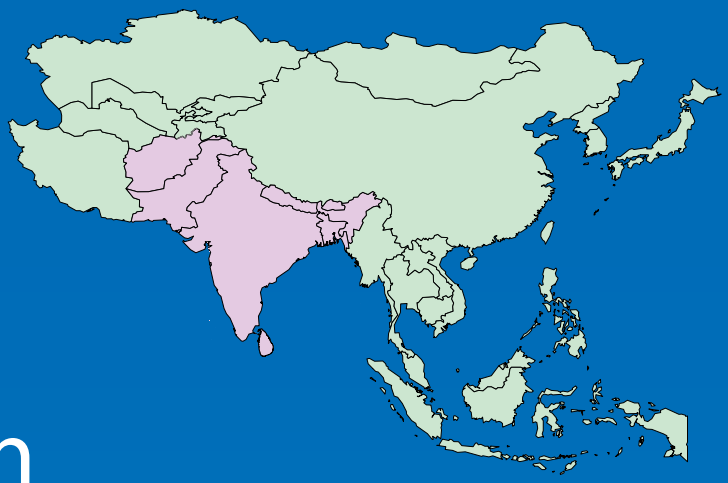

IWMI Research in South Asia

- Revitalizing Irrigation
- Improving Agricultural Water Productivity
- Climate Change and Adaptation
- Urban and Peri-urban Agriculture
- Transboundary Water Transfers
- Groundwater
- Environmental Flows

IWMI
International
Water Management
Institute

Our vision

Water for a food-secure world

Our mission

To improve the management of land and water resources for food, livelihoods and the environment

About IWMI

IWMI is an international non-profit organization that is one of the 15 research centers supported by the Consultative Group on International Agricultural Research (CGIAR).

South Asia's Key Water Challenges

Revitalizing irrigation

In spite of massive investments in irrigation, South Asia has the world's highest concentration of poor people with over 1 billion living on less than USD 2 per day, high levels of malnourishment, high economic growth, high urban growth and low access to energy. The region's underperforming irrigation sector is in need of reform.

Improving agricultural water productivity

Agriculture uses nearly 70% of all available developed freshwater resources. Given the world's projected population growth, Asia's small farmers must somehow learn to produce more food with less water.

Climate change and adaptation

Climate change will intensify existing problems, including reduced rainfall and runoff and increased heat stress. Recurring droughts and floods increasingly result in the loss of lives, loss of rural livelihoods and food insecurity. Much of the technology for climate change adaptation exists now. Implementation of these technologies requires new approaches to policy and management.

Urban and peri-urban agriculture

Urban and peri-urban agriculture (UPA) has much to contribute to growing cities including food security, poverty reduction, better nutrition and green space. City authorities are beginning to understand the need to include urban agriculture in city management strategies.

Transboundary water transfers

Transboundary water issues, international or state, are an ideal platform for promoting cooperation based on mutual trust, transparency and information sharing among riparian countries to ensure the optimal management of water boundaries.

Groundwater

Overexploitation of groundwater resources is leading to falling water tables in the Indo-Gangetic Basin, which is the world's most intensively irrigated region and is also home to over 600 million people. Properly managed, groundwater recharge technologies could make small-scale agriculture productive and sustainable.

Environmental flows

Demands for water for human use are increasingly in conflict with environmental water requirements. The International Water Management Institute's (IWMI's) Global Environmental Flow Calculator (GEFC) helps quantify water demands, including religious and aesthetic dimensions. Quantifying environmental flows helps to bring all the relevant parties to the negotiating table by giving stakeholders a sound basis on which to discuss and negotiate trade-offs.

Front cover photo credits:
Background: Karen Conniff, IWMI
Left: Sanjini de Silva, IWMI
Right: Sharni Jayawardena, IWMI

Revitalizing Irrigation

Irrigation in South Asia is a complex picture. Both India and Sri Lanka are ancient hydraulic civilizations. Large swaths of rural India are serviced by irrigation systems. These schemes were the basis of the Green Revolution, which was credited with preventing mass starvation in the region in the 1960s and 1970s. With the availability of low-cost pumps, more farmers are turning to groundwater resources, raising the question about the future of large-scale irrigation schemes. In Sri Lanka, there is an ongoing debate about how best to revitalize the ancient tank system. In Pakistan, 95% of the country's irrigated areas lie in the Indus Irrigation System, which is the largest contiguous irrigated area in the world. In Nepal, over 80% of the population depends on agriculture. Agriculture consumes 99% of all water withdrawn in Nepal, but only 24% of arable land is irrigated.

