

# Hydrobiological Study of the Yamuna River at Kalpi, District Jalaun, Uttar Pradesh, India



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**Abstract:** Hydro biological study of the Yamuna river at Kalpi in India was carried out for a period of twelve month (October 2013 to September 2014). Four sampling stations were selected for sampling purpose. Collected samples were evaluated for fourteen physico-chemical parameters such as W.T., pH, Conductivity, Turbidity, T.D.S., T.H., T.A., Cl, SO<sub>4</sub>, PO<sub>4</sub>, NO<sub>3</sub>, D.O., B.O.D. and C.O.D. and four biological parameters such as phytoplankton, zooplankton, aquatic macrophytes and fishes. Present study reveals that water quality of the Yamuna river was not fit for drinking purpose but it was satisfactory for fish culture and irrigation purpose. Presence of both pollution tolerant and pollution intolerant species of biological parameters shows that this water was moderately polluted during course of study.

**Keywords:** Yamuna river, Physico-chemical parameters, Biological parameters, Kalpi, India

## Introduction

Water is the most vital resource for all kinds of life on planet. Although water covers 71% of the total surface area of the earth but hardly 1% is available as fresh water. Rivers, dams, lakes, reservoirs, ponds, tanks, streams and other small water bodies are important part of fresh water system of the earth.

Rivers are significant natural sources of water, which are being used for different life supporting activities. In spite of multifarious uses, unfortunately rivers are being used as receptacles for sewage and industrial wastes. Today most of the rivers have become polluted to a great extent by domestic sewage and industrial wastes (Shukla et al., 1989 and Singh and Ghosh, 1999). Pollution of water bodies ultimately affecting aquatic flora and fauna and causing serious diseases to human beings.

Yamuna, the largest tributary of river Ganga, is famous and holy river of India, flows from Yamunotri (Uttarakhand) to Allahabad (Uttar Pradesh) with covering a distance of 1376 km. Now, facing a serious problem of pollution due to unplanned urbanization and industrialization.

Now a day, water quality has become a major concern due to ever increasing human developmental activities that over exploit and pollute the water resources. The assessment of the changes in river communities as a result of the impact of pollution is particularly interesting issue because running water is becoming increasingly affected by anthropogenic discharges (Whitton et al., 1991).

Considering the importance of rivers as fresh water resources, a number of hydrobiological studies have been conducted (Bodola and Singh, 1981; Shukla et al., 1989; Agrawal and Trivedi, 1995; Singh and Gosh, 1999; Sengupta, 2006; Singh and Singh, 2007; Sharma et al., 2008; Mishra et al., 2009; Alam, 2013 and Chandra et al., 2014).

## Aim and Objectives

Objectives of this study was to conduct analysis of 14 selected physico-chemical parameters and compare with maximum permissible limit for drinking water as recommended by W.H.O. and to analysis four biological parameters of the Yamuna river at Kalpi stretch and, thus, conclude hydrobiological features

and pollution status of this river.

## Material and Methods

**Study Area:** The study was carried out at Kalpi stretch of the Yamuna river. Kalpi is a historical city of district Jalaun of Uttar Pradesh in India. It is located in between Jhansi and Kanpur on NH-25 and 30 km. away from district headquarter Orai. It lies to the south east bank of Yamuna and falls under 26° 7' 14" N latitude to 79° 44' 59" E longitude with an average elevation of 112 meters, 5 km length of Yamuna at Kalpi from vicinity of Vyas Mandir (u/s) to Raid drain opening (d/s) was under study programme (Figure 1, 2 and 3).

**Sampling and Analysis:** Four sampling stations named as S<sub>1</sub>- vicinity and in front of Vyas Mandir, S<sub>2</sub>- Kila Ghat, S<sub>3</sub>- Peela Ghat and S<sub>4</sub>- near Raid drain opening were selected for the sampling purpose (Figure. 3). Four drains named as D<sub>1</sub> (Jondhar drain), D<sub>2</sub> (small drain), D<sub>3</sub> (Sua Baba drain) and S<sub>4</sub> (Raid drain) were being open into the Yamuna at study area.

The samples were collected monthly till one year (October 2013 to September 2014) from selected sampling stations.

