Physio-Chemical Study of Sone River in Respect of Fishes

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Abstract

The portion of the district north of the Sone River lies in the Lower Gangetic plains moist deciduous forests ecoregion. The portion south of the Son lies in the Chhota Nagpur dry deciduous forests ecoregion. The northern part of the district lies on a plateau of the Vindhya Range, and is drained by tributaries of the Ganges including the Belan and Karmanasha rivers. South of the steep escarpment of the Kaimur Range is the valley of the Son River, which flows through the district from west to east. The southern portion of the district is hilly, interspersed with fertile stream valleys. During the present study, the physico-chemical characteristics of the water of the Ganga and river Sone, Koshi and Ganga (Near Buxar, Patna, Mokama and Barh) were analysed. The physico-chemical parameter as Temperature, pH, Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total alkalinity (TA), Total Hardness (TH), Total Dissolve Solids (T.D.S), Turbidity & Chloride were used to analyse from these sites.

Keyword: *Physio-Chemical, Environment, Dissolve, Gangetic.*

1. INTRODUCTION

A number of water related challenges, including increasing water scarcity and competition for water between different sectors and states are being faced presently at global level. Freshwater and freshwater-dependent ecosystems provide a range of goods and services for humans, including fisheries, flood protection, wildlife etc. Water is among the most important requirements for sustaining life on earth that nature has created. There won't be life without water. Growth in the population, rapid growth and indiscriminate and unsustainable use of water have resulted in significant water supply depletion and degradation. Water resources are contaminated by disposal of the catchment area's waste, industrial effluent and run-off water. The physico-chemical characteristics of the water of the Ganga and river Sone, Koshi and Ganga (Near Buxar, Patna, Mokama and Barh) are evaluated in this report. There is a distinct link between both the excellently-balanced physico-chemical and biological structure of rivers. The physico-chemical characteristics of river water, which largely decide the pattern of aquatic biota and biological productivity, are therefore important to be studied. This study was carried out in river Sone, Koshi and Ganga (Near Buxar, Patna, Mokama and Barh) to determine the physico chemical parameters of water.

2. LITERATURE REVIEW

Kevin L. Foyle et.al (2020) It is hard to find a definition of gill health in the literature although there is a lot of information on changes to gill structure as a result of infectious and non-infectious challenge. How these changes relate to overall fish health is sometimes not clear. Interaction between the gill, the fish, and a range of anticipated changes in the environment will have a currently unknown effect on marine health and aquaculture production. To a degree, fish will likely be able to ameliorate certain changes, such as compensating for slightly elevated carbon dioxide; however, these actions may come at the cost of compromising other functions such as osmoregulation. Compensation will also depend on gill epithelial health and other environmental factors like external nitrogen and ammonia sources which can rise depending on the direction future culture and levels of eutrophication take. Fish can also remodel gill structure in response to salinity, hypoxia, or acidification but it appears that increased temperatures may be associated with increased pathology observable in the gill, and certain fishes may be more susceptible to change. There is a need for more targeted research into climate change-specific gill physiology and a need to recognise gill health as being a key component of food security and not just fish health.

RobeenaSarah et.al (2019) Ganga is the largest riverine system of India with a fragile ecosystem. Its prone to anthropogenic disturbances because of its cultural, economic and environmental values. The contamination of river Ganga by heavy metals (HM) is due to biotic (anthropogenic sources) and abiotic (pesticides, fertilizers) sources that poses a devastating health hazard to human, plant and edible fish life. The chemical analysis with the help of atomic absorption spectrometer performed on its water samples demonstrated the accumulation of heavy metals such as Arsenic (As), Lead (Pb), Cadmium (Cd), Iron (Fe), Zinc (Zn). Moreover, the spectrophotometric analysis indicated clearly the accumulation of heavy metals in order of occurrence (Fe > As > Cd > Zn > Pb) in liver and (Zn > Fe > As > Cd > Pb) in kidney of edible fish Channa punctatus. The present study has be used to sensitively monitor the extent of heavy metals pollution in the biotic aqua life of river Ramganga system and its suggested that the bioaccumulation of heavy metal in Channa punctatus has reached above permissible limits for human consumption, indicating potential health risks. Necessary biological steps should be taken to handle such food pollution and prevent the environmental risk and food chain disruption.