There is considerable scope to increase land and water productivity in existing irrigated areas, enhance livelihoods and reduce poverty. Realizing this potential will require new approaches to investing in infrastructure, new roles for existing institutions and new institutional options including private sector providers of irrigation services. Future irrigation systems will need to meet the demands of farmers, fishers, energy suppliers, industry, domestic users and the environment. Managers of irrigation systems will need to find ways to generate more value while at the same time halting or reversing decades of environmental damage. In predominantly rainfed areas, supplemental irrigation could significantly increase yields and water productivity with the right investments and supporting policies.

We must look beyond the traditional reforms of irrigation institutions based on Participatory Irrigation Management (PIM) and Irrigation Management Transfer (IMT). Overall, PIM/IMT have had limited impact. More promising approaches entail incentive-based institutional reforms where there is a demonstrated demand for change. These might include public-private partnerships and contracting out of irrigation services to private providers.

Photo credit: Terry Clayton, IWMI

There is considerable scope to improve irrigation performance across Asia.

International partners in South Asia

CGIAR Challenge Program on Water and Food (CPWF)

International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)

International Food Policy Research Institute (IFPRI)

International Livestock Research Institute (ILRI)

La Trobe University, Australia

Norwegian Institute for Agricultural and Environmental Research (Bioforsk)

Resource Centres on Urban Agriculture and Food Security (RUAF Foundation)

University of Melbourne, Australia

World Bank

WorldFish Center

IWMI's research aims to provide policymakers and planners with up-to-date information on regional, national and global water issues. The results of IWMI's research are freely accessible global public goods available online or on request.

IWMI offices regularly convene roundtable discussions, training workshops, conferences and seminars on topical issues.

Ongoing and recently completed research

INDIA

Assessing irrigation subsidies

The Global Subsidies Initiative (GSI) of the International Institute for Sustainable Development (IISD) has developed a methodology for assessing irrigation subsidies and making internationally comparable national estimates of irrigation subsidies. This information will help to develop a uniform method of subsidy analysis. The project comprises two country case studies in Spain and India. The state of Andhra Pradesh in India is included in the detailed subsidy analysis. The proposed approach advocates sharing the operating and maintenance costs of irrigation among multiple users, and makes it possible to recalculate subsidies on a more equitable basis.

PAKISTAN

Revitalizing Pakistan's irrigation sector

The very future of Pakistan depends on how it manages its agricultural water, but a crisis is looming. Existing irrigation systems are underperforming and threatened with salinity, new water demands are rapidly growing resulting in less water available for agriculture, and the possible impacts of climate change in Pakistan are amongst the most severe in the world. National and provincial governments are aware of the imperative and are ready to take action. However, we know that change is not easy. Thus, the question is, "What actions to take and how to get the political support for those actions?" IWMI has initiated a project to transform surface water and groundwater management in the Indus Basin Irrigation System to enhance food security, reduce poverty and adapt to uncertainties brought about by both climate change and changing water demands.

SRI LANKA

Restoring the productive capacities of village irrigation systems

Village settlements in the Dry Zone of Sri Lanka are typically centered around, and dependent on, small irrigation tanks. Villagers use these to harvest and store monsoonal rainwater for multiple uses including agriculture, livestock and fishing, domestic use and for recharge of domestic drinking water wells. The restoration, rehabilitation and improvement of these tanks will make a significant contribution to the nation's economic and social recovery through the generation of direct and indirect on-farm employment opportunities, especially to people displaced from villages in the North and East regions.

