RESEARCH PROGRAM ON Fish
Led by WorldFish

RESEARCH PROGRAM ON Water, Land and Ecosystems

Enhancing productivity and resilience of water systems by integrating fisheries


Photo credit: Sanjiv de Silva/IWMI

Inland capture fisheries[1] contribute to food production, household incomes and the growth of regional and national economies, especially in many low- and middle-income countries where they are a primary source of livelihoods and food and nutrition security.[2,3] Globally, between 17 and 21 million people, 50 percent of whom are women, are directly employed in inland fisheries. The latest annual estimate of inland fisheries catch was 12 million t, representing 12.5 percent of the total global fisheries catch,[2] of which 43 percent comes from 50 low-income, food-deficit countries where agriculture remains critical for economic development.[1] Almost all inland catches are consumed by people,[4] making them critical for household food and nutrition security as well as alleviating micronutrient deficiencies, childhood stunting and other health conditions.[2]

Water control infrastructure associated with irrigation (diversion weirs, barrages, water gates and distribution and drainage canals) supports the production of staple crops globally, but often adversely impacts inland fisheries. Such infrastructure alters the flow of rivers and disrupts the connectivity between aquatic habitats, blocking fish migration routes and degrading fish habitat, and in some cases preventing the completion of fish life cycles.[5,6] This irrigation-fisheries trade-off is set to intensify as many governments in Asia and Africa invest heavily in existing and new irrigation infrastructure as a climate adaptation strategy, typically with insufficient consideration of fisheries. Current and further declines in inland fisheries production risk exacerbating nutritional and income deficiencies among the mainly small-scale

Key messages

- Inland capture fisheries are the primary source of livelihoods and food and nutrition security in many low- and middle-income countries, but are often adversely impacted by irrigation infrastructure.
- With over 300 million ha of irrigation globally and large planned investments, integration of fisheries within irrigation systems, and similar nature-based solutions, can help reposition irrigation infrastructure as multifunctional systems that improve sustainability, livelihoods, and food and nutrition security for a wider range of local stakeholders.
- Realizing benefits from irrigation and fisheries integration for poor and marginalized households requires that technical infrastructure design be combined with social engagement and local institution building.
- Irrigation investments usually occur in longer-term planning at the national level, or in the agreed pipeline of development projects with key donors, so integrating fisheries during early planning stages is critical.
- Irrigation system-specific efforts must be supported by broader systemic change, including the alignment of sectoral policy and regulatory frameworks, to ensure the maintenance of broader landscape integrity and support of irrigation governance models.

fishers across Asia and Africa, with women and children facing particular risk.[7] This in turn may undermine attainment of the Sustainable Development Goals (SDGs) by reducing the production of highly nutritious (SDG 2: Zero hunger, SDG 3: Good health and wellbeing) and economically valuable (SDG 1: No poverty) fish. The fact that malnutrition especially affects women as well as children under the age of 5 years suggests SDG 5 (Gender equality) is also at risk, while the decline of fishstocks undermines SDG 14 (Life below water).

Irrigation systems operate within complex, dynamic and multifunctional socioecological landscapes. With integrated management, both crop and fish production can often be improved simultaneously.[8] Research by the CGIAR Research Program on Fish Agri-Food Systems (FISH), together with the CGIAR Research Program on Water, Land and Ecosystems, partners, and stakeholders,[9] sought to generate evidence and tools to shift policies and investment into integrated water, land and fisheries systems by providing the following:

1. an evidence-based guide for integrating fisheries in irrigation systems
2. a call to action for improved integration of technical and social sciences in the design and implementation of water control infrastructure to better realize system benefits for more inclusive and sustainable development.

Fisheries and irrigation integration can improve system sustainability and enhance benefits

Practical guide for water planners, managers and engineers

A growing body of evidence shows that the integration of fisheries in irrigation systems can benefit both fishers and farmers, as well as the natural environment.[10] To promote this integration, a practical guide was prepared to support those involved in water resources planning and management. The guide focuses on (i) the benefits of integrating fisheries into the planning, design, construction, operation and management of irrigation systems, (ii) the potential negative effects of water control infrastructure on aquatic ecosystems, including fisheries, and (iii) technical, management and governance measures to mitigate negative impacts and enhance fisheries for local people.[11] The need is for institutions to manage the infrastructure as multi-use systems and ensure benefits from integration are inclusive and sustainable.

The guide extends the scope of irrigation systems beyond its infrastructure and command area (physical irrigated area) to the connected upstream and downstream water bodies, which are vital for fish life cycles. There are opportunities to mitigate the impacts of all water control infrastructure through restoration or active management, including regular fish stocking, aquaculture or rice-fish production.

