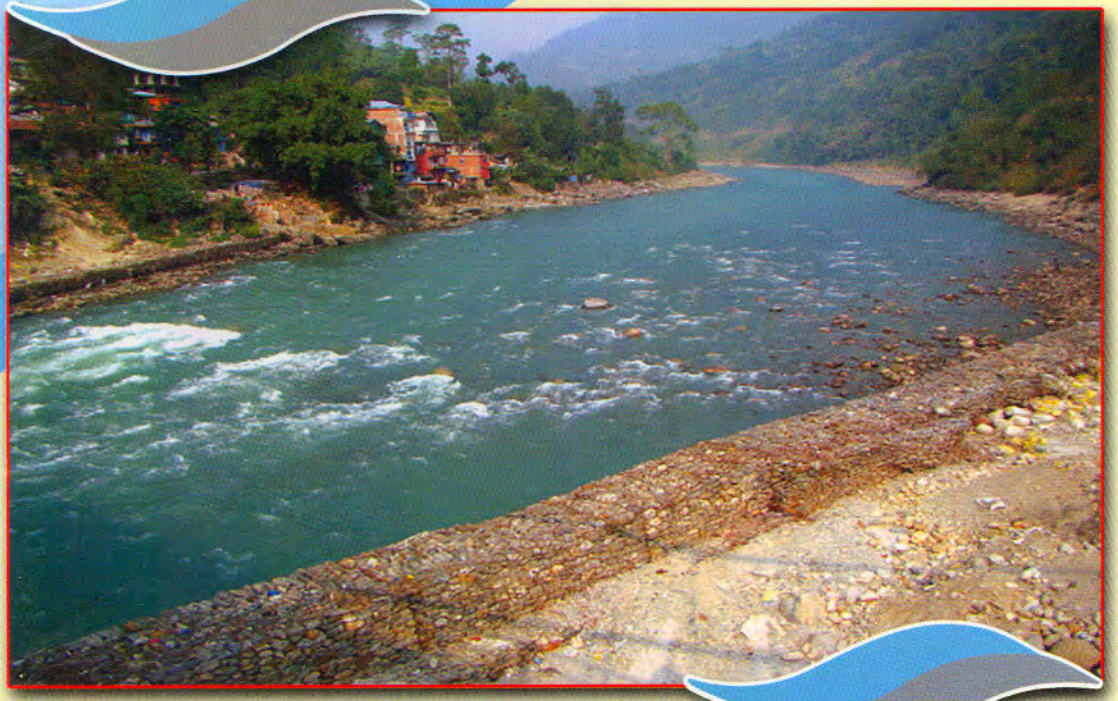
IMPROVE AQUATIC HABITAT - SAVE FISH AND FISHERS



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Introduction

The aquatic ecosystem very often serve as the mirror of environmental degradation due to various anthropogenic activities. In recent years the inland aquatic resources in India, constituted of rivers and their floodplains, reservoirs, estuaries, estuarine impoundments, mangroves and lakes is being subjected to increasing anthropogenic stress. It is expected that the pace of river and floodplain modifications will intensify in the coming years in response to the economic imperatives of development. This implies that the habitat of fish will be placed under increasing pressure. From the fisheries point of view interest in the environmental aspect of these water bodies is centered round harvesting maximum sustainable yield of fishes to meet the 5.3 million t inland fish requirement of the country by 2012. Production of harvestable biological materials from an aquatic ecosystem is dependent on a very complex community metabolism. Thus, the habitat constraints that have no direct bearing on fish can also impair the fish productivity.

How good is the aquatic habitat for fish

The inland fisheries resources, namely the rivers and their tributaries, the flood-plain wet lands (beel, jheel and bheries) and reservoirs where the main thrust for enhancing inland fish production in India would rest do not serve as a good habitat for optimum fish health.

Domestic sewage discharge in river Yamuna

What are the sources of the aquatic habitat degradation

RIVERS

Domestic waste

- Domestic and municipal effluents are estimated to constitute 75% of India's wastewater by volume
- The enormity of sewage pollution is reflected in the river Ganga in which more than 70% of the total pollutional load is contributed by the sewage.
- Municipal sewage is very often accompanied by trade waste synthetic detergents, heavy metals and (MBAS) from small scale industries sprawling around thickly urban areas.

Burning ghat on bank of river Ganga

Industrial wastes

- There are 3 million small-scale industrial units (SSIUs), about 35.30% of them are of polluting nature.
- Of the large water polluting industrial units discharging effluents into the rivers and lakes, only 29% have adequate effluent treatment plants.
- 229 class I cities in India generate about 16662.5 MLD of waste water whereas the capacity to treat only 4037 MLD exists. 345 Class II towns generate about 1650 MLD of waste water whereas capacity to treat only 61.5 MLD exists.

Agricultural runoff

- The problem of water pollution becomes more severe as the magnitude of agricultural runoff containing pesticides and fertilizers is very vast.
- The fertilizer (N+P2O5+K2O) consumption in India has increased from 7.7 million tonnes in 1984 to 17.54 million tonnes of nutrients in 2000-01.
- Use of pesticides also increased from 24,305 tonnes in 1971 to 61,357 tonnes in 1994-95.
- Only 25-30% of total cultivated area is under pesticide cover. Yet the pesticides and their residues have polluted agricultural produce and different components of environment mainly due to improper handling, wrong use schedule, non-awareness about chemicals and their residue behaviour.