For physico-chemical parameters, water samples were collected in plastic bottles of two litre capacity. After collection, samples were properly packed and transported to laboratory in the same day to avoid any changes. Separate BOD bottles were used for sample collection for DO and BOD analysis. Water samples were kept in darkness at 4 °C till analysis in laboratory.

Water temperature was measured by thermometer and pH was measured by pen pH meter at sampling site. Other parameters like Conductivity, Turbidity, T.D.S., T.H., T.A., Cl, SO<sub>4</sub>, PO<sub>4</sub>, NO<sub>3</sub>, D.O., B.O.D. and C.O.D. were analysed in the laboratory according to the standard methods (APHA, 2005; Trivedi and Goel, 1986 and Adoni, 1985).

Plankton samples were collected between 8.0 am to 9.30 am at every selected sampling stations. Plankton net of bolting silk no. 25 was used for sampling purpose. Samples were taken at mid stream 0.5 to 1 m below the surface of water. Collected concentrated plankton samples (10 ml) were fixed and preserved in 5% formalin.

Plankton samples were examined under high power microscope and identified up to genus and species level with the help of standard books and monographs (Prescott, 1962 and Adoni, 1985 for Phytoplankton and Adoni, 1985 and Battish, 1992 for Zooplankton).

## Result and Discussion

**Physico-chemical Parameters:** Observed selected 14 physico-chemical parameters were tabulated and analysed to understand the physico-chemical characteristics of studied water sample. Average value of recorded physico-chemical parameters of 4 sampling sites were tabulated and compared with maximum permissible limit of drinking water (as given by W.H.O.). Data has given in Table No. 1.

**Water Temperature (W.T.):** Maximum temperature ( $31.5^{\circ}\text{C}$ ) was recorded in June and minimum temperature ( $15.5^{\circ}\text{C}$ ) in month of January, with average temperature was  $25.38^{\circ}\text{C}$ . Temperature was suitable for the survival and growth of fish fauna.

**pH:** The pH value was in the range from 7.60 to 8.70. The maximum pH value 8.70 was recorded in the month of June and minimum 7.60 in the month of January with average value of 8.28. Recorded pH was higher in most of the time than the permissible limit of WHO for drinking water (i.e., 6.5 to 8.5) but it was under the limit for fish culture (i.e., 6.0 to 9.0) and irrigation purpose (i.e., 5.5 to 9.0). pH of Yamuna river was alkaline in nature.

**Conductivity:** Conductivity was recorded in the range of  $330\ \mu\text{S}/\text{cm}$  to  $1060\ \mu\text{S}/\text{cm}$  during study period. It was minimum in August month and maximum in June month. The average value of recorded Conductivity was  $601.25\ \mu\text{S}/\text{cm}$ . Registered value of conductivity was more than the prescribed limit of WHO for drinking water (i.e.,  $300\ \mu\text{S}/\text{cm}$ ).

**Turbidity:** Value of Turbidity was in range 26.0 to 200 NTU. Minimum value of turbidity was recorded in the month of February while maximum value in August. Mean value of turbidity was 83.58 NTU. Observed turbidity value was found to be greater than prescribed limit of WHO for drinking water (i.e., 5 NTU).

Where, W.H.O. = World Health Organization

**Total Dissolved Solid (T.D.S.):** The value of T.D.S. was in range from 458 to 675 mg/L. Minimum value of T.D.S. was recorded in January month and maximum value in August while average value was 564.58 mg/L. In most time, noticed T.D.S. value range was more than the limit recommended by WHO

