

# Study on seasonal variation of physic- chemical & Biological Nature of River Ravi at Jammu Division

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**Abstract-** Water is the second essential need for living being after air. We cannot imagine the survival of any living organism without water. In prospective of any country rivers are the life line as they are the main source to fulfil the all demand of water. In a line we can say the health of riverine system is direct proportional to existence of human being . So it is required to monitor the health of riverine system. For moving this vision ahead a study carried out on river Ravi at Khatua district (J&K) as it is the main river of Kathua, in the course of study seasonal basis ( winter, summer and monsoon season) comparison of physic chemical properties at upstream , midstream and downstream of Ravi water has done with the parameters temp. pH conductivity, (D.O.) dissolve oxygen (BOB) biochemical oxygen demand, (COD) chemical oxygen demand, T.D.S.(Total Dissolve Solids) Hardness, alkalinity Co<sub>2</sub> and the stream. The investigatory data show higher limits such as temp. pH conductivity D.O, BOD, Co<sub>2</sub>alkalinityHardness T.D.S. were present in some what higher in these prescribe site then the permissible count pH and W.H.O.(2011) and limits of BIS (2012)Beuro of Indian standards.

**Key words:** Physico-chemical, Seasonal, B.O.D, C.O.D, D.O, Ph, T.D.S

## Introduction

The Ravi river is smallest river of all other trans boundary rivers of India and Pakistan. It is also one of the main river of Jammu and Kashmir Union Territory (U.T) and covers 63 Km stretch in which 55 Km only in Khatua Distric the average width of the river approximately 400 meters in all over the district. It is also the main source of fresh water for irrigation and drinking purpose in Kathwa district. River Ravi is facing pollution threats due to over mining colonization near river bank and agriculture drainage. Many worker time to time conduct many studies regarding the health of riverine system (Jin *etal.*, 2020 a, 2020b). To reveal the health status of Ravi physic chemical properties of water studied where the river stretch in Kathua district is subdivided in to upstream midstream and downstream which is denote by Site 1 , Site 2 and Site 3. The variation in anthropogenic and natural process on seasonal basic such as temperature , precipitation and water volume lead to different attributes for different seasons (Vega *etal.* , 1998., Islam *etal.*, 2018 Barakat *etal.*, 2016) , Monitoring of physicochemical water quality parameters plays a pivotal role in assessment the water environment, ecosystem, hydrochemistry and ecology (Whitehead *etal.*, 2018 , Sarkar *etal.*, 2016, Islam *etal.*, 2019)

## **Materials and Methods-**

1. Site description – The all study concentrated mostly at Kathua district of J&K which is situated between 32<sup>0</sup>17' to 32<sup>0</sup>55' N latitude and 75<sup>0</sup>70' to 76<sup>0</sup>16' E longitude beside one site in punjab . Here we collected samples from three following sits –

Site 1- The village Hutt selected as upstream site of study it is located between 32<sup>0</sup>37' to 29<sup>0</sup>5'N latitude and 75<sup>0</sup>53' to 51<sup>0</sup>9'E longitude.

Site 2- The second site was Basoli which is a small town and Tehsil headqater . It is 45 Km away from site 1 and also considered the mid stream of targeted starch. The coordinates of Basoli are  $32^{\circ}50'N$  and  $75.82^{\circ}E$ .

Site 3- The site 3 is Madhopur on it is a town of Punjab state near to city pathankot. It is 65 km away from site No 2. The coordinates of this ie are  $32.3614^{\circ}N$  Latitude and  $75.59.43^{\circ}E$  Latitude.

2. Collection of Water sample – The water samples were collected in morning between 6:00 am to 8:00am in four B.O.D bottles (foe each site) 4 MPN bottles and One two liter jerry can in the year 2021.
3. Physico- Chemical Analysis- The Thirteen parametes pH, Conductivity, D.O., C.O.D., B.O.D., Colour, Co<sub>2</sub>, Alkenity, Hardness, T.D.S, Odour and M.P.N physico-chemical and Biological parameters were taken to analysed the nature of water. All these parameters done as per A.P.H.A the in the laboratory of department.

#### 4. Biological Analysis-

- a. M.P.N(Most Probable Number)- The Coloiform was detected by using filter plating technique.
- b. Planktonic count- It has done by using sedimentation unit and sedgewick rafter cell.

