



Fisheries of Indian rivers and their role in establishing E-flows: Case study

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CIFRI at a glance:

- CIFRI was established during 1947 under the Govt. of India
- Major focus on fisheries sustainability (Ecology, Fisheries, Water budgeting and Climate change) in Inland open waters



Ecosystem diversity-Home of fish -Fish diversity

Coast line	8,118 kms (3,600 fishing villages)
EEZ	2.03 million sq. km
Continental Shelf	0.506 million sq. km
Rivers & Canals	1,91,024 km
Reservoirs	3.15 million ha
Ponds and Tanks	2.36 million ha
Oxbow lakes & derelict waters	1.3 million ha
Brackishwater	1.2 million ha



Four-dimensional nature of river ecosystem

4. TEMPORAL DIMENSION
behavioural response - evolutionary

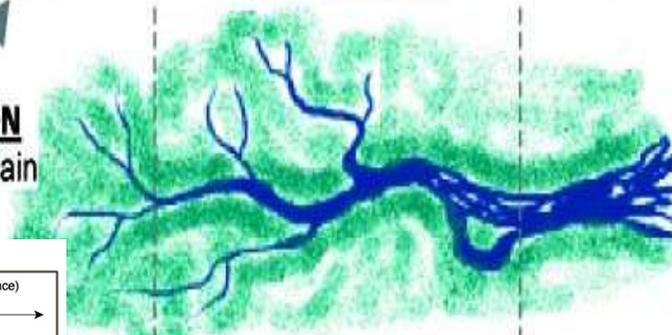
Streams



Medium size rivers

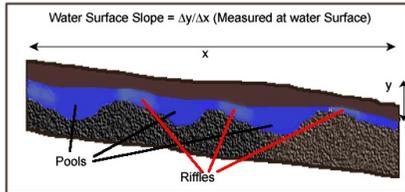


Large rivers



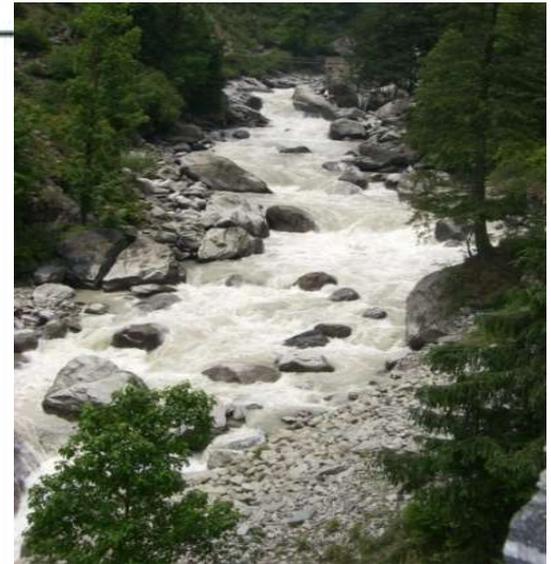
2. LATERAL DIMENSION
channel - riparian/floodplain

Longitudinal Profile



1. LONGITUDINAL DIMENSION
channel - channel

3. VERTICAL DIMENSION
channel - aquifer
(Ward 1979)





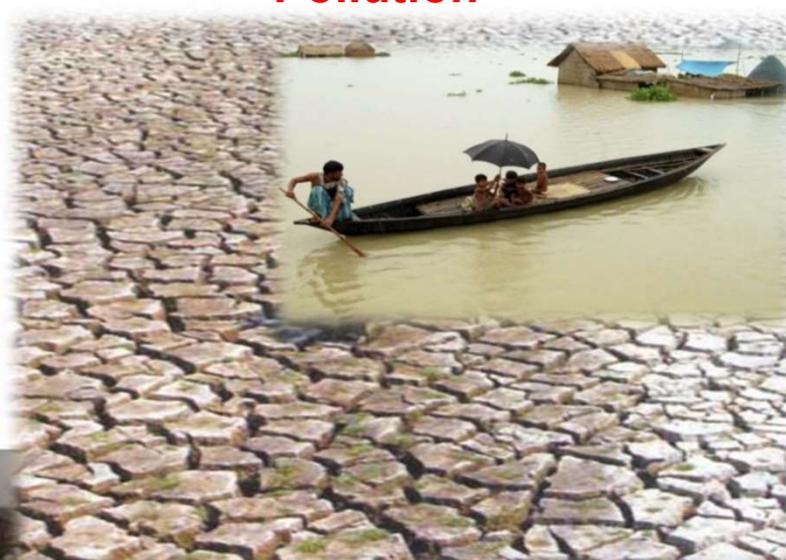
Obstruction/Abstraction



Pollution



Siltation
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Climate change



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Main issues confronting us



A :Conservation

- *What to conserve ?* (*Fishery alone –no*)
 - Ecosystem
 - Stocks
 - Sustainable management of both

B. Enhancement

- Harnessing productivity (Technology)
- Improving production
- Species improvement
- Appropriate combination of indigenous and outside stocks

C. Is Fishery sector responsible for any loss?

- i) Direct ii) Indirect iii) Other sector impinging

D. Other sectors are impinging FISH in a big way

E. So the concept of IWRM ?





River management objectives



- **Extractive objectives :**
- food fishery, recreational fishery, ornamental fishery, bait fishery, fry fishery, others.
- **Ecological objectives :**
- sustainability, conservation,
- **Social objectives :**
- income to fishers, equity/benefit distribution, conflict reduction, revenue to government, contribution to GDP, export income



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Relation of River fish and water



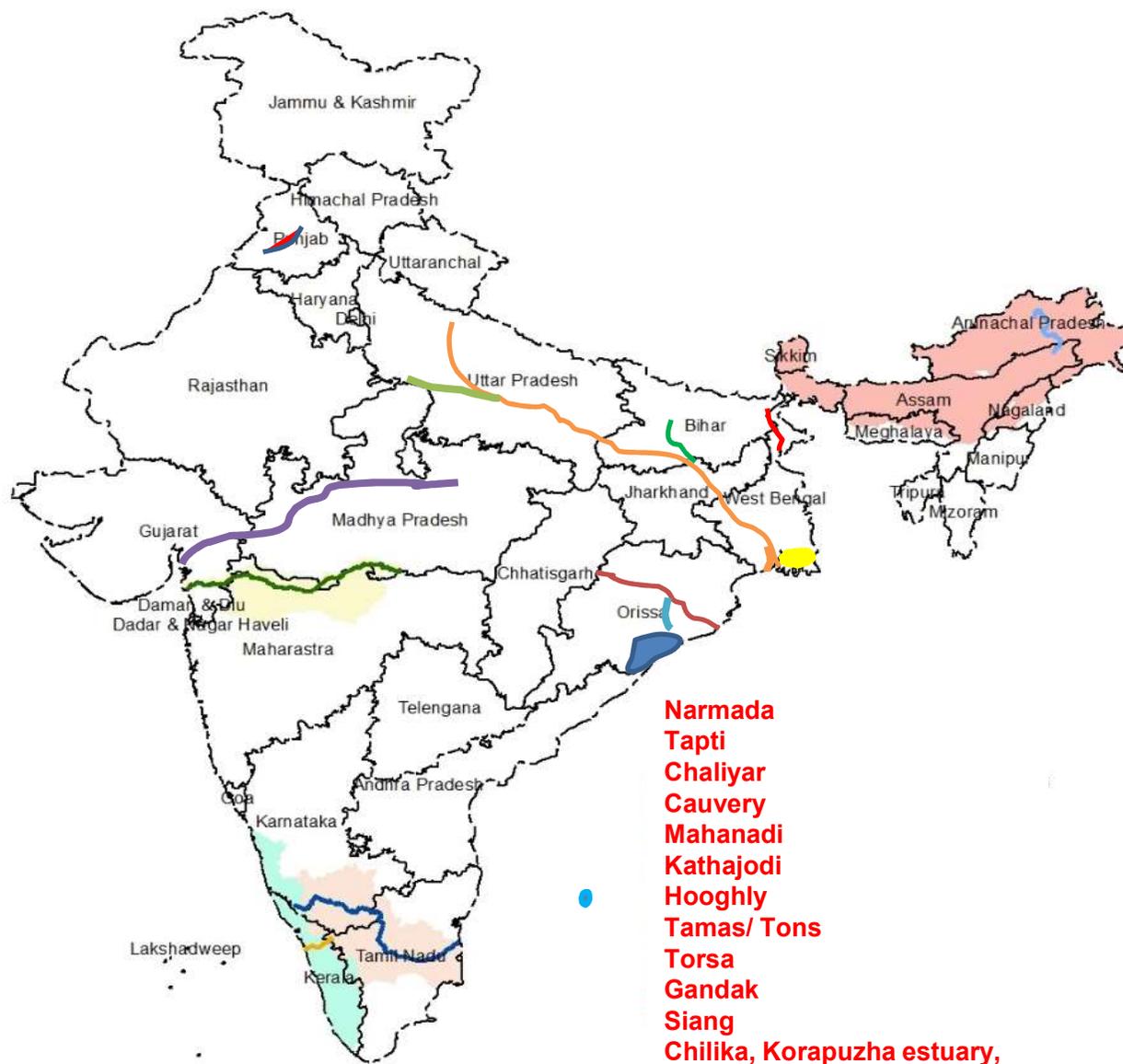
- A group of fishes move large distances within river channels between feeding and breeding habitats.
- A group of fishes that move locally from floodplain water bodies to surrounding plains during floods and return to impoundment later
- A group of fishes that are intermediate between the floodplain resident and long distance migrants.
- **Each group respond differently to changing conditions in river system.**
- A relationship exists between the greater biomass catch of fish with intensity of flooding in river.