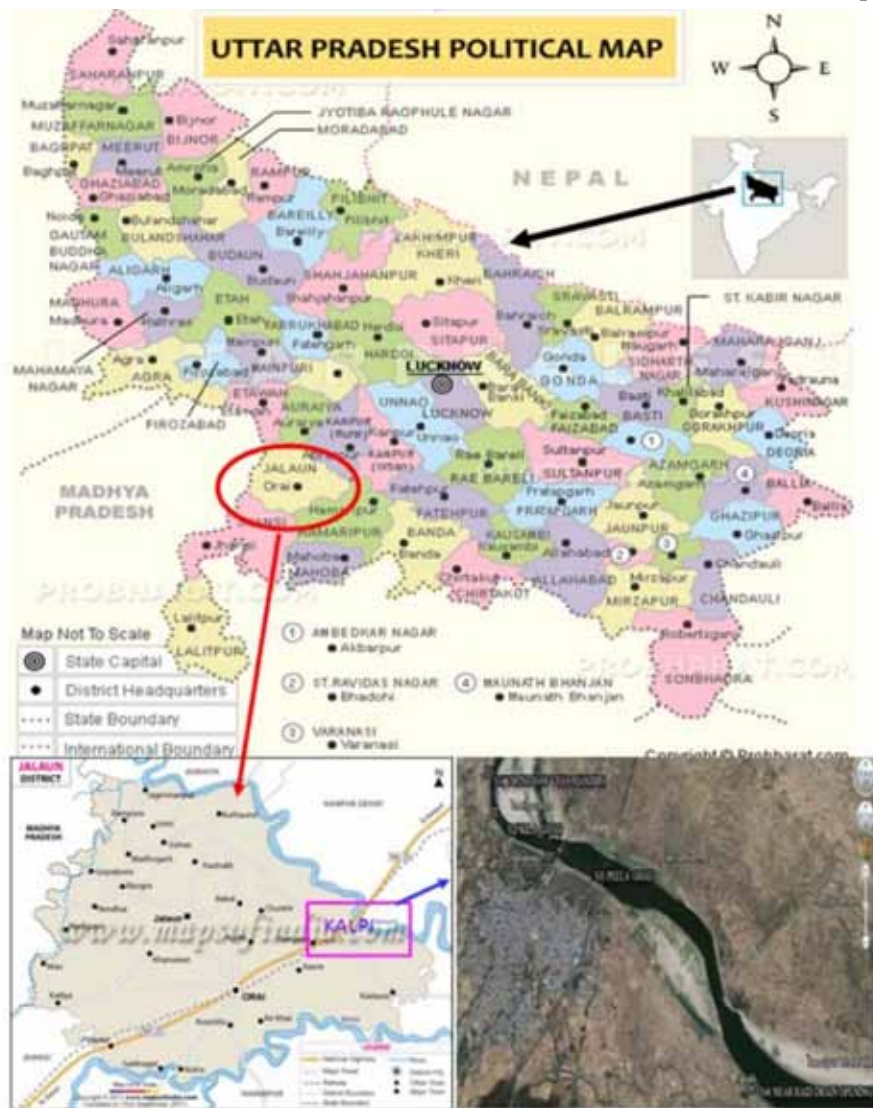


Figure No 1: Map of U.P. express location of district Jalaun

Figure No 2: Map of district Jalaun

Figure No 3: Satellite photograph of whole Study Area (Yamuna river at Kalpi)

Aquatic macrophytes were collected from inside and surrounding of the Yamuna river at all selected sampling sites in all seasons during study span. They were collected by long handled iron hook from different types of habitate. Collected macrophytes were identified up to genus and species level with the help of pertinent literature.

Fish fauna were collected at every selected sampling sites in all seasons of study period by using net of various mesh size. Collected fishes were identified up to genus and species level with the help of standard books and monographs (Jhingran, 1992 and Jayram, 2010).

for drinking water (i.e., 250 mg/L to 600 mg/L).

**Total Hardness (T.H.):** Recorded total hardness of the Yamuna water was in the range of 84.5 mg/L (minimum) to 148.9 mg/L (maximum). Minimum hardness was recorded in the August month while maximum hardness in the June month. Average of recorded hardness was 111.48 mg/L. Recorded hardness value was under the prescribed limit of WHO for drinking water (i.e., max. 500 mg/L).