Growth of agriculture near river banks

Industrial effluent discharge in rivers Damodar and Ganga

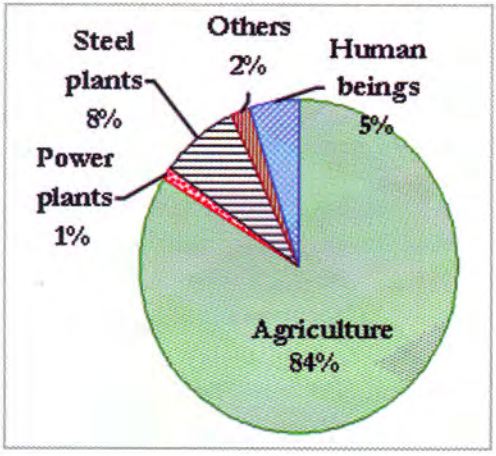
Abstraction of water

» The projected water requirement of India for irrigation and other uses from the different water course, as estimated during 2025 is approximately 1100 billion cubic meter.

» 80% of India's utilizable water is devoted to agriculture in the form of irrigation and 6% for industrial water use (MoWR). Demand of domestic sector is only 5% of the annual fresh water withdrawals in India.

» The large scale abstraction alters the water quality by reducing the load bearing capacity of down stream water. Although water abstracted for the various needs are drained back into the water system, but it is contaminated by a variety of substances detrimental to aquatic life.

Utilization of Damodar river water

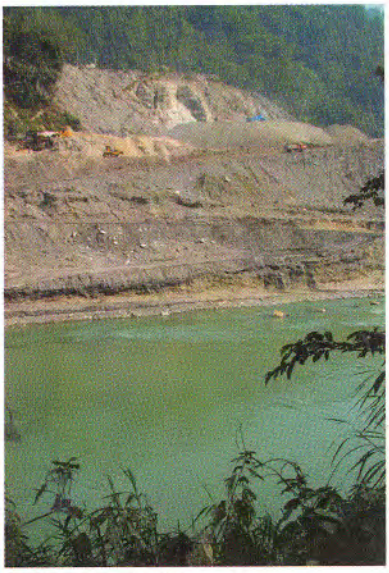


Siltation

» Nearly 5334 million tons of soil is eroded annually from the cultivable land and forests of India.

» On cropland, the erosion can range from less than 3 to more than 50t $acre^{-1}y^{-1}$.

- The country's rivers carry approximately 2050 million tons of soil of which nearly 480 million tons is deposited in the reservoirs and 1572 million tons is washed into the sea every year.
- The loss of storage capacity of reservoir due to silting is by far the most serious problem created by soil erosion .The sediment load of the river Ganga and Brahmaputra are the highest in the country with 586 million t to 470 million t respectively. Of the major river basins studied in the country more than one third carry sediment loads of 100 million t or more.



Soil erosion in Teesta river

Sandification of river bed

The bed of river Ganga upto Patna is predominantly sand blanketting productivity at the soil water interface. Further, frequent and massive sand extraction from the river bed colonization and growth of aquatic fauna and flora.

Sand extraction in Damodar river

Flood Plain wetlands

- The wetlands, located in the states of West Bengal, Assam, Bihar and Uttar Pradesh are mostly in various stages of eutrophication.
- Majority of them are choked with submerged or floating vegetations and have sub optimal water quality causing stress to the resident fish.

Weeds and jute retting in wetlands

Sewage fed bheries

» The sewage fed bheries of West Bengal where fishes are reared in approximately 4,000 ha of water area, is a unique and inexpensive system of rearing fish, sustaining a sizeable fish eating population of Kolkata. But the ecological conditions of the wetlands fed with Kolkata minicipal sewage limit fish production.

Reservoirs

» Industrial development and urbanization in the catchment of reservoirs has caused eco-degradation of the reservoirs.

» Industrial effluents, thermal power plants, domestic water siltation have degraded various reservoirs like Musi, Byramangala, Hussain Sagar, Tungabhadra, Rihand, Panchet, Hirakud Dam, Gorakhpur, Harangi, Bhavanisagar, Govindsagar and Nizamsagar to name a few.

Climate change

Coupled with the other degrading sources of aquatic habitat the climate of India in the past few decades is showing perceptible changes. The manifestations are

» Increase in surface air temperatures of 0.4° C over the past century. In the Gangetic plains the mean maximum air temperature during March to September during 1986-2005 has increased by 0.68°C

and mean minimum air temperature has increased by 0.37°C . Water temperature changes in the upper stretch of river Ganges at Haridwar indicate an increase of 1.5°C in the annual mean minimum water temperature at present compared to the period 1970-86.

» Regional monsoon rainfall variations and rising trend in the frequency of heavy rain events. Percentage of total rainfall in the peak breeding period (May- Aug) in the last two decades declined by 5% whereas it increased by 7% in the post-breeding period in the middle stretch of river Ganga.

» Multi-decadal periods of more frequent droughts, followed by less severe droughts and increasing trend in severe storm incidence along the coast of the states of West Bengal and Gujarat.

» Sea level rise between 1.06-1.75 mm per year.

