Environmental Constraints For Inland Fisheries Development: Issues And Management Options

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NATIONAL WORKSHOP:TOWARDS DEVELOPING AN IMPLEMENTATION PLANFOR INDIA'S 2018 (DRAFT) NATIONAL POLICY ON INLAND FISHERIES AND AQUACULTURE (NIFAP) AND THE SSF GUIDELINES

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INLAND AQUATIC RESOURCES

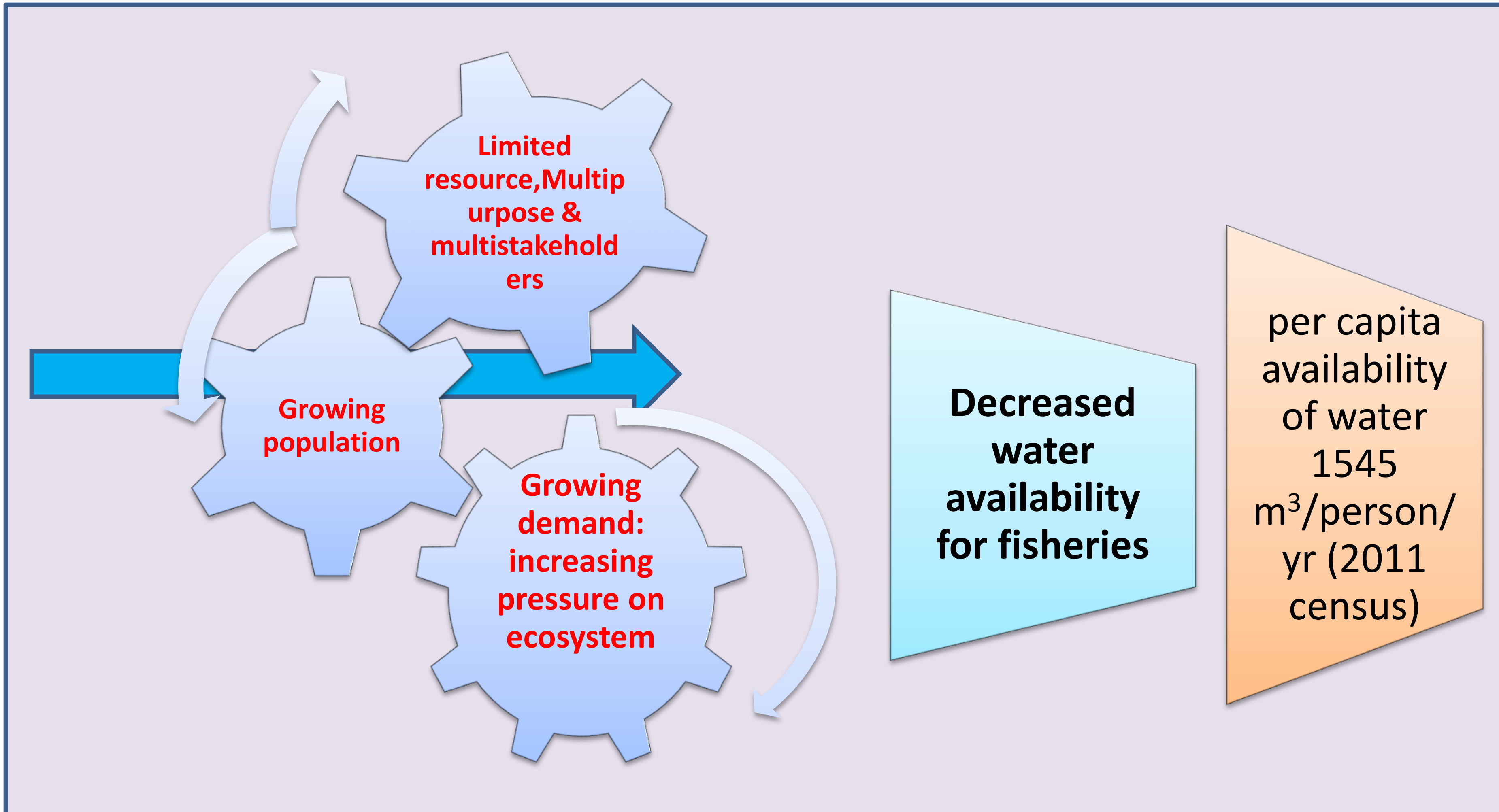
RESOURCE TYPE	SIZE	PRODUCTION POTENTIAL	CURRENT PRODUCTION	GAP IN PRODUCTION
RESERVOIRS	Million hectare	In ‘’000 tonnes	In ‘’000 tonnes	In ‘’000 tonnes
LARGE	1.11	57.0	13	44.0
MEDIUM	.50	39.6	6.5	33.1
SMALL	1.48	148.6	74.2	74.4
WETLANDS	0.52	0.30, (1000kg/ha)	0.05 (100kg/ha)	0.25
RIVERS	45000km	**BIODIVERSITY RESERVES**		
ESTUARIES	0.3			

- **Rich and diverse inland aquatic fisheries resources**
- **Common property resource used by large no of stakeholders**

Goods and services provided by the inland open waters

Goods & Services	*Specification* **(list is not exhaustive)**
Provisioning:	
Food	Production of fish and other aquatic animals/plants
Freshwater	A storage and retention of water for domestic, industrial, and agricultural use.
Fiber and fuel	production of logs, fuelwood, peat, fodder
Genetic materials	medicine, genes for resistance to plant pathogens, ornamental species, etc
Biodiversity	species and gene pool
Regulating:	
Climate regulation	Greenhouse gases, temperature, precipitation, and other climatic processes; chemical composition of the atmosphere.
Hydrological flows	groundwater recharge and discharge; storage of water for agriculture or industry
Pollution control and detoxification	retention, recovery, and removal of excess nutrients and pollutants
Habitat	Nursery & breeding grounds for fish
Natural hazards	flood control, storm protection
Cultural:	
Spiritual and inspirational	personal feelings and well-being
Recreational	opportunities for recreational activities
Aesthetic	appreciation of natural features
Educational	opportunities for formal and informal education and training
Supporting:	
Carbon sequestration	sediment retention and accumulation of organic matter
Nutrient cycling	storage, recycling, processing, and acquisition of nutrients

