ENVIRONMENTAL FLOWS

Environmental Perspectives on River Basin Management in Asia

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GLOBAL SURVEY ON THE ENVIRONMENTAL FLOWS CONCEPT

To coincide with the emergence and expansion of the *environmental flows* concept around the world over the last ten years, a global survey was undertaken to determine the perceptions of water professionals representing a range of water-related sectors. The survey was distributed and responses compiled from May to July 2004. The study was undertaken by Mr Michael Moore of Linköping University (Sweden) in collaboration with International Water Management Institute (IWMI), the World Conservation Union (IUCN) and Stockholm International Water Institute (SIWI). The aims of the survey were:

- To identify how people involved in different water-related sectors perceive and interpret the concept of environmental flows;
- To add to the growing database on the methodologies used for assessing environmental flows and the extent to which the concept is applied worldwide;
- To identify reasons why the concept is not being applied in certain areas and the major challenges for understanding and implementation of the concept;
- To indicate how particular areas are translating the concept into policy and practice; and
- To allow the opportunity for people to voice their opinions on and concerns for the concept within the context of future water resource management.

Who responded?

A total of 272 water professionals representing 64 countries in the six major regions of the world responded to the survey. They represented a scientific / research / academic organisations (43%), government agencies (28%), NGO/civil society/professional organisations (14%), private sector (10%), inter-governmental agencies (4%) and media (0.1%). However, representation of specific groups, particularly water-users, and specific regions of the world was low, demonstrating possible limitations of the survey distribution method as well as the lack of concept awareness and application in many parts of the world.

Concept definition and interpretation

The ways in which respondents defined and interpreted the concept of environmental flows varied widely. In response to the question regarding what terminology is used to refer to the environmental flows concept, 57 different terms were identified. The most common terminology used includes environmental flows (39% of respondents), minimum flows (38%) and in-stream flow requirements (37%). The variety of terms and the ways in which they were defined reflects the original context in which concern over hydrological alterations was raised in different areas and the subsequent evolution in research and practice. The diversity of concept interpretations also follows the evolution of the concept from the early attempts at quantifying minimum flows for specific fish species to the latest holistic approaches that take into account the socio-economic impacts of implementation.

Concept application

The degree to which the concept is being applied around the world shows the growing recognition of the need to consider the environmental water requirements when making decisions about water resource allocations. When the results of this survey are combined with earlier studies, at least 72 countries worldwide were found to apply the concept at present at some level, illustrating the emergence of the concept over the last several years. However, despite the growing awareness, many areas do not yet apply the concept and there are significant obstacles for implementing the concept within existing water management practices, particularly within developing countries. Survey respondents from areas where the concept is not yet applied attributed a general lack of awareness among stakeholders and insufficient policy guidance and management capacity as the main reasons for the lack of application.

Opportunities and challenges for Environmental Flows

A question towards the end of the survey asked respondents to indicate the extent to which they agreed that environmental flows were a necessary part of the efforts to solve problems related to water scarcity. A large majority (88% of respondents) agreed that the

concept of environmental flows was an essential element in the efforts to achieve sustainable water resource management. In addition, many comments added by respondents identified a number of opportunities and recommendations in the future expansion of the concept. "Exchange of information and experience is the key," reported one respondent and issues related to education, knowledge sharing, technical support, public acceptance and effective stakeholder involvement were repeated across many responses.

The most critical obstacles for further understanding and implementation of the concept in water management were found to be the lack of understanding of the socio-economic costs and benefits of environmental flows and the lack of political will. Identifying and effectively communicating the direct and indirect benefits of environmental flows to communities and water users was seen as an essential task by the large number of respondents. Some suggested that an intensive information campaign should be launched detailing the benefits associated with implementing an environmental flows program. Ultimately, the condition in which a river will be sustained is a societal choice, driven by the values that the society places on ecosystem goods and services and determined through a balance of the tradeoffs involved.

Concerns raised by the survey respondents included the potential for escalating conflicts over water resources with the allocation of water for environmental purposes. Many expressed concern that water users, particularly within over-appropriated river basins, see the concept as a threat to their current water use and that it is not possible to implement environmental flows in the conditions of increasing water scarcity.

