollution and failures of implantation scheme for water quality improvement , systematic analytical research methodology is designed/adopted for assessment of problem severity and solution of the problem through the analytical/statistical analysis based on the selected parameter responsible for the different forms of river/stream water pollution. Research methodology is fully concentrated on the analysis based on secondary data obtained from the different state/central government agency/previous researches in context to Rapti River and its pollution, Gorakpur city and river water pollution

Selected City Sewers for Pollution Assessment

Similarly like other rivers, Rapti river is also facing the problem of dirty water, which chief source/reason is the entry of almost 70 million litres of the polluted/dirty waters of the five mainstreams daily, i.e. Baragadava, Domingarh, Basiyadih, Mahewa&Ilahibaag city sewers, direct falling in. Rapti&Rohin river meeting combined at / near Takiyaghat. These streams/sewers are so much incorporated / indebted in the pollution of Rapti river that without cleaning these city sewers Rapti river water pollution free is not possible .Based on the purposes or uses like water supply source for human beings uses i.e. drinking,

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

washing of cloths etc with or without treatment ,suitability of bathing at river front, fitness for wild life /fisheries, irrigation and industrial purposes river water quality parameters used by the state/central government pollution boards were selected for evaluation/assessment of the water quality of five big city sewers dropping/polluting Rapti river water. Due to variation of time ,location and geological factors .it was relied on the estimated/forecasted/derived secondary data obtained from primary data sources from Nagar Nigam/ U P Pollution Board/Geolgical Survey of India rather than experimental data collection and testing through samples. The five selected big city sewers were Baragadava, Domingarh, Basiyadih,Mahewa&Ilahibaag covering the river length of Rapti / Rohin in Gorakhpur city. The details of each at the time of adverse condition i.e. at the peak rainy season in context to length, city area , no of intercepting big /small drains and carrying discharge in terms of million liters per day are shown in table 2 below:

Table 2:Deitails of Five Big City Sewers / Nalas Dropping in Rapti/Rohin River

Location / Drain	*Approx. Length[KM]*	*Routing Places*	*Large + Small Drains*	*Discharge [Un-Treated]*
Bargadava	16.25	Gorakhnath,BilandpurKhatta, Green City Colony, Mahesara-Mohripur	*22+31 [53]*	*25.25MLD*
Basiyadih	6.00	Rasoolpur,Andhiyaribagh,Surajkund, NewMadhopur	*8+12 [20]*	*9.80 MLD*
Domingarh	13.50	DharmshalaBazar,Dilezakpur	*18+23 [41]*	*19.25MLD*
Ilahibaag	18.60	Bus Station, Alinagar, Miyabazar,GasiyariTola, Golghar	*25+33 [58]*	*27.75MLD*
Mahewa/Kataniya	15.25	Mahuisugharpur,Rustampur, Mahewa,HasunpurBarfkhana , Transport Nagar	*21+16 [37]*	*13.93MLD*
Total	**69.60**		***94+113=207***	***95.98 MLD***

Selected Parameters

Each selected stream was evaluated for Potential Hydrogen (pH), Biochemical Oxygen demand (BOD),Chemical Oxygen Demand (COD), Total Suspended Solid (TSS),Total Coliform (T Col.) presence in the respective city sewer besides the length and city sewer carrying peak discharge and cumulative water pollution severity after assigning the weightage to the parameters were determined.

Potential of Hydrogen (pH):

It is a measure of acidic/basic based on relative amount of both hydrogen ion and hydroxyl ions in the water in context to less or more free hydrogen ions measured on pH scale (0-14).pH value 7 is considered as neutral pH subsequently less than 7 as acidic and more than 7 as basic .The reason of pH value taken as indicator of quality of river water is that pH value changes with chemical changes in water and being pH scale representation in logarithmic unit, each pH value number represents the specific position of the quality of water(pH value of 1 is ten times more acidic than 2, pH value of 2 is ten times more acidic than 3 and so on).Besides this the pH value provides the indication about the presence of the following in water:

(i) Chemical constituents water solubility capability
(ii) Amount of chemical constituent nutrient carbon,nitrogen and phopsphprus utilized by aquatic life
(iii) Heavy Metals Copper, Cadmium Lead etc

pH value of river water is the primary and important parameter for the assessment of river water quality as it enable to assess the quantity and form of chemical constituents and its utilization by actuatic living beings, The solubility degree of heavy metals gives indication of toxicity presence in water as low pH value shows more solubility. Extreme value of pH scale 0 and 14 shows the pure acid(hydrochloric acid or battery acid) and pure base(liquid drain cleaner) respectively. Precipitated water is slightly acidic(pH value in between 5 and 6) due to

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

presence of atmospheric carbon- di- oxide gas.Both low and high pH has detrimental effect on water pollution.Low pH water dissolves/corrodes metal and other substances whereas high pH water creates bitter taste and additional chlorine requirement in case of chlorine disinfection.

Biochemical Oxygen Demand

BOD is the oxygen requirement of bacteria/microorganisms living in water involved in decomposing organic matter in the presence of aerobic condition. Every natural water source whether it is closed or open water body must have sufficient concentration of dissolved oxygen(form of oxygen present in water and common river contains in small quantity -10 molecules per million of water) for maintaining the aquatic life and aesthetic quality of water.It is the clear cut indicating parameter in context to the amount of organic water pollution as greater BOD represents higher oxygen demand ultimately lower dissolved oxygen availability for aerobic animals and aquatic organisms. Its measure as index water quality parameter ascertains the organic waste destruction process by microbes status as well amount of organic matter present in river or sewer water.

Chemical Oxygen Demand:

Chemical oxygen demand like BOD is the oxygen requirement but for the chemical processes or reactions involved in the reducing the orgnic, nitrite ,ferrous, sulphide content based on the criteria that strong oxidizing agent combining with carbon di oxide is capable of complete oxidation of organic compounds in presence of acidic condition. It is the measure of pollutants in water through contents of reducing substances in water and quantity of organics presence in water. COD alongwith BOD measurements leads to the identification of water pollution status due to organic content in water. Higher value of COD represents the severe and critical condition of water pollution as compared with its lower value. Removal of BOD/COD/Treated water disposal/dropping of these nalas in the river are of prime importance and must be ensured through making ending one-third of the length of nalas making free from intercepting drain. The current intercepting drains at the last one third length of the each nala must be diverted/stored for required treatment after proper planning. The flow of the water in the last portion of any nala must be uninterrupted and smooth dropping in the river though monitoring and maintenance. This will enable the free and unterrupted flow of water in the nalas ultimately leading to reduce BOD/COD level in the nalas as increase of BOD/COD concentration in water is the interruption of flow leading to stagnation of water in nala. The flowing water has capability to accelerate chemical processing reaction and decomposition of organic matter in a effective and efficient way.

Total Suspended Solid(TSS):

Total suspended solid measurement is the indicative parameter for the quality of waste water treatment operations as the organic and inorganic material present in large quantity is removed through processes through screening, settling, filtration and floatation. Its removal is essential before the disposal of the sewer water in the environment or river water as it adversely affects the aquatic life by absorption of sunlight resulting increased temperature and decreased oxygen and ultraviolet disinfection by blocking/scattering UV light. The measurement of total solid content is carried out by filtering the known volume of water sample on fiter and after drying the weight of total solid is determined and TSS concentration is calculated as total solid weight divided by the filtered volume of water expressed in mg/liter. The problem of total suspended solids in case of Gorakhpur city is very severe as this city falls under flood sensitive areas due to heavy rainfall not only in this location but also the precipitation in Nepal carried by both rivers Rapti/Rohin supported by releasing water at the peak time of monsoon season by Nepal from its dam/reservoirs. In case of heavy rainfall overflow of the streams on the street road due to blockage/slow flow rate at downstream of nalas is the common problem in the every monsoon season. As solid matter present matter entry source mostly eroded surrounding soil ,the flow of the nala in form of restricted channel having the side walls top level mustbe at least 30 cm above the existing road level /maximum precipitation recorded in the previous years in the catchment area.For draining the water of road &other open areas channelized water wells along the sides of the road connected by filtered drains may be the possible solution of this problem.This will not only reduce the total solidcontent of the sewer water but also the all polluting parameters through the uninterrupted and effective flow in the streams. It will also prove a measure for avoiding overflow spreading of the sewer water in the surrounding areas and also flood /heavy rain water with soil erosion content in the drain. Besides this for catching floating materials catchers in the form of bar grid at regular interval and monitoring and maintaining the same may enable a drastic improvement in the water quality of the stream as river water quality.