Environmental concerns for Inland Fisheries



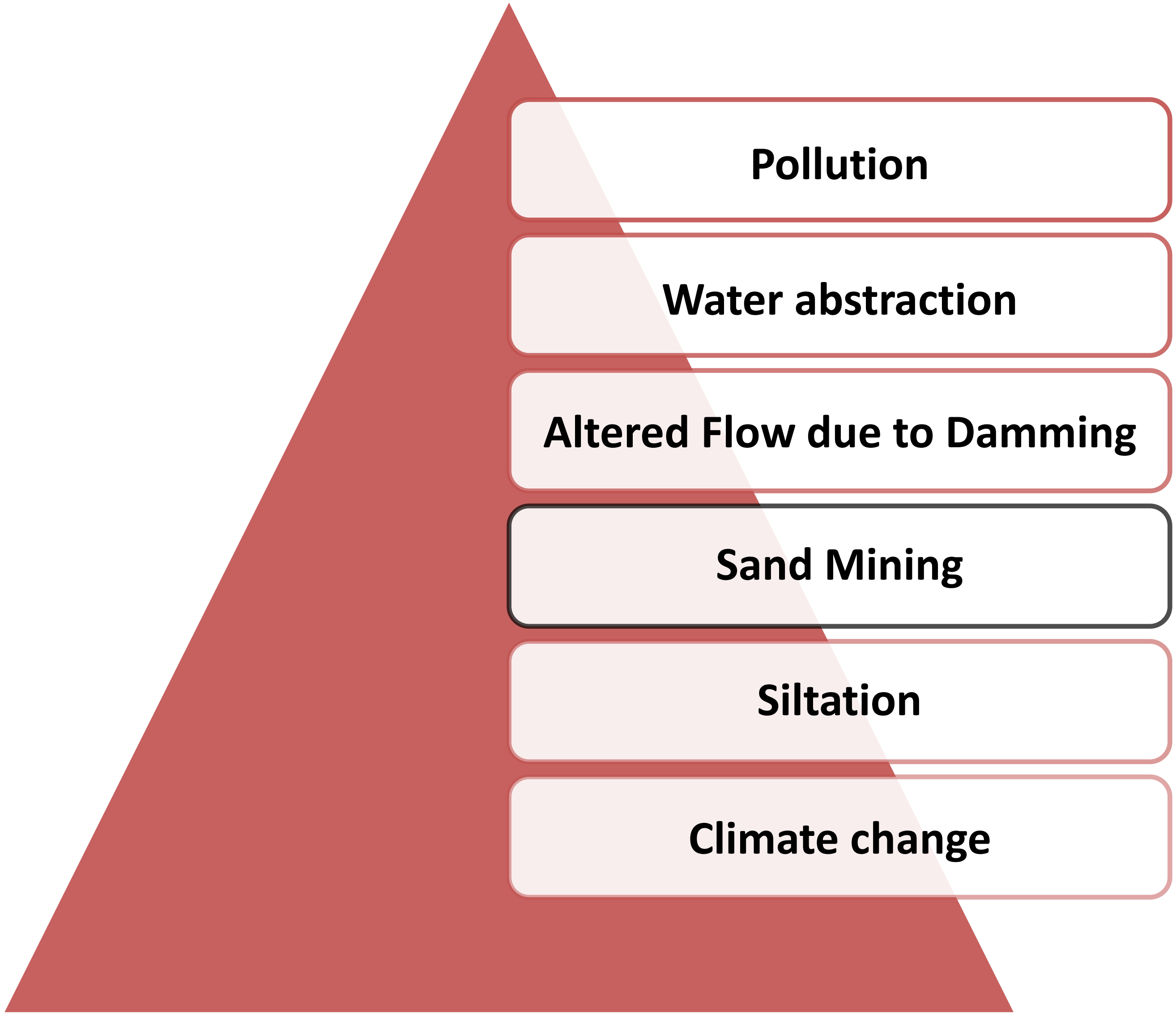
Habitat status of Rivers

- **30 basins marked as Global priority for the protection of aquatic biodiversity by Jenkins and Groombridge (1998), nine are from India**

- **Ganga,Brahmaputra, Godavari, Krishna, Indus, Krishna, Mahanadi, Narmada, Pennar and Tapi ,Cauvery**

- **With the exception of Brahmaputra basins, all others are marked as 'strongly affected' by flow fragmentation and regulation.**

RIVERINE HABITAT DEGRADATION

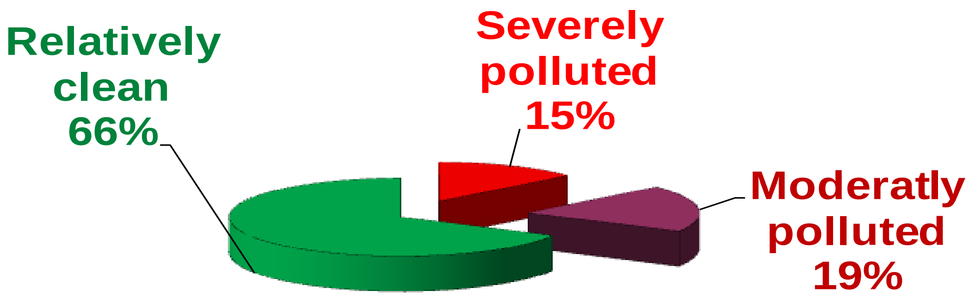


WATER QUALITY STATUS OF RIVERS

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.

S. No	Level of Pollution	Pollution Criteria	Riverine length, Km.	Riverine length percentage
01.	Severely polluted	BOD more than 6 mg/l	6086	15
02.	Moderately polluted	BOD 3-6 mg/l	8691	19
03.	Relatively clean	BOD less than 3 mg/l	30242	66

Analysis of 11 years data with respect to BOD values as indicator of organic pollution



SILTATION

- Spawning & Nursing Grounds affected
- Reduced water availability of water body
- Proliferation of rooted macrophytes leading to swampification
- Increased temperature

Obstruction to fish movement (Dams)

- All major river systems in India are interrupted by series of barriers
- At present nearly 5100 large and medium dams and more than 500 are in the pipeline.
- 135 dams on tributaries of river Brahmaputra-in Arunachal Pradesh
- 330 dams coming up in Uttarakhand
- Vital ecosystem services including fisheries and biodiversity neglected
- Major decline of fish populations witnessed in rivers and wetlands
- Hilsa and mahseers are classical example of fishes being affected

Impact of reduced flows

The Report of the Working Group on Fisheries and Aquaculture of the 12th Five Year plan acknowledges, "Water abstraction for irrigation and power generation is perhaps the biggest reason (for problems of inland fisheries), causing reduced or no flow in the main channel to support fisheries and other riverine fauna and flora."

- Changes in river channel morphology
- Erosion/siltation
- Water quality degradation
- Biodiversity changes
- Landfills and encroachments
- Salinity changes / Hooghly-Matla estuary / Krishna estuary

Case study of River Ganga

Concerns over the deteriorating quality of river Ganga in the past several decades

Interventions

- **GAP I launched in 1985**

- **Mission Clean Ganga in 2009 -Creation the National River Ganga BasinAuthority(NRGBA) Declaration of the Ganga as the 'National River of India'**

- **Launching of the project 'Namami Ganga' in July ,2014**

- **Specific component of the plan was to restore and maintain the biological, or biotic integrity of the national river**

- **The conservation of river Ganga uptil now has been limited to partially successful efforts towards improving water quality by treating waste water.**

Biotic integrity ignored !