The guide outlines a participatory approach with stakeholders engaged throughout to address trade-offs and ensure that multi-functional irrigation systems benefit a wide range of stakeholders, including currently marginalized households. The cyclic approach broadly includes (i) understanding context and engaging with stakeholders, (ii) assessing key impacts and opportunities, (iii) preliminary scoping measures, (iv) trade-off evaluation, (v) committing to implementation, and (vi) monitoring and adapting. Sound institutional and governance mechanisms are also necessary to mitigate conflict between different water users and uses.

Calling for greater social engagement in design and implementation of water control infrastructure

Technical options for minimizing irrigation impacts on fisheries, including fish passage and fish refuge technology, do exist. However, as highlighted in a recent paper by the International Water Management Institute, WorldFish and Charles Sturt University, insufficient recognition of the social context often prevents benefits from their application from reaching the poorest and most marginalized groups.[12] In practice, this means that technical infrastructure design should be organized around "Who should benefit?" if irrigation investments are to move beyond a focus on production and support more inclusive food and nutrition security and enhanced livelihood opportunities.

We call for an extension of how irrigation investments are designed, implemented and managed, arguing that technical interventions alone are insufficient for generating the multiple outcomes necessary to fully achieve development goals.

The *process* of institution building is especially emphasized as critical in bridging the divide between technical solutions and more inclusive outcomes. Institutions must perform two key functions by (i) organizing local stakeholders to collectively become partners in intervention design and implementation and (ii) ensuring that appropriate rules of resource access help poor and marginalized households participate and benefit from technical innovations while preventing powerful stakeholders from monopolizing the benefits. This requires conscious efforts and dedicated resources to create stakeholder-designed, locally appropriate institutions that bring together diverse actors from local communities and decision-making spheres. This process of social engagement must begin at the outset of intervention design and should therefore be viewed as an integral part of the investment.

The community fish refuge project in Cambodia highlights key features of such a process that manages local water bodies for multiple water uses, resulting in increased income and food production benefits to a wide array of local stakeholders.[13] Local institutional development can contribute to the adoption of more holistic intervention designs by facilitating diverse stakeholder consultations from early stages to reflect the multiple ways in which stakeholders rely on and use multi-functional landscapes. In this way, local ecological knowledge gained from resource use can also be incorporated.


Photo credit: Fani Lilaurady/WorldFish

Another example is a long-running fish passage project in Southeast Asia, which has demonstrated that for sustainable scale-out of technical fishway infrastructure, understanding the social factors that can influence its uptake, usefulness, handover and maintenance is important. This project has recently incorporated a framework with the aim of better engaging stakeholders from project outset for more inclusive infrastructure design and management.[14]

Putting research into action

Recommendations for evidence-based policy shifts and investment

With over 300 million ha of irrigation globally and huge investments planned for more, the integration of fisheries in irrigation planning, construction, operation and management has potential for large and beneficial impacts in Asia and Africa.[15] This is already influencing major donors and investors.

Since irrigation investments usually occur within longer term planning at the national level, or in the agreed pipeline of development projects with key donors, early exchanges with irrigation financiers present an opportunity to influence investment decisions at the conceptual or design phase. To ensure stakeholder engagement processes are adequate and result in institutions that are fit for purpose, projects need to build strong transdisciplinary teams of technical and social specialists.

A focus on individual irrigation systems, however, is not sufficient, as the desired shift away from business-as-usual must be systemic in nature. This calls for efforts to ensure government and donor policies are supportive of an expanded vision of irrigation modernization.[14] Legal frameworks should also provide an enabling environment by, for example, supporting better cross-sectoral water-land management, land use rules that allow adoption of different production models, and local institutions seeking to govern irrigation water for multiple users and uses.

Future research for sustained change

The global context in which irrigation takes place is changing rapidly. Fisheries provide an entry point to support the transition toward more sustainable and resilient irrigation systems. However, more evidence is required on opportunities and challenges to successfully integrate fisheries and ensure multiple benefits are realized.

FISH researchers are currently rolling out the guide for fisheries and irrigation integration in Cambodia and Myanmar, with plans to do the same in Zambia and Ghana. In each context, feasibility assessments and pilot implementation are needed to understand how the specific environmental, structural and social conditions influence the generation of benefits, including food, nutrition and income. Based on these activities, cooperation with governments, communities and private sector actors will be needed to establish enabling policies, regulation and human capacity to widely apply the guide within each country. This iterative process is also likely to require supplementary guidance to help government officers, donors, local stakeholders and other practitioners adapt the guide to national and local contexts.

Inland fish production must also be part of the discussion around innovative irrigation technology and practices. For example, the installation of solar panels over fish ponds can provide energy for vertically integrated systems, from pump or aeration systems to post-harvest equipment, be used as a source of income generation, and provide partial shade for fish, a useful climate adaptation strategy. However, the implications of new technology and practices, especially on poor or marginalized groups, still need assessment.