Ways by which the stressed environment impact inland fisheries

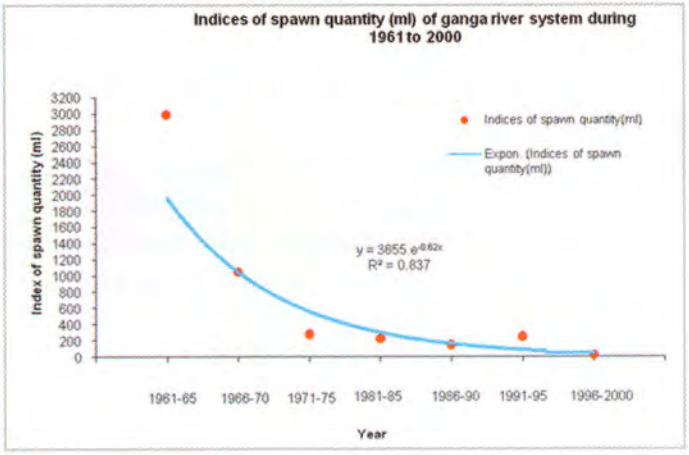
Fish recruitment

Water abstraction and consequent reduced stream flow and shifting pattern of monsoon rains has affected the breeding and recruitment of fishes. The oxbow lakes, deep pools and other lentic water bodies associated with the rivers act as sanctuaries for the brooders which get isolated with inadequate discharge rates.

The fish spawn availability index in river Ganga has declined. The share of the major carp seeds are decreasing at a fast rate. In the middle stretch of river Ganga spawn availability has declined from 281 ml during 1970s to 27 ml in recent years (1996 to 2000).

Majority of fishes of the Ganga river system breed during the monsoon months i.e. June to August depending on

the seasonal floods. Shift of rainfall to the post-breeding period leads to resorption of eggs of IMCs.



Fish composition

The total average fish landing in the Ganga river system has declined from 85.21 t during 1959 to 62.48 t during 2004.In general the percentage of IMC declined with the increase of other fish groups

Invasion of Exotic fish species

» Alterations in the fish composition are prominent in the inland waters.

» In the Allahabad and Varanasi stretch of river Ganga, the share of exotics is mostly that of common carp and is approximately 15 to 30 % of the total catch. In Yamuna (Agra and Mathura) stretch *C. carpio, O. niloticus* and *C. garipenius* constitutes approx. 18-25% of the catch.

Exotic fishes

Change in Salinity

» There has been a overall decline in the salinity of Hooghly-Matla estuary after commissioning of Farrakka barrage with gradient and marine zones pushed down towards sea. This has brought about distinct change in the species composition of fishes with freshwater species making their appearance in tidal zone and a few neritic species disappearing.

» In Krishna estuary on the contrary, the water availability in the river downstream of Prakasam Barrage has dwindled. As a result an increase in salinity from 20 to 35 ppt has occured because of tidal seawater incursion into the riverine stretch and mullets are the dominant catches (80 %).

Obstructions to fish migration

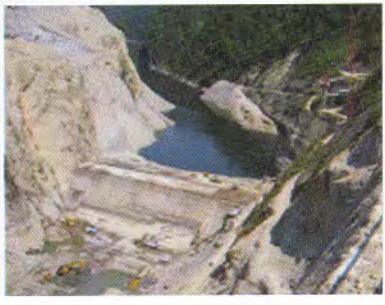
» Hilsa is a classical example of anadromous fishes being affected due to obstruction of their migratory pathways by dams. Their natural migratory range of 1500 km from the Hooghly estuary to Allahabad on the Ganga has been affected.

» The dams in the upper stretches of the river obstruct migration of mahseers *(Tor spp)* and *Schizothorax sp.* that move to the upper stretch of the river for breeding.

» Majority of these hydraulic structures in India do not have the provisions of fish pass, resulting in significant reduction of fish species and yield.

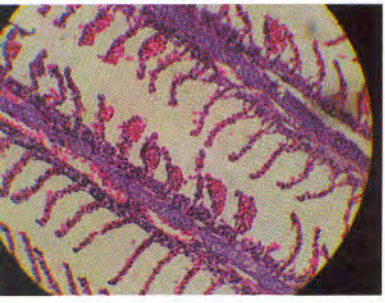
Migratory fishes

Disruption of continuity of rivers



Contamination

Water quality : The adverse effects of sewage pollution are deoxygenation, high BOD load, rapid eutrophication and accumulation of heavy metals in the environment. Sharp fall in dissolved oxygen in water puts the biotic communities under severe stress. This is evident in many stretches of rivers like the stretch from Delhi to Agra in river Yamuna and in the various weed choked wetlands of West Bengal and Assam.



Gill damage in fish

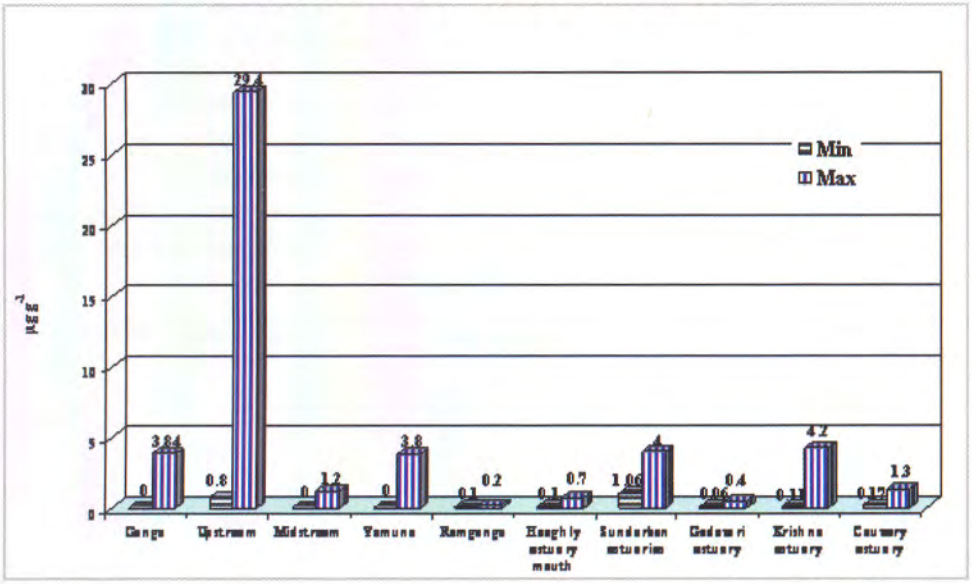
Suspended solids : Exposure of fishes in river Damoder to fly ash produced from thermal power plants cause respiratory distress. This is due to deposition of coal dust particles and fine silt on the gills. Damages occur in the primary and secondary gill lamellae with swollen tips.