S.NO.	Physico-chemical Parameters	Minimum	Maximum	Mean	Maximum permissible limit for drinking water (WHO)
1	Water Temp.(°C)	15.5 Jan.	31.5 Jun.	25.38	-
2	pH	7.60 Jan.	8.70 Jun.	8.28	6.5-8.5
3	Conductivity (µS/cm)	330 Aug.	1060 Jun.	601.25	300
4		26.0 Feb.	200.0 Aug.	83.58	5.0
5	Turbidity (NTU)	458.0 Jan.	675.0 Aug.	564.58	250-600
6		84.5 Aug.	148.9 Jun.	111.48	500
7	T.D.S. (mg/L)	91.5 Jan	215.6 Jun.	173.92	200-600
8	T.H. (mg/L)	14.5 Aug	48.5 May.	26.88	250-1000
9	T.A. (mg/L)	11.05 Aug	29.75 Jun.	22.25	250
10	Cl (mg/L)	0.52 Jan	1.74 Aug.	0.82	0.5
11	SO <sub>4</sub> (mg/L)	0.38 Aug	4.6 Jun.	1.26	50
12	PO <sub>4</sub> (mg/L)	6.0 Jun.	8.53 Jan.	7.45	2-6
13	NO <sub>3</sub> (mg/L)	3.25 Sep.	12.00 Jun.	7.71	3
14	D.O. (mg/L)				
	B.O.D. (mg/L)	10.85 Aug	26.80 Jun.	21.2	10
	C.O.D. (mg/L)				

Table No 1: Average values of recorded physico-chemical parameters of the Yamuna River and their Comparison with maximum permissible limit of W.H.O for drinking water

**Total Alkalinity (T.A.):** Maximum value (215.6 mg/L) of T.A. was recorded in month of June and minimum value (91.5 mg/L) in the month of January while average value was 173.92 mg/L. Noticed T.A. value was below in half of time but more in half of the time of study than WHO recommended limit for drinking water (i.e., 200 mg/L). T.A. of the Yamuna water was more than 100 mg/L in most of the time of study span thus it was suitable for fish culture.

**Chloride (Cl):** Chloride was varied from 14.5 mg/L to 48.5 mg/L and mean value was 26.88 mg/L. Minimum chloride value was recorded in the August month while maximum in May month. Noticed chloride concentration was under the limit of WHO for drinking water (i.e., 250 mg/L).

**Sulphate (SO<sub>4</sub>):** Minimum sulphate (11.05 mg/L) was recorded in the August month while maximum (29.75 mg/L) in June month. Average value of recorded sulphate was 22.25 mg/L. Recorded values of sulphate concentration was under the lower limit (i.e., 250 mg/L) prescribed by WHO for drinking water.

**Phosphate (PO<sub>4</sub>):** Phosphate of Yamuna water was in the range of 0.52 mg/L (in January) to 1.74 mg/L (in August). Average value of recorded phosphate was 0.82 mg/L. Recorded values of phosphate were beyond the permissible limit of drinking water (i.e., 0.50 mg/L).

**Nitrate (NO<sub>3</sub>):** Nitrate was recorded in range of 0.38 mg/L (in August month) to 4.60 mg/L (in June month) and average value of recorded nitrate was 1.26 mg/L. All recorded nitrate values were very low than the recommended limit of WHO for drinking water (i.e., 50 mg/L).

**Dissolved Oxygen (D.O.):** The value of D.O. was ranged from 6.00 to 8.53 mg/L. Minimum value of D.O. was recorded in June month and maximum value in January. Average value of recorded D.O. was 7.45 mg/L. Recorded D.O. values were satisfactory to good because in most time, it was more, than the prescribed limit of W.H.O. for drinking water (i.e., 6 mg/L). It was good for fish culture.

**Biochemical Oxygen Demand (B.O.D.):** Maximum value (12.00 mg/L) of B.O.D. was recorded in month of June and minimum value (3.25 mg/L) in month of September with the average value of 7.71 mg/L. Recorded B.O.D. range was more than the drinking water limit of B.O.D. prescribed by W.H.O. (i.e., 3mg/L).

**Chemical Oxygen Demand (C.O.D.):** C.O.D. of the Yamuna water was varied in between 10.85 mg/L (minimum in August) to 26.80 mg/L (Maximum in June). The average value of recorded C.O.D. was 21.2 mg/L. Noticed C.O.D. values was also more than the prescribed limit of WHO for drinking water (i.e., 10 mg/L).

**Biological Parameters:** Observed selected four biological parameters were tabulated and analysed to understand the biological characteristics of studied water sample.

**Phytoplankton:** Registered Phytoplankton were belong to 35 species of 25 genera of different groups like as Chlorophyceae (12 species of 11 genera), Euglenophyceae (3 species of 2 genera), Bacillariophyceae (5 species of 5 genera) and Cyanophyceae (15 species of 7 genera). In the study period group Chlorophyceae was dominated over rest of the phytoplankton population. Data has given in Table No. 2.