These schemes offer opportunities for the development of inland fisheries and aquaculture. Traditionally, small tank systems were surface irrigation systems that provided supplementary irrigation for the rice crop during the wet season. In years of good rainfall, a second rice crop was cultivated in the dry season with irrigation. The availability of low-cost pumps and efficient micro-irrigation technologies have provided opportunities for the development of conjunctive irrigation systems, involving both surface water and groundwater. Researchers will explore the scope for diversification into high-value crops, and opportunities for integrated crop-livestock farming systems and organic farming. The aim of this is to enhance both land and water productivity of village irrigation systems and help ensure household food security.

Improving Agricultural Water Productivity

Globally, agriculture is reaching or breaching a number of limits: there is little arable land left for agricultural expansion, soil quality is declining and major river basins are near or have exceeded the amount of water available for demand. Despite these harsh realities, many governments continue to act as if they can produce more food by expanding the irrigated area and improving water supply.

There are literally hundreds of technologies and practices for improving water productivity, but only three solutions: using the same volume of water more efficiently to produce more food (e.g., stop leaking canals; timely irrigation and inputs and using new crop varieties); increase supplementary irrigation in rainfed areas (e.g., rainwater harvesting and groundwater); and practice deficit consumptive water use - to reduce water use but also maintain yields leaving excess water for downstream users to increase their yields. None of these solutions can be truly effective without the right policy interventions.

Photo credit: Terry Clayton, IWMI

Water productivity technologies must be matched to the needs of farmers.

Ongoing and recently completed research

INDIA

Water productivity in the Indo-Gangetic Basin

Researchers are mapping water availability and access, poverty and productivity of water to identify technological, social and policy interventions in different regions of the Indo-Gangetic Basin. The goal is to conduct a basin-wide analysis of conditions, constraints and opportunities for improving agricultural water productivity, and alleviate poverty through high potential interventions.

Sustainable water use in the Krishna Basin

Achieving the desired level of agricultural growth that the government expects will be challenging, given the impacts and consequences that climate change and watershed development will have on water security. The main aim of the Krishna project is to assess the impacts of watershed development and climate change on long-term water security for agriculture in the Krishna River Basin, and compare this with the forecasted impacts and adaptation strategies in the Murray-Darling Basin. This assessment and comparison will provide a basis on which to determine whether these strategies can support future food production and their implications on the livelihoods of farmers.

Climate Change and Adaptation

By 2050, more than a billion people could be affected by a decline in the availability of freshwater, particularly in large river basins flowing from the Himalayas. Increased glacier melt is projected to increase flooding and rock avalanches, thereby affecting water resources within the next two to three decades. As glaciers recede and snowmelt diminishes, river flows will decrease. Coastal areas, especially heavily populated mega-delta regions, will be at greatest risk due to increased flooding from the sea and, in some cases, river flooding. IWMI researchers in partnership with governments, nongovernmental organizations (NGOs) and international research institutions are looking into identifying 'no regrets' adaptation strategies that will help safeguard water supplies and food security.

Photo credit: Terry Clayton, IWMI

By 2050, more than a billion people could be affected by climate change in large river basins flowing from the Himalayas.

Ongoing and recently completed research

INDIA

ClimaRice

Examination of historical rice production data in India shows an overall increasing trend in many regions with annual fluctuations. Will this trend continue given the projected change in climate and population increase in India? The ClimaRice project is assessing the behavior of the Indian monsoon in different climate scenarios, and examining its impact on water availability, rice crop production, and the resultant socioeconomic vulnerability and adaptation of farming communities in the Cauvery (Bhavani Subbasin) and Krishna (Lower Krishna Subbasin) basins. The overall goal is to reduce uncertainties in future monsoon projections, demonstrate the applicability of selected adaptation techniques, and enhance the adaptive capacity of the rice crop and irrigation water management practices to climate change through field demonstration, and institutional and capacity strengthening.

ClimaWater

Researchers will estimate the district level vulnerability and change in agricultural productivity as a result of climate change in all districts of the Godavari Basin, India. The main emphasis will be on developing quantitative methods to measure the climate input at regional and farm level. The project will be carried out jointly with partner institutions.