- **Non biological measures like chemical and physical water quality dominate to improve ecological integrity of river Ganges**

- **This has <u>advantages</u> but unfortunately biotic integrity of river Ganges continued to decline**

- **All aspects <u>human induced alteration</u> in the rivers not captured by chemical monitoring.**

- **Chemical monitoring failed to consider the ability of water resources to sustain desirable biological processes at appropriate levels**

- **Ecological integrity a combination of chemical, physical and biotic integrity**

Policy Initiatives Needed

- Assessing environmental flow of river Ganga/other rivers for maintaining its ecological integrity is a major challenge for scientist and its stakeholders
- Closer the decision maker want the aquatic system to be natural, the greater the volume of original flow regime will be required as an environmental flow
- One of the major problems with developing environmental flows in India is the lack of knowledge on how the various ecosystem components respond to changes of flow
- River flows for some rivers systems are set to achieve specific pre-defined ecological, economic or social objective

Habitat status of Wetlands

- Enumeration of the wetland wealth of India as per the National Wetland Atlas 2011 prepared by the Space Application Centre 2011 - estimates

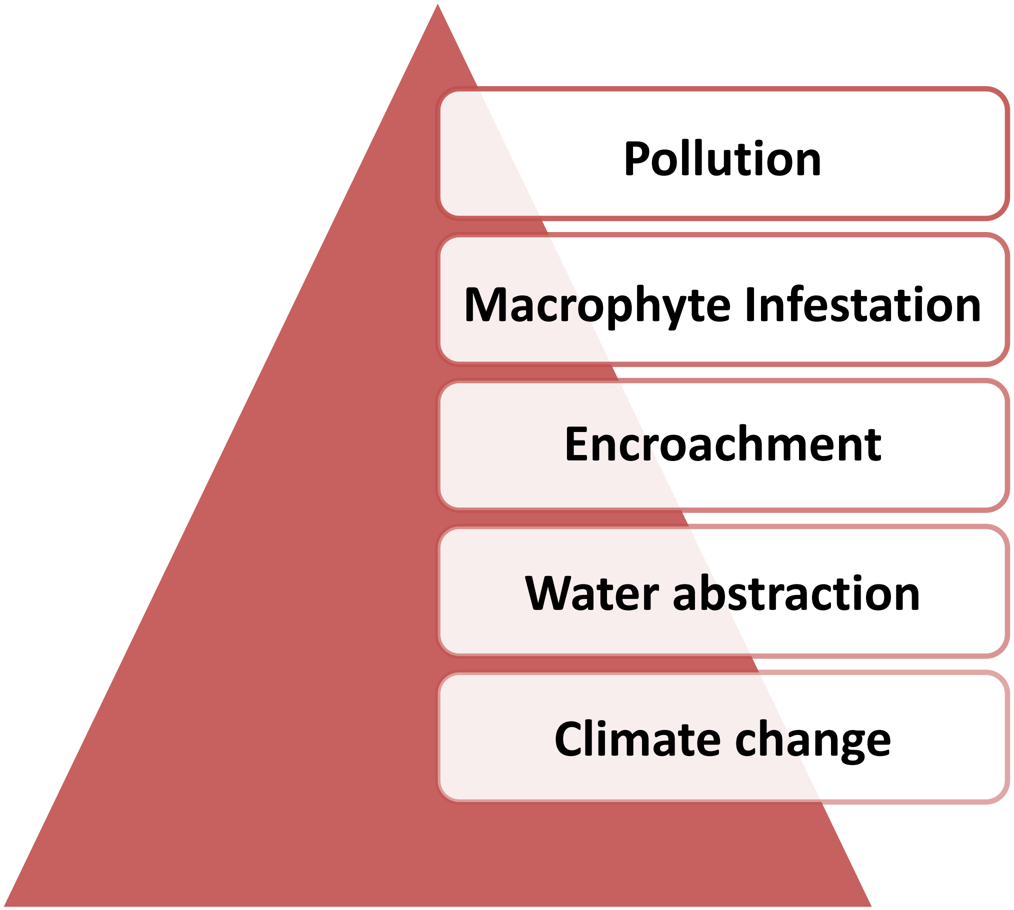
- 56 thousand wetlands with a total area of 15.3 million ha accounting for nearly 4.7% of the total geographical area of the country

- Freshwater wetlands alone support (20 % of the biodiversity in India)

- India has lost more than 38% of the wetland in the last decade with the loss rate being as high as 88% in some districts

- Provide valuable production services. Chilika lake produce 12,000 mt of fish supporting 2 lakh fisherman; Vembanad lake support livelihood of around 1.6 million people. East Kolkata wetlands support the livelihood of 20,000 under privileged families. Subsistence farmers currently produce 15000 mt of fish annually and additionally 150 mt of vegetables daily.

WETLAND HABITAT DEGRADATION



Policy Initiatives Needed

- Wetland management existing Institutional strategies in India regulate only selected wetlands
 (1) wetlands selected under Ramsar Convention
(2) wetlands in ecologically sensitive and important areas
 (3) wet-lands recognized as UNESCO World Heritage site
 (4) high altitude wetlands (at or above an elevation of 2500 m with an area equal to or greater than five hectares)
 (5) wetland complexes below an elevation of 2500 m with an area equal to or greater than 500 ha
 (6) any other wetland identified by the Authority (Wetlands Rules, 2010)

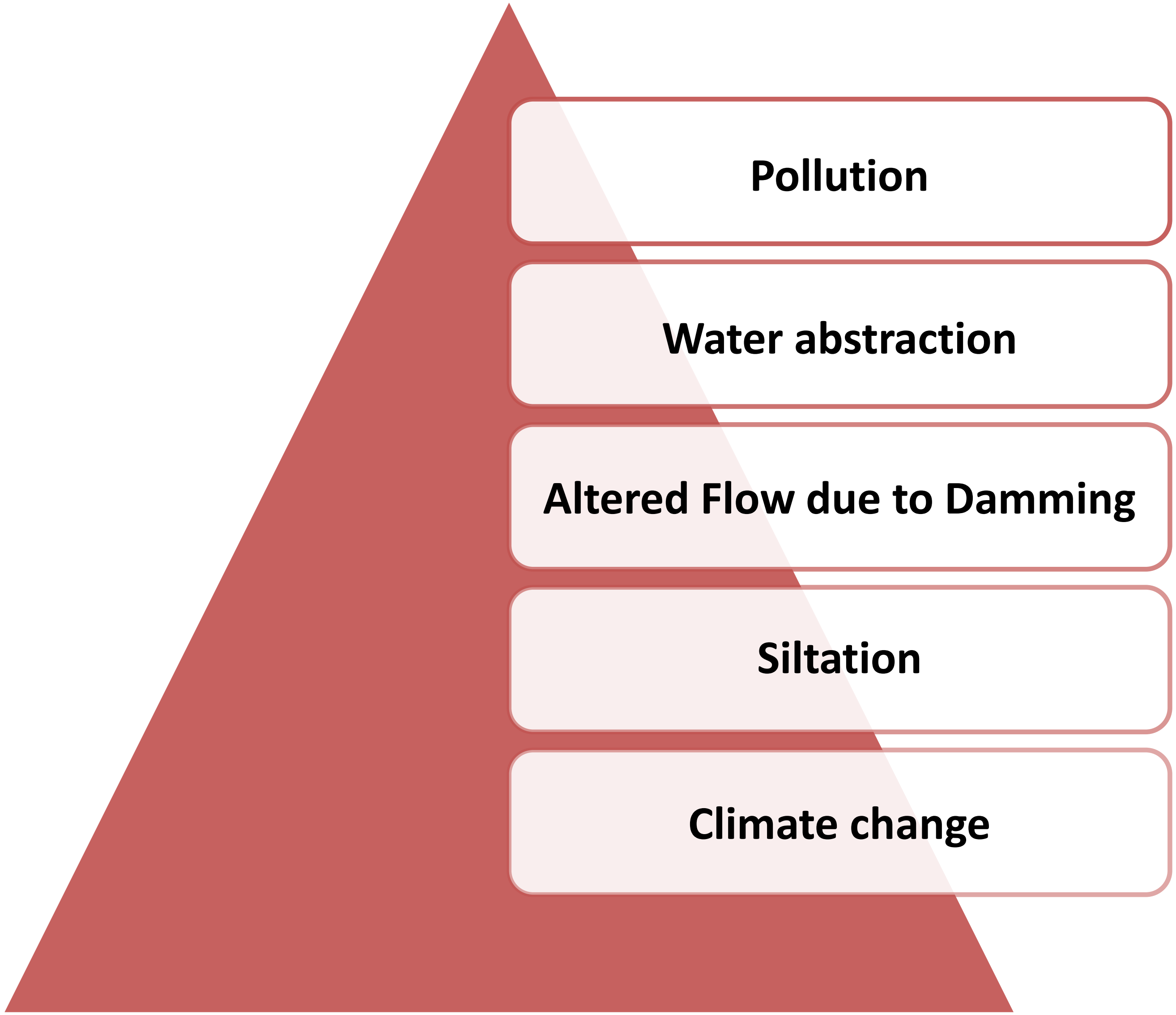
- Excluded are the crucial smaller wetlands in urban and rural areas which historically functioned as urban common property facilities with socio-ecological functions