Any drastic changes in river flows does impact all above, results in loss in fish habitat and economies at different levels.





Recent ongoing CIFRI'S REACH



1. Arunachal Pradesh
2. Gujarat
3. Kerala
4. Karnataka
5. Maharashtra
6. Madhya Pradesh
7. Uttar Pradesh
8. Bihar
9. Odisha
10. Punjab
11. Tamil Nadu
12. West Bengal

Narmada
Tapti
Chaliyar
Cauvery
Mahanadi
Kathajodi
Hooghly
Tamas/ Tons
Torsa
Gandak
Siang
Chilika, Korapuzha estuary,
Canals (Sundarbans, Punjab)



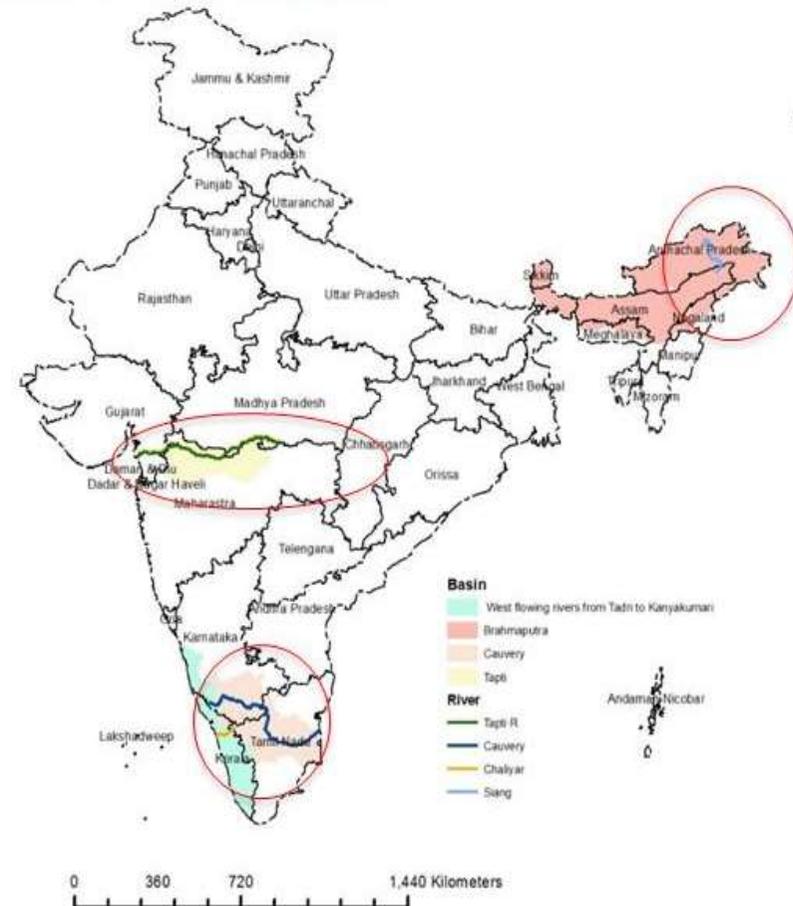


FISHERIES AND SOCIOECONOMICS OF RIVERS Mahanadi, Cauvery, Tapti, Siang AND Chaliyar



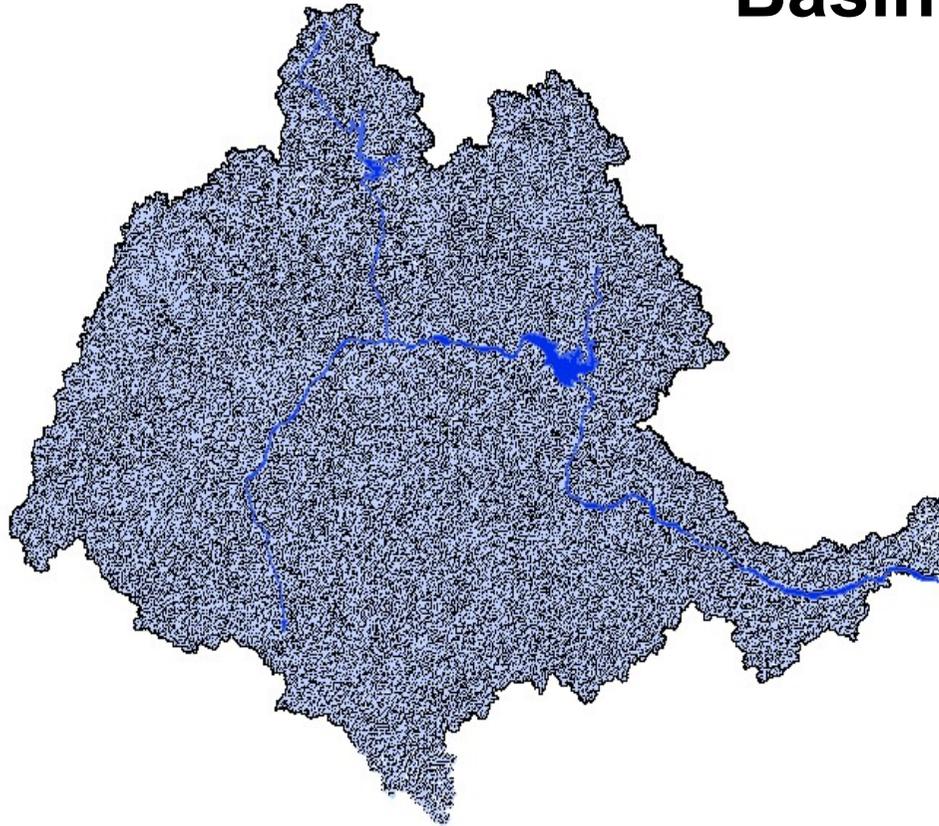
OBJECTIVES

- Characterization of different habitat types based on quantitative and qualitative attributes
- Assessment of fisheries, population structure and fish production
- Assessment of socio-economic status of fishers



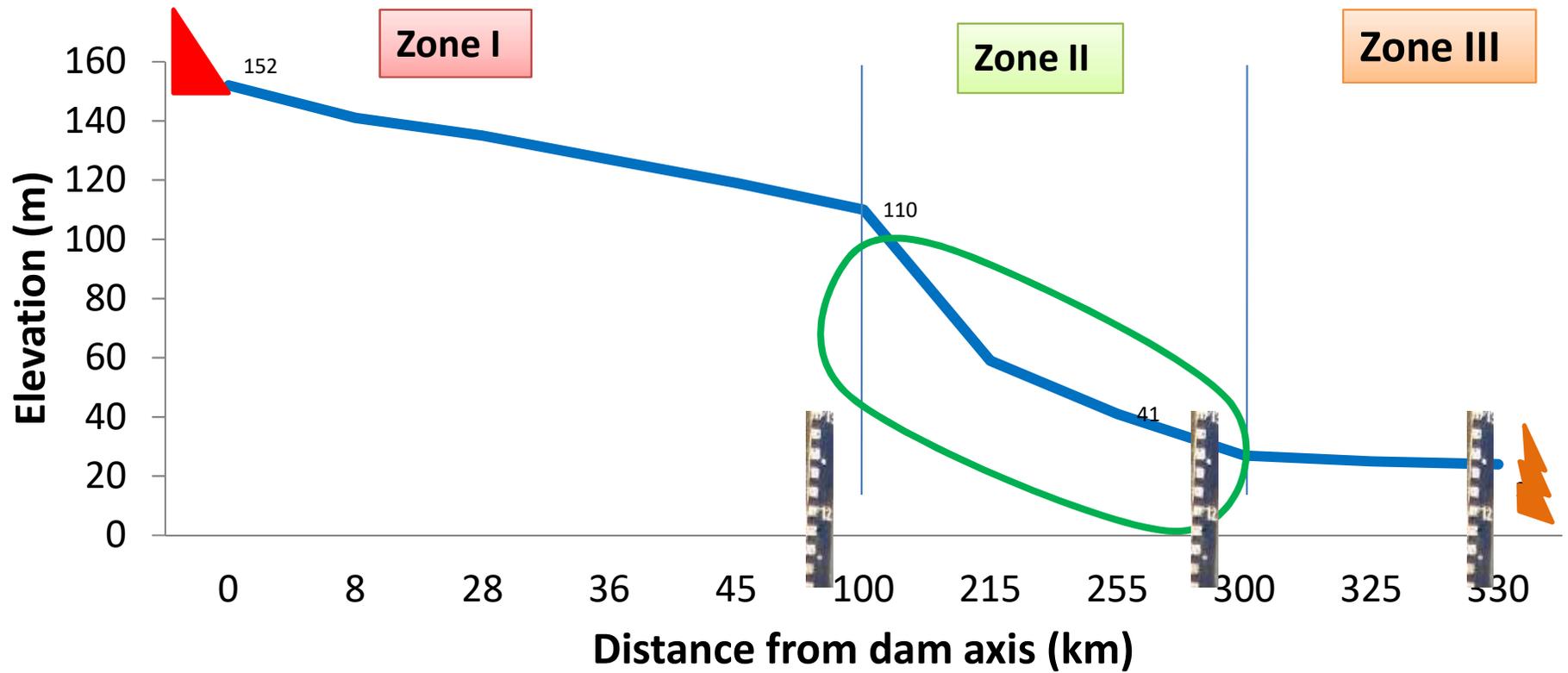


Mahanadi Basin



Mahanadi river: Basin
area of 1,41,589 km²,
nearly 4.3% of the total
geographical area of the
country
Length: 845 km