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

Total Coliform:

Selecting the last parameter total colliform has been made as it represents the bacterial contamination of water which is very important for assessing the water quality sutability for drinking/water supply system. Colliform are the bacteria found in digestive tract of humans as well as animals even in dead condition, plants and soil material. As the disease causing bacteria known as pathogens presence in water is very much less than colliform bacteria (Most of which are not disease causing bacteria known as fecal colliform)testing of colliform bacteria also provides indication of pathogenic bacteria as the only harmful colliform bacteria known as Escheresia Coil (E Coil) is non-growing and non-reproducible. Higher value of total colliform count in MPN/100 milliliters represents the severity of water pollution in context to biological contamination.

5 -COMPARATIVE ANALYSIS OF SELECTED STREAMS:

After collecting the primary data from various state/central government agencies for the selected parameters ,the data were analysed, retrieved ,forecasted and modified keeping in view the locations, time of primary data ,temperature and spatial condition for the compative/stastistical analysis through the secondary data, which are tabulated in Table3 below:

Table3: Parameters for Streams (Nalas) of Gorakhpur City Polluting/Dropping in River Rapti / Rohin

Parameters	Baragadava	Basiyadih	Domingarh	Ilahibaag	Mahewa
Total length of Nala with Intercepting Drains in Km	16.25	6.00	13.50	18.60	15.25
Carrying Discharge in Million litres per day[MLD]	25.25	9.80	19.25	27.75	13.93
Potential of Hydrogen [pH] in terms of PH scale	7.25	6.98	7.07	7.15	7.24
Biochemical Oxygen Demand[BOD]in mg/litre	3.80	3.30	3.00	4.20	4.60
Chemical Oxygen Demand[COD] in mg per litre	18	16.50	14.00	22	24.00
Total Suspended Solids[TSS] in mg per litre	47	62.50	69.00	61.0	50.40
Total Coliform in MostProbable Number [MPN] per 100 ml	40000	36000	25000	32000	43000

Graphical/Chart Representation of Data for Evaluating Parameters

These data were further represented in chart form through the selection of parameters group having the approximate similar value range/characteristics i.e. total length of the city sewer, their carrying discharge and potential hydrogen as shown in chart/figure3 as follows: in another chart(Fig3).