Heavy metals : Heavy metal contamination has been a problem for fisheries in the rivers. Metal is a point source pollutant and since it gets adsorbed or precipitated very quickly on particulate matters, the effect is not clearly observed zone wise in a river. The estuary zones of river Ganga is heavily industrialised with metal contamination in water but the high tidal flushing activity is not allowing the metals to accumulate at alarmingly high levels.

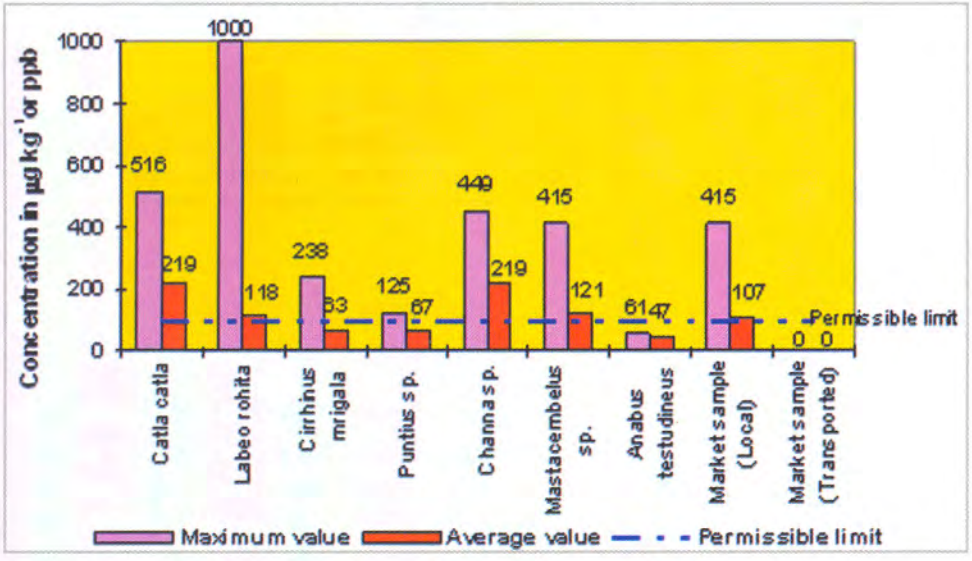
Arsenicosis

The toxic metalloid arsenic contamination in ground water is widely distributed in nature. Nearly 42.7 million people in nine districts of West Bengal are affected with arsenic problem, where contaminated ground water is usually used. In one such area of Nadia district, arsenic concentrations up to 116 $\mu g\ l^{-1}$ have been detected in the surveyed pond water, a level much higher than the National drinking water permissible limit of 50 $\mu g\ l^{-1}$ and WHO limit of 10 $\mu g\ l^{-1}$. A number of fishes were examined for their arsenic accumulation in fleshes. About 20% of the fish samples collected from arsenic affected area had arsenic content above the permissible level of 100 $\mu g\ kg^{-1}$, indicating moderate level of risk associated with human consumption.

Cd level in the sediments of inland waters



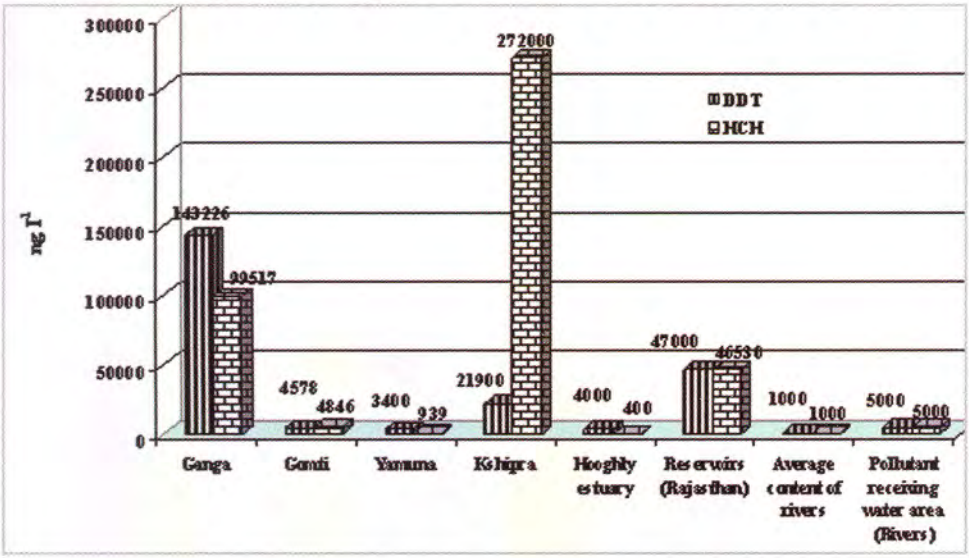
Arsenic contamination in fish fleshes



Pesticides : The pesticide residues from Indian aquatic environment are limited to the organochlorines.This is because organochlorine insecticides were the only group of chemicals used in the initial phase (almost entire amount) and were also the dominant group in the latter

stages (>50%) of use. The organophosphates, carbamates, etc. are esters and are relatively quickly degraded in the environment. Organochlorines, on the other hand, are lipophilic and persistent, which accumulate in the food chain and, therefore, are the compounds routinely encountered in the samples derived from nature.In general, higher residues are reported from the fresh water zone of the estuaries, the sites of effluent and agricultural field washing discharges.