### Result and Discussion-

**Temperature** –The temperature of river water effects physiochemical and biological reactions e.g. pH conductivity and soluble gages and BOD also.The temperature of Raviriver varied widely increased as such we go thought from S1 to S3 stream as  $21.25\pm 0.28$  to  $22.15\pm 0.26$  and average  $21.80\pm 0.25$  in summer session and in winter  $18.25\pm 0.27$ lowest and higher is  $19.10\pm 0.31$  and average mean value is  $18.62\pm 0.29$  and in monsoon session  $21.50\pm 0.51$  lowest and highest in  $22.10\pm 0.42$  Yadav and kumar et al (2011) sharma and walia et al (2016) in the river at Koshi at Rampur District.

**pH :-** pH play an important role pH is the one of the major perameters to river water whether that water is acid or Basic pH changes due to many session and antropoqenticactivity. The pH level of site S1S2 and S3 in winter session in  $7.35\pm 0.4$  to  $7.66\pm 0.17$  and Average  $7.47\pm 0.6$  summer  $7.65$ .However and  $7.10\pm 0.4$  lower and in mansoosession.pH is at S1 site  $7.75$  low and S3  $8.10\pm 0.5$  average  $7.91\pm 0.04$ . HigerpH become higher where. hydroxide ions cone becomes more mottaetall (2017) singh et al (2007) in river garga.

**Conductivity :-** Conductivity is a numerical expression to water's ability to conduct an electric current conductivity depends upon the conc of ions in solution the lowest and higher value of river Ravi in summer session is  $178.00\pm 0.54$ - $185.00\pm 0.55$  and average mean value is  $178.33\pm 0.57$  at S1, S3 site and in winter session  $392.00\pm 2$ - $397\pm 0.61$  and average mean value is  $392\pm 0.24$  high indicator of conductivity show saline conductions. Khannaet all (2007).

**D.O.-**Amount of O<sub>2</sub> that is present in water Do is one of the most important factor which depends upon physical biological and chemical activity of water it show the purely of water. In the present investigation at site S1 in Summer session the D.O. Level is  $8.68\pm 0.37$  –  $8.42\pm 0.35$  higher to lower average in winter session the D.O. value is highest at S1, S2, S3 at S1  $8.68\pm 0.37$  mg/l highest and  $8.42\pm 0.35$  lowest at site S3 mean

average value is  $8.53 \pm 0.34$  and in monsoon session lowest is on S1  $8.80 \pm 1.0$  and Highest  $8.99 \pm 0.15$  average is  $8.91 \pm 0.16$  Khanna et al (2009) reported the similar aspect in river PanavDhoi , Anushka and Deshwal et al (2011) observe highest value of D.O.

**COD-**The COD is amount of chemical oxidant for oxidation of original compound that are present in water alkalinity is B.O.D. positively correlate with COD. The higher value of COD is at winter session is at sit S1  $15.00 \pm 0.04$  lower (gm/l) and higher is  $19.12 \pm 0.65$ , at S3 and mean average  $17.04 \pm 0.66$  and in summer low value at S1  $16.00 \pm 0.67$  (mg/l) high  $19.00 \pm 0.71$  mean average is  $17.66 \pm 0.72$  and in monsoon session lower  $22.00 \pm 0.49$  and Higher  $28.00 \pm 0.51$  due to run of wastes in rainy session Gadhia et al (2013).

**B.O.D.** – The B.O.D is a indicator of organic pollution and measurement of O<sub>2</sub> in water that is required by aerobic organisms. The Bio degradable of organic material exert oxygen tension in water and increase BOD. The BOD level at site is S1  $6.00 \pm 0.04$ , during in winter session and  $7.50 \pm 0.5$  high at S3 site it happen due to the somewhat agriculture run off and through the industrial wastes.

**CO<sub>2</sub>**:- Free CO<sub>2</sub> comes in water due to activity of aquatic organism most of it mashes in form surrounding land especially in the form of organic carbon the dissolved remnants of root and other material in soil that bacteria have broken down. The Co<sub>2</sub> level in winter session is minimum at site S1  $1.47 \pm 0.03$  and maximum at site S3  $3.52 \pm 0.04$  ml/l in  $1.48 \pm 0.03$  average in summer session the Co<sub>2</sub> level at S1  $2.95 \pm 0.02$  and higher at  $3.05 \pm 0.03$  Average  $3.53 \pm 0.04$  and in monsoon session. Co<sub>2</sub> is  $2.90 \pm 0.04$  and maximum  $2.91 \pm 0.03$  and average  $2.91 \pm 0.03$ . This similar result river given by in river Ganga and Nambool river Manipur by Khanna and Bhutani (2005) bysuma and Rajeswari (2013).