By comparison of Palmer's algal index out of recorded 35 species of Phytoplankton, 15 species like as *Euglena viridis*, *Oscillatoria limosa*, *O. tenuis*, *Scenedesmus quadricauda*, *Stigeoclonium tenue*, *Synedra ulna*, *Ankistrodesmus falcatus*, *Oscillatoria chlorina*, *Chlorella vulgaris*, *Cyclotella meneghiniana*, *Euglena acus*, *Phormidium*

*uncinatum*, *Phacus caudatus*, *Navicula viridula* and *Microcystis aeruginosa* are pollution tolerant. Presence of these species of algae (Phytoplankton) indicates organic pollution in water bodies. These species have been listed in Table No. 3 according to their Palmer's index serial (Palmer, 1969).

*Daphnia* sp. and *Cyclops* sp.. Along with 21 species of different group of Zooplankton *Brachionus calyciflorus* was also recorded. Presence of *Brachionus calyciflorus* is considered to be good indication of eutrofication (Sampaio et al., 2002). Data has given in Table No. 4.

Chlorophyceae			Bacillariophyceae		
S No.	Genera	Species	S No.	Genera	Species
1	Ankistrodesmus	falcatus	1	Cyclotella	meneghiniana
2	Chlorella	vulgaris	2	Melosira	sp.
3	Chlorococcum	infusionum	3	Navicula	viridula
4	Cladophora	fracta	4	Nitzschia	angustata
5	Cosmarium	tenuis	5	Synedra	ulna
6	Closterium	sp	Cyanophyceae		
7	Hydrodictyon	reticulatum	S No.	Genera	Species
8	Pediastrum	Simplex	1	Anabaena	
	Pediastrum	tetras	2	Lyngbya	gracilis
9	Scenedesmus	quadricauda		Lyngbya	magnifica
10	Spirogyra	condensata		Lyngbya	spirulinoidus
11	Stigeoclonium	tenuis	3	Merismopedia	elegans
Euglenophyceae				Merismopedia	punctata
				Merismopedia	glauca
S No.	Genera	Species	4	Microcystis	aeruginosa
1	Euglena	acus	5	Nostoc	sp.
	Euglena	viridis	6	Oscillatoria	clorina
2	phacus	caudatus		Oscillatoria	limosa
				Oscillatoria	subbrevis
				Oscillatoria	tenuis
			7	Phormidium	calciola
				Phormidium	uncinatum

Table No 2: List of recorded phytoplankton in the Yamuna River at study area (Kalpi)

**Zooplankton:** Registered zooplankton were belong to 22 species of 16 genera of different groups like as Protozoa (3 species of 3 genera), Rotifera (12 species of 6 genera), Cladocera (5 species of 5 genera) and Copepoda (2 species of 2 genera). Among recorded Zooplankton Rotifer's population was dominant during entire study span. Dominance of Rotifera is indicator of organic pollution. Pollution indicator species like *Brachionus* sp. and *Keratella* sp. were recorded along with clean water indicator sp. like

1	Euglena viridis	Euglenophyceae
2	Oscillatoria limosa	Cyanophyceae
3	O. tenuis	Cyanophyceae
4	Scenedesmus quadricauda	Chlorophyceae
5	Stigeoclonium tenue	Chlorophyceae
6	Synedra ulna	Bacillariophyceae
7	Ankistrodesmus falcatus	Chlorophyceae
8	Oscillatoria chlorina	Cyanophyceae
9	Chlorella vulgaris	Chlorophyceae
10	Cyclotella meneghiniana	Bacillariophyceae
11	Euglena acus	Euglenophyceae
12	Phormidium uncinatum	Cyanophyceae
13	Phacus caudatus	Euglenophyceae
14	Navicula viridula	Bacillariophyceae
15	Microcystis aeruginosa	Cyanophyceae

Table No 3: List of pollution tolerant species of recorded Phytoplankton in the Yamuna river at Kalpi in order of decreasing emphasis (Palmer, 1969).