- These urban ecosystems have transformed to protected lakes, parks, and mangrove forests that belong to the state, valued for public ecosystem services such as ground water harge, recreation, and flood protection.

- The urban poor living at subsistence level—whose livelihood resilience, health, and nutrition depended on access to provisioning ecosystem services of these wetlands—affected

- Thus the existing national legislations on wetland regulation is inadequate to protect a majority of the wetlands in India

RESERVOIR HABITAT DEGRADATION



Reservoirs

- Industrial development and urbanization in the catchment of reservoirs has caused eco-degradation.
- Degradation due to 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

Major Policy Initiatives Needed

- Rivers, reservoirs and their floodplains should be taken as a single ecological entity for implementation of any comprehensive environmental plan
- A holistic assessment of the instream water needs of rivers Involving all stakeholders is imperative for developing an effective conservation plan for river
- Clear river health objectives synchronizing water quality targets and environmental flow requirements should be determined for policy implementation by governments and stake holders.
- A common framework needs to be created for the river basin area that can be used towards implementing the integrated watershed management strategy for river starting from Gram Panchayat (village council) to the river-basin level in a unified manner.
- A unison of political will of the Central and State Governments is needed to implement the measures adopted in the plan stringently.
- A mass movement involving all communities and ordinary people in implementing the ameliorative measures for restoration of the ecological entity is the need of the hour.

Habitat changes due to climate variations

- **Some of the recent assessments on climate variability in India predict increased incidence of flood, drought, tropical cyclones**
- **Without additional mitigation, global mean temperature is to increase by 3.7 to 4.8°C**
- **Sea level to rise by ~50 cm by 2100**
- **Increasing water stress**

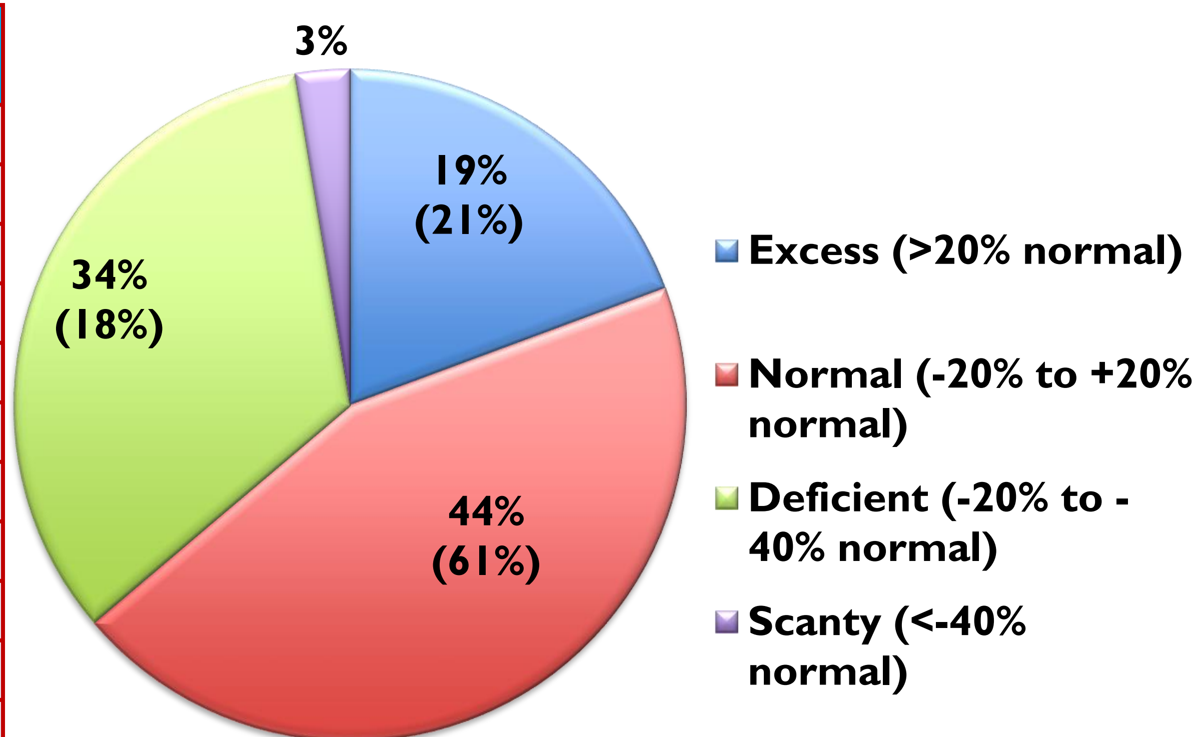
IPCC (2014)

- **Under such a scenario the multiple benefits that inland fisheries and aquaculture provide in terms of protein food, livelihood security and poverty alleviation are threatened**
- **Understanding the specific alteration in the inland aquatic habitat quality occurring over the years due to climate change is essential to sustain the benefits of fisheries and aquaculture**

Rainfall Distribution is Crucial

Scenarios of 2016 and 2017, Normal Monsoon Years

Year	Rainfall Departure (%)
2000	-8
2001	-15
2002	-19
2003	+2
2004	-13
2005	-1
2006	-1
2007	+5
2008	-2
2009	-23
2010	+2
2011	+1
2012	-8
2013	+6
2014	-12
2015	-14
2016	-2
2017	-4