**Alkalinity**:- The alkalinity is the capacity to neutralize acid and is usually due to the presence of carbonate Bi/carbonate and hydroxides. In winter session Alkalinity is minimum at site S1  $110.00 \pm 0.47$  (mg/l) and maximum at S3  $119.00 \pm 0.048$  and in summer session minimum  $112.00 \pm 0.52$ ,  $118.00 \pm 0.04$  maximum at S3 site average mean value is  $115.33 \pm 0.11$  Sarkar et al (2007) and Javed et al (2020) observed equal range for alkalinity.

**Hardness**:- Hardness reveals the conc of Ca & mg ions in water, Hardness of water is due to the presence of chloride, nitrate, sulphate and bicarbonate of calcium and magnesium, Kumar et al (2010). The Minimum hardness in winter at site S1  $125.00 \pm 1.43$  and  $132.00 \pm 1.42$  and summer at site S2  $126.00 \pm 1.25$  maximum  $135.00 \pm 1.31$  and monsoon session minimum  $180.00 \pm 2.51$  mg/l maximum  $195.00 \pm 2.060$  average  $188.00 \pm 2.68$  Kumar et al (2010) Mishra (2003).

**T.D.S**:- The water is a universal solvent dissolving solid and gases the solids are present in water in suspected or dissolve state some dissolve chemical may effect the with hazard being toxic and carcinogenic. The minimum T.D.S. in winter session at site S1  $167.00 \pm 0.42$  mg/l and maximum at S3  $172.00 \pm 0.51$  in summer minimum  $155.00 \pm 0.47$  and maximum  $162.00 \pm 0.36$  in monsoon session at site S1 minimum TDS is  $167.00 \pm 0.39$  maximum  $172.00 \pm 0.41$  at site S3.

**Odour** : - odour of the water samples at three site respectively pleasant in nature.

**M.P.N**- Rivers are used as dumping site for domestic effluent since ancient time so most of the rivers water has a big amount of coliform bacteria which found in fecal matters of human being. The abundance of coliforms persists all over the year in river water. But during rainy season the drainage system get overflow and a big amount of domestic effluent mix with the water of river in the result high level of coliform abundance in water of Ravi river.

**Planktonic Analysis**- The phytoplankton and zooplankton are the biological indicator of a

Water body. The Ravi river is found very poor in planktonic richness during research period abundance of planktonic species of families Bacillariophyceae, Chlorophyceae, Myxophyceae, Desmids and Rotefera were recorded at all sites. The abundance of planktons were recorded maximum during winter season and minimum during rainy season. The site-3 has highest planktonic concentration during all season. The member of Similare observation was Vats Deepika et al., (2018), Khanna D.R (2011) Kirti Rajee (2020) during working with different water body.

### Physico-Chemical Parameters of Ravi River during Winter Season 2021 at Site 1, 2, 3

| Parameter              | S1                 | S2                 | S3                 | Average             |
|------------------------|--------------------|--------------------|--------------------|---------------------|
| Temp (C)               | 18.25±0.27         | 18.53±0.28         | 19.10±0.31         | 18.62±0.29          |
| pH                     | 7.35± 0.14         | 7.42±0.16          | 7.66±0.17          | 7.47±0.18           |
| Conductivity (mhos/cm) | 392.00 ±0.21       | 388.00±0.20        | 397±0.23           | 292±0.24            |
| D.O (mg/l)             | 9.50 ± 0.46        | 10.12±0.51         | 11.00±0.61         | 10.20±0.63          |
| C.O.D. (mg/l)          | 15.00±0.59         | 17.00±0.61         | 19.12±0.65         | 17.04±0.66          |
| B.O.D. (mg/l)          | 1.89±0.04          | 1.92±0.05          | 1.97±0.05          | 1.92±0.04           |
| Colour                 | Grenish            | Greenish           | Greenish           | -                   |
| Co2 (mg/l)             | 1.47±0.03          | 1.45±0.02          | 1.52±0.04          | 1.48±0.03           |
| Alkanity (mg/l)        | 110.00±0.47        | 115.00±0.45        | 119.00±0.48        | 114.00±0.47         |
| Hardness (mg/l)        | 95.00±0.42         | 95.50±0.43         | 98.00±0.44         | 96.16±0.42          |
| T.D.S. (mg/l)          | 167.00±0.42        | 169.00±0.43        | 172.00±0.51        | 168±0.53            |
| Odour                  | pleasant           | pleasant           | pleasant           | -                   |
| M.P.N                  | 2× 10 <sup>4</sup> | 3× 10 <sup>4</sup> | 5× 10 <sup>4</sup> | 3.3×10 <sup>4</sup> |

