

Linking rivers, barrages and fish migration*

Regulating fluvial systems by dams, barrages and construction of inter-basin link canals, has severe impacts on fish populations across the world's rivers. In India, all major fluvial systems are interrupted by a series of barriers. This includes small weirs to large dams and salt-water barriers preventing saline incursion to the estuarine lakes. One major reason for decline in the populations of commercially important and ecologically unique fish species has been the blocking of migratory routes of spawners to upstreams or to the estuarine areas.

Interlinking of rivers – linking all major rivers in the Himalayas and Peninsular India through an extensive barrier and canal system has been recently projected as the 'silver bullet' to all water problems in the country. The proposal has received unstinted support from all developmental aspirants. India's Supreme Court has also provided necessary legal clearance to the project, overruling all ecological and socio-economic concerns raised against the plan. This project is feared to obstruct the natural flow of rivers impeding the movement of fishes, impacting their population, as well as leading to a homogenization of fish fauna and, most importantly, the livelihood of the fishers.

Commemorating the World Fish Migration Day (WFMD) 2016 and the 20th Anniversary of the Ashoka Trust for Research in Ecology and the Environment (ATREE), Bengaluru the Community Environmental Resource Centre of ATREE and the Kerala University of Fisheries and Ocean Studies (KUFOS) organized a national consultation and panel discussion on 'Linking Rivers, Barrages and Fish Migration'. The main aim of the gathering was to create awareness about the impacts of barrages on fish migration and fishery resources.

The Fresh Water Working Group (FWWG) of the Society for Conservation Biology (SCB), World Fish Migration Foundation and The Kerala Chapter of Indian Science Congress Association (ISCA), also collaborated with the event.

Mara Pandian (Principal Secretary to the Departments of Environment, Forests and Fisheries and Vice Chancellor in-charge of KUFOS, Kochi) inaugurated the Seminar. V. Narayana Pillai (Central Marine Fisheries Research Institute (CMFRI), Kochi), Himanshu Thakkar and Parineeta Dandekar (South Asia Network for Dams, Rivers and People (SANDRP), Pune), K. V. Jayachandran (KUFOS), Nachiket Kelkar (ATREE), V. V. Binoy (National Institute for Advanced Studies, Bengaluru), A. Bijukumar (Department of Aquatic Biology and Fisheries, University of Kerala, Thiruvananthapuram), Rajeev Raghavan (KUFOS) and E. V. Radhakrishnan (CMFRI) were the panelists. Priyadarshan Dharma Rajan (ATREE) moderated the sessions. Close to 80 delegates, including fisheries and conservation researchers, social scientists, environmental activists, graduate students and representatives from the fisher communities participated in the seminar and subsequent discussions.

All speakers equivocally stressed that most Indian rivers and their tributaries have one or more dams, and several barriers have been built to regulate salinity in major estuaries. As a result, the breeding migration of fish and shellfish has been greatly impacted leading to reproductive failure and changes in population recruitment patterns. Although some mitigation measures have been proposed and implemented (e.g. fish ladders) their success has been exceedingly poor.

Kelkar opined that dams and barrages are the sole reason for the collapse in riverine fisheries-based livelihoods in India. Species such as the hilsa (*Tenualosa ilisha*), Pangas (*Pangasius pangasius*), anguillid eels (*Anguilla bengalensis*, *A. bicolor*) as well as the Indian major carps (catla, rohu and mrigal) have become commercially extinct in many upstream reaches of the Gangetic and peninsular Indian rivers. On the other hand, boom-

ing production in freshwater aquaculture has created a somewhat false impression that India has an overall large 'inland fish-based economy'. In the midst of this, riverine fisheries stand today as a failed economic sector that is threatened by further depletion and damage from impending river 'development' projects.

V. V. Binoy discussed how human induced rapid environmental changes (HIREC) could trigger undesirable behavioural patterns or block the expression and modulation of vital behaviours under crucial circumstances in fishes, leading them into an evolutionary trap and extermination. Migratory fishes are the foremost victims of HIREC, as such species may need to utilize different sensory mechanisms, behaviours and cognitive traits to obtain biologically significant resources such as food, mate and shelter, as well as to avoid the threat of predation in different microhabitats through which they migrate.

Jayachandran mentioned that barriers and river linking affect the downstream flows and result in the drying-up of rivers during summer. Several freshwater prawns (e.g. *Macrobrachium* spp.) and fishes need to migrate to their spawning grounds to complete their life cycle. Linking rivers and obstructing migratory pathways overlooking the life-history needs of fish and shell fish populations could lead to the extirpation of several important species. Bijukumar, who discussed the importance of environmental flow requirements between marine and freshwater systems, proposed an ecosystem approach considering environmental flows, habitat heterogeneity and hydro-ecological relationships for the conservation of migratory fish stocks.