The survey demonstrated that there is considerable interest in the concept of environmental flows around the world and within all water-related sectors of society. It provided an opportunity for people to voice their concerns regarding the concept in the context of future water resources management. A detailed research report on the survey is currently being compiled as part of the Comprehensive Assessment of Water Management in Agriculture (http://www.iwmi.cgiar.org/Assessment/Index.asp)

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ENVIRONMENTAL FLOWS AND WATER RESOURCES MANAGEMENT IN INDIA

Rivers have always held a special place in the socio-cultural ethos in India, and most of them are also treated with reverence. However, the ever-growing human population and the consequent demand for water to increase agricultural production, urban supplies and industrial development have led to extensive regulation and diversion of river flows by constructing embankments and dams or barrages, especially during the past century. The drastic reduction of water flow in the rivers, and in some cases, its total elimination except for the monsoon season (e.g. Yamuna river downstream of Tajewala), has caused rapid degradation of riverine ecosystems together with a steep decline in biodiversity, especially the fisheries. Many reaches of rivers have lost their waste assimilation capacity to the extent that they have turned into sewer drains. These changes have in turn seriously affected the livelihood of millions of people who depend upon the rivers and their resources, and caused underestimated economic losses by way of the value of riverine resources, health impacts of polluted surface and groundwater, and increased costs of wastewater treatment. Assuming that benefits have accrued elsewhere in the form of increased agricultural production and energy for industrial production, they only reduced the social and economic equity. The total benefits have never been evaluated against the total losses.

India is facing a challenge of managing its limited water resources with high spatial and temporal variability. Similarly to many countries, the national water policy, however, accords the lowest importance to the water needs of aquatic environment. Water has become a cause of division and discord between neighbouring countries, states and people. One readily fails to recognize the links between the mighty Himalaya, the Sundarban mangroves and the enormous coastal fisheries in the Bay of Bengal.

Yet, India has been conscious of the problem of water quality in the rivers since the early 1970s when legislation was enacted to prevent and control water pollution. Later, the Ganga Action Plan was launched to improve water quality in the River Ganga. Now, the National River Conservation Plan extends the efforts to reduce pollution in all rivers. However, despite considerable effort and costs, the water quality continues to decline. While the growing human population, and consequently the increased pollution load, as well as the problems related to the operation and maintenance of the sewage treatment plants are held responsible, there has been practically no attention paid, until recently, to the loss of the assimilation capacity of the rivers due to the absence of flow.

A major roadblock on the way to the recognition of the importance of flow maintenance in rivers, however, is the nearly total lack of studies on the relationships between the flow and functioning of river ecosystems in India. Practically all Indian studies on rivers focus on water quality or various organisms without reference to flow regimes, although the fishery scientists have, for more than half a century, voiced concern over the effect of dams on migratory fish. Indian studies have never considered the rivers as ecosystems whose ecological integrity (physical, chemical and biological characteristics) and dynamics are governed by their hydrology (the flow regimes) and fluvial geomorphology.

The issue of flow was highlighted in a judgment of the Supreme Court of India which in May 1999 directed the government to ensure a minimum flow of 10 m^3/s in the Yamuna River in its course through Delhi - to improve the river's water quality. Since then, the requirement of a minimum flow in rivers has been discussed at several forums in the context of water quality. In May 2001, the Government of India constituted the Water Quality Assessment Authority (WQAA) which in turn constituted, in May 2003, a Working Group to advise the WQAA on "minimum flows in rivers to conserve the ecosystem". Notwithstanding the use of the phrase "minimum flow", the emphasis on the "ecosystem" is noteworthy. However, for various reasons, the Working Group has not yet finalised its recommendations.

The issue of environmental flows is gradually gaining attention from hydrologists, ecologists and fishery scientists. A national workshop on environmental flows is being planned for early 2005 to be held in New Delhi.

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ENVIRONMENTAL FLOW RESEARCH IN BANGLADESH

Within the framework of a capacity building programme between the Dutch Delft Cluster (a co-operation platform of five Dutch institutes including WL/Delft Hydraulics, Alterra, Delft University of Technology and UNESCO-IHE) and the Bangladesh University of Engineering and Technology (BUET) a research is carried out with a focus on i) suitability of methods to assess environmental flows in Bangladesh and ii) inclusion of socio-economic aspects in environmental flow assessments. Besides the BUET, other agencies / institutes in Bangladesh involved in these studies include WARPO (Water Resources Planning Organization), BWDB (Bangladesh Water Development Board), CEGIS (Centre for Environmental and Geographic Information Services), IWM (Institute of Water Modelling) and the JRC (Joint River Commission).