Significant Records:

- Ecological asset were identified (**Ansupa floodplain wetland and Satkosia wild life sanctuary** and 38 deep pools serving are shelter sites for fish during lean season).
- Livelihood mapping showed **fisheries is the top income** source for the people. Hence, underlines the importance of river water connectivity with river for fish catch.



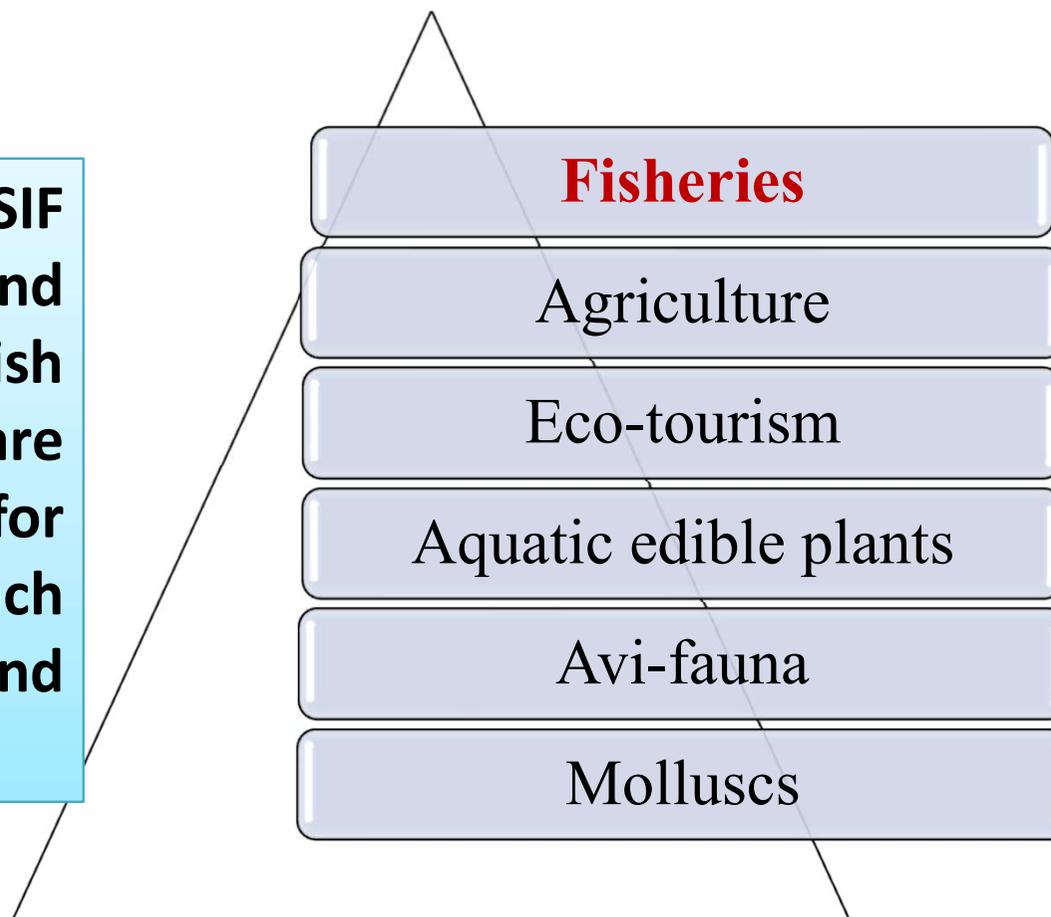


ANSUPA WETLAND



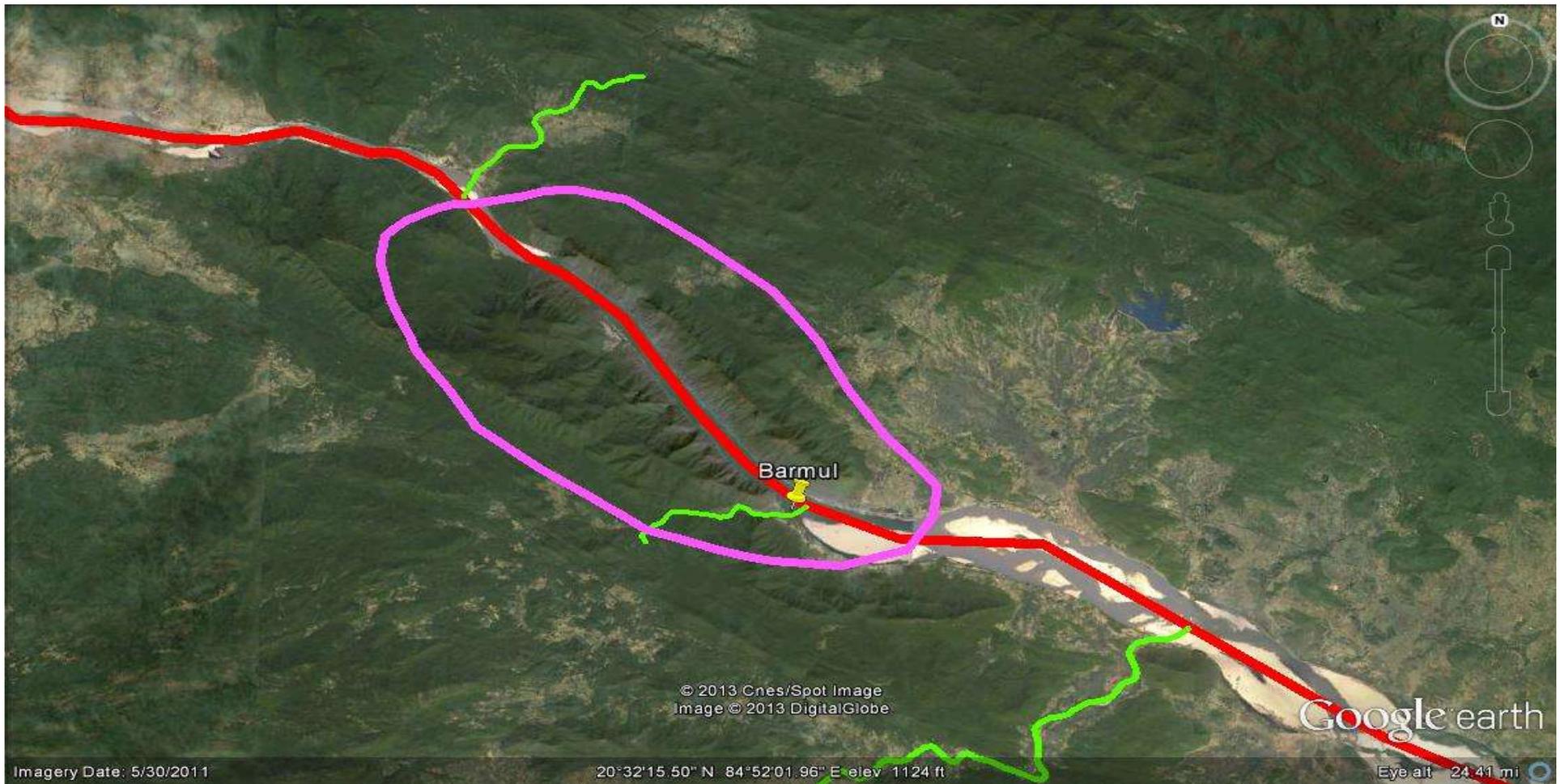


Fish species of SIF (Nutrient rich) and ornamental fish importance are major focus for future studies such as conservation and exploitation.