Wider scale integration requires efforts to promote FISH findings to government and multisector actors at regional, country and local levels. FISH researchers are committed to continue engaging with actors at key global events and through regional and local dialogues with donors and relevant water resources, irrigation, agriculture and fisheries departments.

Notes

1 Inland fisheries are "fisheries which are carried out in freshwater or estuaries and whose target species are those that spend all or part of their life-cycle therein". FAO Inland Water Resources and Aquaculture Service, Fishery Resources and Environment Division. 1992. Review of the state of world fishery resources. Part 2: Inland fisheries and aquaculture. FAO Fisheries Circular (FAO), no. 710 (rev.8). Rome: FAO. 26 pp.

2 [FAO] Food and Agriculture Organization of the United Nations. 2018. The state of world fisheries and aquaculture 2018 - Meeting the sustainable development goals. Rome: FAO. 227 pp.

3 [FAO] Food and Agriculture Organization of the United Nations. 2020. The State of World Fisheries and Aquaculture 2020. Sustainability in action. Rome: FAO. https://doi.org/10.4060/ca9229en

4 As opposed to the large percentage of marine catch used for fishmeal and fish oil.

5 Conallin JC, Baumgartner LJ, Lunn Z, Akester M, Win N, Tun NN, Nyunt MMM, Swe AM, Chan N and Cowx IG. 2019. Migratory fishes in Myanmar rivers and wetlands: Challenges for sustainable development between irrigation water control infrastructure and sustainable inland capture fisheries. *Marine and Freshwater Research* 70(9): 1241. https://doi.org/10.1071/MF19180

6 Mahood SP, Poole CM, Watson JE, MacKenzie RA, Sharma S and Garnett ST. 2020. Agricultural intensification is causing rapid habitat change in the Tonle Sap Floodplain, Cambodia. *Wetlands Ecology and Management* 28(5): 713–26. https://doi.org/10.1007/s11273-020-09740-1

7 Youn SJ, Taylor WW, Lynch AJ, Cowx IG, Douglas Beard T, Bartley D and Wu F. 2014. Inland capture fishery contributions to global food security and threats to their future. *Global Food Security* 3(3–4): 142–48. https://doi.org/10.1016/j.gfs.2014.09.005

8 McCartney M, Funge-Smith S and Kura Y. 2018. Enhancing fisheries productivity through improved management of reservoirs, dams and other water control structures. Penang, Malaysia: CGIAR Research Program on Fish Agri-Food Systems. Program Brief: FISH-2018-11. https://hdl.handle.net/10568/96630

9 The guide was developed by a multidisciplinary team of researchers from WorldFish, IWMI, FAO, and other experts and practitioners, and draws on years of CGIAR and partner research. The call to action, in the form of a journal paper, reflects the perspectives, experiences and shared concerns of IWMI, WorldFish and colleagues at Charles Sturt University working on incorporating fish ladders in water control infrastructure in Southeast Asia.

10 Dubois MJ, Akester M, Leemans K, Teoh SJ, Stuart A, Thant AM, San SS, Shein N, Leh M, Moet PM and Radanielson AM. 2019. Integrating fish into irrigation infrastructure projects in Myanmar: rice-fish what if…?. *Marine and Freshwater Research* 70: 1229–40. https://doi.org/10.1071/MF19182

11 [FAO] Food and Agriculture Organization of the United Nations, WorldFish and [IWMI] International Water Management Institute. 2020. Increasing the benefits and sustainability of irrigation through the integration of fisheries - A guide for water planners, managers and engineers. Colombo. https://doi.org/10.4060/cb2025en

12 Duncan N, de Silva S, Conallin J, Freed S, Akester M, Baumgartner L, McCartney M, Dubois M and Sellamuttu SS. 2021. Fish for whom?: Integrating the management of social complexities into technical investments for inclusive, multi-functional irrigation. *World Development Perspectives* 22: 100318. https://doi.org/10.1016/j.wdp.2021.100318

13 Kim M, Mam K, Sean V, Try V, Brooks A, Thay S, Hav V and Gregory R. 2019. Guidelines for community fish refuge-rice field fisheries system management in Cambodia. Phnom Penh, Cambodia: Fisheries Administrationand WorldFish Cambodia. https://hdl.handle.net/20.500.12348/3632

14 Phi HL, Hermans LM, Douven WJ, Van Halsema GE and Khan MF. 2015. A framework to assess plan implementation maturity with an application to flood management in Vietnam. *Water International* 40(7): 984–1003. https://doi.org/10.1080/02508060.2015.1101528

15 McCartney MP, Whiting L, Makin I, Lankford BA and Ringler C. 2019. Rethinking irrigation modernisation: realising multiple objectives through the integration of fisheries. *Marine and Freshwater Research* 70: 1201–10. https://doi.org/10.1071/MF19161

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