The suitability of different environmental flow assessment methods is tested in three rivers: the Surma-Kushiyara, the Teesta and the Gorai. The Surma-Kushiyara river system has low-lying floodplains, which are flooded annually during the monsoon. This enables recession agriculture and a significant fish production. Both rivers originate from the Indian Barak River, which bifurcates at the border of Bangladesh. Changes in this bifurcation point alter the distribution of water into the two rivers, leading to very low flows in Surma. The construction of a dam for hydropower generation about 400 km upstream of the Bangladesh border will lead to higher low flows and reduced high flows. Planned future withdrawals for irrigation of the Cachar plain 200 km upstream of the border will reduce low flows. The Teesta, which is a tributary to the Jamuna (Brahmaputra), is located in the most drought prone area of Bangladesh. Upstream abstractions for irrigation both in India and just across the border in Bangladesh have changed the downstream flow regime. The Gorai, an off-take of the

Study Rivers in Bangladesh

Ganges, is the main fresh water supply to the Sunderban mangrove area in south-west Bangladesh. Due to morphological changes the off-take point of the Gorai is silting up, leading to a reduced inflow into this river. The mangrove system downstream, which provides habitat to a large population of Bengal tigers, is degrading due to changing salinity. The increased salinity has lead to the replacement of paddy cultivation by shrimp farms.

The study so far has made progress in collection and analysis of hydrological data for the above three rivers and made use of several hydrology-based methods of environmental flow assessment (including Tennant, Constant Yield, Flow Duration Curve and the Range of Variability Approach – RVA). In addition, remote sensing images have been used to prepare landuse and ecotope maps of the Surma-Kushiyara and Teesta rivers' study sites. These maps are validated with field checks through vegetation surveys. Inventories of fish and other fauna complement the description of the ecosystems that are being supported by the river. Currently, flood modelling is underway and field investigations of the Gorai

study site has started. All these data will be used in order to allow comparison of different environmental flow assessment methods and to recommend best practices to the Bangladesh water managers.

Socio-economic aspects of environmental flows are examined through research conducted at Delft University of Technology. The research focuses on relationships between people and river flow regime and incorporation of those into environmental flow assessment. A case study was carried out in the Surma-Kushiyara basin to test a conceptual model which describes these relationships. The research primarily consisted of interviews at the household level in four villages along the Surma: two villages dominated by fishermen and two - by farmers. It is found that:

- The main ecosystem goods and services are the enabling of cultivation and the provision of fish, which generate food and income for 40 to 80% of the population (with 25 to 70% of the population being entirely dependent on income from aquatic ecosystems).
- Flooding is the main characteristic to sustain the current use of the river ecosystem, direct use of the river is less important. Annual flooding during monsoon is important for cultivation during flood recession. Dry season (April / May) water levels still need to be high enough to link river and floodplain – to maintain fisheries
- Although flooding is important for agriculture and fisheries, most of the people prefer to have no flood, because depth and timing of flooding are unpredictable.

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A TRAINING COURSE IN ENVIRONMENTAL FLOWS

A training course on Environmental Flows was held on 11 September 2004 in Madrid as part of the 5-th International Symposium on Eco-hydraulics. The course was delivered by Jackie King (Southern Waters, Cape Town, South Africa) and Angela Arthington (Griffith University, Brisbane, Australia) and attended by 19 environmental scientists and practitioners from around the world.

Dr King gave a thorough presentation of the development of holistic methodologies in South Africa. She then explained the details of the holistic DRIFT methodology (Downstream Response to Imposed Flow Transformations) and its recent addition: DRIFT SOLVER. DRIFT SOLVER uses the Microsoft Excel Solver Tool to optimize the allocation of a given volume of water to various flow components (i.e. low flows / floods) in order to minimize the environmental impact. Prof. Arthington focused her presentation on the development of holistic environmental flow assessment methods in Australia, in particular the Benchmarking Methodology - a risk management tool that predicts future riverine changes by using evidence of past riverine responses to altered flow regimes.

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More information on environmental flows can be found at

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