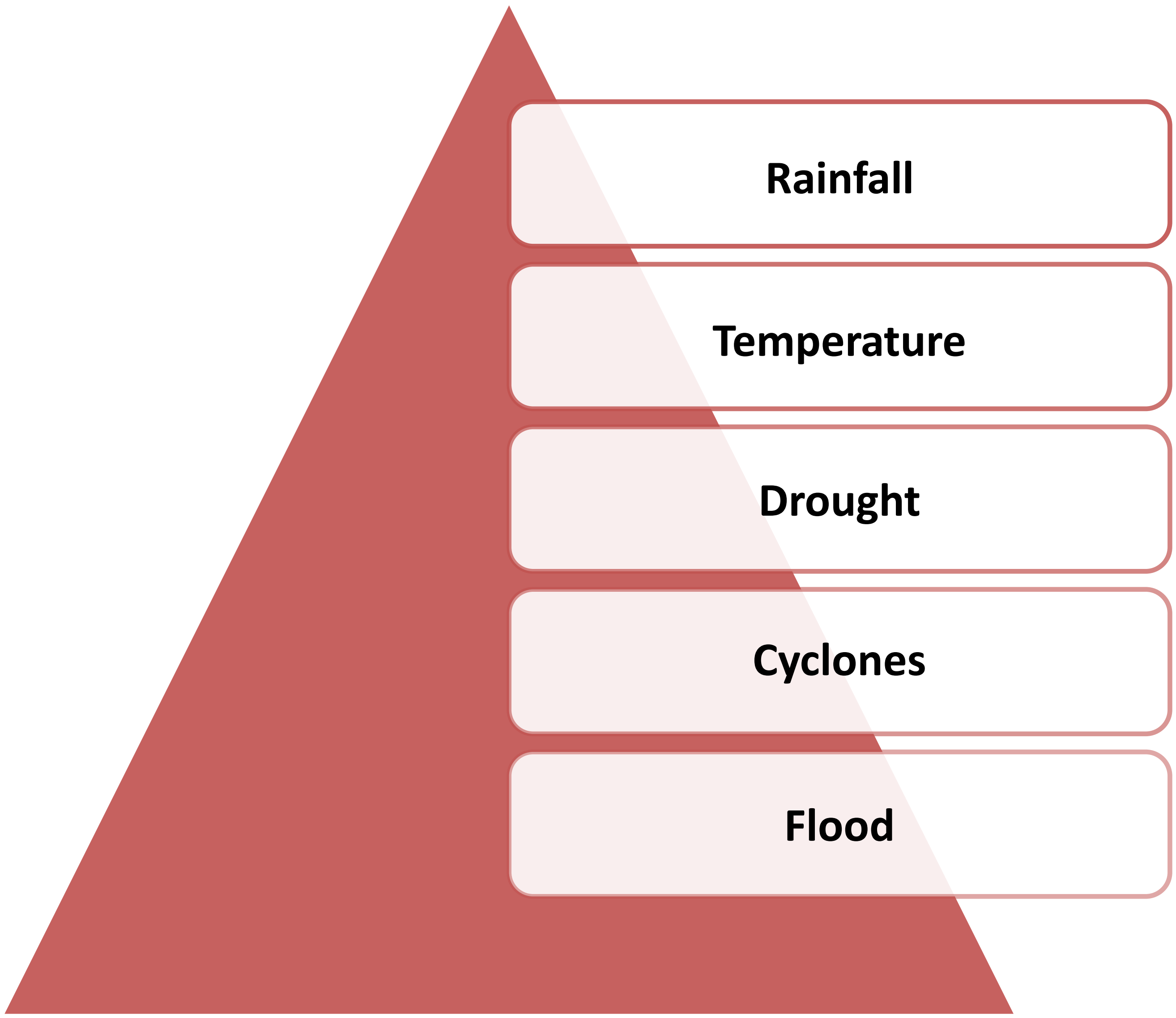
Even with normal monsoon in 2016 and 2017

- **34 and 18% area had deficit rainfall**
- **19 and 21% excess, respectively**

Why is the fisheries sector concerned about climate change

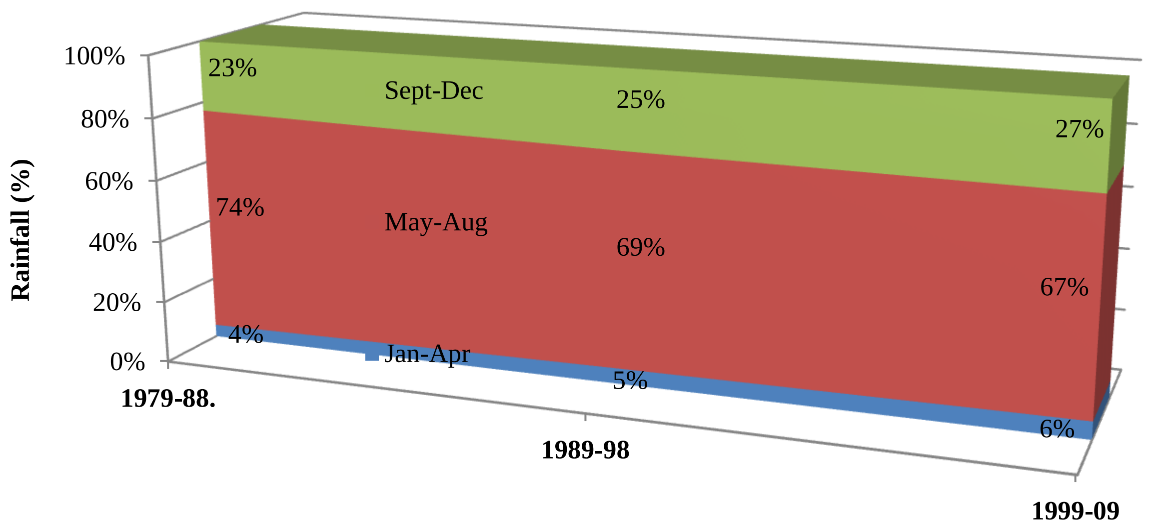
- **Aquatic environment differ from terrestrial environment**
- **The sector is threatened by - pollution runoff - land use transformation - competing aquatic resource uses**
- **Over-exploitation of resource**
- **Compounding effect of climate change**

Aquatic habitat alteration –climate change



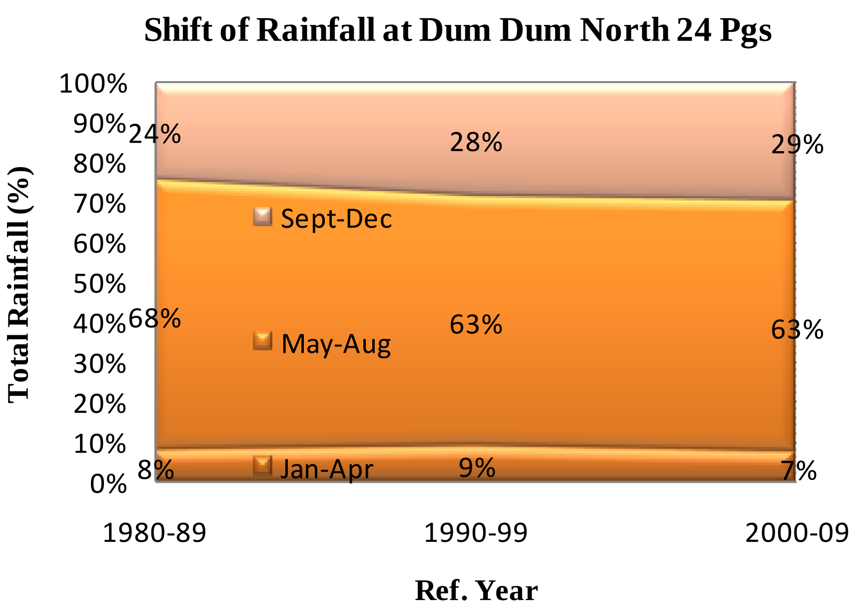
Alteration in Seasonal pattern of rainfall

