Comprehensive assessment of water management in agriculture

water for food, water for life issuebrief#9

Sustaining inland fisheries:

Synergies and tradeoffs with water for agriculture

Inland fisheries provide millions of people with income and billions with food. Because benefits tend to accrue to local communities, in particular the rural poor, inland fisheries have a high value in poverty reduction efforts. But these benefits largely go unacknowledged in water resources planning and management. As a result, many inland fisheries are under threat due to changes in water quality, flow regimes, and habitat availability and connectivity.

Although fisheries deplete very little, if any, water, they do require particular quantities and seasonal timing of flows in rivers and dependent wetlands, lakes and estuaries. This can mean tradeoffs with the use of water for agriculture, as well as other uses. However, win-win opportunities do exist; there are, in many cases, synergies between agriculture and fisheries that can be exploited, if water management policies and practices support it.

Sustaining inland fisheries and optimizing their productivity can reduce poverty and hunger, contribute to economic growth, and increase overall water productivity. But the Comprehensive Assessment (CA) indicates that achieving these benefits will require action in a number of areas (see Box 1).

Box 1: Action areas for water management to support inland fisheries

Water allocation decisions need to take inland fisheries fully into account. This requires better **valuation methods** that reflect the contribution of inland fisheries to nutrition and livelihood security, as well as the larger economy.

Environmental flow requirements for fish communities, in terms of timing and amounts, need to be better understood and new knowledge incorporated into water decision-making and management.

Agricultural and irrigation systems and practices need to be modified to take full advantage of synergies with fisheries—thereby improving water productivity.

More accountable governance and management schemes need to be established and fully supported for inland fisheries.

Partnerships need to be built between fisheries and other interest groups concerned with water management.

Photo: C. Béné

A source of food, income, and "social security" for the poor

Fisheries are vital for food security and nutrition. The Food and Agricultural Organization (FAO) estimates that over 1 billion people rely on fish as a major source of animal protein, and over 3.5 billion depend on fish for at least 20% of their protein. Fish are also rich in vitamins, minerals, fatty acids and other micro-nutrients necessary for a healthy diet. In Southeast Asia, fish, not diary products, are the main source of calcium for growing children.

Fisheries also make a significant contribution to household incomes. In both tropical Africa and Asia, communities living near river and wetland systems derive a substantial share of their household income from fishery-related activities. For example, an IUCN study in the Zambezi basin showed that households with access to delta, wetland and floodplain fisheries rely on them for 13 to 43% of their cash income (see Table 1).

Water development and management decisions rarely recognize the special role fisheries play in livelihood strategies—a role that irrigated agriculture can complement but not replace. Unlike crop production, fisheries can provide a source of ready income all year around, and thus help to smooth out income flows. They also provide a form of "social security" for vulnerable households—for instance when crops fail, the primary wage earner loses his or her job, or the larger economy takes a down turn.

Studies have shown that a disproportionately high number of poor and vulnerable women (e.g. female heads of households) engage in fish processing, fish retailing, and trading. For uneducated and poor women, these activities, which do not require large capital investments or high technical skills, may be their only source of cash income—in particular in societies where men control a large part of the household's main cash-generating activities.

Photo: R. Thamma

Neighborhood fish seller, Sri Lanks. The bulk of inland fisheries production, processing and marketing is small-scale and local. This means direct benefits for rural communities. However, the informal nature of these local, small-scale activities is also one reason why the contribution of inland fisheries is not accurately reflected in national figures.

Threats to fisheries

Competition for water is among the most critical challenges facing aquatic ecosystems in many countries. The need for water to support fish and fisheries can conflict with the needs of other water users, in terms of water quality and flow requirements. And, presently, fisheries and the people who depend on them are losing out to more powerful and visible water users. In part, this is because inland fisheries are greatly undervalued in policy-making and water management arenas—at local, basin and national levels. Another contributing factor is that the environmental flows required to sustain fisheries in many systems are not known.

Water development, particularly how water infrastructure is designed and managed, has direct and most often negative consequences for fisheries (see Box 2). The volume of water diverted for irrigated agriculture can also have negative consequences for downstream fisheries. Although this water may be returned in part to the river, it disrupts flow patterns and often contains fertilizer and pesticides which contribute to eutrophication and water pollution. While the net impact of irrigation withdrawals on fisheries is most likely negative, in some irrigated landscapes, such as rice-farming systems, these may to some extent be offset by the provision of new fish habitats in reservoirs, canals and flooded fields.