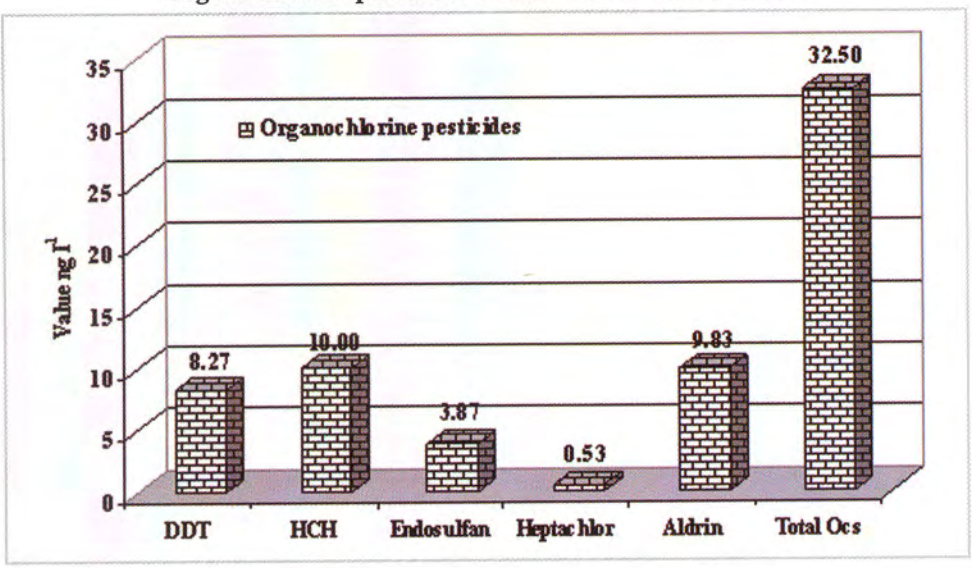
Maximum organochlorine pesticides residue in the surface water of India



Pesticides as runoff from agricultural fields is also a major source of pollutant in floodplain wetlands.

Safe levels of Pesticides for water and fish : In India, permissible limits of the organochlorine pesticides for aquatic organisms or their consumers have not yet been developed.Thus the US EPA limits (EPA,2002, 2006) are considered for comparison. All the surface water resources are contaminated with the residues of organochlorine pesticides, the level of which often cross thousand times over the permissible limits.However, the residues in fish fleshes are below harmful level for human consumption except in a few cases.

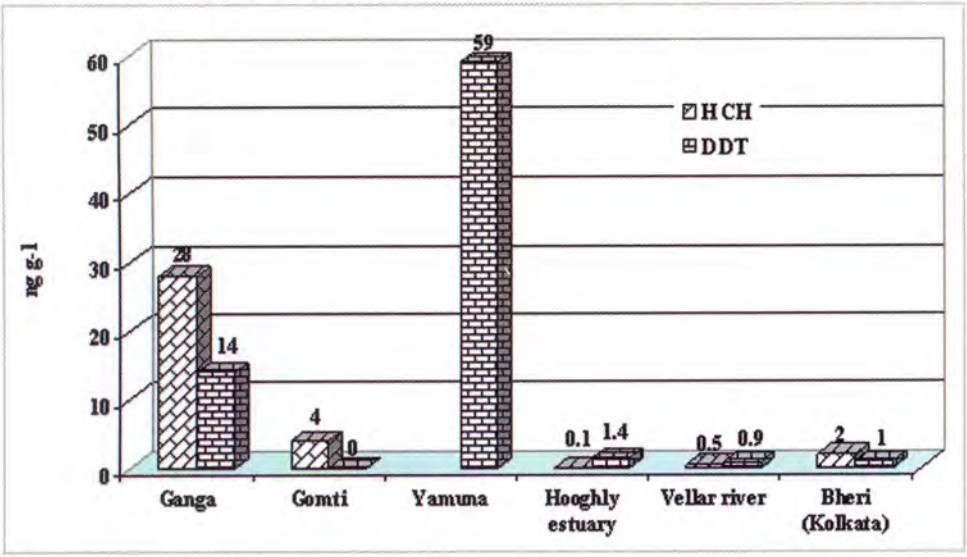
Organochlorine pesticides in the water of Bansdah beel



US EPA limit of organochlorine pesticides (ngl^{-1})

Pesticide	For human health	CCC for Aquatic organism
α -HCH	2.6	---
β -HCH	9.1	---
γ -HCH	19.0	---
4,4'-DDT	0.22	1.0
4,4'-DDE	0.22	---
4,4'-DDD	0.31	---
Aldrin	0.049	---
Dieldrin	0.052	56 / 19 (fresh water / saline water CCC)
α/β -Endosulfan	62000	56
Heptachlor	0.079	3.6/3.6 (fresh water/saline water CCC)