### Physico-Chemical Parameters of Ravi River during Summer Season 2021 at Site 1, 2, 3

| Parameter              | S1          | S2          | S3          | Average     |
|------------------------|-------------|-------------|-------------|-------------|
| Temp (C)               | 21.25±0.28  | 22.00±0.27  | 22.15±0.26  | 21.80±0.25  |
| pH                     | 7.65±0.03   | 7.42±0.04   | 7.10±0.04   | 7.39±0.03   |
| Conductivity (mhos/cm) | 178.00±0.54 | 172.00±0.53 | 185.00±0.55 | 178.33±0.57 |
| D.O (mg/l)             | 8.68±0.37   | 8.51±0.36   | 8.42±0.35   | 8.53±0.34   |
| C.O.D. (mg/l)          | 16.00±0.67  | 18.00±0.69  | 19.00±0.71  | 17.66±0.72  |
| B.O.D. (mg/l)          | 3.50±0.03   | 3.52±0.04   | 3.59±0.05   | 3.53±0.04   |

|                 |                   |                     |                   |                     |
|-----------------|-------------------|---------------------|-------------------|---------------------|
| Colour          | Muddy             | Muddy               | Muddy             | -                   |
| Co2 (mg/l)      | 2.95±0.02         | 2.98±0.03           | 3.05±0.03         | 2.99±0.02           |
| Alkanity (mg/l) | 150.00±0.52       | 155.00±0.53         | 159.00±0.55       | 1.54±.0.52          |
| Hardness (mg/l) | 94.00±0.44        | 96.00±0.46          | 99.00±0.47        | 96.33±0.42          |
| T.D.S. (mg/l)   | 155.00±0.42       | 157.00±0.41         | 162.00±0.36       | 1.58.00±0.29        |
| Odour           | pleasant          | pleasant            | pleasant          | -                   |
| M.P.N           | 5×10 <sup>4</sup> | 6.5×10 <sup>4</sup> | 8×10 <sup>4</sup> | 6.5×10 <sup>4</sup> |

**Physico-Chemical Parameters of Ravi River during Mansoon Season****2021 at Site 1, 2, 3**

| <b>Parameter</b>       | <b>S1</b>         | <b>S2</b>           | <b>S3</b>           | <b>Average</b>       |
|------------------------|-------------------|---------------------|---------------------|----------------------|
| Temp (C)               | 21.50±0.50        | 21.75±0.51          | 22.10±0.42          | 21.78±0.41           |
| pH                     | 7.75±0.03         | 7.89±0.03           | 8.10±.005           | 7.91±0.04            |
| Conductivity (mhos/cm) | 230±0.48          | 235±.0.41           | 246±.0.45           | 237±0.41             |
| D.O (mg/l)             | 8.80±10           | 8.96±15             | 8.99±15             | 8.91±0.016           |
| C.O.D. (mg/l)          | 22.00±0.49        | 25.00±0.51          | 28.00±0.51          | 25. ±0.52            |
| B.O.D. (mg/l)          | 2.30              | 2.42                | 2.53                | 2.41±0.12            |
| Colour                 | Feculent          | Feculent            | Feculent            | -                    |
| Co2 (mg/l)             | 2.90±0.04         | 2.87±0.03           | 2.98±0.03           | 2.91±0.03            |
| Alkanity (mg/l)        | 162.00±0.37       | 167.00±0.42         | 169.00±0.44         | 166±0.42             |
| Hardness (mg/l)        | 98.00±0.51        | 99.00±0.52          | 105.00±0.56         | 100±0.46             |
| T.D.S. (mg/l)          | 178.00±0.41       | 184.00±0.43         | 189.00±0.46         | 183±0.45             |
| Odour                  | Pleasant          | Pleasant            | Pleasant            | -                    |
| M.P.N                  | 1×10 <sup>5</sup> | 1.2×10 <sup>5</sup> | 1.5×10 <sup>5</sup> | 1.2× 10 <sup>5</sup> |