NEPAL

Appropriate water storage technologies

Researchers examined the economic and technical feasibility of several storage options and their impacts on local livelihoods, environmental consequences, adoption and their ability to perform under different climate change scenarios. The study was conducted in the international Koshi River Basin, a transboundary basin that spans the borders of China, Nepal and India. The findings of the study offered some new perspectives on viable storage options and suggested methods for selecting suitable interventions. The project built on a new partnership between IWMI and the University of British Columbia.

SRI LANKA

Impacts of climate change on water resources in Sri Lanka: A review and vulnerability mapping

There is growing evidence of climate change impacts in Sri Lanka, but there is little research on how climate change impacts agriculture and the country's water resources. A recent study by IWMI attempts to answer these questions. The study reviews the status of climate change research in Sri Lanka, and the mitigation and adaptation strategies proposed. Researchers will conduct a preliminary mapping of "vulnerability hot spots" in districts where the agricultural sector is considered to be especially vulnerable to climate change. This is a pioneering study in this field.

Urban and Peri-urban Agriculture

IWMI and the Greater Hyderabad Municipal Corporation are exploring options for urban agriculture. *Photo Credits*: International Water Management Institute (IWMI)/Resource Centres on Urban Agriculture and Food Security (RUAF).

Ongoing and recently completed research

INDIA

Hyderabad

Hyderabad is a rapidly developing IT and biotech city which also happens to have a growing urban poverty profile. The number of people inhabiting slums is estimated to be around two million. In 2005, the Greater Hyderabad Municipal Corporation (GHMC), supported by the RUAF-Cities Farming for the Future (CFF) project, created a multi-stakeholder team to study urban agriculture and explore its potential. In 2006, Serilingampally, a suburb of Hyderabad, was selected as a pilot municipality to develop urban agricultural activities.

Serilingampally authorities from GHMC received city stakeholders from Sri Lanka with support from RUAF-CFF. These activities have opened a window for the exchange of ideas at policy-making level. GMHC has expressed interest in exploring avenues to include urban agriculture as a part of its city greening program, and is keen to test the allotment garden concept in some of the open spaces close to community dwellings and to develop a city strategic agenda on urban agriculture. This agenda will include close links with self-help groups and the State of Andhra Pradesh.

Bangalore

Bangalore is India's third-most populous city, its fifth-largest metropolitan area and world center for information technology. The city has also pioneered several initiatives including greening, large-scale waste recycling and vegetable distribution. In the inner city areas, urban horticulture initiatives, though scarce, are visible in the form of backyards and front yards, as well as terrace gardens. These small spaces are effectively used for growing and recycling of household waste.

The RUAF Foundation (the international network of Resource Centers on Urban Agriculture and Food Security), of which IWMI is a member, together with a local NGO, Development of Humane Action (DHAN) Foundation, has mobilized stakeholders involved in UPA activities, including the local municipality, schools, a university, and urban producers and community organizations to create a UPA enabling team. A first analysis shows that there is significant scope for peri-urban agriculture versus urban horticulture. Establishing productive and economically viable agricultural production nodes in the peri-urban zone surrounding Bangalore has significant strategic importance and fits within the land use planning associated with the Bangalore Draft Master Plan. It is seen as a means of addressing urban food security and redressing the current trend of rural/peri-urban to urban migration and the associated increase in urban poor.

Peri-urban farming on the outskirts of Bangalore; Flower production for local markets earns good income; and Farmers' markets are popular with shoppers looking for fresh produce. *Photo credits*: International Water Management Institute (IWMI)/Resource Centres on Urban Agriculture and Food Security (RUAF).

PAKISTAN

Faisalabad

Research conducted by IWMI formed the basis for inter-sectoral dialogue on the negative impacts of wastewater use for crop production, institutionalizing interventions, and enhancing the knowledge and skills of Pakistan's Lady Health Workers (LHWs). Working with the Faisalabad department of the National Program for Family Planning and Primary Health Care (NPFP & PHC), researchers pilot-tested a field program, with diagnostic support provided by the Institute of Public Health, Lahore, and Punjab Medical College, Faisalabad. The research included health assessment surveys, raising awareness about health risks associated with wastewater-based livelihoods, and educational outreach programs on sanitation and hygiene behavior.

