Summary
SUMMARY

Riverine ecology plays an important role to maintain environmental balance. But since 1970 the river pollution is increasing in India due to municipal solid wastes, sewage discharges, drains, runoff from crop lands, industries and raising of population density. Obviously eco balance is being disturbed with its rapid deterioration. Rivers fulfil the various human needs in various ways like power generation, irrigation, drinking water and fish production along with other aquatic animals habitat.

In the above light river Betwa which is the major tributary of river Yamuna was worked out in Hamirpur district. It is an interstate river between Uttar Pradesh and Madhya Pradesh. The total stretch of the river is 590 Km. the basin includes parts of a number of district of Bundelkhand region viz: Tikamgarh, Chhatarpur, Sagar of M.P. whereas Lalitpur, Jhansi, Jauloun and Hamirpur of U.P.. The tributaries of this river are; Ghurai, Gairao, Barwa, Gaurukha, Dhasan, Lakeri, Chainich, Parwaha, Jamini, Bina, Bearma. Parichha, Dhukwa, Matatila and Rajghat are major projects on Betwa basin. Matatila dam provides power generation as well as 16.36 MCM water for drinking purpose for Jhansi, Jalaun, Hamirpur and Gwalior districts of bundekhand region. Parichha weir provides irrigation and Dhukwan weir enhances the irrigation capacity of betwa cannonls. Rajghat project is an inter-state project of the M.P. and U.P. to provide irrigation and power generation.

The projects existing on the downstream are Matatilia, Dhukwan and Parichha weirs. Thus the Rajghat dam project serves as mother storage for
irrigation in U.P. and M.P. through a cascade of hydraulic structures in the downstream of river Betwa.

A stretch of this river under study is 22 Km. Hamirpur is situated on the left bank of the Betwa river. Drains, sewer, nalas and city sewage discharge into the river without any treatment which cause population.

All the meteorological conditions (Atmospheric temp, photoperiod, relative humidity, rain fall) have direct impact on the Betwa river water. Besides physical factors viz Water temp; water current, turbidity are also directly related to the meteorological conditions.

As regards the chemical nature of the river water it was found alkaline within the permissible range throughout the study period which is suitable for much fish production. The highest value were observed in August 2005 due to flood whereas normally it was highest in summertime and pH was also observe in summertime in the month of May at discharge point which was due to high temperature, much organic and inorganic matters and low water volume. pH showed direct correlation with total alkalinity and inverse relationship with CO2. Heteropneustes fossilis showed tolerance up to 11 pH. Whereas other fishes die off at this range. Total alkalinity, total hardness are produced by carbonates, bicarbonates and hydroxyl ions. Maximum concentration of these factors were recorded in summer seasons at sewage discharges and mixing points. These factors are quite essential to be studied for determining the suitability of water for fish culture as well as for the assessment of drinking water quality.

The maximum concentration of total dissolved solids was found at discharges points during rainy seasons due to continuous sewage discharges, much municipal solids waste and organic matters, runoff from crop lands at contained different kind of nutrients by which aquatic weeds grow more.
Dissolve oxygen is one of the most important and critical parameters for the assessment of water quality. In the river Betwa water the minimum level was recorded in the month of May and in the month of August during the two years of study, whereas the maximum level was found in winter season at down stream where river is widest and shallow. It showed direct relationship with phyto planktons and positively related with fish productivity. During summer high temperature and bacterial activities decreased D.O. and increased B.O.D. in the river water.

B.O.D, C.O.D. and CO2 are organic pollution indicators. The maximum concentrations of these factors were recorded in summer and rainy seasons in the study span at discharges and mixing points due to high temperature, decomposition of organic matters while in monsoon heavy influx of discharges and leaching of soil in river showed much growth of coliforms and other microorganisms in river water which resulted increase in B.O.D. whereas toxicity in water is assessed by C.O.D. High CO2. caused toxic to fish and showed inverse relationship with D.O. and pH. The concentrations were found much higher than acceptable limits of B.O.D, C.O.D and CO2 in the month of August 2005 at Phothia village (Station-01). Ammonical nitrogen (NH4-N) is one of the most important indicator of pollution. The highest value was recorded at sewage discharges point. Sewage has large quantities of nitrogenous matter. Thus its disposal tends to increase the ammonia content of waters. High concentration was found in summer due to animal excretae sewage discharges and decomposition of organic matters at high temperature. Higher concentration of it is harmful to fish production and drinking purpose nitrite values were found corresponding to that of ammonical nitrogen presence of a small quantity of it indicated faecal pollution in river water.