## Micro-vegetation diversity during different

| Sr.                      | Families     | Site- 1 |        |       | Site-2 |        |       | Site- 3 |        |       |
|--------------------------|--------------|---------|--------|-------|--------|--------|-------|---------|--------|-------|
|                          |              | Winter  | Summer | Rainy | Winter | Summer | Rainy | Winter  | Summer | Rainy |
| <b>Bacillariophyceae</b> |              |         |        |       |        |        |       |         |        |       |
| 1                        | Navicula     | +       | -      | -     | +      | +      | +     | +       | +      | +     |
| 2                        | Diatoma      | +       | +      | +     | +      | +      | +     | +       | +      | +     |
| 3                        | Cymbella     | +       | -      | -     | -      | -      | -     | +       | +      | -     |
| 4                        | Amorpha      | -       | -      | -     | +      | +      | +     | +       | -      | -     |
| 5                        | Frustulia    | +       | +      | -     | -      | +      | +     | +       | -      | -     |
| 6                        | Nitzschia    | -       | -      | -     | +      | +      | -     | +       | -      | -     |
| 7                        | Cocconia     | +       |        | -     | -      | -      | +     | +       | +      | +     |
| 8                        | Fragillaria  | -       | -      | -     | +      | -      | -     | +       | -      | +     |
| 9                        | Tabellaria   | +       | +      | -     | +      | +      | -     | +       | +      | -     |
| 10                       | Synedra      | -       | -      | -     | -      | -      | -     | +       | +      | -     |
| <b>Chlorophyceae</b>     |              |         |        |       |        |        |       |         |        |       |
| 1                        | Crucigenia   | +       | +      | -     | +      | -      | -     | +       | +      | -     |
| 2                        | Protococcus  | +       | +      | -     | +      | +      | -     | +       | +      | -     |
| 3                        | Tribonema    | -       | -      | -     | -      | +      | -     | +       | -      | -     |
| 4                        | Oedogonium   | +       | +      | +     | +      | +      | +     | +       | +      | +     |
| 5                        | Scendesmus   | -       | -      | -     | +      | +      | -     | +       | -      | -     |
| 6                        | Spirogyra    | +       | +      | +     | +      | +      | +     | +       | +      | +     |
| 7                        | Microspora   | +       | -      | -     | -      | -      | +     | +       | +      | -     |
| 8                        | Cladophora   | -       | -      | -     | -      | -      | +     | +       | +      | +     |
| 9                        | Pleurococcus | +       | -      | -     | -      | +      | -     | +       | +      | +     |
| <b>Myxophyceae</b>       |              |         |        |       |        |        |       |         |        |       |
| 1                        | Microcystis  | -       | +      | -     | -      | +      | +     | +       | +      | -     |
| 2                        | Anabaena     | +       | -      | +     | +      | +      | -     | +       | +      | +     |
| 3                        | Phormidium   | +       | +      | -     | +      | +      | -     | +       | +      | -     |
| 4                        | Merismopedia | +       | +      | -     | -      | -      | -     | +       | +      | -     |
| 5                        | Oscillatoria | +       | +      | +     | -      | +      | +     | +       | +      | +     |
| <b>Desmids</b>           |              |         |        |       |        |        |       |         |        |       |
| 1                        | Closterium   | +       | +      | -     | +      | +      | +     | +       | +      | -     |
| 2                        | Cosmarium    | +       | +      | -     | +      | +      | -     | +       | +      | -     |
| <b>Rotifera</b>          |              |         |        |       |        |        |       |         |        |       |
| 1                        | Polyarthra   | +       | +      | +     | +      | +      | +     | +       | +      | +     |
| 2                        | Brachionus   | +       | +      | -     | +      | +      | +     | +       | +      | +     |

## **Conclusion-**

Declining of water quality is one of the highly concerns across the world. Both natural and anthropogenic activities are responsible for declining water quality. A huge number of factors directly and indirectly affects the water quality of river Ravi. After studies the served parameters It was conducted that the water quality status of Rarpriver is not adequate means water quality is not good. After doing the comparative study of parameters of given 3 sampling sites along with WHO and APHA and BIS standard.