The experiences of these LHWs have been passed on to health workers throughout the district. Deworming with anti-helminthic medicines, a major activity of this project, has now been expanded to the whole district and the local health department is providing treatments twice a year. The project team is collecting data regularly on the occurrence of diarrheal episodes, which appears to be in decline as a result of this program.

SRI LANKA

Gampaha

Since 2000, the Western Province Department of Agriculture in Sri Lanka has been promoting home gardens and family business gardens in Gampaha (an urban city in the Western Province) to meet nutritional needs, to generate income for underserved communities and to contribute to the greening of the city. An estimated 1,100 families in the area are involved in this project, supported by IWMI/RUAF programme.

Urban agriculture is mentioned in the agricultural policy documents related to the establishment of city home gardens and supporting women in cities to develop capacity for such activities. In 2007, key institutions and stakeholders from the city, the provincial government and civil society started the process of further analysis of the forms of, and actors involved in, urban agriculture in the city with the support of IWMI/RUAF. Their overall vision was to create a cleaner, greener and more food-secure city by promoting and strengthening urban agriculture.

Transboundary Water Transfers

Transboundary water issues, international or state, are an ideal platform for promoting cooperation based on mutual trust, transparency and information sharing among riparian countries to ensure the optimal management of water boundaries. Over the past five years, IWMI research has contributed to an active debate on large-scale surface water transfers, and research on transboundary issues in Central Asia and Africa has brought to light a number of lessons that may have relevance for South Asia.

Ongoing and recently completed research

INDIA

India's National River-Linking Project

The National River-Linking Project (NRLP) was conceived as a means to ease water shortages in western and southern India while mitigating the impacts of recurrent floods in the eastern parts of the Ganga Basin. The NRLP, if and when implemented, will be one of the biggest interbasin water transfer projects in the world.

While for some the NRLP is the *only* option for meeting India's future water needs, others foresee less-costly, more balanced alternative water management options. Until publication of the series, *Strategic Analyses of the National River Linking Project (NRLP) of India*, by IWMI and the CGIAR Challenge Program on Water and Food (CPWF), the dialogue was lacking a sound information base and was based largely on assertions or opinions. The series is meant to provide the basis for a balanced, analytical, national discourse on India's water future and the best approaches to shaping that future, including some of the proposed NRLP transfer schemes.

Alternative water management options

- Increasing water productivity
- Recharging groundwater

- Arresting declining trends in canal irrigated areas
- Managing tank irrigation with increasing conjunctive use of surface water and groundwater irrigation
- Developing effective institutions and polices for water demand management
- Implementing strategies for increasing agricultural productivity in rainfed areas
- Water management for intensive culture fisheries
- Improving the livestock-water interface

Groundwater

Photo credit: Terry Clayton, IWMI

Groundwater use has seen exponential growth in many parts of South Asia.

In some parts of South Asia, groundwater use has seen exponential growth. Groundwater is now the major driver of agricultural growth and rural economies in all across India. Whatever their discipline, most researchers agree that groundwater management is not a function of hydrology alone. Groundwater management is a complex political ecology and some of the most effective management levers, like subsidies for diesel and electricity, lie outside the water sector.

Other parts of South Asia have an abundance of groundwater. The potential for groundwater use in these areas has been largely neglected, in part, because so much attention has been given to areas of overexploitation, and, in part, because people are unaware of or have no incentives to make the necessary investments. The greatest challenge will be applying the lessons learned elsewhere while tapping this potential.

Ongoing and recently completed research

INDIA

Indus River Basin: A global hot spot of groundwater use

The Indus River Basin boasts the highest groundwater use in the world. The agricultural boom supported by such high levels of extraction is simply not sustainable under the current scenario. A high level of agricultural production could be maintained with the right combination of investments, policies, and water management and farming practices.

