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ARENA

EVOLVING POLICY REFORMS AND EXPERIENCES FOR ADDRESSING DOWNSTREAM IMPACTS IN WORLD BANK WATER RESOURCES PROJECTS

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ABSTRACT

The systematic integration of environmental flow requirements (EFR) in water resources management decision-making and policy reforms is a complex task and still a developing field, on which agreement does not yet exist, even in industrialized countries. The complexity is compounded by lack of data and weak institutional capacity. In addition, environmental flow assessments, i.e. the process of determining EFR, can be costly and may yield uncertain results with limited utility to decision-makers.

This paper focuses on the evolving policy reforms and operational experiences within the World Bank to mainstream EFR into water resources management. It includes a brief discussion of the context of environmental flows in the World Bank's work, and looks at the evolution of the World Bank's policies related to the integration of environmental flow considerations in its activities. Five case studies illustrate the World Bank's varied involvement in environmental flow issues. The paper concludes with recommendations for improving the integration of environmental flow considerations into water resource development and management. Copyright © 2003 John Wiley & Sons, Ltd.

KEY WORDS: environmental flow assessment; environmental impact assessment; World Bank

INTRODUCTION

Many of the world's rivers have been modified through storage, diversion, and control structures to provide abstractions for urban and agricultural supplies, to generate electricity, to maintain flows for navigation, to return drainage flows, to control floods, and to provide security against climate variability. In many rivers, almost all the flows have been diverted. Further, the seasonality of flows and the size and frequency of floods have been modified through these interventions. Partly as a result, there is an increasing recognition that modifications to river flows need to be balanced with maintenance of essential water-dependent ecological services (Naiman *et al.*, 2002). The flows needed to maintain these services are termed 'environmental flows'.

The systematic integration of environmental flow requirements (EFR) in water resources management decision-making and policy reforms is a complex task and still a developing field. The complexity is compounded by lack of data and weak institutional capacity. In addition, environmental flow assessments, i.e. the process of determining EFR, can be costly and may yield uncertain results with limited utility to decision-makers. This paper focuses on the evolving operational experiences within the World Bank to mainstream EFR into water resources management. It has six sections. The second section briefly discusses the context of environmental flows in the World Bank's work. The third looks at the evolution of the World Bank's policies related to the integration of environmental flow considerations in its activities. In the fourth section, five case studies illustrate the World Bank's varied involvement in environmental flow issues. Section five draws broad lessons. The paper concludes with recommendations for improving the integration of environmental flow considerations into water resource development and management.

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ENVIRONMENTAL FLOWS AND DEVELOPMENT

Environmental flows and the biophysical and socioeconomic nexus

In the last decade, environmental flow assessment (EFA) has emerged as a distinct topic in water resources management and environmental impact assessment (EIA), although it is still a young discipline without uniform agreement on approach, methods, or criteria. An environmental flow is an allocation of water with a prescribed distribution in space and time that is deliberately left in a river, or released into it to manage river health and the integrity of ecosystems sustained by the river flows. In addition to spatial and temporal aspects, environmental flows often have important quality dimensions. Flows allocated for irrigation, water supplies, hydroelectric power generation, and navigation are not environmental flows; even though they may support some aspects of river health, maintenance of river health is not their purpose.

EFA and other limnological work (building block method, flood pulse concept, and others) have expanded the conceptual notion of environmental flows from being simply a minimum or low flow to include multiple aspects of the flow regime, such as regular and more extreme flood events. The different components of the environmental flow regime may support different aspects of river health, and alteration of one component of the environmental flow regime may affect river-supported ecosystems differently than the alteration of another component. The magnitude of the change to a particular flow component will also affect the degree of impact to river health. Generally, the larger the change to the environmental flow, the greater the impact. The environmental flows required to support ecosystems dependent on a particular river(s) system(s) vary considerably; each presents a unique case, where perturbation to the flows will create different impacts (Brown and King, 2003).