Direct livelihood opportunities provided by Ansupa





SATKOSIA GORGE (wild life sanctuary and home for large bodied carps and catfishes)





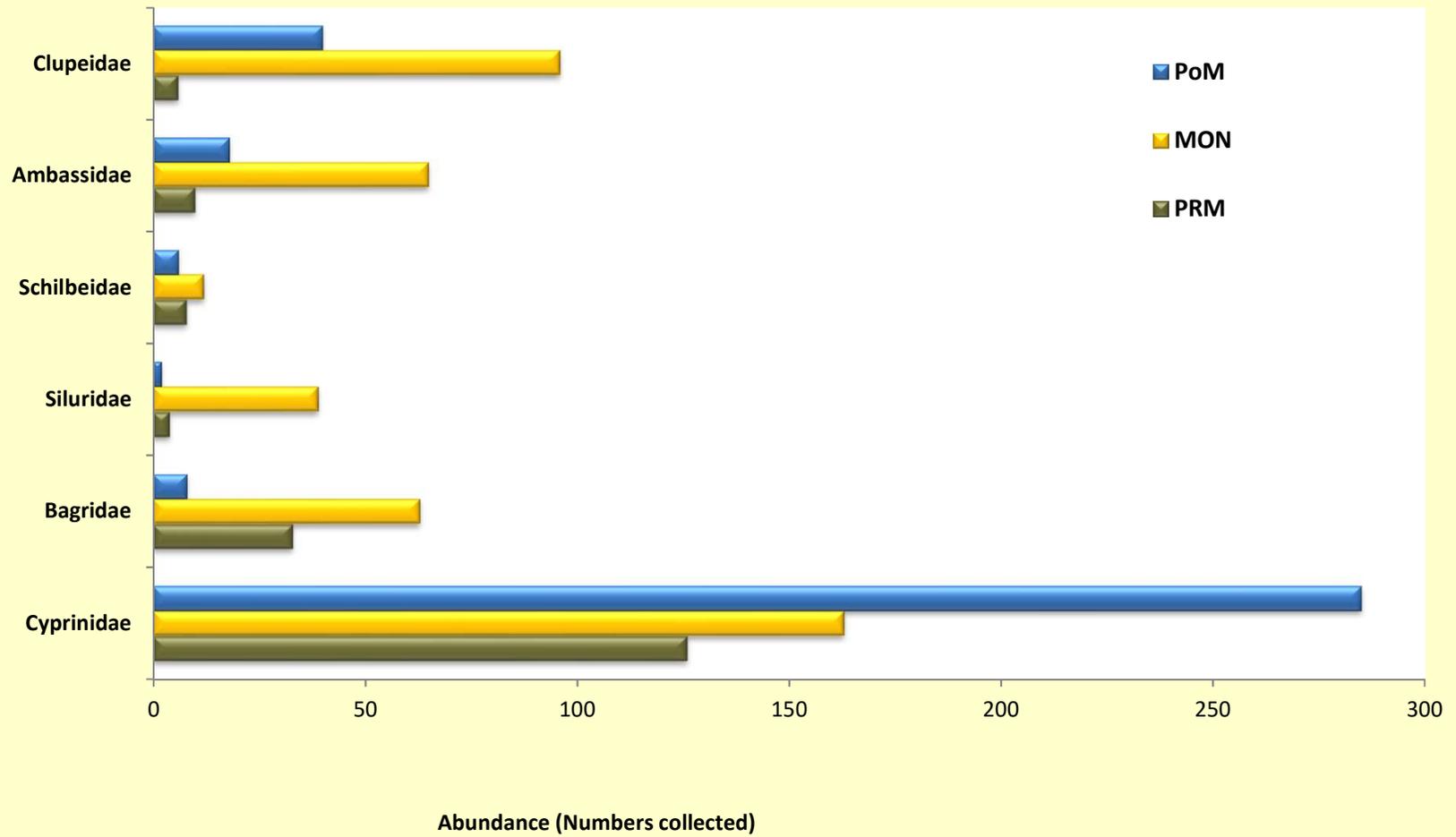


Fishes of river Mahanadi

A total of **113 (76+37) species** belonging to **44 (20+24) families** was reported in the Mahanadi river. While **Day (1869)** has recorded **146** species of which several were collected from the Cuttack region. **Job (1955)** work covering a stretch of 104 km of the main Mahanadi presents a record of **86 species**.

*First record of the Burmese river gizzard shad, **Gonialosa modesta (Day, 1870)***





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Endangered Fish (IUCN Red List 2012.2)



State fish of ODISHA

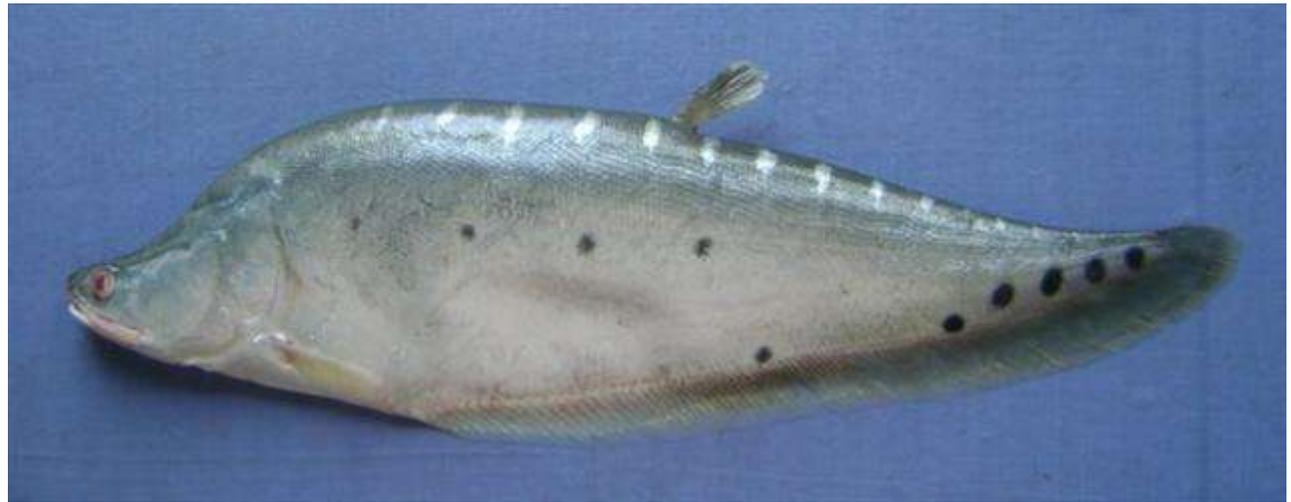


Tor mahanadicus





NT (IUCN)



Generalised linear model (GLM) analysis observed that depth ($P < 0.01$) and water temperature ($P < 0.05$) are significantly correlated with *C. chitala* and *Tor tor mahanadicus* distribution. Study underlined that a depth of 18 to 30 feet should be maintained in the river course as deep pools as habitat preference of *Chitala chitala* during lean season.





Breeding stage water requirement

Tor mahanadicus breeds during post monsoon season with a river discharge more than 60000 cusec with water temperature 24.0 ± 0.5 °C, pH 7.5 and DO 7.4 ppm