Nitrates are the end products of the biochemical oxidation of ammonia. Algae and bacteria both incorporate ammonia very rapidly. High quantities of
chlorides along with nitrogenous compounds indicate faecal pollution in aquatic system. Higher concentration of chloride was recorded at station 1st and IIIrd in the month of May due to influence of human interference and sewage discharge. Phosphate is a limiting factor as its deficiency lowers the growth of algae, aquatic weeds and slow down the eutrophication process in natural waters. In the Betwa river water maximum level was found during monsoon season in both the years due to runoff from crop lands storms and discharges of sewage at upstream. Whereas the deficiency was noticed at station IV (Down stream) in the month of February. Lack of phosphorus is often the chief cause of poor productivity of waters. Natural water having phosphorus contains of more than 0.2 ppm PO₄ is likely to be quite productive. Excess PO₄ in river waters is a sign of heavy organic pollution.

Sulphate is ecologically important for the growth of micro and macro flora. Maximum concentration of it in Betwa river was found in summer seasons due to much domestic sewage in less volume of river water at discharge point at upstream. Hydrogen sulphide is oxidized in two ways first is by bacterial metabolism and second involves the use of molecular oxygen.

The importance of Na and K both are similar. Maximum concentration of them was found in Betwa River during rainy season and low concentration was recorded in winter season. Discharges points and leaching of soil were responsible for their concentration. Sodium is metabolized by blue greens and potassium is a necessary requirement for all algae. Under low potassium condition, growth and photosynthesis of algae are poor and respiration high. Sodium is essential to sustain fish life.

Fluoride is considered as a serious pollutant and its toxicity is harmful for drinking water and fish productivity. Its highest value was found in rainy season due to runoff and leaching of soil at discharge point of up stream.
Domestic and municipal solid wastes, city sewage, sewers etc. increased the organic and inorganic matters in the aquatic body which affected biological factors.

Bacterial communities are considered as indicators as water pollution but the environmental conditions have a marked effect on the rate course, and extent of the self purification brought about in stream by bacterial activity. When rivers are polluted by sewage, or by certain nitrogenous organic trade wastes the essential food requirements of bacteria are likely to be satisfied and rapid breakdown of organic matter takes place. Bacteria found in river waters are dangerous to health on account of the poisonous toxins.

Their maximum concentration was recorded at Pothia and next to it at discharged point in rainy season whereas minimum was recorded in winter season at all sampling stations. The count was much higher than acceptable limite in Betwa River, obviously water was contaminated and showed pollution.

Chlorophyceae, bacillariophyceae and cyanophyceae (Mixophyceae) groups of phytoplanktons were studied qualitatively and quantitatively in the period of study (Jan2004- Dec2005).

Chlorophyceae group was abundant during summer and monsoon seasons and density was lesser in the winter season. These variations were marked in summer season due to high concentration of dissolved organic matters high temperature and pH. They were confined to sewage discharges points

Bacillariophyceae abundance was during winter season and touched a peek level in November to march whereas minimum recorded in rainy season. They were found in clean water and sensitive to toxic pollutants.
The abundance of blue greens during summer touched a peak level in April to June due to high temperature, rich phosphate and nitrogen. Phytoplanktons consisted the major part about (62% and 65%) of the total plankton quantity.

Zooplanktons are the primary consumers in the food chain. In the course of study they were consisted of protozoa, rotifera, copepoda and cladocera. The density of prozoans noticed higher than total zooplanktons. Their maximum density was found at city sewage discharge in the month of June due to high temperature and much organic matters. Their maximum number have also seen in summers.

In crustaceans, cladocera and copepoda were recorded 4 genera each. Their maximum density recorded in the month of May due to sewage discharges and high temperature and alkalinity at station III. They are the indicator of organic pollution.

Zooplanktons exhibited diurnal vertical migration. They are positively related with water temperature, photoperiod as well as phosphate, nitrate and alkalinity.

The summer season was the peak of zooplanktons.

Aquatic weeds are mostly aquatic angiosperms in the form of free floating, submerged, emergent and marginal weeds. In the present study aquatic weeds of Betwa river water were observed and found only free floating and submerged.

Free floating species were Eichhornia crassipes, Lemna paucicostata, Spirodella polyrhiza, Nymphoides Cristatum, flowering and fruiting of Lemna paucicostata, Spirodella polyrhiza were seen from Jan to May and Eichhornia crassipes which is known as water hyacinth flowering in Sept and Oct and
seeds remain dormant from Nov to June. Whereas flowering and fruiting of Nymphoides was usually in winter season from Oct. to Feb. These free floating forms predominate and were found in side pools of the river.

Luxuriant growth of Eichhornia covers entirely the surfact of the water, nala and low land impoundment which greatly hampers navigation and fishing.

