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ICAR-CIFRI
NATIONAL INNOVATIONS ON CLIMATE RESILIENT AGRICULTURE (NICRA)

NICSIF
National Innovations in Climate Smart Inland Fisheries
NICRA Newsletter, ICAR-CIFRI, Barrackpore, Kolkata-700120

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Mystus tengara


Mystus gulio

About CIFRI NICRA

Climate change is one of important environmental challenges of 21st century. Nearly 700 million rural populations directly depend on climate sensitive sectors (agriculture, forests and fsheries) and natural resources (such as freshwater, mangroves, coastal zones, grasslands and biodiversity) for their subsistence and livelihoods. Any adverse impact on water availability due to recession of glaciers, decrease in rainfall and increased fooding in certain areas would threaten food security. The impacts are already being felt in India. India is bestowed with vast and varied inland open-waters which form the traditional sources of fsheries supporting a large number of landless poor fshers. In recent times, fsh production from these resources has declined due to increased man-centric interventions. The resultant impact has been an erosion of livelihood base for the traditional fshers, who depend exclusively on these resources for their livelihood and nutritional security. Fisheries sector is known to supplement protein food to weaker section of the society. Communities that depend on inland fsheries resources are likely to be vulnerable to climate change. Climate change is only one among many environmental and anthropogenic stresses faced by inland fsheries but is likely to exacerbate the effect of other stressors in years to come.

The ICAR-Central Inland Fisheries Research Institute initiated research on climate change way back in 2004 under the ICAR research project 'Impact, Adaptation and Vulnerability of Indian Agriculture to Climate Change' and is being continued under the ICAR Project 'National Innovations on Climate Resilient Agriculture' (NICRA). In the last several years the Institute has emerged as the nodal organization on climate change research on Inland Fisheries in the country.

Present Objectives

Assessment of reproductive biology, spawning behavior of major riverine and estuarine fshes in Gangetic and peninsular river in relation to climatic variability.

Identify and/or formulate adaptation-mitigation strategies in inland fsheries to climate change.

Principal Investigator's Desk


Dr. U.K. Sarkar

It is my immense pleasure to bring out this NICRA newsletter from ICAR-CIFRI. We have been involved on this important facet of research since last several years. As climate change is a subtle phenomenon acting on a large spatio-temporal scale, its impact assessment on inland fsheries has been really a challenging task. We have achieved few milestones already and presently working on a number of crucial aspects involving climate change impacts on inland aquatic ecosystems, fsh stocks and associated fsher folk communities. This newsletter is a ref ection of the enthusiasm of our research team and dissemination of the fndings. I acknowledge the valuable inputs of Dr. M.K. Das, former PI, NICRA and Prof. A.P. Sharma, former Director and PI, NICRA for taking this project to newer heights. Since taking responsibility, I have been trying to upkeep the standard of our output so that we can inf uence and support decision of the key policy makers. Any suggestions are highly solicited.


Eutropiichthys vacha

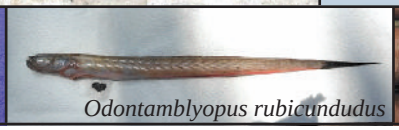

Labeo calbasu


Channa punctatus


Johnius coitor


Mystus cavasius


Puntius sophore


Odontamblyopus rubicundudus

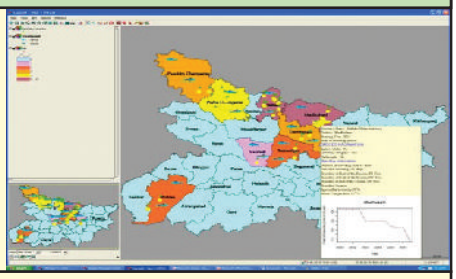

Amblypharyngodon mola


Trichogaster fasciata

Fish images: Species selected under study

Research Highlights

Development of E-atlas on freshwater fsh hatcheries



The hatchery survey data over time scale of 20 years were collected from the major fsh breeding states of Assam, West Bengal, Odisha, Bihar, Andhra Pradesh, Madhya Pradesh and Uttar Pradesh. A standalone software in the form of E-atlas has been developed. The atlas integrates data on hatchery location, fsh species cultivated, onset and period of breeding, spawn output of inland fsh over the years.