Environmental flows are not only important for riverine or riparian ecosystems, but are vital to other aquatic and hydrologic systems, including the coastal zone, groundwater, and wetlands. The systems dependent on environmental flows provide many vital social and economic services and benefits, such as fisheries, nutrient removal, water supply, and forest products with a direct link between environmental flows and human well-being. Since different components of environmental flows support different aspects of the associated ecosystems, disruption to different environmental flow components impacts different benefits and services dependent on the flows. Understanding the range of benefits and services provided by the ecosystems supported by the various environmental flows is the fundamental development concern with environmental flows, which has vital distributional implications when assessing possible changes to flows.

Water and poverty

Water and environment are linked to poverty alleviation in two important ways: first, strategies to reduce poverty should not lead to further degradation of water resources or ecological functions and services; and second, more sustainable water use and improved environmental quality should contribute to reducing poverty (Hirji and Ibrekk, 2001). A broad definition of poverty extends well beyond income and consumption, to include inequality, health, opportunity, livelihoods and vulnerability.

Understanding the biophysical, social, and economic linkages is critical to addressing the environment, water, and poverty nexus, because often it is the poor who are directly or indirectly dependent on terrestrial and aquatic ecosystems for livelihoods and well-being. 'Because of social and economic disadvantages, the poor often live in fringe areas, where access to potable supplies and adequate sanitation facilities are limited and where higher mortality, morbidity, and disease rates prevail. Or, they live in highly vulnerable areas (floodplains and degraded watersheds), where buffering capacity to natural and anthropogenic shocks and disasters is limited. Also, poor communities relying on flood recession agriculture, dry season livestock water supplies, or fishing are often left out when major upstream water allocation or urban/industrial developments decisions are made without adequate consideration of downstream uses' (Hirji and Ibrekk, 2001, p. 2).

Environmental flow allocation

Historically, most water resources development projects have been concerned only with flows for hydropower, irrigation, water supply, or other tangible and quantifiable economic and social benefits. Flows left in the river or flowing into the sea were often seen as wasted water. As the importance of aquatic ecosystem services has become

better understood, consideration of environmental flows and their socioeconomic benefits is gaining greater weight along with consideration of the benefits from non-environmental flows. Evaluating all competing uses of river flows within a common socioeconomic framework would provide for a comprehensive development approach that considers the distribution of costs and benefits from all allocation options.

Environmental flow allocation is simply a part of overall water allocation. Defining environmental flow requirements entails identifying and assessing trade-offs among all possible flow regimes. Allocating river flows in many cases reflects a zero sum situation, however. Where allocation for one use such as irrigation comes at the expense of the quantity, timing, or quality of water available for ecosystem functions, river health often suffers. In all but totally natural rivers, river health that is dependent on environmental flows reflects a negotiated state of river resources among competing uses of river flows. This fact implies that some guidance or process should exist to decide or negotiate environmental and other flow allocations and the desired state of river health. Assistance in developing these processes is an important role for organizations concerned with development. Determination and allocation of environmental flows has both technical and institutional elements; support and capacity are needed for both aspects.

EVOLUTION OF ENVIRONMENTAL FLOW REQUIREMENTS IN THE WORLD BANK'S WATER SECTOR ACTIVITIES

Water sector investments

The World Bank is engaged in a range of activities in the water sector, from development of water services such as water supply systems, sanitation, hydropower generation and irrigation, to activities focused on management of the resource such as bulk water supply, watershed management, wastewater treatment, capacity building, and support for client country agencies that plan, allocate, and ensure the quality of water resources. Accordingly, World Bank investments are both for infrastructure and institutional development, yet client engagement may also include technical assistance or sector planning.

Developing and transition countries invest an estimated US$70 billion annually in water resources management. About 90% of the investment comes from domestic sources. The World Bank has historically invested about US$3 billion a year in water-related sectors, accounting for about 5% of investment in developing countries. The World Bank has a total active water portfolio of about US$23 billion, or about 12% of its total lending. Of this amount, about US$9 billion is for water resources management activities, while about US$14 billion is for water services.