Maximum organochlorine pesticides residue in the aquatic biota of India

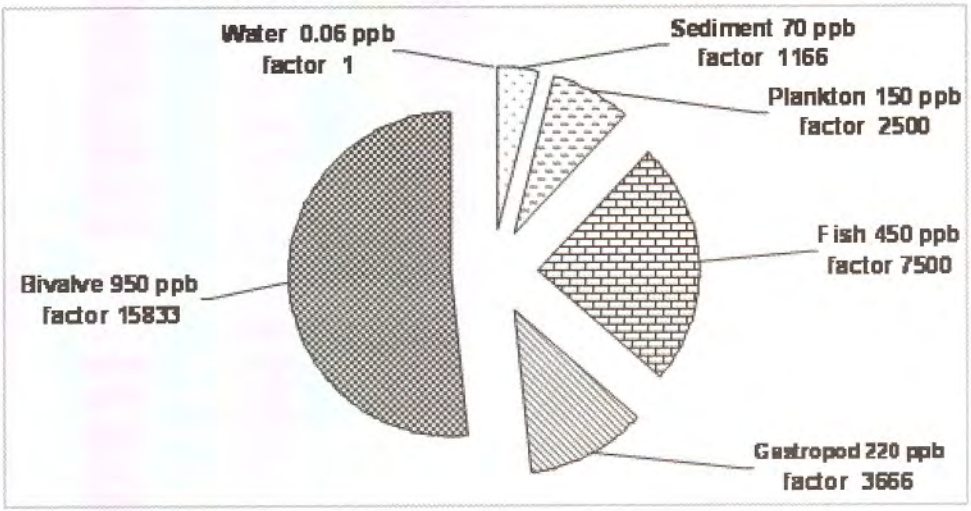


Paper and pulp mill effluent : Impact of toxic discharge from paper and pulp mill in river Hooghly or sugar mills in rivers Kali, Churni is reflected in erratic movement and mortality of fishes. Bleaching powder present in the paper and pulp mill effluents release free chlorine which is highly poisonous with corrosive properties and is responsible for fish mortality. Sugar mill effluents deplete DO in the river water resulting in fish morbidity and mortality.

Bio-magnification of pollutants : Organochlorine pesticides are lipophilic and persistent, accumulate along the food chain and, therefore, are the compounds routinely encountered in the samples derived from nature.

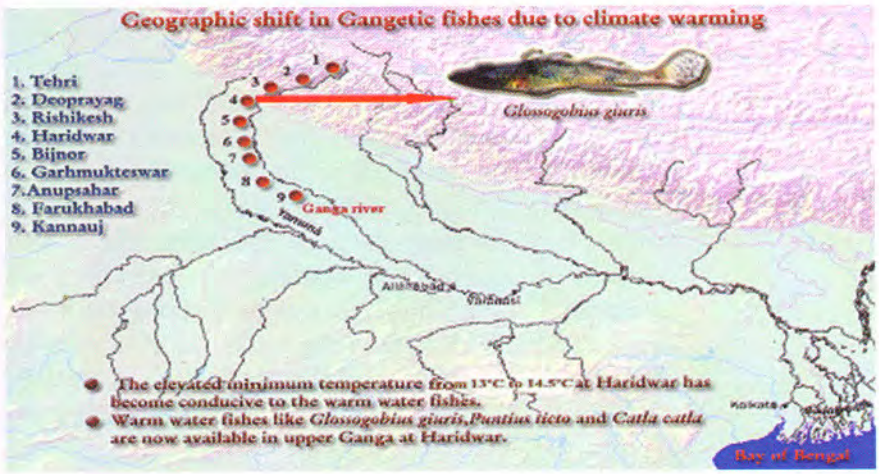
In the Hooghly estuary, studies were conducted to determine the bio-concentration factor of DDT. The observed levels of DDT in different components of the food chain and bio-magnification factors show the bio-concentration factor of 7500 for fish and 15833 for bivalves indicating risk associated with the terrestrial consumers including human beings.

Biomagnification of DDT in aquatic food chain in Hooghly estuary



Climate change

Shift in geographical distribution of the Gangetic fishes is evident. Warm water fishes like *G. giuris*, *P. ticto*, *X. cancila*, *M. vittatus*, *C. catla* mainly inhabiting in the middle and lower Ganga, are now available in upper Ganga at Haridwar and above. The present increase of 1.5°C in the annual mean minimum water temperature in the upper stretch of river Ganges at Haridwar has resulted in such shift.