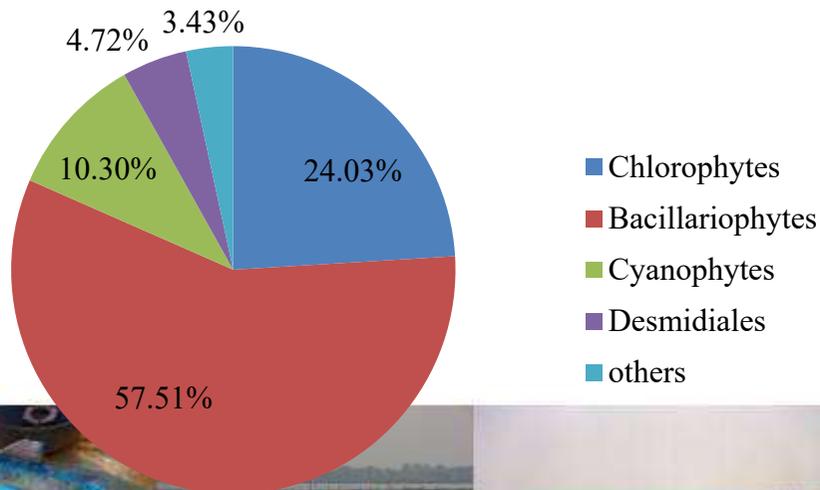
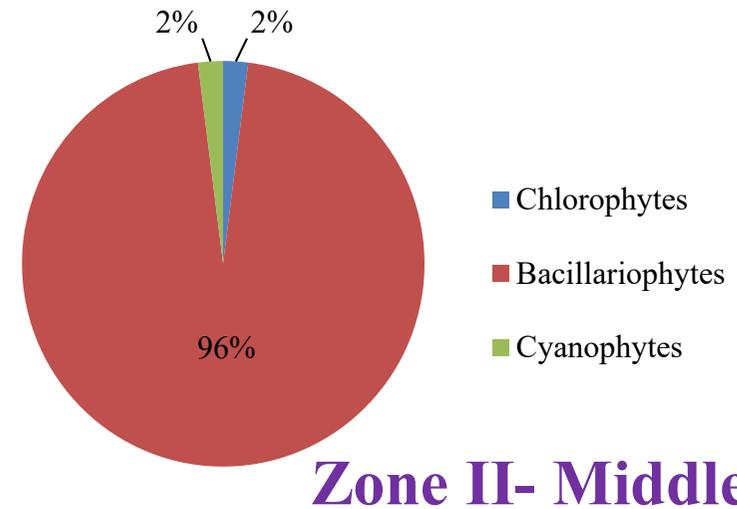
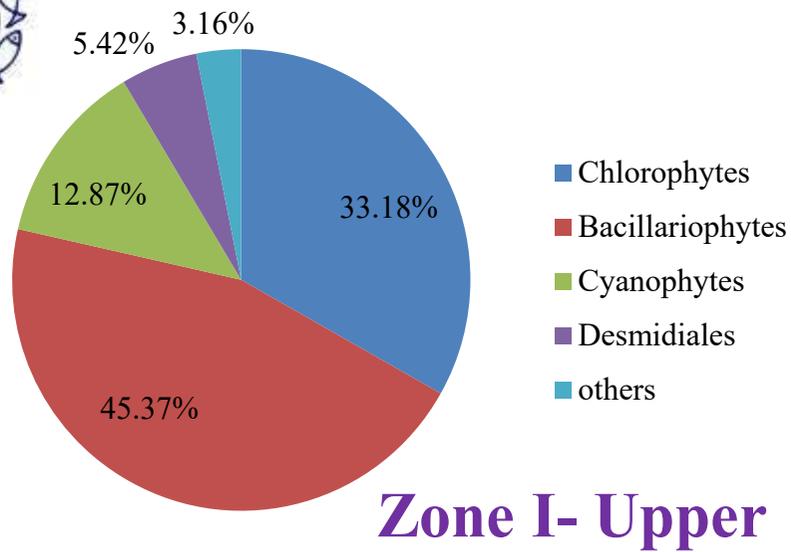
Sahoo A.K. and Sahoo B., (2015) Environmental flow estimation under climate change. Current Science.109 (9): 1522

Sahoo A.K. Sharma A.P. and Suresh V.R., (2016) Managing rivers: Ecohydrology an effective tool under climate change. National Academy Science Letters. DOI 10.1007/s40009-016-0454-0





Percentage of Phytoplankton composition in different stretches of river Mahanadi





Plankton species suitability water requirement

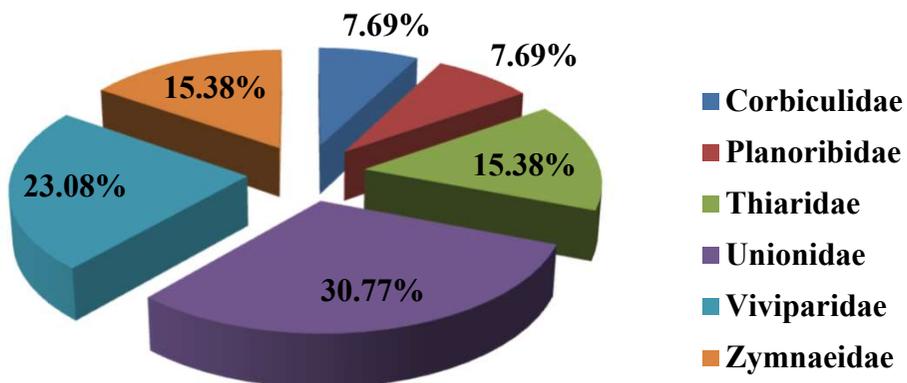


- Association between habitat variables (Flow, Dissolve oxygen, BOD, transparency, specific conductivity, nitrate, phosphate and magnesium) with phytoplankton abundance showed that **Fragilariophytes and Cyanophytes** are more influenced by Phosphate and Specific conductivity during Low flow (8000 to 15,000 cusec) than high flow (>90,000 cusec).

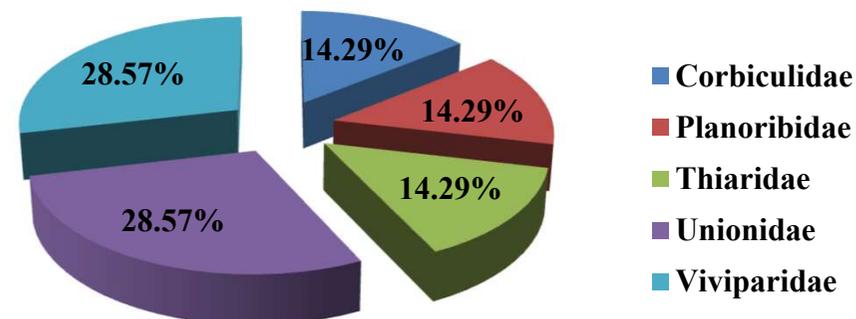




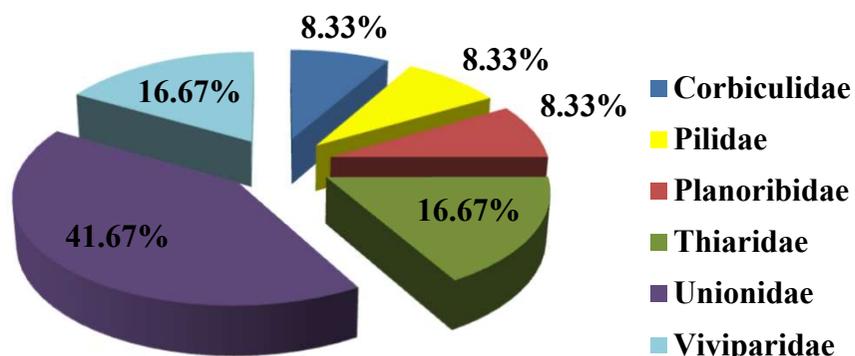
Macrobenthos composition in different stretches of river Mahanadi



Zone I- Upper



Zone II- Middle

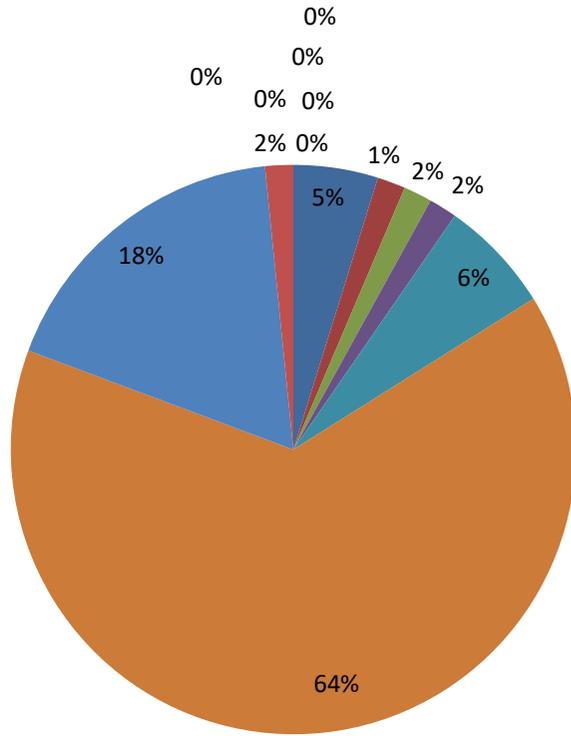


Zone III- Lower





Fresh water zone



- *Bellamyia bengalensis*
- *Corbicula striatella*
- *Parreysia (R) lima*
- *Parreysia occata*
- *Thiara sp.*
- *Thiara(T) lineata*
- *Thiara (m) tuberculata*
- *Thiara scabra*
- *Tellina opalina*
- *Mactra turgida*
- *Mactra mera*
- *Nerita articulata*
- *Polychaeta*
- *Nematoda*