Freshwater management also affects marine and brackish water fisheries. For example, even deep-water fisheries of the eastern Mediterranean experienced a marked downturn following the regulation of the River Nile's flow by the Aswan

Table 1: Contribution of inland fisheries to household income in the Zambezi basin (US$/household/year)

	Barotse floodplain	Caprivi-Chobe wetlands	Lower Shire wetlands	Zambezi Delta
Cattle	120	422	31	0
Crops	91	219	298	121
Fish	180 (43%) 1st	324 (28%) 2nd	56 (13%) 2nd	100 (39%) 2nd
Wild animals	6	49	1	0.4
Wild plants	24	121	48	29
Wild foods	0	11	7	4
Clay	2	0	8	0.1

Source: Turpie, J.; Smith, B.; Emerton, L., and Barnes, B. 1999. Economic value of the Zambezi Basin Wetlands. Cape Town: IUCN Regional Office in Southern Africa.

Analysis of household income sources in the parts of the Zambezi basin showed that inland fisheries were either the first or second highest money-earning activity—contributing more to household incomes than either cattle or crop production in some areas of the basin.

High Dam. Particularly in fresh-salt water transitional zones, changes in flow can affect the reproduction and growth of both freshwater and marine fish, as well as crustaceans and mollusks.

Benefits of an ecosystem approach

To conserve and, where possible, enhance fisheries resources will require managing rivers, wetlands, lakes, estuarine areas, and land as part of a continuum—what is commonly known as an ecosystem approach (see CA Brief 1). This can be a challenge, particularly in low-capacity and data-deficient environments. But it offers a much better chance at long-term sustainability than the sector-based approach still prevalent in the vast majority of countries.

Practically speaking, an ecosystem approach seeks to optimize ecosystem services from a given landscape, such as crop production, fisheries, flood mitigation, and biodiversity. But in most cases tradeoffs are unavoidable. Deciding which services of a particular ecosystem to privilege involves negotiating the interests of numerous sectors and stakeholders. One mechanism to promote such an integrated, multi-sectoral approach is through participatory scenario-based negotiations—where the needs of stakeholder groups, such as fishers, can be better integrated with those of other sectors' interests

Opportunities to increase water productivity

It is not simply a choice between fisheries and other benefits from water. Well-planned and managed systems can integrate all services. Agricultural systems and practices can be modified to accommodate fisheries—resulting in net positive gains to water productivity.

Many farmers already take advantage of the synergies between fisheries and agriculture to varying degrees. They may divert irrigation water or harvest rainwater to fill small aquaculture "finger ponds" to provide their families with food and income between crop harvests. Or they may stock fish in reservoirs or livestock watering ponds as a means of mosquito and/or weed control, with the added benefit of improved household food security.

Rice farmers in Asia have traditionally managed the aquatic fauna of paddy fields as a valuable supplement to rice production (see CA Brief 5). In Sri Lanka, an IWMI study showed the value of fisheries to be about 18% of the total economic returns to water in irrigated paddy production. More intensively managed fish stocking and harvest has even been shown to increase rice yields (due to weed control and the aeration of soils) by some 10% while producing up to 1,500 kg/ha of fish and reducing the need for pesticides.

Examples of Integrated Agriculture-Aquaculture (IAA) systems are now found throughout the world, the basic principles of which are to: (1) use the nutrients found in agricultural by-products for fish production; and, (2) optimize the agricultural use of water. Using these principles, fish production has been successfully integrated into row crops

Box 2: Negative effects on fisheries from water development and management in agriculture

Dams:

- Interrupt longitudinal connectivity
- Stop water flooding the floodplain (loss of habitat)
- Change water discharge patterns
- Alter salinity patterns in estuaries
- Change sedimentation levels—affecting both river and marine environments
- Entrain adult and/or juvenile fish—preventing migration

Water extraction:

- Alters flow regimes
- Reduces the extent of downstream habitats (e.g. wetlands, lakes)
- Alters salinity patterns in estuaries

Introduction of fertilizers and animal waste through drainage water or runoff:

- Causes accelerated growth of algae and aquatic plants, leading to a reduction in the level of dissolved oxygen in the water (eutrophication)

Introduction of pesticides:

- Causes water pollution

Box 3: Establishing environmental flows

Environmental flows can help balance the water needs of fisheries with those of agriculture and other competing uses. Environmental flows are not intended to mimic a pristine river but rather to support the river's ecological functioning to sustain desired services to people and nature. Several methods have been developed to determine the environmental flow requirements for rivers, wetlands and estuaries, but more work is needed, particularly for calculating the needs of the bigger river systems of the tropics.

Environmental flows are not just about water quantity, but also need to consider timing and rates of change. To support fisheries, artificial flow regimes may have to act as triggers for breeding and allow fish to migrate, access riparian floodplains, and otherwise complete their normal life cycles. Such regimes can to some extent offset the negative impacts of dams on fisheries. For example, flood releases from the Pongolo Dam in South Africa were successful in rehabilitating fisheries in the floodplain, and flows released from the Pak Mun Dam in Thailand were able to restore natural levels of fish migration and breeding in the downstream river.