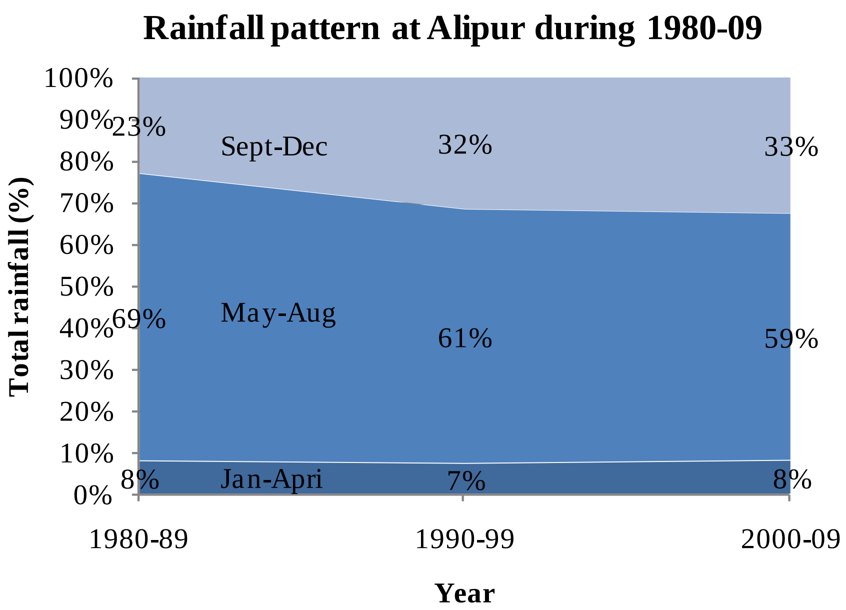
Rainfall pattern at Allahabad during 1979-09



- **Analysis of the monthly data of rainfall of the middle stretch of river Ganga split into three equal periods (Jan-April), (May-August) and (September-December).**
- **Total rainfall declined 7% in (May- Aug.) whereas it increased by 4% in the post-breeding period**

Alteration in the seasonal pattern of rainfall in gangetic plains

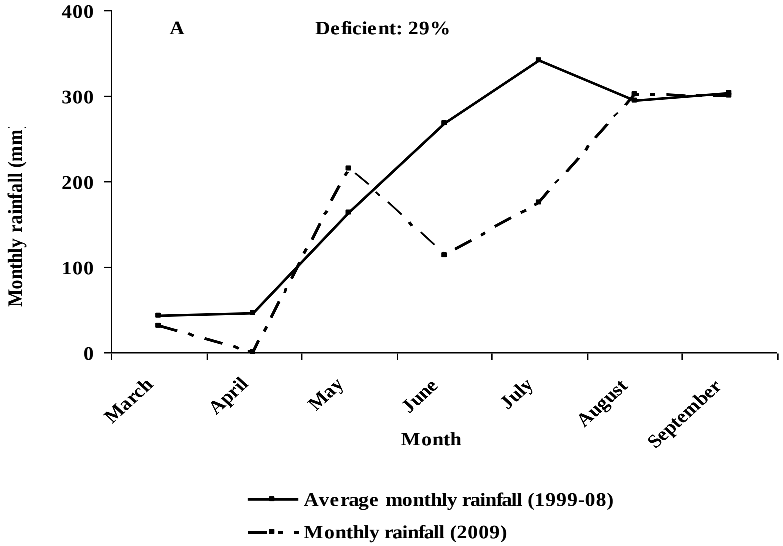


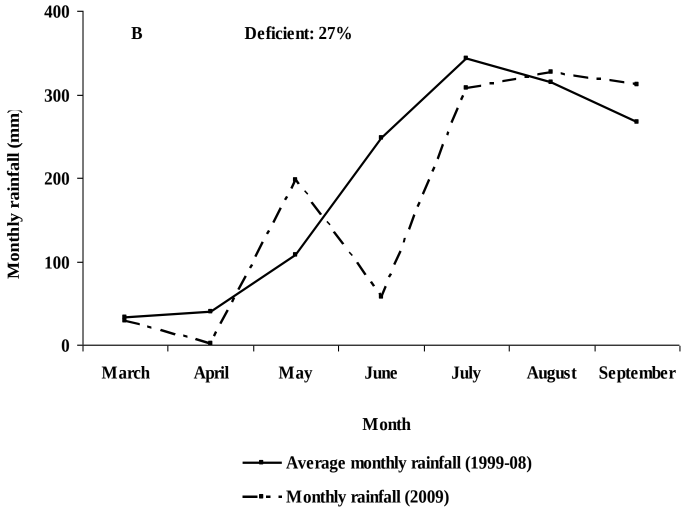


- **Annual total rainfall (May-August) declined 5 % and increased 5 % in post monsoon months (Sept-Dec) at Dumdum, 24 Parganas (N).**
- **Similar pattern rainfall distributions were observed at Alipur district of West Bengal during 1980-09.**