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

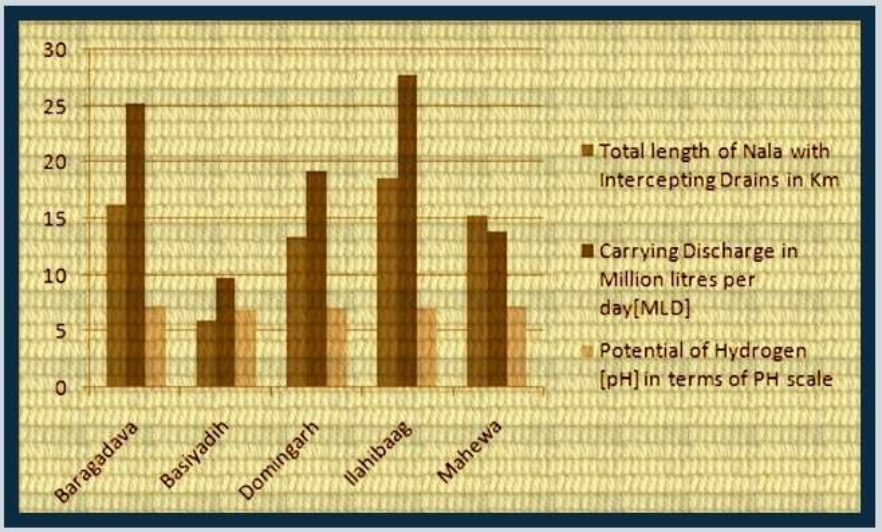

Fig2: Total Length, Carrying Discharge &Potential Hydrogen for Selected Nalas

BOD/COD content of the Rapti River are the basic parameters adopted by pollution control board to debar the river water quality for top three uses/categories. Both represents oxygen requirement for living/survival of micro-organigm in water and for chemical processes on going respectively for decomposition of organic compounds/oxidation of organic compounds, Figure 3 below represents the BOD Vs COD in the same chat while both performs separate necessary functions in context to river water pollution

Fig3: Biochemical Oxygen Demand Vs Chemical Oxygen Demand For City Sewers

A close look on the total suspended solid parameter value shows that the value range lies in between 47-71.40 mg / liter with lowest value of Baragadava city sewer(47 mg/liter)and highest value that corresponds to Ilahibaag city sewer. Hence, datas pertaining to this parameter is represented in form of vertical bar chart/histogram in(figure 4)as follows:

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

Fig4: Total Suspended Solids(TSS) for Selected City Sewers

Keeping in view the higher values of this parameter in comparison with other parameters, the graphical representation of the data pertaining to the selected stream sewers is represented in the following horizontal bar chart.

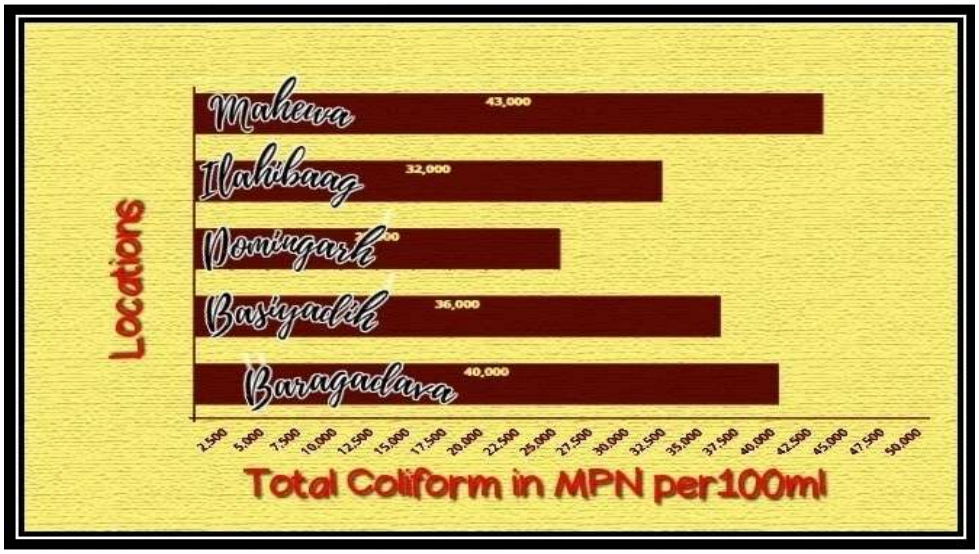

Fig 5: Total Coliform(T. Coli.) for Selected City Sewers

Analytical Analysis, Review &Discussions:

After Identification of the comparative pollution status based on different parameters represented in table/chart forms of five streams or city sewers dropping/polluting Raptiriver, the percentage variation of the each parameter were compared with control parameterthat is the average data of each parameter belonging to Rapti river based on UP PollutionBoard or Nagar Nigam reports. As stream discharge is too less than the river discharge hence control parameter were taken as the maximum value of stream discharge of the biggest stream in context to length /carrying discharge. Similarly the effective length of the Rapti river were taken from Domingarh to Jhangaha based on the city sewers dropping / polluting /mixing water in Rapti River near Gorakhpur.