(especially rice), hydroponic horticultural systems, silkworm production and animal husbandry. Although these systems are knowledge-intensive, overall costs for inputs, weed control and waste disposal are reduced, while profits are enhanced. IAA also reduces risks in vulnerable, often rainfed, small-scale farming systems.

In many systems, there is potential to increase present levels of fisheries production through intensification methods and technologies, such as stocking and aquaculture. All of these options require provision of adequate quantities of clean water, a suitable habitat, and appropriate management arrangements. According to a recent study, a prudent stock and recapture strategy adopted for 5% of the available small reservoir surface area in Asia alone would be able to increase the rural fish production in the region by 5 million tons per year. In West and Central Africa, full-time fishers land about 570,000 tons of fish per year, valued at US$295 million (first sale value). But the potential total annual fisheries production for this region is about 1.34 million tons with an estimated annual value of US$750 million (see Table 2).

Better valuation, better governance

The major constraints preventing more productive small-scale fisheries are not technical, but relate to the need for effective governance and institutional arrangements. In particular, processes are needed for determining water allocation and use policies that achieve clearly defined poverty reduction outcomes through fair, realistic and transparent trade-off decisions. Two elements are essential to such a process: (1) the effective and meaningful participation of stakeholders in the policy arena, and their involvement in management, particularly at the local level, and (2) approaches to resource valuation that quantify less tangible (social) functions and services, such as food security, provision of "social security", and biodiversity. In general, where better valuation has occurred, the profile of fisheries has been raised and adjustments made to national policies regarding water allocation to support fisheries.

Decentralisation and participatory democratisation, with downward rather than upward accountability, are seen as promising models for reforming current governance. But this type of reform should not be seen as a universal panacea to improve equity and empowerment. As empirical evidence demonstrates, when human capacity and social capital at the community level are low, decentralisation may exacerbate unequal power distribution and reinforce the marginalisation of some groups. However, careful governance adjustments emphasizing better accountability of decision-makers at all levels and better representation of marginalized groups can yield true pro-poor reform.

Fisheries provide an important ecosystem service that can be harnessed more effectively through approaches that integrate fisheries with other uses of water. Emerging, more holistic approaches to water management, of which the CA sets a prime example, enable us to search for synergies between the various options for water use. In this arena fisheries have strong allies and will generally benefit from any approaches which take a broader ecosystem perspective. More short-sighted, sector-based, approaches will ensure their continued decline. New evaluation and governance approaches for fisheries and aquaculture must be complemented by, and integrated with, similar reforms for other sectors that rely upon, or impact, the ecosystem services provided by water.

Photo: R. Welcomme

Fish fry farm integrated with rice paddies, Bangladesh.

Table 2: Value of current and potential production in some West and Central African fisheries

	Value of production (million $/yr)	Potential production (million $/yr)
River basins		
Senegal-Gambia	16.78	61.60
Volta (rivers)	7.12	8.32
Niger-Benue	94.60	82.24
Logone-Chari	17.71	71.64
Congo-Zaire	47.80	208.00
Atlantic coastal	46.66	179.30
Major lakes		
Volta	28.40	44.02
Chad	33.00	90.75
Kainji	3.30	3.30
TOTAL	295.17	749.17

Source: Neiland, A. and Béné. C. (Eds.) (In press) Tropical river fisheries valuation: a global synthesis and critical review. WorldFish Center, Penang and IWMI Colombo.

WorldFish CENTER

Comprehensive assessment of water management in agriculture

For more information. Email: comp.assessment@cgiar.org Visit: www.iwmi.cgiar.org/assessment

The Comprehensive Assessment of Water Management in Agriculture (CA) is a five-year initiative to analyze the benefits, costs, and impacts of the past 50 years of water development and management in agriculture, to identify present and future challenges, and to evaluate possible solutions. The CA's Issue Brief series, published by the International Water Management Institute (IWMI), presents key findings from the main Assessment report *Water for Food, Water for Life: A Comprehensive Assessment of Water Management in Agriculture* (Earthscan). More on the CA donors, co-sponsors (CBD, CGIAR , FAO, Ramsar), process and publications can be found at: www.iwmi.org/assessment.

This Brief is based on the chapter "Inland Fisheries, Aquaculture and Water Productivity" by P. Dugan, V. V. Sugunan, R. L. Welcomme, C. Béné, R. E. Brummett and M. C. M Beveridge in the book *Water for Food, Water for Life: A Comprehensive Assessment of Water Management in Agriculture*, 2007.

Writer: Sarah Carriger, waterwrites.com; Editor: Lisa Schipper; Design concept: mcn creative associates.