Dina Nath Pandi et.al (2018) A study was carried out to evaluate the ecology and diversity of the zooplankton of the Ganga River at Arrah from Bihar, India from January 2018 to December 2019. Varied physical and chemical parameters supporting the zooplankton and corresponding biodiversity indices were studied. The water temperature showed inverse correlation with pH, dissolved oxygen, whereas direct relationship with total alkalinity, hardness, chloride, nitrate and sulfate. A total of 23 genera of zooplankton belonging to 6 genera of Rotifera, 5 of Protozoa, 5 of Cladocera, 4 of Copepoda and 3 of Ostracoda were identified with a density from 2 to 213 ind./L. The analysis showed that density of zooplankton declined in post-monsoon and remained maximum in summer because of the various environmental and inflow characteristics of the water body. The density of zooplankton showed direct correlation with total alkalinity, hardness and chloride of water but inverse correlation with water temperature, pH and dissolved oxygen. Shannon-Weiner index, Margalef richness index, Pielou's evenness index, Menhninick's index and Simpson index were won't to assess relation of water quality with zooplankton and limnological profile of the river. The diversity indices indicated moderate to high diversity of zooplankton and moderately polluted conditions of the river.

DipakPaul et.al (2017) River Ganga is considered sacred by people of India for providing life sustenance to environment and ecology. Anthropogenic activities have generated important transformations in aquatic environments during the last few decades. Advancement of human civilization has put serious questions to the safe use of river water for drinking and other purposes. The river water pollution due to heavy metals is one of the major concerns in most of the metropolitan cities of developing countries. These toxic heavy metals entering the environment may lead to bioaccumulation and biomagnifications. These heavy metals are not readily degradable in nature and accumulate in the animal as well as human bodies to a very high toxic amount leading to undesirable effects beyond a certain limit. Heavy metals in riverine environment represent an abiding threat to human health. Exposure to heavy metals has been linked to developmental retardation, kidney damage, various cancers, and even death in instances of very high exposure. The following review article presents the findings of the work carried out by the various researchers in the past on the heavy metal pollution of river Ganga.

3. METHODOLOGY

Flora and Fauna Diversity in Sonbhadra District

The portion of the district north of the Son River lies in the Lower Gangetic plains moist deciduous forests ecoregion. The portion south of the Son lies in the Chhota Nagpur dry deciduous forests ecoregion. The northern part of the district lies on a plateau of the Vindhya Range, and is drained by tributaries of the Ganges including the Belan and Karmanasha rivers. South of the steep escarpment of the Kaimur Range is the valley of the Son River, which flows through the district from west to east. The southern portion of the district is hilly, interspersed with fertile stream valleys. Kaimoor Wildlife Sanctuary lies mostly within the district, reaching generally east and west along the spine of the Kaimur Range, and extending to the Son River at its eastern end.

The whole of the area is covered with natural scrubby jungle and somewhere thick forests. Almost the entire plateau exhibits a uniform horizontal stratification of rocks. The top of the plateau is unsuitable for the growth of broad-leaved plants and, is represented by uniform scrubby dry vegetation. The broad-leaved plants are generally seen on the slopes of the plateau. Overall, the entire forest is mixed dry deciduous, but evergreen trees are frequently seen in

ravines. According to a revised classification of forest type in India by Champion & Seth (1968), the forest type of Sonbhadra District is tropical dry deciduous. The whole area of the district has an interesting diversity of flora and vegetation due to variable plains, slopes, hills, and climate, represented by dry deciduous vegetation, natural scrub jungle, patches of grasses, and thick forest. The whole area of the district is covered with rich plant diversity with trees at the top layer, shrubs at the middle layer, and herbs, climbers, and twiners at the ground level. Kushwaha et al., (2018) repoerted 705 species of Angiosperms under 459 genera and 110 families including 78 cultivated ones that have been planted in the area for different purposes.

