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**EDITORIAL**

## FISHERIES OF RIVER GANGA UNDER CHANGING CLIMATE



India is bestowed with a variety of open inland water bodies in the form of rivers, wetlands, reservoirs, lakes etc. which serve as an enormous potential source for fisheries production ensuring national food security. Besides, the fisheries sector plays a key role towards uplifting socio economic conditions of poor

fishers through their daily family income as artisanal fisheries. Of all these openwater resources, rivers are the hub of aquatic biodiversity sustaining life in the form of flora and fauna. River Ganga sustains unique source of multiple ecosystem services to the mankind since decades. The river not only supports rich indigenous biodiversity including Gangetic Dolphin but also a part of spiritual life of millions witnessed by Maha Khumb Mela and several rituals. Therefore the river Ganga is revered as the holy River of India. However, in the recent years set of factors including river modification, habitat degradation and over exploitation of important commercial fish stocks have become evident. However, with the boom of rise in population, prolific urbanization coupled with industrialization, the river has been under tremendous pressure impacted majorly by anthropogenic vulnerabilities and climate change. In the recent years, climate change has been a major challenge, for the aquatic resources and lives. Unlike terrestrial animals, fishes are susceptible to certain critical environmental parameters modifications, as their population directly depends upon the environment. The variability of life cycle including population recruitment, feeding and predation of fishes depends upon its aquatic environment and its habitat.

River Ganga after its origin passes through different plains of the country with varied hydrological regime therefore completely modulated by the climate impacts. Migratory keystone fish species of river Ganga viz. Mahseer (*Tor putitora*) and Hilsa (*Tenuulosa ilisha*) traverse hundreds of kilometres to complete their life cycle processes. Alteration in any climatological parameters can upset the entire life cycle processes. Variability and changes in climatic factors could disturb the spatial distribution of the wild fish stocks, therefore changing the habitat and recruitment processes. The river Ganga and majority of its tributaries are particularly snow fed originating from the Himalays. Therefore, decrease in snow cover owing to global warming has severely affected the basin hydrology. River flow is a key factor for maintaining physical, chemical and biological structure of a river ecosystem. The nature of flow determines the biotic communities and their interactions with the floodplains. The floodplain wetlands, those are connected to the river Ganga form an important part of riverine habitat for the fish recruitment processes. Reduction of river discharge therefore could severely impact on the indigenous fish recruitments on the other hand, with the rise of sea level, intrusion of salt water in the brackishwater section of river Ganga may also be impinging upon the biodiversity. Moreover, frequent extreme climatic incidences such as severe tropical cyclonic storms and floods in the coastal part of the river have severely impacted on the biodiversity and coastal inhabitants through salt water intrusion in the freshwater stretches of river Ganga therefore changing the fish diversity and recruitment physiology. As per the projection of IPCC 2022, climatic impact on fisheries sectors particularly in coastal parts may relate to increase in sea level, amplify in cyclones, rise in groundwater salinity and water stress areas. Therefore, the impact on estuarine fisheries, an integral part of the river could be the most

impacted sector influenced by the climatic alterations. While, the freshwater sections of the river could be potentially impacted resulting to the decrease in surface water availability and river flows. Majority of the indigenous fishes of river Ganga depend upon the timely rainfall during monsoon, as it triggers the early maturation for a successful recruitment. ICAR-CIFRI, has recorded that an alteration in precipitation in the selected stretches of river Ganga at Prayagraj in Uttar Pradesh over the period of 1979-2009. During this period, the total rainfall declined by 7% in May-August (peak breeding period of fishes like Indian Major Carps in the river). In addition, availability of natural fish spawn in river Ganga has come down to meagre 568 ml at present, as compared to 1500 ml during 1965-69. Moreover, the shift in rainfall patterns has also altered the basic breeding requirements like turbidity and river flow in the river Ganga. The impact could be noticed in the pattern of river water temperature. The rise of annual mean temperature (AMT) of river water by 0.99°C at Haridwar has shown that several warm water fishes like catfishes and carps migrate upstream of the river. In addition to the freshwater and estuarine stretches of the river Ganga, effect of climate change like increase AMT in river water and altered hydrological regime has created added pressure into the floodplain open wetlands of river Ganga. In our recent studies conducted by ICAR-CIFRI, several fishes species

(*Glossogobius giuris*, *Puntius ticto*, *Xenentodon cancila*.) inhabiting in the warm water areas of the river are now recorded in the upstream of the river upto Devprayag. We have recorded the impact of climate change on the breeding phenology of anadromous Hilsa indicating interesting findings such as early maturity and altered spawning behaviour.