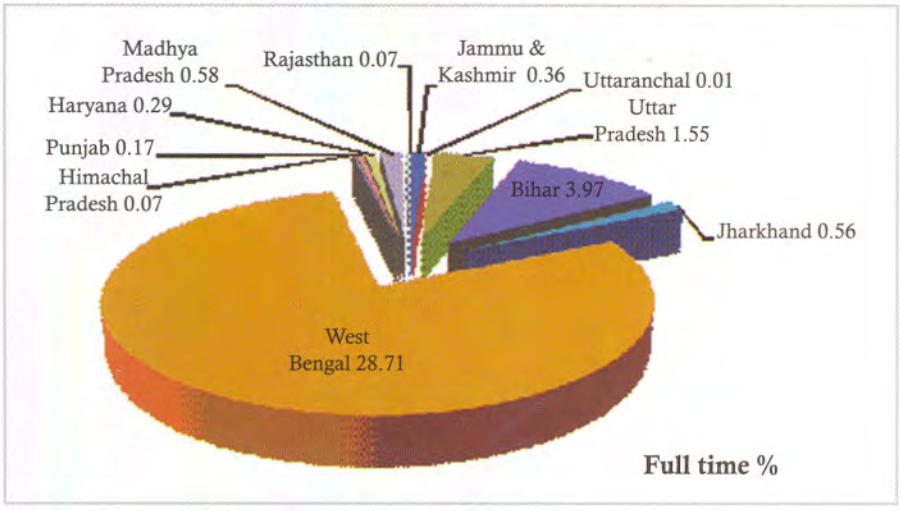
Changes in environmental flow

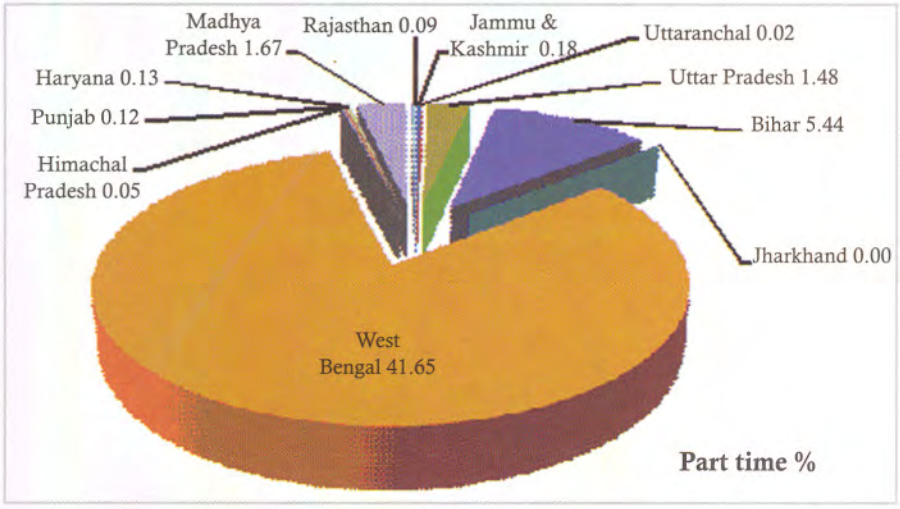
The National Water policy (NWP) of India stipulates (Clause 14.3) that "Minimum water flow should be ensured in the perennial streams for maintaining ecology and social considerations". However, the NWP also places environment in the fourth order of priority for allocation of water. The sequence of priority is drinking water, irrigation, hydropower, and then environment. This means that at any particular location, the available water after supplying the requirements of drinking, irrigation and hydropower requirement, the requirement of environment will be fulfilled. On the other hand, the concept of a minimum flow in the river stipulates that a certain quantity of water is to be first allocated to maintain this minimum flow, and all other requirements are to be supplied only from the balance if any. This upgrades the environment requirements at priority one. Thus it is seen that placing of environment at fourth priority in the NWP creates a conflict with the concept of minimum flows or EFR.

How are the fishers affected

Livelihood issues: Fisheries are one of the main sources of livelihood and employment opportunities for the rural poor, particularly the fisher community. In case of inland waters, fisheries in open waters (Rivers, Reservoirs, Floodplains and Estuaries) are, although, of subsistence type, yet, have high potentials for production enhancement. The fish catches from these waters contribute significantly to their food and nutritional security. Inland aquaculture has witnessed the highest growth rate and emerged as the most important and contributing activity to fisheries sector. The livelihood options exist for both the poor and large fish farmers through horizontal and vertical integration of the enterprise. Unfortunately due to degradation of the inland aquatic resources the rivers, wetlands and reservoirs has not been able to attain their fish production potential.

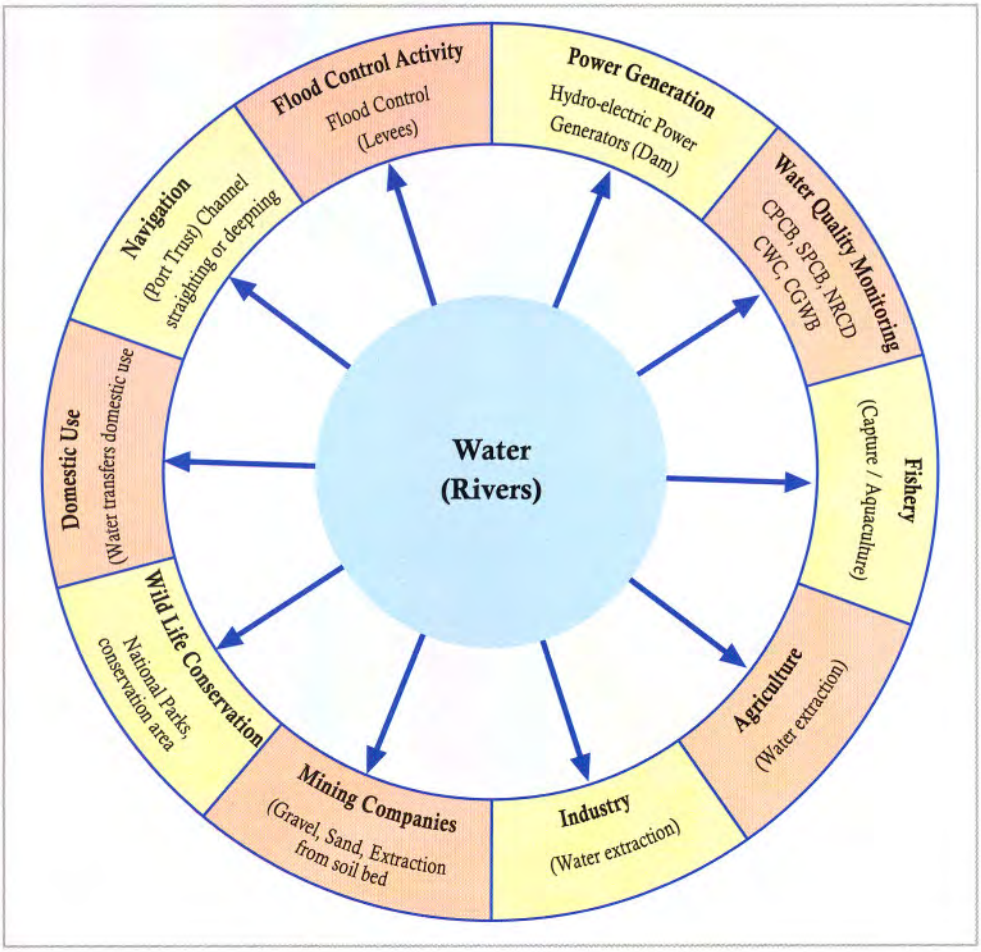
Fishers engaged in fishing activities in the states of Gangetic plain





Concerns of stake holders of Inland waters

India is endowed with vast open large water bodies and small closed waters. These waters have multiple uses, ownerships and stakeholders.