Status of research and use of Environmental Flow Methodologies in India

In many developing countries, such as India, the issues of environmental water demand have not yet received the required attention. The first National Workshop on Environmental Flows, held at New Delhi, in March 2005, brought together over 60 participants from national agencies and research institutions. The workshop generated a significant interest to the concept of environmental flows in the country and it also revealed the existing confusion in this field.

Since independence in 1947, India has witnessed rapid urbanization, industrialization and intensification of agriculture, all of which have greatly affected the rivers in different ways. Most Indian rivers, at present, are highly regulated. In India, very limited (negligible) efforts have been given to assess the environmental flows in river systems. By using hydrological desktop method an attempt has been taken to quantify the environmental flow requirements (environmental demand) of major river basins including Cauvery, Krishna, Godavari, Narmada, Mahanadi, Brahmani and Baitarani and some others. These environmental flows assessments (EFA) were focused on single issues. One of the major problems with developing environmental flow work in countries like India, is that despite existing significant knowledge on some aquatic ecosystem components (e.g., fish), it has never been interpreted in the context of environmental flow assessments. However, managing flows without consideration for other ecosystem components may fail to capture system processes and biological community interactions that are essential for creating and sustaining the habitat and well-being of the aquatic species like fish. Since fish species are very sensitive to flow, it has been argued that if the flow is appropriate for them, it will probably serve most other ecosystem needs. Recent advances in EFA methodologies like holistic approach can be considered for taking care of these problems

4. ANALYSIS

Both lentic and lotic water bodies are present within the project zone. Son and Ghagar rivers are the perenial lotic water bodies whereas there are some seasonal lentic water bodies in the form of ponds also present. In order to assess the aquatic biodiversity and to understand the impact of present project, the samples were taken from the various points both right and left bank of river Son and the river Ghagar (a left side tributary of the river Son).

Sampling Rationale for Aquatic Biodiversity

In order to understand the aquatic ecosystems, the abiotic components of physical (temperature, substrate type, width, depth, and transparency), and chemical nature (pH, conductivity etc.) were recorded. Under biological components, bottom dwelling benthos, plankton (both zoo and phyto), and nectones (Fish) were sampled. The phytoplanktons were abundant in the lowland area of the river and they are opted to represent the autotrophs. In case of the heterotrophs, the benthic macro invertebrates with high indicator value were considered suitable. Fish is important to ecosystem for the same functions. Fish is a cheap source of highquality animal protein and hence as nutritional food. A qualitative study of these indicator groups provide the knowledge of aquatic flora and fauna while quantitative studies help to understand the community features such as taxonomic composition, abundances and assemblages which vary with the physical and chemical attributes of the ecosystem.

Sampling for Plankton Communities (Phytoplankton and Zooplankton): Planktons were sampled by sieving 100 litres of water through plankton net mesh size (45 µ). The sieved samples were preserved in 4% formalin for microscopic study. Identifications has completed with the help of standard keys.

Benthos (Phytobenthos): The phytobenthos were collected by scraping 3 x 3 cm surface area of submerged algal substrate. Temporary mounts were prepared from the preserved samples and then examined under x400 magnification to record the algal (green, blue green etc) flora. However, to record the diatom flora, permanent Naphrax mounts prepared after treating the samples in acid-peroxide, and then examined at x1500. Literature cited above was used to identify the diatoms.

Zoobenthos (Benthic Invertebrates): The macroinvertebrate fauna was sampled carefully. Soft substratum in the form of clay and silt was sampled with test sieve (mesh size 0.05 mm). Samples were preserved in 5% formalin for laboratory analysis. Macroinvertebrate samples were identified up to species level with help of standard keys (Edmondson 1959; Edington &Hildrew 1995).

Nekton (Fish): Fish samples have been collected by experimental fishing through cast net and gill net and through local fishermen. The samples were preserved in 10% formalin for species identification with the help of standard keys (Day 1958; Talwar & Jhingran1991; Jayaram 2002).