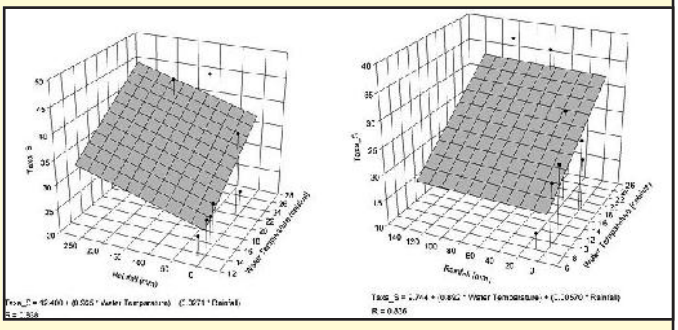
Spawning of *Tenualosa ilisha* infuenced by temperature

In Indian shad, *T. ilisha* recorded conducive spawning (gonadal maturity, VII stage and peak GSI at a water temperature range of 29-32°C. Earlier studies reported an optimal temperature range of 26-30°C for conducive spawning.

Climate variation and fsh recruitment

A decline in spawn availability of IMCs in Ganga river system is evident. Spawn prospecting studies near Allahabad revealed a signifcant decline in the share of the Indian Major Carps spawn in recent years (13%) compared to the 1980s (46%).

Predicting fsh assemblage pattern and climate variation



Region specifc multi-parameter regression equation of biodiversity indices (as dependent variable) and climatic factors (viz, water temperature and rainfall) was generated to quantify changes expected in fsh diversity in a specifc stretch of river under projected temperature and precipitation regimes.

Between the two climatic variables considered (i.e. - water temperature and rainfall), the present fndings reveal a signifcant ($P < 0.05$) positive correlation between fsh biodiversity indices (taxa richness, Simpson's index, Shannon weaver index) and water temperature. A positive infuence of rainfall on fsh species biodiversity was recorded but it is found to be statistically insignifcant.

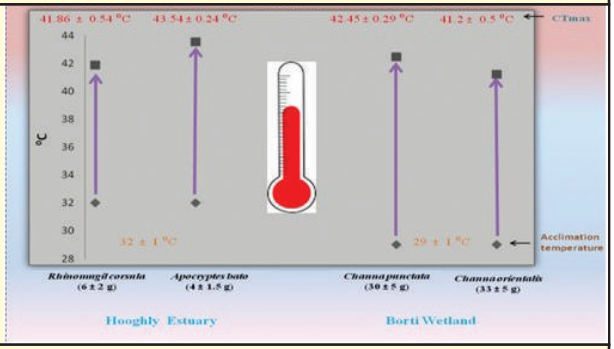
Chlorophyll concentration and climate variables

In the estuarine part of river Ganga, Chlorophyll-a had a sharp correlation with water and air temperature. Positive correlation also existed among TDS, Specifc Conductivity and Chlorophyll-a. Water temperature is having a highly signifcant effect on Chlorophyll-a and will be greatly infuenced by future climatic variability.

Wetland as carbon store

Potential of Carbon capture and ultimate Carbon accumulation in the sediments of different types of wetlands were determined. Sediment accumulated Carbon measurement in wetlands reveals signifcant accumulation of Carbon in the range of 24.7 MgC/ha to 40.3 MgC/ha in 0-15 cm of sediment.

Thermal tolerant fsh species



Upper thermal limits (CTmax) of selected estuarine fshes were 41.86± 0.54°C and 43.54 ±0.24°C ($p<0.01$) for Rhinomugil corsula and *Apocryptes bato* while same were 42.45±0.29°C and 41.2 ± 0.5°C ($p<0.05$) for wetland fshes *Channa punctatus* and *Channa orientalis* respectively. Most importantly, *Apocryptes bato* is most tolerant fsh species followed by *Channa punctatus* indicating their better survival potential than other two species in future temperature scenario. Estimation of CTmax for other commercially important inland fsh species is presently under way.

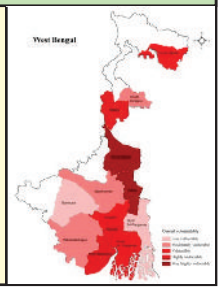
Fish species composition in relation to climate change

Comparison of historical records of fsh composition with the present data reveal decline of various earlier abundant fsh species like *Hemibagrus punctatus, Puntius carnaticus, Gonoproktopterus dubius, Tenualosa ilisha, Cirrhinus cirrhosa* with an unusual increase in abundance of exotic species *Oreochromis mossabicus, Oreochromis niloticus* and transplanted *Catla catla*. These changes are being correlated with the habitat changes induced by the various anthropogenic factors including climatic variations. The seasonal trend during the same period showed a decrease in the number of rainy days during South West monsoon and an increase during the North East monsoon.

*Page photographs: Screenshot of E-Atlas; Multi-parameter regression model between fsh diversity and climatic factors; CTmax Data

Research Highlights (contd.)