**Aquatic Macrophytes:** In the study period various forms of aquatic macrophytes were observed and identified from different sampling stations of the Yamuna river at Kalpi. Identified plants belongs to 12 species of 11 genera includes in 8 families. Eichhornea, Potamogeton and Cyperus like aquatic Macrophytes along with other 8 genera were recorded. These Macrophytes indicates presence of high phosphate and nitrate in water bodies. Data has given in Table No. 5.

**Fish Fauna:** Twenty nine species of fishes represents 21 genera of 10 families were observed and identified in the river Yamuna at Kalpi during course of study at selected sampling stations. Along with other 28 species of fishes *Clarias batrachus* like pollution indicator fish was also recorded. Alam, (2013) reported 13 species of fishes from Yamuna at Kalpi stretch (Jalaun,U.P.). IIT (s), (2012) have recorded 67 species of fishes belongs to 51 genera of 23 families in Auraiyya to Allahabad stretch of Yamuna river. Data of recorded fish fauna from river Yamuna at 4 sampling sites in Kalpi has given in Table No. 6.

### Conclusion

On the base of over all hydrobiological analysis and discussion it is clear that water quality of the Yamuna river at study area was not fit for drinking purpose but it was satisfactory for fish culture and irrigation

Protozoa			Rotifera			S. No.	Fish	Species	Local Name	Family
S.No	Genera	Species	S.No	Genera	Species					
1	Arcella	dentata	1	Asplanchna		1.	Anabas	testudin-eus	Kabai/Jalebi	Anabantidae
2	Paramecium	caudatum	2	Brachionus	calyciflorus	2.	Barilius	barna	Ghilra	Cyprinidae
3	Vorticella	campanula		Brachionus	caudatus	3.	Catla	catla	Catla/Bosa/Bhakur	Cyprinidae
<b>Cladocera</b>				Brachionus	falcatus	4.	Chagnius	chagnio	Chhagau	Cyprinidae
S.No	Genera	Species		Brachionus	plicatilis	5.	Channa	gachua	Girai/Bilaua	Channidae
1	Alona	rectangula		Brachionus	quadridentatus		Channa	marulius	Padam saur	Channidae
2	Bosmina	longirostris	Brachionus	rubens	Channa	punctatus	Sauri/Gurrie	Channidae		
3	Ceriodaphnia	reticulata	3	Filina	Longiseta	6.	Cirrhinus	mrigala	Nain/Mrigla	Cyprinidae
4	Daphnia	carinata	4	Keratella	cochlearis	Cirrhinus	reba	Rajya/Lah-Kariya	Cyprinidae	
5	Moina	brachinata		Keratella	tropica	7.	Clarias	batrachus	Mangur	Clariidae
<b>Copepoda</b>			5	Philodina	citrina	8.	Cyprinus	carpio	Common Carp	Cyprinidae
S.No	Genera	Species		Polyarthra	sp.	9.	Esomus	danricus	Anjara	Cyprinidae
1	Cyclops	bicuspidatus				10.	Eutropi-ichthys	vacha	Bachuwa	Schilbeidae
2	Marcrocylops	albidus					11.	Hetero-pneustes	fossilis	Singhi
12.	Hypothal-micthys	molitrix							Silver Carp	Cyprinidae
13.	Labeo	bata							Bata	Cyprinidae
	Labeo	calbasu							Karaunt/Calbasu	Cyprinidae
	Labeo	gonius							Khursa	Cyprinidae
	Labeo	rohita							Rohu	Cyprinidae
14.	Mastacembelus	armatus							Bam	Mastacem-belidae
15.	Mystus	tengara							Chhota tengra	Bagridae
	Mystus	seenghala							Tengan	Bagridae
16.	Notop-terus	chitala							Chital/Moya	Notopteri-dae
	Notop-terus	notopterus							Patra	Notopteri-dae
17.	Ompok	bimacula-tus							Pabda/Jalkapoor	Siluridae
18.	Oxygaster	bacaila							Chelhua	Cyprinidae
19.	Puntius	sarana							Putiyah/Khabda	Cyprinidae
20.	Rita	rita							Rita	Bagridae
21.	Wallago	attu							Parhin/Lanchi	Siluridae

Table No 4: List of Recorded Zooplankton in the Yamuna River at study area (Kalpi)