Development challenge: emerging trends

For the World Bank, which has historically been concerned with the development of flows for irrigation, water supply, and hydropower generation, the challenge is to develop procedures and frameworks that help client countries to incorporate consideration of environmental flows (along with more traditional flow allocations) into project development. An additional challenge is to assist client countries to integrate more effectively environmental flow considerations into their domestic water policies and develop the capacity to address both the technical and institutional aspects of environmental flow assessment and allocation. Another important challenge is to support greater inclusiveness and participation in decision-making processes to empower the impacted communities, often the poor, who are most dependent on environmental flows, to play a more active role in water allocation and water resources management.

The World Bank's work in water and environment has been influenced by several factors, including global events and emerging trends in thinking and discourse about the concepts, principles, and approaches that govern water resources management. It is also the result of internal dialogue and processes based on the decades of development experience of World Bank staff. Dams in many ways provide a touchstone for the intersection of water resources management and environmental management. Dam development, which in the 1940s and 1950s was dominated by engineers, has in the past two decades been increasingly influenced by environmental and social scientists and by the affected communities. World Bank projects increasingly mirror this trend.

The safeguard policies

The Bank has ten safeguard policies in place to minimize adverse impacts. The ten environmental and social safeguard policies are: environmental assessment, forestry, indigenous peoples, involuntary resettlement, management of cultural property, natural habitats, pest management, projects in disputed areas, projects in international waters, and safety of dams. These are complemented by a Bank policy on public disclosure. Three of these relate to environmental flow issues: environmental assessment (EA), natural habitats, and projects on international waterways.

Operational Policy 4.01 Environmental Assessment (EA) was adopted in 1989 and updated in 1999. OP 4.01 includes three types of EAs: project-specific EA, sectoral EA and regional EA, all of which can be used for the evaluation of proposed water sector investments. OP 4.01 sets the protocol to conduct EA for projects based on international best practice including the scope and scale of the EA, classification of projects, capacity development for client countries, public consultations, and disclosure (World Bank, 1999). OP 4.01 states that 'EA evaluates a project's potential environmental risks and impacts in its area of influence, which includes the area within the watershed which the project is located or any affected estuary or coastal zone'. It provides a formal mechanism to influence project preparation and implementation and to integrate measures to prevent, minimize, or mitigate significant environmental impacts.

Operational Policy 4.04 Natural Habitats, adopted in 1995 and revised in 2001, addresses the loss of important natural habitats including freshwater lakes and rivers, coastal marshes, wetlands, and estuaries caused by long-term changes in land and water use (World Bank, 1995).

Operational Policy 7.50 Projects on International Waterways, adopted in 1994 and revised in 2000, addresses the impacts from projects on changes in quantity and quality of water flows among international riparian owners, but it does not implicitly or explicitly consider or discount water for environment as a legitimate use (World Bank, 1994).

Water Resources Management Policy Paper

In 1993, the World Bank issued a comprehensive statement, the Water Resources Management Policy Paper (WRMPP), in response to global concerns over growing water scarcity and increasing degradation of water quality. The WRMPP marked a major shift in developing investments in the water sector and reflected significant internal changes in the World Bank's orientation. Specific objectives in the WRMPP include that 'Water and energy supplies gained through conservation and improved efficiency can be used instead of developing new supplies to extend service to the poor and maintain water dependent ecosystems', and that 'The water supply needs of rivers, wetlands, and fisheries will be considered in decisions concerning the operations of reservoirs and the allocation of water' (World Bank, 1993, p. 12). These statements reflect an emphasis on demand management as an important policy objective with a residual environmental benefit, and explicitly recognizes EFR as an important use of water to be considered in water allocation.

The WRMPP has encouraged reforms in water management institutions, policies, and planning in client countries and has guided the Bank in helping clients create incentives to promote these reforms and develop capacity to implement them. It has served as the basis for developing regional and country level water resources management strategies. The WRMPP has provided a foundation for mainstreaming environmental considerations into Bank water sector lending and non-lending operations.