Physio-Chemical Profile of Aquatic Ecosystem:

The physio-chemical parameters are studied in the river Son & Ghagar

Table 1: Physico-chemical characteristics of sampling site

Parameters	**Son river**	**Ghagar River (right side tributary of theSon river**
Date/Time	21.10.2019/12:15 pm	22.10.2019/9:50 am
AT (^oC)	29.5	24.8
WT (^oC)	32.3	28.5
Current velocity (ms^{-1})	0.3	0.2
pH	7.00	7.13
DO (mgl^{-1})	8.0	7.2
Conductivity (mho/cm)	0.911	0.883
Transparency (m)	0.4	0.5
Alkalinity (mgl^{-1})	350	300
Width of river (m)	200 m	50 (approx.)
Habitat Type	Riffles & Runs	Riffles & Pools
Land-use	Forest type at left bank and agriculture & village at right bank	Forest canopy

Substrate composition	Coarse sand & silt	Cobble/pebbles/silt/clay

Biological profile of aquatic ecosystem:

Phytoplankton: In primary study, a total of 13 phytoplankton genera were recorded from the river Son and Ghagar belonging to 3 classes; Bacillariophyceae, Chlorophyceae and Cyanophyceae. Among 13 genera, 5 were common in both Son and Ghagar while 3 were restricted to Son and 5 to Ghagar river.

Table 2 Distribution of phytoplankton taxa in the Sone and Gagar river

Phytoplankton	Taxa	Son	Ghagar
Bacillariophyceae	*Synedra sp.*	+	+
	Cymbella sp.	+	+
	Cyclotella sp.		+
	Navicula sp.	+	+
	Fragilaria sp.		+
Chlorophyceae	*Ulothrix sp.*	+	+
	Closterium	+	+
	Hydrodictyon	+	
	Spirogyra sp.		+
	Pediastrum	+	
	Stigeoclonium		+
Cyanophyceae	*Lyngbyasp.*	+	
	Spirulina sp.		+

Zooplankton: The zooplankton community was mainly compraised of Protozoans and rotifers in both water bodies.

Benthos

Phytobenthos: A total of 6 phytobenthos genera were recorded from study area belonging to class Bacillariophyceae. These genera were Achnanthessp.,Gomphonemasp.,Naviculasp., Cymbellasp. Synedra sp. and Caloneissp.

Zoobenthos: The zoobenthos community was mainly dominated by phylum mollusc followed by arthropoda (dipterans). Among the mollusca, pelecypoda were most dominant class followed by gastropoda. Total 6 species viz Parreysiaandersoniana, Parreysiacaerulea, Corbicula striatella, Lamellidenscorrianus, Lamellidansmarginali,

Radiatulagaudichaudiwere recorded in the species for pelecypoda, however, Lymnaeaaccuminata, Thiarascabra, Pila globosawere common genera found in the study area of river Son and Gagar.

Nectons (Fish): Total 10 species viz. Labeorohita, Puntius sophore, Puntius chola, Bagarius, Clupisomagaura, Rita, Wallago attu, Mystustengara, Catla and Cyprinus carpio were recorded form Sone River in 2 km up and downstream near P7/1. However, from the secondary information

Joshi et al (2014) reported 89 species belonging to 10 orders and 25 families in the Sone River at 4 sampling points between Uttar Pradesh and Bihar stretch.

5. ESTIMATION OF ENVIRONMETAL FLOW FOR SONE RIVER

The incoming water in the river Sone registers strident annual variations, which was recorded at the Indrapuri barrage and discharge from the barrage also varied accordingly. In general, the incoming water registered depletion during the time period between 1976 and 2011. The highest flow was registered in 1978 at 1255407 MCM and minimum 167829 MCM in 2010. There was almost declining trend in incoming flow after 1999 till 2010. But it drastically increased to a tune of 829014.5 MCM in 2011 due to heavy rains in the upper catchment area.