Submerged aquatic weeds which were observed are Ceratophyllum spp., Hydrilla verticillata, Vallisneria spiralis, Potamogeton perfoliatus, Najas minor. They were most abundant in side pockets. Hydrilla and vallisneria flowering and fruiting was seen from oct. to march. Whereas Potamogeton and Najas flowering and fruiting was during all seasons of the year. Ceratophyllum flowered from Jan to March. Occasionally Najas, Vallisneria and Hydrilla grown separately or also in a mixed occurance. Their excessive growth appear with the starting of rainy season and generally they choke many rivers, canals, lake and ponds besides it they affected the fish production and fishing in the river water. A large amount of runoff from cultivated fields, domestic and city sewage, which includes organic matters, enrichment of minerals and silt these act as promoters of the growth of aquatic weeds.

Fishes are the most economically important aquatic biota, their growth and density denote the quality of water. In the present study various food value fishes were dragged out and studied during the study period (Jan 2004 to Dec 2005). There were 14 families 28 genera and 33 species recorded in the river Betwa. Labeo rohita, L.calbasu, Cirrihinus mrigala, Catla catla, Mystus seenghala, Heteropneustes fossilis, Clarias batrachus, Wallago attu, Channa punctatus, Mastacembelus armatus, were more abundant species during the period of study.
In Betwa River the bed is composed of fine brown sand but the banks of the river are muddy with vegetation. The density of fishes at station IIInd (Betwa ghat) and on station Ist (Pothia village) was more than other sampling stations. Though the maximum number was recorded at station IIInd (Betwa ghat) and minimum at station IVth (Down stream) near Ramaini pump canal.

Among the available fishes the hard fishes i.e. Heteropneustes fossilis, Channa punctatus and Clarias batrachus were much tolerance in chemical changes of water factors are high temperature, high pH. and low D.O. as tolerance limit of these factors for Heteropneustes fossilis is temperature 38°C, pH 11.0 and D.O. 3.5 to 4.0 ppm and for clarias batrachus the temperature is 35°C, pH 10 and D.O. 4 to 4.5 ppm whereas for channa punctatus the temperature is 35°C, pH 10.5 and D.O. 3.5 to 4.0 ppm.

**Aim, Conclusion and Recommendations**

Having in view the present investigation of the river Betwa, planning is to improve the quality of water for the betterment of fish production along other aquatic biota as well as suitability for drinking purpose might be done which will be very beneficial along with to over come with the problem of water pollution. Further it will maintain the healthy environment.

On the basis of findings of the present work, the conclusion is made after summerizing it. The river Betwa is not a shallow river due to which aquatic weeds were found rare and fish fauna is rich. The basin of the river is badly affected by the digging of the sand on the southern and northern sides by pockland machines which affects the ecology of the river. In longer period it might change its physio-graphic nature.

Municipal solid waste along with plastics electronic wastes etc. which are dropped in to the river. Besides, Nala, domestic and sewer discharges reach
in river and dead bodies mostly at the confluence of Betwa and Yamuna are thrown. Further the human activities viz. faeces, washing of clothes at ghats and cattles near village points cause pollution in the river and the runoff chemicals fertilizers, pesticide and insecticides from cultivated area also additional pollution in this river. Thus the physical and chemical nature of water is badly effected which has adverse impact on fish productivity and the water becomes unpotable.

Though the river water in its long run has the self purification quality but the pollution load is so much that still the rivers remain polluted.

To maintain the river ecology the suggestions are put forward which are to be carried out at Govt. level and with the cooperation of localized population.

All types of drainages i.e. Nala, sever, domestic etc. should be diverted and collected in some pockets like ponds and their water be used for irrigation purpose by canal scheme, as the said water will be rich in enhancing the fertility of land. Thus it will be beneficial in two ways.

Another way is by using of treatment plants before the discharge of the said water in to the river.

Digging of sand by Pockland machines should be checked whereas manual digging might be permitted under the prescribed suitable criteria for maintaining even level.

Soil erosion should be checked by disallowing deforestation and by doing plantation.

All types of solid wastes must not be allowed to throw in the river. They should be thrown in low lying lands.
By public awareness programmes for making the environment clean and the health hazards by pollution.

There should be some water pockets adjoining the river for washing of clothes, human excretory activity and cattles et.c

Leaching of the water in river from the chemicals treated crops might be checked by bordering the crop fields.

To enhance the fish productivity in river proper application scientific measures as given in physico-chemical analysis of river water are required which will solve the food problem and beneficial for the peoples as rich porteinous food.

It is essential because the fish culture in rivers is not being managed by the Govt. or any agency.