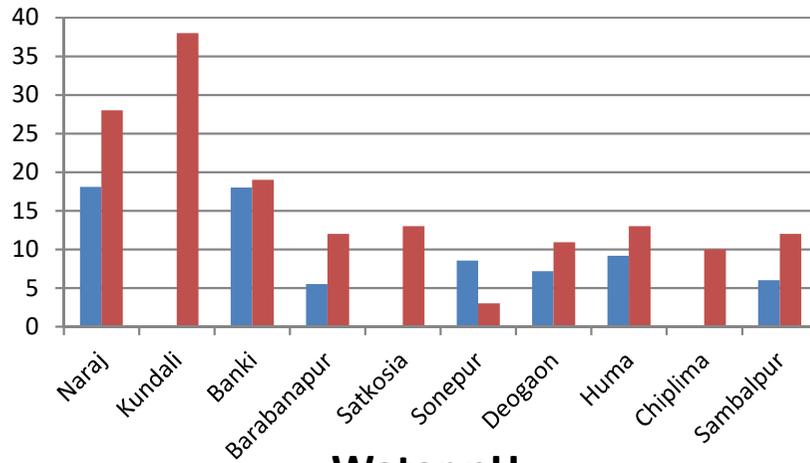




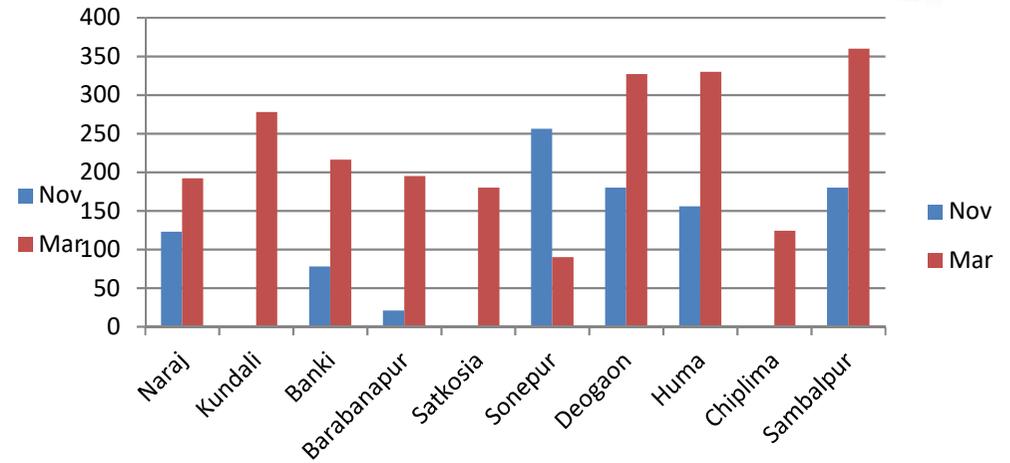
Physico-chemical parameters:



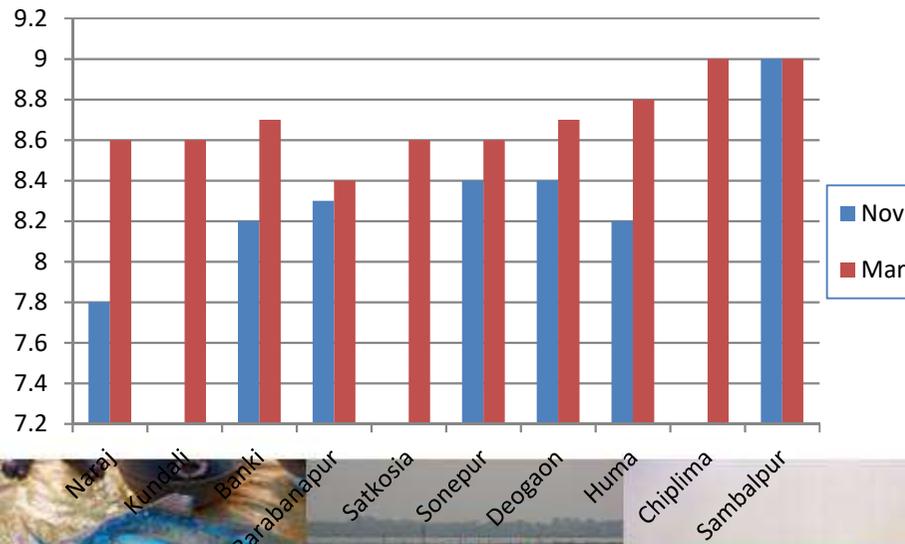
Water depth (ft)



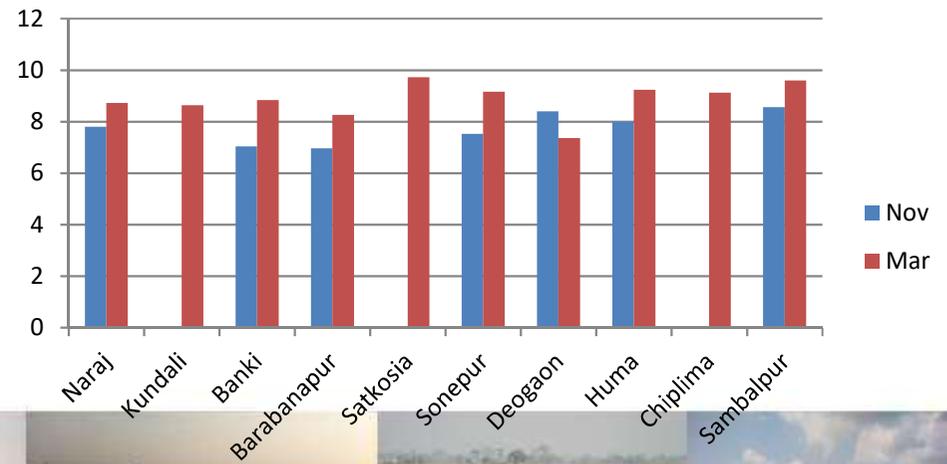
Transparency (cm)



Water pH



Dis. oxygen (mg/l)



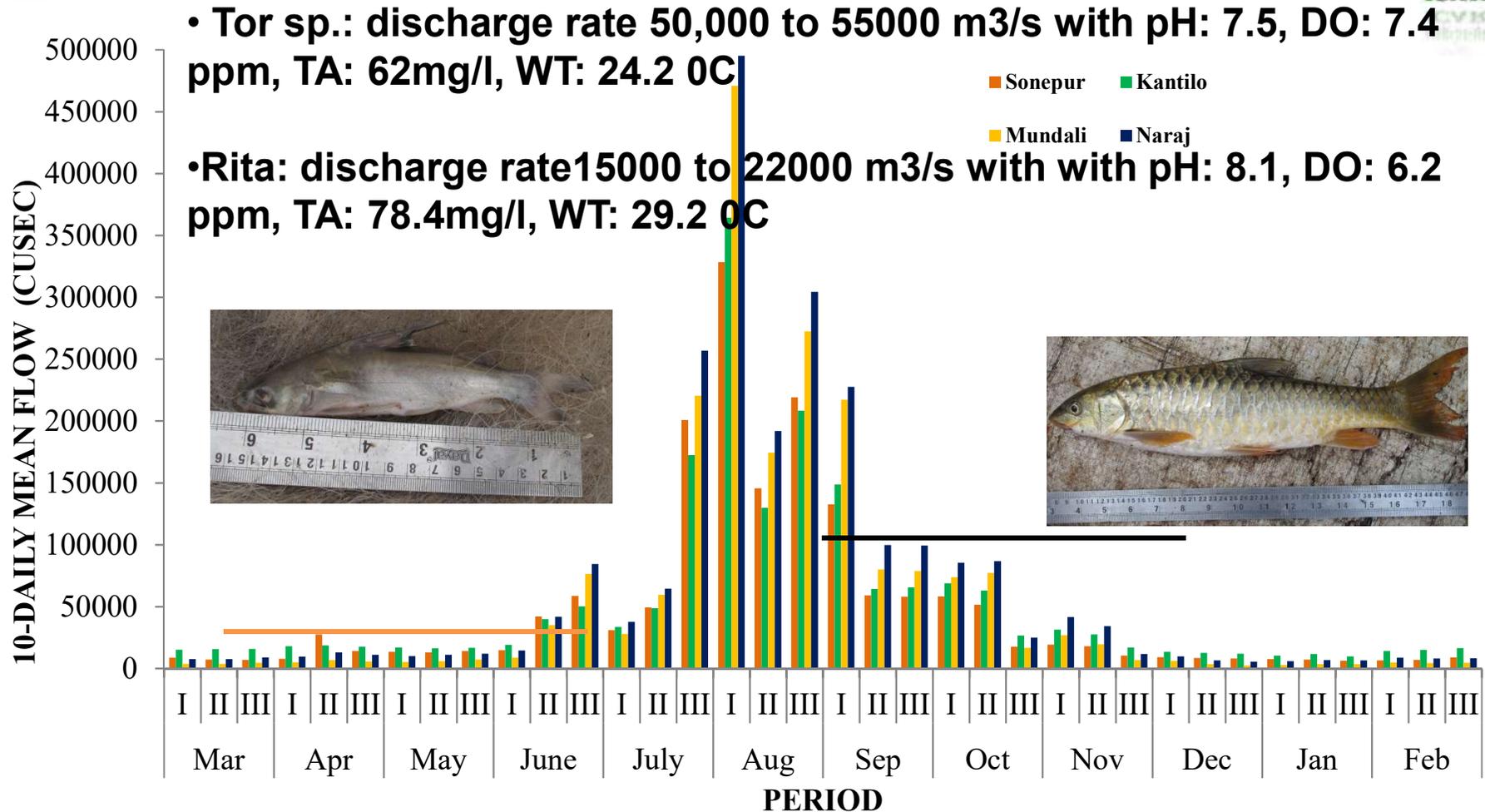


- Redundancy analysis (RDA) was preferred over canonical correspondence analysis (CCA) because of unimodal response of biotic community to the gradient of water quality. **Biotic parameters such as fish, benthos and plankton diversity were associated with the water quality parameters such as velocity, dissolve oxygen, silicate and TDS and observed that fish community is inclined more towards TDS and periphyton is more inclined to higher Silicate value and benthic community is more inclined towards the water velocity. It was noticed that higher the velocity (>0.8m/s) the lesser diversity of *Thiara lineate***





Water requirement for fish species:





Awareness on Mahanadi fish conservation through e-flows:



Staff of State Fishery Dept. Odisha



State Fishery Department, Village panchayat, and NGO, Utsharga, jagatsinghpur, Odisha



Fishermen of Boudh Dist.