Dandekar pointed out that, riverine fisher communities – one of the most vulnerable sections of Indian society – are not recognized as legitimate water users, nor considered when decisions regarding dams or environmental flows are made. Thakkar said that environmental impact assessment (EIA) should be conducted with due considerations to biotic, ecological and social impacts, and scientists need to be proactive while carrying out critical assessments of EIA reports.

*A report on National Consultation and panel discussion on 'Linking Rivers, Barrages and Fish Migration' organized by Ashoka Trust for Research in Ecology and the Environment (ATREE) and Kerala University of Fisheries and Ocean Sciences (KUFOS) on 21 May 2016 at KUFOS Seminar Hall, Kochi, Kerala.

Priyadarsanan pointed out that at present the world is loudly thinking about decommissioning dams and other barriers for protecting riverine ecology and fish habitats. The country should assure the ecological health of rivers by integrating state of the science ecological thoughts while considering any developmental projects, and developmental decisions should be underpinned by best available scientific knowledge, societal values, preferences and perceptions.

As part of the discussions and deliberations, several recommendations under different themes were compiled.

Science: In India, there is still very little research conducted on how stream ecology is impacted by river-related human interventions and its impacts on riverine fish and fisheries. In the wake of global change, it is important to bring in more clarity as to where the country stands and where it is headed to. The science of ecohydrology which is well-developed elsewhere, needs to be promoted in India for a better understanding about riverine fish responses to flow alterations. A national database on minimum water requirement, e-flow, optimum water release, nutrient flow, etc. for various river systems should be prepared on a priority basis. Other priority areas suggested for science and research include (a) studying life-history traits and their links with cognition, and e-flow requirements for important migratory fish species; (b) designing and developing species-specific fish ladders and fish passes to suit the regional context; (c) developing hatchery life-training proto-

col for fishes that are used in ranching and stock enhancement.

Public awareness: Awareness among public and fishing communities on native freshwater fish species, their biology, behaviour and conservation needs to be improved. These can be made part of school and university curricula as well. Scientists and policy makers need to be sensitized with regard to ecological issues concerning developmental projects and EIA reports.

Policy: The Government of India together with relevant policy think-tanks and National and State research organizations needs to undertake critical assessment and appraisal of river interlinking policies and promote an ecosystem approach to river conservation.

There needs to be in place a clear-cut policy on fish biodiversity, dams and EIAs, as well as a national database on minimum water requirement, e-flow, water release rates, nutrient flow, etc. for various river systems (and for species/groups of fishes). The EIAs conducted should consider biotic, ecological and social impacts. The overall governance mechanisms for riverine fish conservation in India should be improved.

Kerala-specific issues: The Vembanad Lake in Kerala is the largest Ramsar site on the west coast of India, harbouring high biodiversity and supporting rural livelihoods. The Thanneermukkom salt-water barrage constructed to bolster paddy cultivation obstructs the migration and breeding of fish and shellfish, affecting the livelihood of lake-dependent fishers. There is need for a detailed un-

derstanding of species-specific impacts and development of mitigation strategies. There is also a need to develop studies to understand in detail, the floodplain migration of fishes in Kerala and enforce a ban on monsoon floodplain fishery (*ootha piditham*), when spawning individuals are targeted in large groups (often in hundreds) as they migrate en masse for breeding. Many such species that form the basis of monsoon floodplain fishery have a declining population and are listed as threatened in the IUCN Red List.

The river linking and national waterway programmes have the potential to extinguish any leftover fisheries systems in Indian rivers. The panel expressed deepest concerns over the shoddiness in conducting EIAs in the country, and opined that many are based on poor science. The meeting emphasized on the need for improved governance mechanisms for riverine fish conservation in India, and suggested a National Conservation Plan for the fluvial systems. It further recommended that 'fish' should be an important consideration in decision-making on any interventions to the aquatic systems.

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MEETING REPORT

Chemistry for harmonious development and a sustainable future*

Advances in chemistry in recent years have undoubtedly created considerable benefits for humankind which have led to improved health, enhanced quality of life, a better environment and more sus-

tainable development. At the same time, new scientific discoveries may lead to new risks, including the potential for new chemical compounds to be used in chemical warfare. The rapid increase in the use of chemicals and their build-up in our environment also come at a price for human health and biodiversity. Many toxic chemicals have been associated with direct impact on global warming, polluted air and water, causing chronic health problems. As our understanding of chemistry and science increases, so must

our sense of responsibility towards harnessing chemistry for humanity's cherished goal of peaceful, happy and harmonious coexistence. It is also important to raise awareness and educate people regarding various beneficial uses of chemicals, recent innovations, potential risks, trends and practical challenges in the field of chemistry.

In an endeavour to provide a common platform for researchers and students from academia and industry to share their valuable views, experience and

*A report on the UGC-sponsored two-day conference entitled 'National Conference in Chemistry: Environment and Harmonious Development (NCC-2016)' held during 7-8 April 2016 by the Department of Chemistry, Shyam Lal College, University of Delhi at the India International Centre, New Delhi.