Community participation : The multiple ownership of the water bodies for sustainable exploitation of fish stocks can be achieved through community participation and co-management. It is also high time to implement the code of conduct for responsible fisheries. The country has a strong traditional wisdom and know-how in different aspects of fisheries

and aquaculture. While the programmes could benefit greatly by harnessing these, it is also imperative that there should be an active community participation for their successful implementation. The people's participation programmes have demonstrated that participation in the fish conservation programme is possible only when the members of the target group are able to pool their efforts and resources in pursuit of objectives and goals they set for themselves. The most efficient means of achieving this objective are small, democratic and informal groups of 8 to 15 like minded people. All the programmes on conservations aiming at ecological restoration for maintanace of optimum fish health and socio-economic development would have better chances of success if people visualise these as their own activity. The fish conservation movement necessarily involves both.

The agencies and laws governing the aquatic resources

» For inland fisheries and its beneficiaries as stake holder the significance of water lies in the fact that water in the river, reservoir or lake serve as habitat for fish unlike other stakeholders. For suggesting any policy for inland fisheries development it is essential to understand the structure and mechanism of water quality governance in India.

Policy Framework

» The policy framework of Government of India for management of water resources are elucidated in National Water Policy (2002); National Conservation Strategy and Policy Statement on Environment and Development (1992); Policy statement for Abatement of Pollution (1992) and Draft National Environment Policy (2004).

» The policy statements and strategies advocated are technological measures like use of clean technologies and water pollution control systems; zoning strategy

like setting up of source specific and area wise water quality standards and time bound plans to prevent and control pollution; fiscal incentives for environmentally clean technologies, recycling and reuse of wastes and conservation of natural resources, operationalization of polluter pays principle and command control like enforcement of pollution control norms, environmental audit, EIA and clearance of projects by MOEF above certain size.

Legal Framework

- The Water (Prevention and Control of Pollution) Act, 1974 : It has created the Central and State Pollution Control Boards (CPCB and SPCBs).
- The Water Cess Act, 1977: It was amended in 2003 and its main attention is to enhance the finance of the CPCB and SPCBs by imposing a levy (cess) on water consumed by certain industries and by local authorities.
- The Environmental (Protection) Act, 1986: It empowers the Central Government to decide emission standards, restricting industrial sites, laying down procedures and safeguards for accident prevention and handling of hazardous waste investigation and research on pollution issues.
- The Environment Impact Assessment introduced in 1994, empowered Central Government to impose restrictions and prohibitions on installation expansions or modernization of 30 types of activities unless an environmental clearance is granted.

Institutional Framework

- At present, states generally plan, design and execute water supply schemes. Water supply and sanitation is a state responsibility under the Constitution of India. The states may give the responsibility and powers to the Panchayati Raj institutions (PRIs) and

Urban Local Bodies (ULBs). In addition, a variety of different government institutions at the centre have a role in the management of declining of water supply.

» Ministries of Water Resources, industry, power, agriculture, environment and forests, rural development, urban development are some of the major stakeholder's ministries that have a mandate in water resource management.

» Other important institutions that have a major role in water resource/quality management are Central Water Commission, Central Groundwater Board/Authority, Central Water Quality Authority, Central and State Pollution Control Boards.

What is emerging out very clearly from the various researches conducted in India is that we will have to live with water scarcity and variability in coming years. Thus managing water for agricultural production, domestic and industrial consumption and fisheries / environmental uses along with maintaining the water quality will be a daunting task. The various technical guidelines / solutions, awareness programmes will have no practical use to the water users especially for fisheries, unless supported by decision making people who ensure that solutions are inbuilt into governance and institutional framework.

Projects addressing Aquatic Ecosystem and Fish Health Management at CIFRI

- Developing fish-based indicator tools for environment monitoring
- Monitoring and bioaccumulation of metal and pesticides contamination in the food chain of inland open waters
- Microbial diversity assessment and their role in environmental mitigation in inland waters
- Estimation of stress mediated genetic contamination in fishes from different stressed ecosystems
- Developing health management protocols for inland aquatic ecosystems through proteomics
- Arsenic In Food Chain: Cause, Effect and Mitigation
- Impact Adaptation and Vulnerability of Indian agriculture to climate change- Impact assessment of climate change on Inland Fisheries
- Microbial Phosphorus Transformations in Inland Open Waters
- Bio-prospecting of genes and allele mining for a-biotic stress Tolerance
- Toll-like Receptors in Phylogenetically Divergent Fish Species-Their Contribution in Modulating the Innate Immunity
- Nutrient profiling and evaluation of fish as a dietary component
- Assessment of inland resources using remote sensing technique
- Development and standardization of Database on Web GIS platform for capture fisheries
- Strengthening of Database and Geographical Information system of the Fisheries Sector

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