Nestlé milk water footprints

The growth in agricultural productivity was a major driver behind the economic growth of the Moga District in India's State of Punjab. Extensive groundwater irrigation revolutionized agricultural production, but has led to severe water stress, which has become a limiting factor for sustaining agricultural growth. Nestlé, a major milk producer with a large dairy processing plant in Moga, approached IWMI to help them assess their water footprints for milk and crop production, and suggest ways the company could reduce that footprint and mitigate any adverse impacts their operations might be having on water. IWMI researchers calculated the internal and external water footprints and made specific recommendations on water-saving measures that the company could adopt or promote within the Moga District to help stop or reverse declining groundwater reserves. Nestlé will use the final report, submitted to in May, 2010, as part of its strategic planning process for dairy operations in India.

SRI LANKA

Impact of groundwater development on property rights under small tank systems

Centuries-old small tank irrigation systems continue to support a sizeable number of small farmers. In recent decades, their performance has declined markedly. Various interventions aimed at rehabilitating small tanks have had limited impact. Meanwhile, ready access to low-cost diesel and petrol pumps for groundwater abstraction has radically transformed agrarian systems in areas with small tanks, and low-cost water on demand has led to increasing commercialization of production in upland areas. Traditional property rights are also being affected. IWMI is analyzing these impacts on marginal and landless households brought about by the proliferation of groundwater development, and the enclosure of state land by more affluent households as privately owned parcels for commercial farming.

Hydro-geochemical characterization of aquifer systems in the Jaffna Peninsula

The Jaffna Peninsula once enjoyed a higher level of agricultural development than most other parts of Sri Lanka. Three decades of civil conflict seriously disturbed civilian life and agriculture in the region and much of the irrigation infrastructure fell into a state of serious disrepair and neglect. The end of the conflict offers tremendous opportunities to redevelop groundwater irrigated agriculture in the peninsula. IWMI is working with researchers from the universities of Jaffna and Peradeniya, and the Institute of Fundamental Studies (Kandy) to produce up-to-date maps of the geochemical characteristics of four important aquifers (Figure 1). Researchers will map the geochemistry and water quality of the aquifer systems and groundwater recharge areas, estimate recharge rates, identify chemical and pathogen sources in groundwater, and identify likely agricultural and nonagricultural sources of contamination. Data and information from these studies will be made available for future research, and land and water use monitoring.

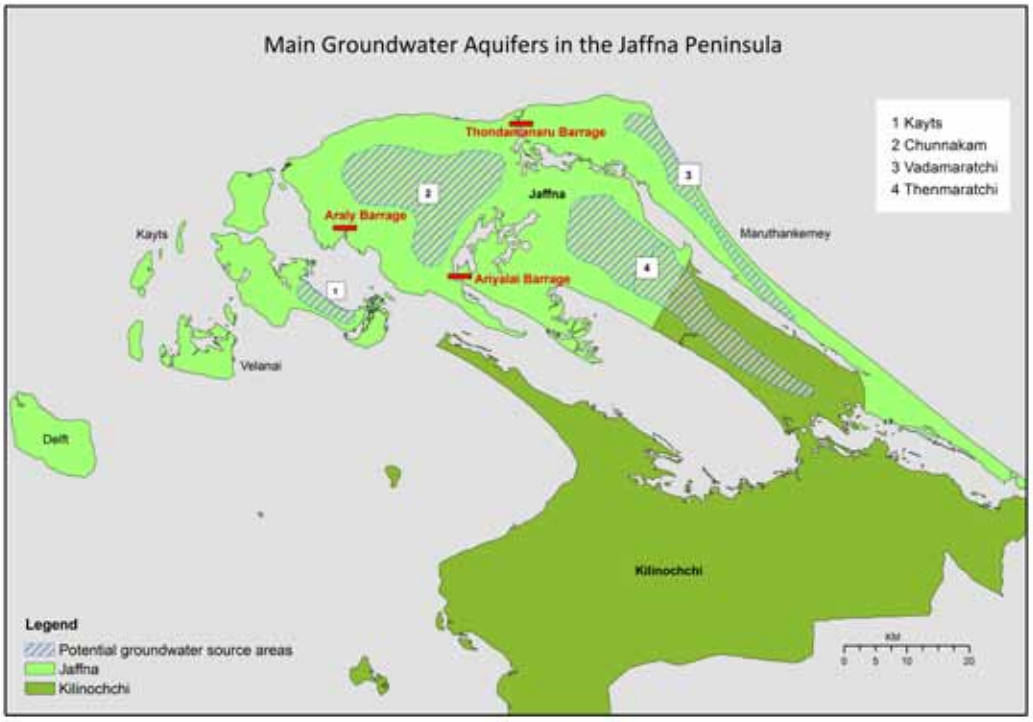

Figure 1. Main groundwater aquifers in the Jaffna Peninsula. *Source:* Created by A. D. Ranjith (GIS/RS Unit, IWMI).