Habitat changes during drought

Pattern of rainfall

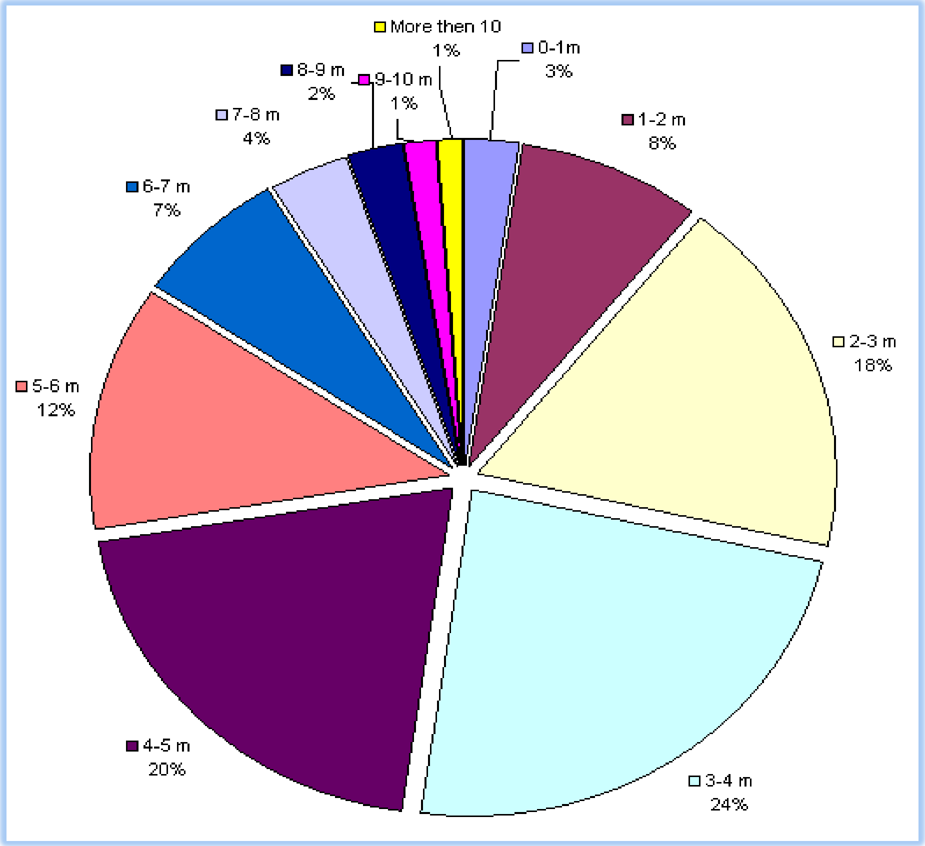




Averages rainfall distribution during 1999-08 and 2009 in (A) North 24 Paragans (B) Bankura

- **Deficit rainfall (March to September 2009)**
- **North 24 Parganas -29%, Bankura - 27%**

Habitat changes during storms and cyclones Aila --2009

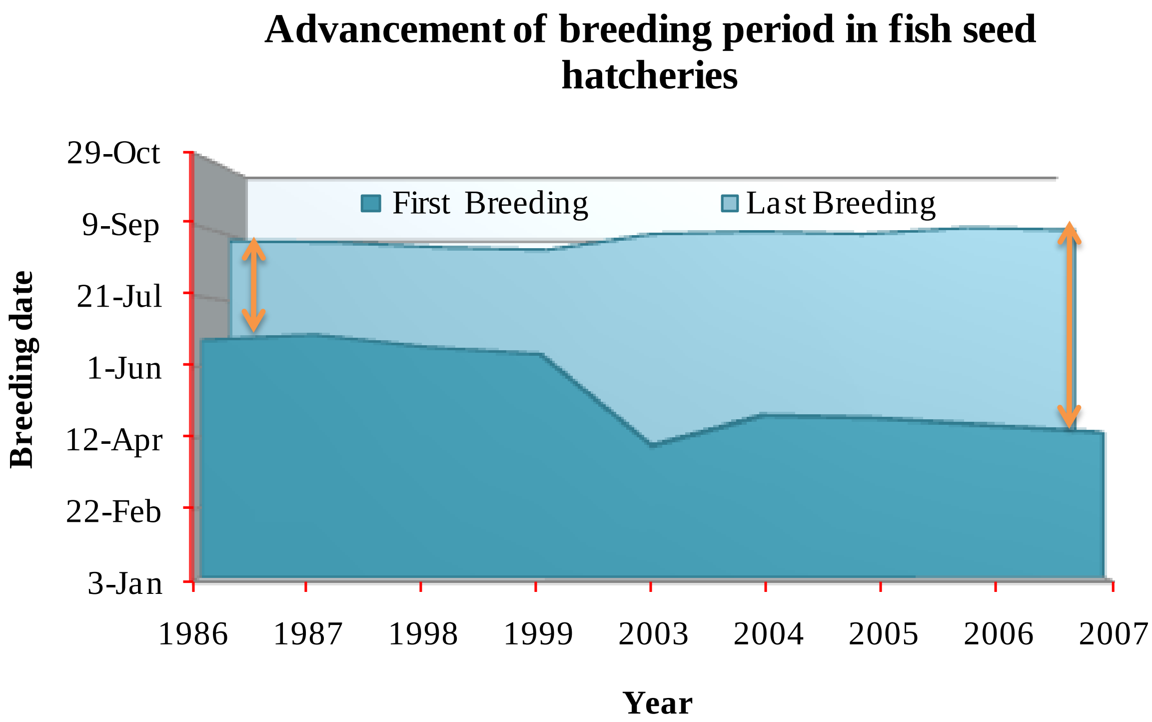


Changes in salinity

- **The intrusion of seawater into the upstream riverine zone alter the chemical composition of the inland water**
- **South 24 Parganas assessed (DEM) indicate 3% land submergence in case of 1m sea level increase**

Blocks	Hasnabad & Hingalganj	
	Post AILA	Pre-AILA
Water Salinity	23ppt	12ppt
Soil Salinity	4.3 mmhos/cm	1.4-2.9 mmhos/cm

Positive impact on aquaculture



- **Positive impact of enhanced temperature and altered rainfall on spawning of Indian Major Carps evident in aquaculture where there has been an advancement of breeding period in hatcheries of West Bengal, Orissa and Assam in the last two decades.**
- **It shows an extended breeding period by 45-60 days with breeding season extending from 110-120 to 160-170 days at present.**

Approach of Inland fisheries to climate change adaptation

- The impacts occurring in the river basins due to climate change needs to be assessed together with other environmental changes

- Hydrological impacts of two most important drivers of change in the Ganga basin viz., development of reservoirs and barrages and climate changes are largely opposite to each other. The time scale of impact vary

- Firstly - climate change in our country must be viewed in the broader context within which a variety of other environmental changes are taking place at different temporal and spatial scales

- Secondly - an understanding of the distinct characteristics of the social-ecological system in any particular region of our country is a prerequisite for development of a sound adaptation strategy

- An effective and pragmatic approach is to find interfaces through which climate change adaptation activities are integrated with routine policies, measures and activities which are undertaken on a regular basis by government and different stake holders

So, what to do?

Mitigation?

Adaptation?

Both?

Climate-smart Agriculture

- **How prepared are we?**

Technology Need for

Climate-Smart Sustainable Agriculture

Climate-Smart Sustainable Agriculture

Agriculture that sustainably

- increases productivity
- increases resilience (adaptation)
- reduces/removes greenhouse gases

  and

- enhances achievement of national food security and development goals

Global Technology Watch Group
Climate-Smart Sustainable Agriculture

Objectives

1. To prepare a global technology database for climate-smart sustainable agriculture.

2. To prioritize these technologies as per Indian context.

3. To prepare a Report for the Government and Industry for accelerating action for early adoption of the technologies.

Steps in Prioritization of Technologies
A Multi-Criteria Analysis

1: Scout all the available technologies from literature, expert judgement, stakeholders feedback, etc.

2: Identify potential technologies based on expert judgement

3: Rank all the technologies based on technological, economic and environmental criteria (Ranking 1).

4: Send to reviewers (~20) for their ranking

5: Identify top 10 technologies.

6: Prioritize the top 10 technologies based on policy and socio-cultural criteria (Ranking 2).

7: Identify non-conventional, innovative and disruptive technologies

8: Suggest big-ticket projects.