GEF operational strategy for international waters

The Global Environment Facility's (GEF) programmatic policies and strategies also influence the World Bank's work on water, in part because the Bank is one of GEF's implementing agencies. In 1995, GEF adopted an operational strategy for its International Waters Program that focuses on degradation of the quality of transboundary waters from land-based sources of pollution, physical habitat degradation, introduction of non-indigenous species, and excessive exploitation of living and non-living resources. The overall objective has been to catalyse implementation of a comprehensive ecosystem-based approach to manage international waters and associated policy and institutional reforms and investments that address priority transboundary issues. The GEF has several projects that actively address environmental flow considerations.

Implementation of water resources management principles: mixed results

An internal report from the World Bank's Operation Evaluation Department (OED, 2001) noted that the goals of the 1993 WRMPP remain relevant and appropriate, although implementation progress has been slow and the Bank and governments have not taken sufficient account of social and environmental concerns in the management of water resources. Yet, it also found that a sharp shift away from the traditional infrastructure investments has taken place in recent years towards more investments in environment and resource management.

A review for the World Bank's environment strategy indicates 'that the integration of environmental quality objectives in Bank projects remain the weakest and most poorly understood area of water resources management policy and institutional reform process. The value of natural assets such as watersheds, recharge areas, wetlands and floodplains as natural storage facilities and as central elements of the hydrological cycle and ecological systems is not fully appreciated. The inability to communicate this message and mobilize this support for actions that call for the protection of natural assets represents a major failure of the environmental community' (Hirji and Ibrekk, 2001, p. 29).

The World Commission on Dams (WCD) notes that the World Bank has become a global leader in integrating social and environmental considerations into water development and management and has played a major role in fostering steady improvements in practice in developing countries. The report also states that ample room for improvement still exists in working with client countries to improve project decision-making and to address environmental flows issues more effectively (WCD, 2000).

Water Resources Management Group

In March 2000, the World Bank established the Water Resources Management Group (WRMG). Members of the WRMG include water sector managers, specialists from the regions, representatives from water-using sectors (water supply and sanitation, irrigation, energy), members of the Environment Department, and other stakeholders from the Bank Group. The WRMG provides an integrating function within the World Bank Group. It also manages operationally oriented partnerships such as the Bank Netherlands Water Partnership Program (World Bank, 2001a). The BNWPP operates through subprogrammes corresponding to various integrated water resources management topics.

'Dams Planning and Management' is one subprogramme under the BNWPP that supports a number of activities for enhancing the quality of dams and reservoir operations. However, the 'Environmental Flow Allocation' subprogrammes have the specific objective to assist World Bank client countries to integrate environmental flow considerations into water resources management and project development activities. The initiatives supported by the EFA subprogramme to date include: providing support for economic analyses of the Lesotho Highland Water Project Instream Flow Study recommendations; analysis of environmental flow issues in the Usangu Wetlands in Tanzania; determination of environmental flows for Chilika Lake in India; and support to the Mekong River Commission. Other windows in the BNWPP programme that touch on environmental flows issues include Water Rights Systems and Water Resources, and Livelihoods of the Poor.

Environment strategy

Approved in 2001, the World Bank's new Environment Strategy, entitled *Making Sustainable Commitments*, underscores poverty–environment–water links as a major focus of the World Bank's recent work (World Bank, 2001b). To support the implementation of the Environment Strategy, the Environment Department is developing a series of Water Resources and Environmental Management Technical Notes for World Bank task managers. Three Notes on environmental flow assessments, focusing on concepts and methodologies, selected case studies, and case studies of managed floods will be published in 2003.