Environmental Flows

An IWMI study in 2004[1] provided the first global picture of environmental water scarcity. At that time, an estimated 1.4 billion people lived in river basins where current water use is in conflict with environmental water requirements. The situation has improved a little, if at all, since that time. Discussions about environmental flows are ultimately discussions about trade-offs: water reserved for the environment means less water for human uses, thereby increasing competition amongst users and potentially leading to disputes and conflict. IWMI's research and work with partners has led to two important conclusions: all dimensions of environmental flows can be quantified, even religious and aesthetic; and quantifying environmental flows helps to bring all the relevant parties to the negotiating table by giving stakeholders from all sides a sound basis on which to discuss and negotiate trade-offs.

Why we go 'beyond minimum flows'?

Over the past several decades, people from a growing number of sectors have begun to appreciate that the environment is an important water user and must be allocated an appropriate share of the available resources along with energy, agriculture, fisheries, transport, industry and domestic users.

[1]Smakhtin, V.; Revenga, C.; Döll, P. 2004. *Taking into account environmental water requirements in global-scale water resources assessments*. Colombo, Sri Lanka: International Water Management Institute (IWMI). 29p. (Comprehensive Assessment of Water Management in Agriculture Research Report 2).

Initially, people talked in terms of the 'minimum flow' necessary to maintain specific ecosystems or services. The minimum flow concept was, and to some extent remains, constrained by a focus on hydrology. Over time, the concept of environmental flows has gone beyond minimum flows to include objectives that consider the spatial and temporal patterns of an entire flow regime of a river and ecologically important relationships between river flows, floodplains, estuaries and aquifers. Recent efforts have also incorporated social and economic aspects in environmental flow assessments, particularly in terms of the effects on subsistence users of rivers and floodplains.

Ongoing and recently completed research

INDIA

World Wide Fund for Nature (WWF) Ganga Basin Project

In 2008, IWMI entered into a partnership with WWF, India, and the Hong Kong and Shanghai Banking Corporation (HSBC) in a three-year program, "For a Living Ganga." The program brought together researchers, NGOs and government partners to calculate the environmental flow requirements for the Upper Ganga River, an iconic but rapidly developing river. IWMI organized teams of local and international experts to adapt existing environmental flow tools to the Indian requirements, especially for religious needs.

GLOBAL

The Global Environmental Flow Calculator (GEFC)

The Global Environmental Flow Calculator (GEFC) is a software package for rapid desktop assessment of Environmental Flows (EFs) with applications for river basin planning. The EF estimation technique uses monthly time step series reflecting natural unregulated flow conditions. Environmental flows aim to maintain an ecosystem or upgrade it to a specified environmental management class. The higher the class, the more water is needed for ecosystem maintenance and more flow variability needs to be preserved. The GEFC designates six classes ranging from 'unmodified' to 'critically modified'.

Policy and Institutional Reform

Policymakers and planners throughout South Asia are well aware of the drivers affecting land, water and the environment. They recognize the need to review and revise policies and institutions to meet the challenges posed by growing populations, urbanization and climate change, and are actively engaged in that process. Given the accelerated rate of change, there is less room for error than in past decades. Investing in viable agricultural water management and 'no regrets' climate change adaptation solutions requires, among other things, a solid scientific basis.

Approximately 90% of the researchers working on issues in South Asia are South Asian scientists. IWMI provides links to a global network of research institutions and can mobilize the resources to address pressing issues.

Photo credit: Terry Clayton, IWMI

Policy reform is needed to encourage new practices.

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