Developing a framework for assessing vulnerability of inland fsheries to climate variability in India



Application of this framework showed that the differential vulnerability of inland fsheries to climate variability exhibited among the districts of West Bengal refected different spatial combinations of climate exposure, sensitivity and adaptive capacity.

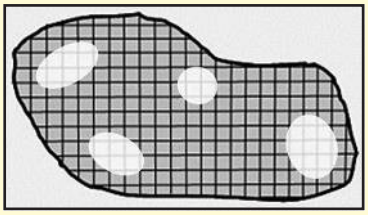
This is a practical analytical tool to understand the contribution of the indices of the sector to climate vulnerability at district level and forms an important basis for policy makers to develop appropriate adaptation strategies to minimize the risk of fsheries sector.

Adaptation to combat climate risks

Temporary Pre-Summer Enclosure in foodplain wetlands

On the face of perceptive water stress since 2010, the fshermen of Bhomra wetland (West Bengal) have been suggested the adaptive measure of temporary pre-summer enclosure. A provision of enclosure/pen is made around the deepest part of the beel during pre-summer as the water level starts to recede. The commercially important fshes are deliberately restocked within the enclosure after catching them from the surrounding waters with the help of cast and drag nets. The fshes are harvested from the enclosures intermittently based on size. This modifed MSMH (multiple stocking multiple harvesting) process of keeping the high value fshes into the enclosures and subsequent harvesting of large sized individuals is continued for several weeks during January-March. This strategy can be used in other wetlands facing similar problems of water stress in summers to sustain livelihood of fshermen.

Deep Pool Refuge based Fishery



Decreasing water levels can be overcome during winter season by creating deep pools by digging in the beel or by demarcating the naturally existing deep pools. These pools will provide shelter to fshes for survival and growth during the dry season.

In Akaipur wetland (West Bengal), regions of deep pools locally termed as 'komor', created by digging activities of crabs and catfshes over the years are well demarcated by the experienced fshermen. Fishing activity in this zone is prohibited throughout the year except during February. Local fsher folk believe that when most part of the wetland dries up, these areas either ensure availability of harvestable fsh stocks during dry months or provide summer refuge to base stocks for recruitment in the preceding seasons.

HRD Programs

Training program on *"Impact of climate variability on inland fsheries and strategies for adaptation"* organized at ICAR-CIFRI, Barrackpore during 16-17th March, 2015

Expert consultation on *"Climate variability and resilience in inland Fisheries"* organized at ICAR-CIFRI, Barrackpore on 18th March, 2015

*Page photographs: Vulnerability index map of West Bengal; Temporary pre summer enclosure; Deep pool refuge

Critical Issues & Recommendations for Adaptation

Flood

Effects	*Adaptations*	
	Pre food	**Post food**
• Escape of fsh stocks • Introduction of disease & predators	• Harvest fsh at smaller size • Provide importance to fsh species that require short culture period and minimum input • Increase infrastructure of hatcheries for assured seed production	• Continuous supply of fsh seed from hatcheries or raising of fsh seed in hatcheries • Cage culture in large water logged bodies for raising seed from fry to fngerlings

Drought

Effects	*Adaptations*	
	Pre drought	**Post drought**
• Loss of fsh stock • Reduction in water quality	Selection of suitable fsh species like *Anabas testudineus*, *Heteropneustes fossilis*, *Channa striata* and *Clarias magur* which can favorably adapt to water stress and high temperature condition	• Parts of wetland that retain water for 2-4 months can be used for fsh production with appropriate fsh species (catfsh, tilapia etc.) • Increasing infrastructure sophistication of hatcheries

Important Publications

1. Das MK, Sharma AP, Sahu SK, Srivastava PK and Rej A. 2013. Impacts and vulnerability of inland fsheries to climate change in the Ganga River system in India. Aquatic Ecosystem Health & Management. 16(4): 415-424.
2. Das MK and Sharma AP. 2010. Add fsheries and aquaculture management to our solutions for climate change and food security. Bulletin no. 167. Central Inland Fisheries Research Institute (Indian Council of Agricultural Research). Barrackpore, Kolkata.
3. Das MK, Srivastava PK, Rej A, Mandal ML and Sharma AP. 2016. A framework for assessing vulnerability of inland fsheries to impacts of climate variability in India. Mitigation and Adaptation Strategies for Global Change. 21:279-296. DOI 10.1007/s11027-014-9599-7.
4. Sharma AP, Joshi KD, Naskar M and Das MK. 2015. Inland fsheries & climate change: vulnerability and adaptation options. ICAR-CIFRI Special Publication, Policy Paper No. NICRA/Policy/2015-16/1. ISSN 0970-616X

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