Raptiriver enters in the Gorakhpur through Domingarh in northwest and flow direction is south east, hence total coliform in MPN /100ml of Domingarh assessed as 26000 MPN/100ml by UP Pollution Board is taken as control parameter. Further percentage variation of each parameter of stream categorizing showing higher , lower & mixed pattern with controlled parameter were determined and tabulated in the table4 as follows:

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

Table 4: Percentage Variation of Different Parameters With Controlled Parameter

Parameters	Control Parameter	Baragadava [%]	Basiyadih [%]	Domingarh [%]	Ilahibaag [%]	Mahewa [%]
Percentage Variation of Different Streams is Lower Than River Rapti						
Effective Length of Nalas/River in Km	**30.00**	**44.17**	**80.00**	**55.00**	**38.00**	**49.17**
Discharge in million liters per day(MLD)	**27.75**	**09.01**	**64.69**	**30.63**	**00.00**	**49.80**
Percentage Variation of Different Streams is Higher Than River Rapti						
Potential hydrogen in terms of pH scale	**06.95**	**04.32**	**00.43**	**01.73**	**02.88**	**04.17**
Percentage Variation of Different Streams shows mixed Trend as Compared with River Rapti						
Biochemical Oxygen Demand in mg/liter	**03.40**	**11.77 Higher**	**02.94 Lower**	**11.77 Lower**	**23.53 Higher**	**35.29 Higher**
Chemical Oxygen Demand in mg/liter	**20**	**10.00 Lower**	**17.50 Lower**	**30.00 Lower**	**10.00 Higher**	**25.00 Higher**
Total Suspended Solid in mg/liter	**60**	**21.67 Lower**	**04.17 Higher**	**15.00 Higher**	**02.33 Higher**	**16.00 Lower**
Total coliform in MPN / 100ml	**26000**	**53.85 Higher**	**38.46 Higher**	**03.85 Lower**	**20.08 Higher**	**65.39 Higher**

Total length and carrying stream discharge are interrelated to each other that higher the length, higher the stream discharge except Mahewanala which covers the area of southern part of the Gorakhpur which is the low lying area as compared to other parts of area and most flood prone part of the city.The logical reason of longer length nala to carry the higher discharge is the larger basin area covered and precipitation catchment by the concerning streams. Potential hydrogen(pH) in terms of pH scale is almost same for all streams almost adhering the neutral pH value 7 in the pH scale,it means that on the basis of this parameter the water in the all stream sewrs flowing were neither acidic nor basic at the time of test ,which is further supported by UP pollution board standard permissible limit of pH for all categorieies of uses in between 6.5-8.5 except category E i.e. industrial use, irrigation purposes and controlled disposal for which lower limit of pH is 6.This indicates that proper adoption of cleaning &maintaining the water quality measures may enable the fitness of water for all purpose use and chances of recycling of the water ,safe and pollution free water disposal of sewers water is possible.

Based on the Biochemical oxygen demand ,IlahibaagNala and MahewaNala falls in highest polluted water content category whereas BaragadavaNala has the moderate polluted water content. Basiyadih and Domingarhnalas are less polluted as compared with the other nalaas as the BOD value represents the requirement of oxygen for bacteria/microorganisms engaged in survival in decomposing organic matter in the presence of aerobic condition.Higher BOD represents the higher oxygen demand level for the survival of bacteria/microorganism present in water .In other words the oxygen present in the water is

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

not sufficient for the bacteria/microorganism survival and growth ultimately resulting the incomplete decomposition of the organic matter remained residue as organic matter responsible for water pollution. Though the COD value for all thenalas show almost similar trend like BOD but on the basis of this parameter Ilahibaag and MahewaNalas are most critical in context to water pollution. Just like BOD, chemical oxygen demand for Ilahibaag and Mahewa city sewers also stands on the top of the selected city sewers. Chemical oxygen demand is in higher category representing higher oxygen demand level for chemical processes for the removal of impurities in the form of chemical element/compound presence in water harmful for the health.In other words the processing of chemicals present in water suffers from adverse effect in lack of oxygen requirement of ongoing chemical processes resulting in lacking of drinking water possibility use/water supply source use.The presence of organic maters and chemicals are the primary factors adversely affecting the quality of water to such a level that water is neither fit for drinking nor for bathing