## **Reference:**

- Sharma.R.C.,O.P.GusainandJuyal,C.P.1990.HighAltituderiverBhilnganaofGarhwalHimalaya.In: River pollution in India. Ed. Trivedy, R.K.(ed). Ashish publication House, NewDelhi.
- Khanna, D.R., S.P. Badola, H.R.Singh and Dobriyal, A.K.1992. Observation on seasonal trends in diatomic diversity in the river Ganga Saptasarovar at, Hardwar. In: Sehgal, K.L. (Ed.) Recent Researches in Coldwater Fisheries. Today and tomorrow Printers and Publishers, New Delhi. pp. 99-107.
- Trived P. K., Goel R. K. Chemical and Biological Methods for Water Pollution Studies. Publish by Environmental Publications, Post box 60, Karad 415 110. 1986.
- APHA. Standard Methods for the Examination of Water and Wastewater, 19th edn. American Public Health Association, New York. 1995.
- Shukh,R.,1996.Comparativestudiesofphysic-chemical characteristics of water quality of river Betwa. Kolardamand upper lake of Bhopal. Thesis of Ph.D.(Chemistry) Barkatullah University Bhopal.
- Sharma Y. Etal., (1997) Water Pollution Control - A Guide to the Use of Water Quality Management Principles. Edited by Richard Helmer and IvanildoHespanhol Published on behalf of the United Nations Environment Programme, the Water Supply and Sanitation Collaborative Council and the World Health Organization by E. and F. Spon ©. 1997.
- Singh K. P., Malik A., Mohan D., Sinha S. Multivariate statistical techniques for the evaluation of spatial and temporal variations in water quality of Gomti river (India)—A case study. *Water Research*. 2004;38:3980-3992.
- Fakayode, S.O. Impact Assessment of Industrial Effluent on Water Quality of the Receiving Alaro River in Ibadan, Nigeria. *Ajeam-Ragee*. 2005;10:1-13.
- Wetzel R.G., Likens G.E. Limnologicalanalysis.3rd ed. Springer-Verlag, New York, 391. 2006.
- Kumar, K.,K.K. Rautela, K.L. Bisht, V.D. Joshi, A.S.Rautela and Dobriyal, A.K.2006 Ecological studies on the Biodiversity of river Khoh in the foothills of Garhwal Himalaya:PartI:Phytoplanktonanalysis. *J. Natcon*.18: 71-80.
- Sinha M. R., Dev A., Prasad A., Ghosh M., Tagore R. N. Physico-chemical examination and quality assessment of groundwater (Hand-Pump) around Patna main town, Bihar state, India. *Journal of Chemical and Pharmaceutical Research*. 2010;3(3):701-705.



Namrata S. Physico-chemical properties of polluted water of river Ganga at Varanasi. *International Journal of Energy and Environment*. 2010;1(5):823-832.

Singh, M. R., Gupta A., Beeteswari K. H. Physico-chemical Properties of Water Samples from Manipur River System, India. *J. Appl. Sci. Environ. Manage.* 2010;14(4):85-89.

Das S. Cleaning of the Ganga. *Journal Geological Society of India*. 2011;78:124-130.

Census of India. Provisional Population Totals, Ministry of Home Affairs, Government of India, New Delhi. 2011.

Khanna D.R, Rakesh Bhtiani, Gagan Matta, Vikash Sing and Gaurav Bhadauriya 2012: Study of Planktonic Diversity if River Ganga From Dev Pryag To Roorkee Utterakhand(India). *Environmental Conservational Journal* 13(1&2 211-217,2012

Rai B. etal., (2013) Pollution and Conservation of Ganga River in Modern India. *International Journal of Scientific and Research Publications*. 2013;3(4):1-4.

Kumar B., Venkatesh M., Tripathi A., Anshumali. A GIS-based approach in drainage morphometric analysis of Rihand River Basin, Central India. *Sustain. Water Resour. Manag.* 2018;4(1):45-54.

Deepika Vats and Shiv Nath Yadaev 2018: Plankton Diversity of Ganga River In Haridwar District U.K *International jr. Of Scientific Engineering and Science*. 25-26

Kirti Raje Singh and Amita Panday 2020: Algal Flora of Yamuna River In Allabad. *International Jr. Of Current Advbance Research* 22126-22127

Jin, G.Q., Zhang, Z.T., Yang, Y.H , Y.H., Hu, S.H., H.W Barry , D.A., Li, L., (2020) a- Mitigation of impact of a major benzene spil into a river through flow control and in situ activities carbon absorption. *Water Res* 172. <https://doi.org/10.1016/j.watres.2020.115489>.

Jin, G.Q., Xu, J., Mo, Y.M., Wei. T., Wang, Y.G., Li, L., 2020b- Response of sediments and phosphorus to catchment characteristics and human activities under different rainfall patterns with Bayesian Networks. *J Hydrol*. 584 <http://doi.org/10.1016/j.jhydrol.2020.124695>