Water resources sector strategy

The World Bank issued a Water Resources Sector Strategy in February 2003. The WRSS takes stock of eight years of World Bank experience with implementing the 1993 WRMPP, and incorporates the World Bank's renewed commitment to poverty alleviation. The Strategy acknowledges that the principles articulated in the WRMPP

remain valid, but that the World Bank needs to make some adjustments to become a better partner in assisting its clients to use water resources for growth and poverty reduction in a socially responsible and environmentally sustainable manner. The WRSS reflects the current conception of environmental flow requirements within World Bank policy. Their importance is clear in the draft's following statement: 'Aquatic services, including the preservation and management of wetlands and floodplains, both underpin the fisheries and crop production system on which many poor communities depend, and serve vital functions in attenuating extreme hydrologic events. The Report of the WCD has correctly stressed that the rights of ''downstream ecosystems and people'' have historically been ignored. Here, too, new forms of practice are evolving, with maintenance of ecological flows now becoming an issue addressed in the design of new infrastructure, and in re-calibrating of operating rules in river basins. The Bank is actively engaged in bringing best practice to bear, through knowledge generation, through partnerships, and through its operations' (World Bank, 2003).

EMERGING ENVIRONMENTAL FLOW ASSESSMENT EXPERIENCES

The treatment of environmental flows in World Bank-supported projects occurs in diverse contexts. The following case studies demonstrate that environmental flow components of river flow regimes differ markedly, and perturbations to environmental flows can come from different types of causes. The cases also demonstrate that the ensuing consequences—environmental, social, and economic—of altering environmental flows can vary a great deal. The particular circumstances also define the options that are available to address the trade-offs.

Determination of environmental flow requirements: a complex process

The first two cases focused on determining environmental flow requirements as part of project EAs. In these cases, the central challenge is not only the methodological difficulties of determining EFRs for aquatic ecosystems, but also the integration of EFRs with other consumptive and non-consumptive uses in allocation decisions that consider economic trade-offs, and the incorporation of those requirements into the rules for operating flow regulatory structures. The third case concerns the development of national or basin frameworks for integrated water resources management, which incorporate cross-sectoral issues and demand for urban, rural, industrial, agricultural, mining, energy, and environmental uses of water. In addition, they integrate EFR objectives in water resources planning and allocation decision-making. The final two cases provide an example of ecosystem restoration programmes to help redress problems caused by alteration of environmental flows.

Case 1: Lesotho Highlands Water Project In-stream Flow Study

The Lesotho Highlands Water Project (LHWP) is a major inter-basin transfer project that exports water from the Senqu River in Lesotho to the water-short industrial heartland of South Africa (the Senqu River in Lesotho becomes the Orange River in South Africa). The World Bank contributed only about 3% of the project financing, but its role and participation was crucial to obtain broad international support and ensure that the project met sound economic, technical, dam safety, and environmental standards. This international waters project, planned in five phases, will yield an eventual transfer of up to 70 m^3/s. The 1986 treaty between South Africa and Lesotho (with a 'no-objection' from Namibia) provided the basis for Phase 1, which is being implemented by the Lesotho Highlands Water Authority (LHDA). At inception, the LHWP was the largest public undertaking in Africa. It provided substantial development benefits to Lesotho and was the most cost-effective and reliable supply of water to South Africa. Phase 1A—the Katse Dam, tunnels, and Muela power station—used the social and environmental assessment from the 1986 feasibility study and concluded that the project did not present any insurmountable environmental obstacles to development. However, the treaty was drafted at a time when insufficient attention was paid to downstream environmental aspects of the project. The 1986 treaty provided minimal compensation flows of 0.5 m^3/s for Katse Dam (Phase 1A project) and 0.3 m^3/s for Mohale Dam (Phase 1B project), representing about 3% of the mean annual runoff of the respective river systems. These flows were stipulated without adequate understanding of the implications on downstream uses (World Bank, 1998).

Since then, environmental awareness and sensitivity in the region have increased. The new water law in South Africa, for example, has elevated the importance of EFR in water allocation policy. The recent inclusion of the Delta of the Orange River as a Ramsar Convention site, a wetland of international significance, has also contributed to increased awareness.