As it is observed from the table/chart, that Baragadava&Mahewa stream sewer contains total suspended solids less than other nalas indicating that flow in these nalas are controllable and little monitoring / maintenance work towords the water quality improvement is required. Rest three Nalas i.e. Basiyadih, Domingarh and Ilahibag needs special attention for removal /prohibiting the entry of solid content in the nalas

It is observed from the figure/chart that the severity of the pollution based on total coliform measure in ascending order lies with Domingarh, Ilahibaag, Basiyadih, Baragadava and Mahewa. Thus trend shown based on the total colliform is similar to the total suspended solid but in reverse order. The river water quality based on this parameter is always assessed in conjunction with other parameters as it depends upon various factors including the water quality parameters such as organic /inorganic nutrients in water, temperature, pH, suspended solids , flow condition etc. As total colliform value in Most probable number/100 ml indicates the presence of total coliform bacteria in water and no bacterial contamination or bacteria presence in water is desirable for use as drinking water.. Control measures for the improvement in the river/stream water quality for other parameters will automatically applicable in this and no extra control measure is desirable for this parameter. However boiling enables the killing of bacteria but have the limitations of small scale applicability and cost effectiveness in case of flowing water. However a combination of filtration and chemical disinfection treatment of water with chlorine or chloramine(a mixture of chlorine &ammonia with limited quantity up to 4mg/lire of water) before use of river water as a water supply is commonly and most widely adopted technique for bacteria removal and adhering the quality of water fit or suitable for drinking .

For the identification of severity of water pollution removal each stream parameters were evaluated after assigning the due weight age to the parameters selected.TSS was given the maximum weightage(45%) assuming the basic parameter responsible for the pollution of water, while 20% of weight age is given to the each parameter BOD/COD keeping in view the necessity of maintaining the quality of water. For use of river water as drinking water or water supply source the responsible parameter pH was given an weight age of 5%.The remaining two parameters ,length of stream &carrying discharge were given a weightage of 4% for each while the lowest weightage of 2 % was given to total coliform MPN/mldue to its complete dependency on other parameters.

Table 5: Determination of Water Quality Pollution Severity Index for Sewer Streams

Parameters	Baragadava	Basiyadih	Domingarh	Ilahibaag	Mahewa
Total length of Nala with Intercepting Drains in Km	16.25x0.04 **=0.65**	6.00x0.04 **=0.24**	13.50x0.04 **=0.54**	18.60x0.04 **=0.74**	15.25x0.04 **=0.61**
Carrying Discharge in Million litres per day[MLD]	25.25x 0.04 **=1.01**	9.80x0.04 **=0.39**	19.25x0.04 **=0.77**	27.75x0-04 **=1.11**	13.93x0.04 **=0.56**
Potential of Hydrogen [pH] in terms of PH	7.25x0. 05	6.98x0. 05	7.07x0.0 5	7.15x0. 05	7.24x0.05 **`=0.36**

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

scale	**=0.36**	**=0.35**	**=0.35**	**=0.36**	
Biochemical Oxygen Demand [BOD]in mg/litre	3.80x0.20 **=0.76**	3.30x0.20 **=0.66**	3.00x0.20 **=0.60**	4.20x0.20 **=0.84**	4.60x0.20 **=0.92**
Chemical Oxygen Demand [COD] in mg per litre	18x0.20 **=3.60**	16.50x0.20 **=3.30**	14.00x0.20 **=2.80**	22x0.20 **=4.40**	24.00x0.20 **=4.80**
Total Suspended Solids[TSS] in mg per litre	47X0.45 **=21.15**	62.50X0.45 **=28.13**	69.00x0.45 **=31.05**	61.40x0.45 **=27.63**	50.40x0.45 **=22.68**
Total Coliform in MostProbable Number [MPN] per 100 ml	40000x0.0002 **=8.00**	36000x0.0002 **=7.20**	25000x0.0002 **=5.00**	32000x0.0002 **=6.40**	43000x0.0002 **=8.60**
TOTal [Sum]	**35.53**	**40.27**	**41.11**	**41.48**	**38.53**