No. of Technologies Scouted

Component	No. of Tech.
1. Crop improvement	86
2. Land and Water Management	110
3. Soil and Nutrient Management	30
4. Microbial Technology	13
5. Geo-ICT	18
6. Crop Protection	40
7. Mechanization	40
8. Horticulture & Post-Harvest Technology	49
9. Agro-forestry	10
10. Prot. Culti., Vertical Farming & Hydroponics	85
11. Animal Husbandry & Livestock	30
12. Fisheries	17
13. TIFAC team	160
14. Stakeholder meetings	142
Total	689

Prioritization Methodology

STEEP Methodology

Factors:

1. Socio-cultural
2. Technological
3. Economic
4. Environmental
5. Policy

Two-step prioritization:

Step 1:

1. Technological
2. Economic
3. Environmental

Step 2:

1. Socio-cultural
2. Policy

Prioritization Step 1
Technological, Economic and Environmental Criteria

A. Technological
   1. Impact on production
   2. Ease of implementation
   3. Mechanization/ICT compatible
   4. Readiness level

B. Economic
   5. Enhanced income of farmers
   6. Economic feasibility

C. Environmental
   7. Energy efficiency/renewable energy
   8. Greenhouse gas mitigation
   9. Climate vulnerability/risk reduction

Weightage for Technological, Economic and Environmental Criteria

Criteria	Weightage (%)*
Impact on production	20
Ease of implementation	10
Mechanization/ICT compatible	5
Readiness level	10
Economic feasibility	15
Enhance income of farmers	15
Energy efficiency/renewable energy	10
Greenhouse gas mitigation	5
Vulnerability/risk reduction	10
Total	**100**

***Weightage varies for different sub-sectors**

RANKING OF TECHNOLOGIES (FISHERIES SECTOR)

Expert --

CRITERIA	Economic feasibility	Readiness level	Impact on production	Ease of implementation	Mechanization /ICT compatibility	Enhance income farmers	Energy efficient /renewable energy	Reduce emission /GHG	Potential for risk /vulnerability reduction	Total	Rank
Weightage (100)	10	15	15	15	5	20	5	3	12	100	
TECHNOLOGIES											
1.Cage culture of fish											
2.Fish cum paddy culture											
3.Drought tolerant fish culture											
4.Waste water aquaculture											
5.Integrated Fish livestock farming											
6.Pen culture of fish											
7.Periphyton based fish culture											
8.Brackish water aquaculture											

Prioritization Step 2
Socio-cultural and Policy Criteria

A. Socio-cultural:

1. Socio-cultural complexity
2. No-regret characteristics

B. Policy:

1. Institutional complexity
2. Urgency
3. Small farmers friendly

Weightage for Each Criteria

Criteria	Weightage (%)
Institutional complexity	20
Socio-cultural complexity	20
Urgency	20
No-regret characteristics	20
Small farmers friendly	20
Total	**100**

RANKING OF TECHNOLOGIES (FISHERIES SECTOR)

CRITERIA	Score for Rank 1	Urgency of action	Institutional complexity	Social complexity	No regret character	Small farmers friendly	Score	Final Rank		Score	Very high	Very low
Weightage (100)	75	5	5	5	5	5	100			Urgency	100	0
TECHNOLOGIES										Institutional complexity	100	0
1.Cage culture of fish	30.86	70	80	30	30	60	22.64	3		Social complexity	100	0
2.Fish cum paddy culture	26.34	80	50	50	30	90	21.75	4		No regret character	100	0
3.Drought tolerant fish culture	24.25	50	50	20	80	90	17.68	8		Small farmers friendly	100	0
4.Waste water aquaculture	29.6	70	80	60	60	90	20.2	7				
5.Integrated Fish livestock farming	30.25	80	80	60	60	90	21.15	5				
6.Pen culture of fish	29.1	50	50	60	30	60	20.3	6				
7.Periphyton based fish culture	30.64	80	50	90	20	90	23.48	2				
8.Brackish water aquaculture	33.64	80	50	90	20	90	25.73	1				

List of top 10 technologies: Final Ranking

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.

Final Weightage for Each Factor

Factor	Weightage (%)*
Technological	35
Economic	25
Environmental	15
Socio-cultural	10
Policy	15
Total	100

- **Final ranking was given taking 75% weightage for the technological, economic and environmental parameters**
- **25% weightage for the socio-cultural and policy parameters.**

Technology Validation Workshop

- Technologies scouted by the GTWG Sustainable Agriculture group validated in the workshop attended by President, NAAS, Chairman, National Steering Committee, GTWG project, DG ICAR and around 30 distinguished Fellows of NAAS. organized at National Academy of Agricultural Sciences (NAAS) in 2018

Top 10 Technologies

Top 10 Technologies
Fisheries and Aquaculture

1. Brackish water aquaculture
2. Periphyton based based crap culture
3. Cage culture fish
4. Fish cum paddy culture
5. Integrated fish livestock farming
6. Pen culture of fish
7. Waste water aquaculture
8. Drought tolerant fish culture

Brackish water aquaculture

- **Intensive storm surges and inundation of the coastal areas causes salinization due to mixing of saline water with fresh water.**

- **Brackish water aquaculture of some species extensively cultured in the coastal states of India viz., *Mugil cephalus M.parsia, Lates calcarifer, Chanos chanos, Etroplus suratensis* forms a very useful option**

Periphyton based aquaculture

- **Aquaculture is predominantly dependent on fish species feeding low in the food chain and act as carbon sink and aid in carbon sequestration.**
- **Adopting measures to increase phytoplankton and periphyton growth could be a major energy saving measure .**
- **The technology holds promise for the farming of any herbivorous fish which is capable of harvesting periphyton from substrates.**

Pen culture system

- Pen is an enclosure that can be utilized to hold fishes as captive stock in open water (wetlands, reservoirs).

- Useful to produce fish in shallow, derelict and weed choked water bodies, where aquaculture is not possible and fishing difficult.

Cage culture

- The technology is based on non consumptive use of water for Fish culture in floating cages installed in wetlands, reservoir, river, or off shore sea
- Maricultur of (Cobia and Silver Pompano) *Lates calcarifer, Cobia Rachycentron canadum, Mugil cephalus, Etroplus suratensis* and in inland fresh waters are *Labeo rohita, Cirrhinus mrigala, Pangasius sp. Channa sp. and Heteropneustes fossilis*
- Serve as a means of subsistence fishery

Fish cum paddy culture

Technology used in coastal areas and in other freshwater areas for subsistence fishery

Integrated fish livestock farming

- ❑ Ducks, poultry, pig, cattle, buffalo, sheep and goat are common in mixed farming.

- ❑ The by-product utilization of one sub-system e.g. excreta of livestock becomes an input to a second sub-system i.e. in fish culture

Waste water aquaculture

- ✓ **Multiple use, reuse and *integration of aquaculture* with other farming systems**.

- ✓ **Intensification of aquaculture practices in resources of *wastewater and degraded water* such as ground saline water.**

Drought tolerant fish culture

- ✓ **Smaller ponds that retain water for 2-4 months used**

- ✓ ***Pangasius* sp., *Puntius javanicus Clarias gariepinus* ,piranha *Pygocentrus nattereri* used for fish production**

Thank You

Fish for Health

Fish for Tomorrow