S. No.	Family	Genus	Species	Ecological Nature
1.	Cerato-phyllaceae	Cerato-phyllum	demersum	Submerged
2.	Hydrochar-itaceae	Hydrilla	verticillata	Submerged
3.	Hydrochar-itaceae (Najada-ceae)	Najas	minor	Submerged
4.	Potamoge-tonaceae	Potamo-geton	crispus	Submerged
		Potamo-geton	pectinatus	Submerged
5.	Hydrochar-itaceae	Vallis-neria	spiralis	Submerged
6.	Azollaceae	Azolla	pinnata	Floating
7.	Pontede-riaceae	Eichhor-nia	crassipes	Floating
8.	Lemna-ceae	Lemna	paucico-stata	Floating
9.	Nympha-ceae	Nym-phaea	sp.	Floating
10.	Lemna-ceae	Spiro-della	polyrhiza	Floating
11.	Cypera-ceae	Cyperus	esculentus	Emergent

Table No 5: List of recorded Aquatic Macrophytes in the Yamuna river at study area (Kalpi)

S. No.	Fish	Species	Local Name	Family
1.	Anabas	testudin-eus	Kabai/Jalebi	Anabantidae
2.	Barilius	barna	Ghilra	Cyprinidae
3.	Catla	catla	Catla/Bosa/Bhakur	Cyprinidae
4.	Chagnius	chagnio	Chhagau	Cyprinidae
5.	Channa	gachua	Girai/Bilaua	Channidae
	Channa	marulius	Padam saur	Channidae
6.	Channa	punctatus	Sauri/Gurrie	Channidae
	Cirrhinus	mrigala	Nain/Mrigla	Cyprinidae
7.	Cirrhinus	reba	Rajya/Lah-Kariya	Cyprinidae
	Clarias	batrachus	Mangur	Clariidae
8.	Cyprinus	carpio	Common Carp	Cyprinidae
9.	Esomus	danricus	Anjara	Cyprinidae
10.	Eutropi-ichthys	vacha	Bachuwa	Schilbeidae
11.	Hetero-pneustes	fossilis	Singhi	Hetero-pneustidae
12.	Hypothal-micthys	molitrix	Silver Carp	Cyprinidae
13.	Labeo	bata	Bata	Cyprinidae
	Labeo	calbasu	Karaunt/Calbasu	Cyprinidae
	Labeo	gonius	Khursa	Cyprinidae
	Labeo	rohita	Rohu	Cyprinidae
14.	Mastacembelus	armatus	Bam	Mastacem-belidae
15.	Mystus	tengara	Chhota tengra	Bagridae
	Mystus	seenghala	Tengan	Bagridae
16.	Notop-terus	chitala	Chital/Moya	Notopteri-dae
	Notop-terus	notopterus	Patra	Notopteri-dae
17.	Ompok	bimacula-tus	Pabda/Jalkapoor	Siluridae
18.	Oxygaster	bacaila	Chelhua	Cyprinidae
19.	Puntius	sarana	Putiyah/Khabda	Cyprinidae
20.	Rita	rita	Rita	Bagridae
21.	Wallago	attu	Parhin/Lanchi	Siluridae

Table No 6: Recorded fishes from the Yamuna River at all sampling sites in Kalpi

purpose. Presence of both pollution tolerant and pollution intolerant species of biological parameters shows that this water was moderately polluted during course of study.

Following measures could be applying to clean-up project for Yamuna river at the study area.

1. Public awareness programmes for community participation in various Yamuna water quality restoration programme should be encouraged.
2. Segregation of domestic and industrial wastes and separate treatment scheme should be used for both type of wastes. Disposal of all type of garbage, solid and semisolid waste into the river Yamuna should be restricted.
3. All type of drainage like nala, sewer etc. should be diverted and using treatment plants before discharge of the waste water into the Yamuna river. Treated sewage water can be used for irrigation.
4. Maximum utilization of sewage treatment facilities, reduction of gap between waste water generation and its treatment.
5. Establishment of Combined Effluent Treatment Plant (CETP) is necessary for small industries effluent treatment and all the small scale industries (paper industries of Kalpi) should be connected with CETP(s).
6. There should be some water pockets like pools in adjoining area of the river for washing of cloths, cattle bath and idols immersion etc.
7. Agricultural runoff from croplands might be checked by making boundary wall in surroundings of crop fields.

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