Based on the analytical analysis the water quality pollution severity of the selected stream in context to improvement probability in stream water quality shows very much marginal difference and water quality pollution severity in descending order may be expressed as follows:

(a)Ilahibaag&Domingarh are the most severe streams in context to water pollution and remedial measures to improve the quality of water

(b)Basiyadih&Mahewa falls in moderate category as the basiyadih length and stream discharge is lowest as compared to other streams selected while in case of Mahewa stream length discharge ratio is minimum.

(c)Baragadava stream is the least polluted stream and proper monitoring for the uninterrupted flow may lead the improvement in the quality of water.

Statistical Analysis

After identification of the big streams pollutions status in context to water quality statistical analysis of the mean value of the parameters with control parameter related to Rapti river were carried out to identify cumulative effect of city sewer dropping through determining percentage variation between the two values and standard deviation for each parameter shown in table 6. Control measures for the improvement in the river/stream water quality for other parameters will automatically applicable in case of total coliform for river waters and no extra control measure is desirable for this parameter. However boiling enables the killing of bacteria but have the limitations of small scale applicability and cost effectiveness in case of flowing water.However a combination of filtration and chemical disinfection treatment of water with chlorine or chloramine(a mixture of chlorine &ammonia with limited quantity upto 4mg/lire of water) before use of river water as a water supply is commonly and most widely adopted technique for bacteria removal and adhering the quality of water fit or suitable for drinking.Hence this parameter is ignored in statistical analysis.

Table 6-Statistical Analysis of Average Value of Parameters with Control Parameters

Parameters	Control Value	Mean Value of Parameters	Standard Deviation	PercentageVariation
Total length of Nala with Intercepting Drains in	30.00	13.92	11.37	53.60

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

Km				
Carrying Stream Discharge in Million litres per day[MLD]	27.75	19.20	6.05	30.81
Potential of Hydrogen [pH] in terms of PH scale	06.95	7.14	0.13	2.73
Biochemical Oxygen Demand[BOD]in mg/litre	03.40	3.78	0.27	11.18
Chemical Oxygen Demand[COD] in mg per litre	20	18.90	0.78	5.50
Total Suspended Solids[TSS] in mg per litre	60	58.06	1.37	3.23

It is evident from statistical analysis that sewer stream water and Rapti river water both have almost the similar water qualities pollution status especially in context to theuse of water for drinking purposes/water supply source.As both capacities are proving inadequate due to suspended solid content/silt deposition ,which is further supported by the overflow of the streams and flood event in RaptiRiver,removal of silt of rapti river through the silt excluders at frequent intervals of bandhas lying in Gorakhpur City and monitoring of the River silt cleaning through silt extractor are the essential requirement for the quality improvement of river water.

6. CONCLUSION

After studying the locational features of river Rapti,Gorakhpur City, Present status of riveras well as big streams water quality with the practices adopted towards the river water quality monitoring, analytical and statistical analysis based on water quality parameter ,the following conclusions were drawn:

1-The root level causes of Rapti river water pollution is the mixing of solid waste and eroded soil with rain water carried by the nalas ,which flow is interrupted causing bacterial contamination as well as concentration of harmful constituents ultimately leading to the adverse effect on river water quality. The basic steps towords the improvement of water quality needs to be adhere is the separation of house hold solid waste &rain water mixing with nalah discharge and uninterrupted flow of big streams must be ensured through bypass draining system of big streams of approximate one third length making the intercepting drain free.

2-Development of sanitary landfill /dumpsites beyond the 20 km of the city boundary at all exit roads in areas where neither closed or open water body source exists. Further the rain water recharging should be done in the existing lakes/tals/artificial reservoirs with well defined boundary through sandwells interconnected with sand drains on the opposite sides of the nalahs along the road.