For Phase 1B, the World Bank supported a detailed EA that addressed upstream issues and a separate instream flow requirement (IFR) study to address downstream impacts of the water transfer within Lesotho. The IFR study was commissioned in 1997 after the project was appraised. This was, in part, due to delays in the selection of the IFR study consultants and LHDA's desire to maintain the project contractors who had been working on Phase 1A. To ensure compliance with the safeguard policy, the World Bank's Staff Appraisal Report for Phase 1B included an explicit clause that stated that LHDA would have an IFR policy and operating rules in place that were agreed to by the Bank before the impoundment of the Mohale Dam. The Mohale Dam was impounded in December 2002.

Methodological improvement. From a methodological point of view, the IFR study is the most comprehensive effort supported by the World Bank to address EFR in project development. Downstream Response to Imposed Flow Transformation (DRIFT), a sophisticated methodology that integrates biophysical considerations with social and economic considerations, was developed specifically for the project's IFR study (see Arthington *et al.*, this issue).

The study team consisted of 27 international specialists, and the study included a one-year data collection period. The study objectives were to assess the possible changes in river conditions across multiple biophysical parameters under four possible operating regimes for planned infrastructure. Based on the predicted river changes, the study assessed the socioeconomic impacts on persons affected by the changes—the population at risk. The four possible scenarios ranged from a minimal change in flow condition to the operating regime negotiated under the original treaty, which was considered the most critically severe change from natural flow conditions.

Influence on dam design. Preliminary findings from the IFR study influenced the design of the Mohale Dam. The sizing of the Mohale Dam outlet works was modified to a much higher release capacity (of up to 3.5 m^3/s) than the stipulations of the 1986 treaty for the project, and the capacity of the low level outlet structure was also increased to 57 m^3/s. The new design allows greater flexibility with multi-level release outlets for quality control and a larger release structure for simulated floods.

Preliminary decisions by LHDA indicate that the IFR study is having a significant impact on decision-making. During the interim period, LHDA has increased the Katse Dam release from 0.5 m^3/s to 0.75 m^3/s, which is close to the design limitation of the compensation pipe for Katse Dam. The IFR policy has increased the Katse releases to 240% of the treaty minimum levels. Releases from Matsuko Weir, which is not governed by the treaty, have been increased from 0.05 m^3/s to 0.6 m^3/s. IFR policy releases at Mohale have increased by almost 340% of the treaty minimum levels. A comprehensive mitigation and compensation program, a first of its kind for downstream impacts, is under preparation.

Influence on final decision-making. The success of the EFA will ultimately hinge on the final decision-making regarding the implementation of the agreed IFR policy adopted by the two governments. An important determinant of the overall success, and especially below Mohale Dam, will be the role played by the impacted communities in this decision-making process. This IFR case will also be an important precedent for both South Africa and the Southern African Development Community. It will be an early test of South Africa's commitment to addressing the provisions of the new water law to an international waters project. It will be a similar test for the implementation of the Protocol for Shared Watercourses in the Southern African Development Community. The new South African Water Law's 'Reserve' provision has received much publicity; its implementation will also provide a real test to the spirit of the law.

Case 2: the Mekong River Commission instream flow rules

The Mekong is the largest river in Southeast Asia and a tremendous asset for basin inhabitants. Maintaining flows in the dry season is important to maintain river health, as well as for navigation and salinity control for irrigation in the Mekong Delta in Vietnam. The delta encompasses 12% of Vietnam's land area, houses about 17 million people, and accounts for half of Vietnam's rice production and one-quarter of its gross national product. Although the dry-season flow of the Mekong River into the delta averages 2000 m^3/s, at least 1500 m^3/s is needed to retard seawater intrusion into the delta. During low periods, typically from March to May, seawater from the South China Sea intrudes into the delta, which adversely affects as much as 2 million hectares of agricultural land

and creates domestic water supply problems. Flood flows are also necessary to maintain the Great Lake (Tonle Sap) (GEF, 2000).