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Assessment of fish and fisheries of the Ganga river system for developing suitable conservation and restoration plan



Sponsored by -
**NMCG, Ministry of Jal Sakti
Govt. of India**



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FINDINGS



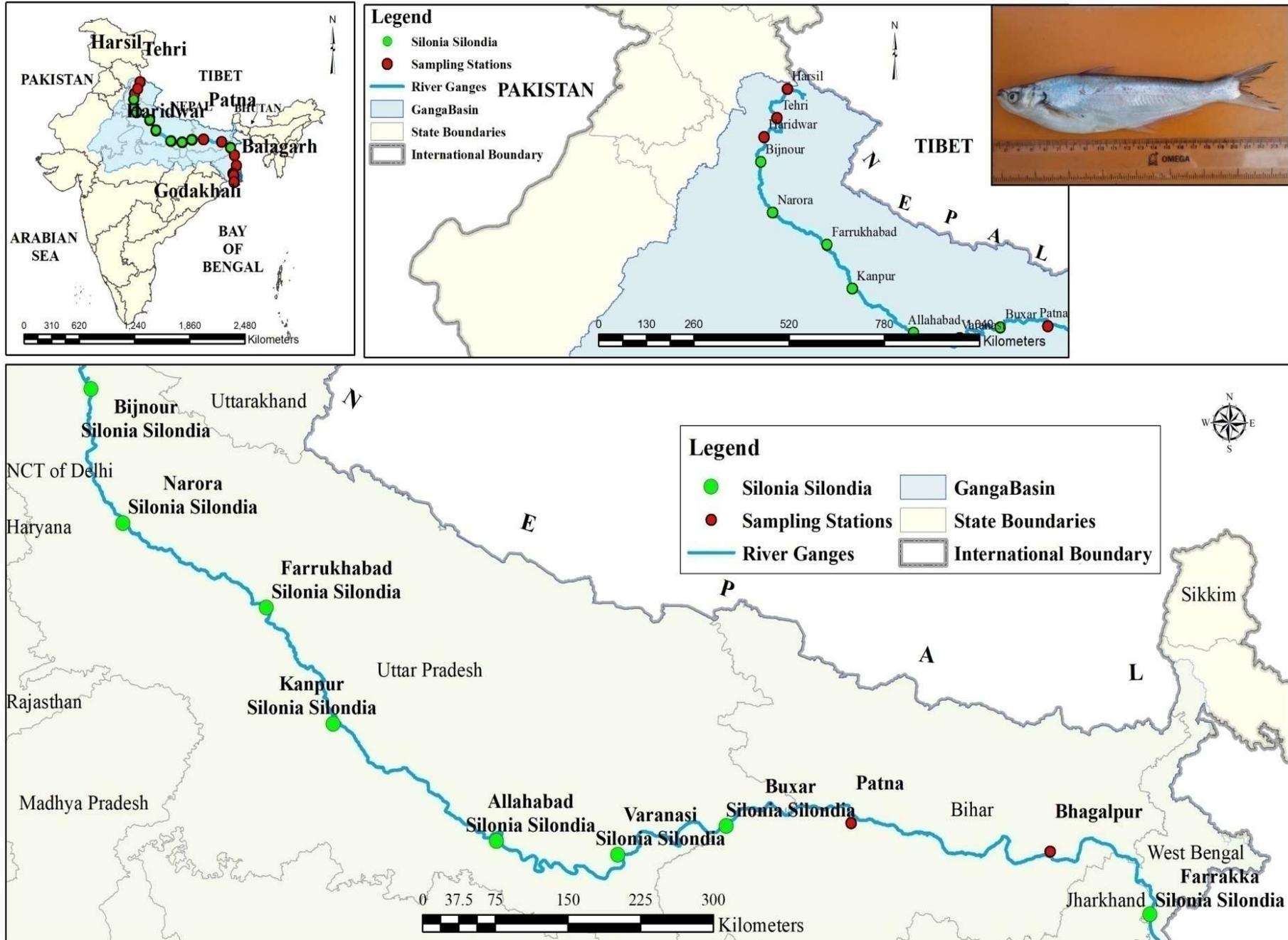
- ❖ An all total of **190 fish species** belonging to **133 genera**, **60 families** and **17 orders** were recorded from 18 selected sampling stations so far under the project.
- ❖ Maximum number of species were recorded from **Bijnour (N=99)** and **Narora (N=91)** in **Uttar Pradesh**
- ❖ Out of 190 fish species recorded, total of **12 Near threatened (NT)**, **03 Endangered (EN)** and **04 Vulnerable (VU)** have been recorded as per **IUCN Red list category ver. 3.1** from the entire stretch of the river Ganga.



Threat status (IUCN)	Number of species enlisted
Near threatened (NT)	12
Endangered (EN)	03
Vulnerable (VU)	04
Least concern (LC)	120
Not evaluated (NE)	45
Data deficient (DD)	06



LOCATION OF SAMPLING STATIONS WITH SILONIA SILONDIA ON RIVER GANGES





River ranching of depleted fish stock and awareness programme





भारत का राजपत्र The Gazette of India

असाधारण
EXTRAORDINARY
भाग II—खण्ड 3—उप-खण्ड (iii)
PART II—Section 3—Sub-section (iii)
प्राधिकार से प्रकाशित
PUBLISHED BY AUTHORITY

सं. 4009] नई दिल्ली, बुधवार, अक्टूबर 10, 2018/आश्विन 18, 1940
No. 4009] NEW DELHI, WEDNESDAY, OCTOBER 10, 2018/ASVINA 18, 1940

जल संसाधन, नदी विकास और गंगा संरक्षण मंत्रालय

(राष्ट्रीय स्वच्छ गंगा मिशन)

अदेश

नई दिल्ली 9 अक्टूबर, 2018

क्र.सं. 5195(अ).—गंगा नदी अत्यधिक पवित्र और हम देश के लोगों द्वारा अत्यंत प्यार कीये गयी है तथा गंगा नदी बेसिन अर्थात् क्षेत्र के निवासियों द्वारा भारत में दूसरा नदी बेसिन है, जिसमें भारत देश की अर्धशत प्रतिशत मृत्ति निम्नलिखित है तथा जो लगभग एकसय करोड़ जनसंख्या के लिए पोषणीय है।

और गंगा नदी विशेष रूप से विकसित हो तथा महत्व के रूप में बढ़ती है जिसका महत्वपूर्ण नैतिक और स्थानिक प्रभाव विकास के साथ अन्य विज्ञान, वृ-आधुनिकीकरण, वैज्ञानिक, सामाजिक-सांस्कृतिक और आर्थिक कारण है।

और गंगा नदी को राष्ट्रीय नदी का दर्जा दिया गया है तथा नदी उपनदी में मिलाई, धरतु, औद्योगिक और अन्य प्रयोजनों के लिए बेसिन में सर्वत्र पानी की बढ़ती मांग के साथ धरतु, अत्यधिक और आधुनिक, अत्यधिक महत्व विविध क्षेत्रों में उत्पादक क्षेत्र कर रहा है जो नदी के स्वास्थ्य को नष्ट करने में प्रभावित कर रहा है।

और भारत सरकार, समुचित पर्यावरण प्रदाय तथा नदी में प्रदूषण के प्रवेश के नियंत्रण को सुनिश्चित करने के लिए नदियों की पौष्टिकता की बढ़ती करने और उसे बनाए रखने के लिए बचसबद्ध है।

और यह सुनिश्चित करना आवश्यक है कि गंगा नदी में इन समय पानी के निबंध प्रदाय को पूरी तरह से बनाए रखा जाए, जिसमें सौसमी विद्याओं को बढ़ाने कि नदी में प्रदाय की निगरानी सुनिश्चित हो सके।

केंद्रीय सरकार ने पर्यावरण (संरक्षण) अधिनियम, 1986 (1986 का 29) के अर्द्धन अधिसूचना का सं. 3187 (अ) तारीख 7 अक्टूबर, 2016 द्वारा गंगा नदी जल क्षेत्र के संरक्षण, संरक्षा और प्रदाय तथा निबंध विधि उपयोजनों के लिए एक अतिरिक्त अर्द्धन राष्ट्रीय स्वच्छ गंगा मिशन का गठन किया था। अर्द्धन।