3-Complete length of the Raptiriver within the city river front on both banks with clear &well defined dropping points of the nalas. The sewer treatment plant of adequate capacity depending upon the stream discharge for each big stream and applying water treatment techniques such as water treatment plant, chlorination, filteraration and bioremediation may enable the quality of river water for use as drinking water or water supply source.

4-Proper monitoring of silt removal of nalahs as well as Raptiriver and avoiding the overflow or spreading of streams dirty water must be ensured. The grid catchers at frequent intervals for catching the floating materials in nalas must be provided.

REFERENCES

[1] A Sediment budget for the Ganga–Brahmaputra Catchment. Current Science, 84(1): 1041–1047.
[2] Ajai Kumar Rai, Brajesh Mishra, A Prospective Study of Design and Development Issues of Various Shallow/Hybrid Foundation as Flood and Earthquake proof Foundation, International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249-8958 (Online), Volume-6 Issue-6, August 2017

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

[3] APHA., Standard methods for the examination of water and waste water. American Public Health Association Washington D.C. (2005).
[4] Brown, R.M., Mccleiland, N.J., Deiniger, R.A., and Oconnor M.F.A., "Water quality index- crossing the physical barrier", Proc. Int. Conf. on water pollution research, Jerusalem, vol. 6, pp.787-797, 1972.
[5] Bureau of Indian Standards, Indian Standards (IS: 10500) Drinking Water Specification: New Delhi (2004).
[6] Chakrapani GJ (2005). Factors Controlling Variations in River Sediment Loads. Current Science, 88(4): 569-575.
[7] DistrictGazetteersBooks of Bahraich, Shrawasti, Balrampur,Siddhartha Nagar, SantKabirNagar,Basti, Gorakhpur, Maharajganj, Deoria and Kushinagar published by Department ofDistrictGazetteers, Government of Uttar Pradesh.
[8] Glazyrin GE, Tashmetov HK (1995). Sediment yield alteration of Mountain Rivers and climate change in central Asia. In Proceedings of a Boulder Symposium. IAHS Publication, 226(1): 187.
[9] Government ofUttarPradesh,StateWater Resources AgencyFebruary 2020, Development Of RiverBasin Assessment and Plans for all Major River Basins in Uttar Pradesh, Rapti Basin Plan (Volume-I).
[10] Rawat, B.P., Nag, S. and Nigam, A.C., (1997),Geoenvironmental Appraisal-A Case Study in Rapti Basin Covering Parts ofBahraich, Gonda, Basti and Siddharthanagar Districts ofUttar Pradesh, GeologicalSurveyofindia, Sp!Pub 48 (1), p, 85-89.
[11] Said, A., Stevens, D., and Selke, G., "An innovative index for evaluating water quality in streams", Environmental Management, vol. 34, no.3, pp. 406–414, 2004.
[12] Saksena, D.N., Garg, R.., and Rao, R.J., "Water quality and pollution status of Chambal river in National Chambal sanctuary", Madhya Pradesh, J. Environ. Biol., vol. 29, no.5, pp. 701-710, 2008.
[13] Srivastava, A., Kumar, R., Gupta,V., Agarwal, G., Srivastava, S., and Singh,I., "Water quality assessment of Ramganga River at Moradabad by Physico-Chemical Parameters Analysis", VSRD-TNTJ,vol. 2, no.3, 119-127, 2011.
[14] Tripathi, V.M., Tewari, D.D., Tiwari, H.D., Tiwari, S., and Uppadhya, M.P., "Physico–chemical characteristics of river Rapti nearby industrial area Balrampur, U.P. India", Natl. Envirron. andPollu. Technol., vol.7, no.1, pp. 73-77, 2008
[15] World Health Organization; Guidelines for drinking Water Quality: Vol.1, Recommendation 2nd Edition; Geneva, WHO (2008).
[16] Wasson RJ, Juyal N, Jaiswal M, McCulloch M, Sarin MM, Jain V, Srivastava P, Singhvi AK (2008). The Mountain-Lowland Debate: deforestation and Sediment Transport in the Upper Ganga Catchment. Environmental Management, 88(1): 53-61.