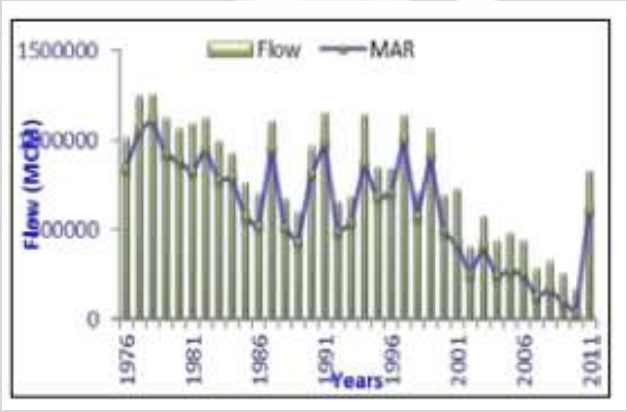

Fig. 1. Annual incoming water in the river Sone at Indrapuri barrage (1976-2011)

The water discharge from Indrapuri barrage also showed similar declining trend over the period. It was 839206 MCM in 1976 and 1111996 MCM in 1978, but reduced to mere 31408 MCM in 2010. There was almost declining trend in discharge values since 1999 onward till 2010. Time series data of monthly discharge from Indrapuri barrage shows almost similar annual trend in different months till 1999, which was gradually declined later on. Maximum water discharge at the tune of 221991 MCM was recorded in the month of September 1987, while there was no discharge during several other months.

6. BIODIVERSITY OF SONE RIVER

Fish diversity and fishery

The river has torrential flow at its up and midstream segments and passes through gorges in this section. The substratum in the upstream and midstream segments generally consists of bedrocks and boulders; while gravels, sand, silt and clay in downstream. Due to variations in the substratum and the habitat, river holds rich fish diversity. A total of 89 fish species belonging to 63 genera 25 families and 10 orders have been collected from the river during the study. Species richness at Tilauthu, Dehri-on-Sone, Andhari and Koilwar stretches was 80, 77, 77 and 76 respectively. The family Cyprinidae showed its versatile presence represented by 36 species belonging to 20 genera followed by Bagridae (7 species and 3 genera) and Schilbeidae (6 species and 5 genera). Fish fauna of the river in general is Gangetic in character with admixture of Himalayan and peninsular elements, hence important from the

zoogeographical point of view. The peninsular forms are represented by Labeo boggut and Salmophasia boopis and recorded from Tilauthu centre only. About seventy percent of the total species recorded were common at all centers showing their long range distribution pattern. As per IUCN red list, among the total 89 species recorded from the river, eight species are listed as Threatened in which 7 are near threatened and 1 vulnerable.

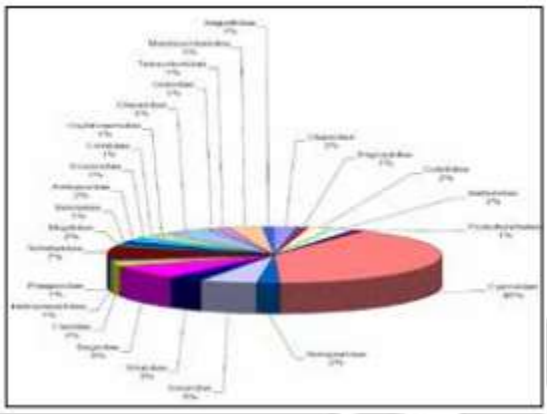

Fig.2 Percentage Distribution of fish species in different families of the river Sone

7. CONCLUSION

On analysis of 36 years water discharge data of the river Sone at Indrapuri Barrage by using GEFC, the river is observed in Critically Modified (Class F) condition with discharge of mere 5.16 % of MAR and resultant 2-5 % wetted perimeter. Hence, as per Calculator, the estimated 18.9 % of MAR would be helpful in restoration of the stretch from Critically Modified to Moderately Modified Class (C). Further, to maintain the river in Slightly Modified Class (B), 34.2 % of MAR will be required. Besides, EF estimation the present study also revealed loss to the fish diversity, fisheries and invasion of exotic species owing to decreased flow. His review article summarizes the current situation of heavy metal pollution in the river Ganga.

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