Based on our scientific experiences through ongoing and past studies over the decades, we realized that a concerted efforts on gathering and correlating time series data of river Ganga with the climate variability's is need of the hour. In addition, a holistic research efforts including biodiversity, ecosystem services, GIS based mapping of susceptible areas along the river stretch, intensive peoples and community participation and integrating with climatic vulnerability assessment and sensitivity components for the holy river Ganga could reduce the impact of climate change on river ecosystem significantly Therefore adaption strategies may be built on the priority basis with the active participation of Government and different stakeholders to protect the biodiversity including fisheries and Gangetic Dolphin under the changing climate. □

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### **Dr. Basanta Kumar Das**

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Born in Athilabaj, District Balasore, Odisha on 20 March 1966. Educated at Orissa University of Agriculture and Technology, B.F.Sc. 1988, M.F.Sc. 1991, Ph.D. 1998, Post-Doc at FRS Marine Lab, Aberdeen, Scotland, UK 2006-2007. At present Dr. Das is the President, Inland Fisheries Society of India to date; President, Professional Fisheries Graduates Forum and President, Orissa Fisheries College Alumni Association. Started his career as Scientist, ICAR-National Academy of Agricultural Research Management, Hyderabad, 1994-95; Scientist, ICAR-Central Institute of Freshwater Aquaculture, Bhubaneswar, 1995-98; Scientist Sr. Scale, ICAR-Central Institute of Freshwater Aquaculture, Bhubaneswar, 1998-2003; Sr. Scientist, ICAR-Central Institute of Freshwater Aquaculture, Bhubaneswar, 2003-2009; Principal Scientist, ICAR-Central Institute of Freshwater Aquaculture, Bhubaneswar, 2009-2016. His main field of research includes Aquaculture & Molecular Immunology, Fish Health Management, Inland Fisheries.

Dr. Das Developed Linkages with Worldfish, NACA, FAO, GIZ, SAARC, BOBP, IUCN, World Bank, RMIT University, Waterloo University, University of Manitoava, University of Aberdeen, TWAS, MoEF &CC, Ministry of Jalshakti, DoF, NMCG, NFDB, CPCB, CWC, State Fisheries Departments. Guided 25 Ph.D. and 35 Masters students including 2 post Doc and 2 international students. Signed 11 MOU with the Govt. department,



3 MoU for commercial, 7 MoU for consultancy project. 2 MoU for research collaboration and 3 MOU for academic and research collaboration. More than 355 international publications having Citations–6751, h-index – 38, i10 index – 119.

Received Awards/Honours like Jawaharlal Nehru Award for outstanding post graduate research conferred by ICAR 1999; Lal Bahadur Shastri Young Scientist Award conferred by ICAR for the biennium 1999- 2000; Dr. Hiralal Chaudhuri Annual Awards 2001-2002; DBT Overseas Associateship 2005; Krushakbandhu Award by Orissa Krushak Samaj 2011; Dr. M.S. Swaminathan Award for Best Indian Fisheries Scientist by Professional Fisheries Graduates Forum 2011; Krushi Ratna Award from Orissa Krushak Samaj 2016; Eminent Zoologist of the Year Award by Zoological Society of India 2017; Krushak Gourav Award from Orissa Krushak Samaj 2017; Cashless Award for making ICAR-CIFRI a Cashless Office, ICAR, New Delhi, 2017; Ganesh Chandra Vidyarthi Award for Hindi Journal, Nilanjali, ICAR, New Delhi, 2018; Best annual Report Award of ICAR-CIFRI, ICAR, New Delhi, 2019; Sardar Patel Outstanding ICAR Institution Award-2020 under Large Institute Category, ICAR, New Delhi, 2020; Rafi Ahmed Kidwai Award for Outstanding Research in Agricultural Sciences under Animal & Fisheries Sciences Category, ICAR, New Delhi, 2020; Ganesh Chandra Vidyarthi Appreciation Award for Hindi Journal, Nilanjali, ICAR, New Delhi, 2020; Agri-Food Empowering India awards 2021; Special Felicitations for outstanding and exceptional contribution to the Nation by State Bank of India, 2022. He is a Fellow of the International Society for Environmental Protection (ISEP); Member, Executive Council, India Science Congress Association for the year 2020-2021; Member, The National Academy of Sciences, India.

### **Dr. Amiya K. Sahoo**



Dr. A.K.Sahoo is currently working as Senior Scientist, in Riverine and Estuarine Fisheries Division at ICAR-Central Inland Fisheries Research Institute, Barrackpore. Since more than 10 years, he is working in the area of Ecohydrology under climate change, Environmental flows, River basin approach towards sustainable fisheries and Fish health. Dr. Sahoo has wide working experiences in different rivers including rivers Mahanadi, Ganga, Teesta, Narmada, Cauvery particularly on Impact assessment due to hydropower projects. He has immense contribution towards Conservation of migratory fish species through technical guidance on Fish pass, delineating the migratory path of fish through tagging and fish breeding. The major migratory fish species under investigations are Hilsa, Mahseer and Trouts. Dr. Sahoo is a recipient of many awards including Young Scientist Award from AFS, Padmashree S. Ayyappan gold medal award, ZSI Gold Medal, University Gold medal and fellow of JFLS and has more than 90 publications to his credit. He is currently serving as Guest Editor to Frontier's in Marine Biology. Dr. Sahoo represents as Technical member to Expert Appraisal Committee, River Valley Project, MoEFCC and Technical member of Biodiversity ISO certification and Farakka Barrage Authority.

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