(क) गंगा नदी और उसकी महाप्रवाह नदियों के जल की गुणवत्ता और पर्यावरणीय बढ़ती संरक्षण, संरक्षा और प्रदाय को सुनिश्चित करने के उद्देश्य में सर्वत्र विभिन्न क्षेत्रों में विविध विधुओं पर बनाए रखने के लिए, अतिरिक्त गंगा नदी और उसकी महाप्रवाह नदियों में पर्यावरणीय 5941 GI/2018

**MINISTRY OF WATER RESOURCES, RIVER DEVELOPMENT AND GANGA REJUVENATION
(NATIONAL MISSION FOR CLEAN GANGA)**

ORDER

New Delhi, the 9th October, 2018

S.O.5195(E).—Whereas, the River Ganga is the most sacred and deeply revered by the people of this country and the Ganga river basin is the largest river basin in India in terms of catchment area, constituting twenty six per cent of the country's land mass and supporting about half a billion population;

And whereas, River Ganga is unique as having special properties, features and importance, holding reasons that are hydrological, geomorphological, historical, socio-cultural and economical with significant temporal and spatial flow variation;

And whereas, River Ganga has been given status of a National river and the ever increasing demand for water in the basin for irrigation, domestic, industrial and other purposes coupled with pollution ingress from different sources including domestic waste, industrial waste, into river system is affecting the health of the said river for long;

And whereas, the Central Government is committed to restore and maintain the wholesomeness of the rivers ensuring appropriate environment flows and simultaneously preventing the pollution ingress into the said river;

And whereas, it is considered necessary to ensure that uninterrupted flows of water are maintained throughout its length at all times in River Ganga to ensure continuity of flows in the river without altering the seasonal variations;

And whereas the Central Government vide notification S.O. 3187(E), dated the 7th October, 2016 under the Environment (Protection) Act, 1986 (29 of 1986) has constituted an authority, namely, the National Mission for Clean Ganga for Rejuvenation, Protection and Management of River Ganga basin for the following purposes, namely:-

(a) to determine the magnitude of ecological flow in the River Ganga and its tributaries required to be maintained at different points in different areas at all times with the aim of ensuring water quality and environmentally

[भाग II—खण्ड 3(ii)] भारत का राजपत्र : असाधारण 5

- (iii) the project which is at different stages of construction, where physical progress on ground has been initiated and made and reported to appropriate authority shall also make necessary provisions to maintain the stipulated environmental flow before and after commissioning of the project;
- (iv) the mini and micro projects which do not alter the flow characteristics of the river or stream significantly are exempted from the set environmental flows;
- (v) to ensure the release of desired quantities of water to maintain environmental flows, flow conditions in these river reaches shall be monitored at hourly intervals from time to time;
- (vi) the Central Water Commission shall be the designated authority and the custodian of the data and shall be responsible for supervision, monitoring, regulation of flows and reporting of necessary information to the appropriate authority as and when required and also authorised to take emergent decisions about the water storage norms in case of any emergency. The Central Water Commission shall submit flow monitoring-cum-compliance report on quarterly basis to National Mission for Clean Ganga;
- (vii) the concerned project developers or authorities shall install automatic data acquisition and data transmission facilities or required necessary infrastructure at project sites at appropriate locations specified by the Central Water Commission within six months from the date of this order. The installation, calibration, maintenance of flow monitoring facility shall be the responsibility of the project developers or authorities and they shall submit the data to the Central Water Commission from time to time;
- (viii) the Central Government through National Mission for Clean Ganga may direct release of additional water in the River Ganga to meet special demand as and when required.

IV. The concerned Central and State authorities shall implement demand side management plans to reduce water withdrawal from River Ganga by adopting good and scientific practices such as efficient method of irrigation, reuse and recycle of water including monitoring and regulation of ground water withdrawals for various purposes.

3. This Order shall come into force on the date of its publication in the Official Gazette.

4. This Order shall apply to the upper Ganga River Basin starting from originating glaciers and through respective confluences of its head tributaries finally meeting at Devprayag up to Haridwar and the main stem of River Ganga up to Unnao district of Uttar Pradesh.

(F. No.- Estt.Oy/2016-17/111/NMCG/Vol III)
RAJIV KISHORE, Executive Director(Admn)





Maintaining Longitudinal connectivity in rivers

Ecological flows

+

Fish Pass





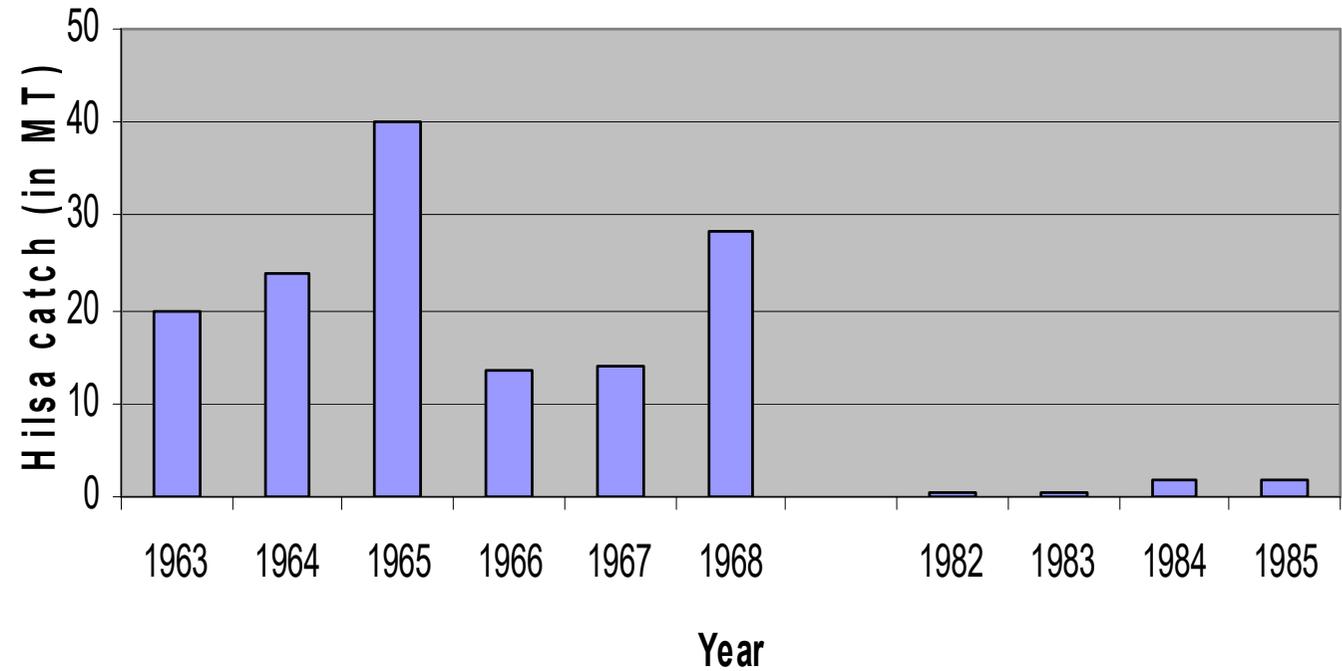
Hilsa fisheries improvement in middle stretches of river Ganga





Upstream Farakka Barrage

Hilsa Catch at Allahabad



Trend of hilsa catch at Allahabad



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CWC, NMCG, IWAI & CIFRI



Hilsa ranching station, Farakka



©ICAR-CIFRI



Hilsa tagging to understand the migration of hilsa in the middle stretch of river Ganga



GUIDELINES FOR MAINTAINING LONGITUDINAL CONNECTIVITY THROUGH DAMS



CENTRAL WATER COMMISSION

SEPTEMBER 2017

3.3.3 Guidelines for maintaining longitudinal connectivity for fish migration

1. Optimum ecological/environmental flows must be estimated taking into account of fish migration, and recruitment.
2. Bypass channel is recommended in the middle and lower stretches of the river for maintaining the fish habitat and migration.
3. Detailed behavioral study on fish migration and habitat requirement of the targeted fish species must be carried out before designing of fish pass/bypass.
4. Design of fish pass in barrages must be site and species specific and should be installed in a straight way with optimum continuous flows and natural slope of the river.
5. In dams with wide gorge or relatively flat topography at abutments, provision of fish passes in the form of fish ladder/ bypass channel should be explored. In other dams, provisions of fish lift shall be explored.
6. In dams, where fish ladder/bypass channel/lift etc. is not suitable due to technical constraint of height and site topography, other conservation measures such as creation of fish hatchery/ fish farm may be considered
7. For planning and design of fish pass in a particular dam and river reach, CIFRI or any other specialized agency shall be consulted.
8. Environmental flow may be used for fish pass water requirement.



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Present/Future work on environmental flows:



GIZ-CIFRI-E-flows Mahanadi delta



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Ohh...Water....

***You are not something
that is needed for life;
you are life itself.***



THANK YOU