Upstream support. The World Bank is the implementing agency for the GEF-funded Water Utilization Project (WUP), which supports the Mekong River Commission (MRC). MRC's members include Cambodia, Laos, Thailand, and Vietnam. The project's broad objective is 'to establish mechanisms to promote and improve sustainable water management in the Basin, including reasonable and equitable water utilization by the countries of the Basin and protection of the environment, aquatic life and the ecological balance of the Basin'. The WUP has three components: (1) developing analytical tools, including various basin models to support decision-making for determining, monitoring, and implementing flow allocations and water quality rules; (2) drafting rules to establish flow allocations, define water sharing and water quality; (3) strengthening institutional capacity (regional and national) to implement rules and manage basin waters. As mentioned, the BNWPP Environmental Flows subprogramme is providing upstream technical support for the EFA process. This can potentially yield important benefits for cooperatively developing the water resources of the Mekong River in a sustainable manner for the long-term benefit of the region's people.

Case 3: sustainable management of the Usangu Wetland and its catchment

The Usangu catchment and Great Ruaha River, a major tributary of the Rufiji River in central Tanzania, interact in a complex manner. Water flows are highly seasonal, with almost the entire annual flow coming in the wet season. The Great Ruaha River starts in the highlands of the Usangu catchment, where it supports rice irrigation, livestock, and fishing. From here it flows down to the Ruaha National Park, and onward to the Mtera Reservoir. The Mtera Reservoir is the major regulatory structure for two hydroelectric generating plants at Mtera Dam (of 80 MW) and at Kidatu Dam (of 220 MW), which generate 40% of the country's electricity. Since the early 1990s, shortages of water at Mtera have led to national power rationing, and the Tanzania National Electricity Supply Company (TANESCO) has blamed activities in Usangu. In Ruaha National Park, the Great Ruaha has dried up every dry season since 1993 (King and Thomas, 2001).

The reason for the changes is diverted flow for agriculture. Dry-season irrigated agriculture has expanded on the alluvial fans from 5000 to 45 000 ha, and rainfed farmland has replaced the original acacia stands. Irrigation diversions capture almost all of the dry-season flows from the Ruahu tributaries, so the trickle of water that enters the Ihefu Swamp from the Great Ruaha is not enough to move through the swamp to the park downstream. During the wet season, the irrigation abstractions have reduced the flood flows, so the annual flooding of the grassy plain no longer takes place, although the amount of water reaching the Ruaha River channel remains essentially unchanged. Since the wet season provides almost all the annual flow for the Ruaha, the total amount of water flowing in the river remains unchanged (King and Thomas, 2001).

The hydrologic and ecosystem changes have accompanying welfare changes. Farmers who now have irrigation, both large and small schemes, have benefited significantly with improved income, enough for their children's education and health services. The intensified agricultural production has increased tax revenue, and more food is available for consumption and sale in Tanzania. Many households have better access to water for domestic purposes from the expanded network of irrigation canals. The changes, however, have negatively impacted others. Pastoralists do not have enough water for their livestock and are forced to use the Ihefu Swamp or encroach on cultivated areas leading to conflict with fishermen and farmers. Downstream domestic water users suffer during the dry season. Village women need to walk up to 20 km to collect water, and a clear gender impact exists. Local fishermen who rely on the Ihefu have declining catches, and local villagers reliant on money from hunters have declining livelihoods as less water and habitat are available for game. The Ihefu Swamp supports significant biodiversity, and the fringe areas between the wetland and brush area are vital habitat. Wildlife in the Ruaha National Park is more scarce with the lack of dry season flows, which affects tourism revenue to the local economy. All of these changes have led to increased tension and conflict among the different water users in the area (King and Thomas, 2001).

The World Bank-funded River Basin Management and Smallholder Irrigation Improvement Project (RBMSIIP) in Tanzania is promoting water resources management reforms in a very weak policy and institutional environment. It represents the first project in which the Ministry of Water and Livestock Development is working with

the Ministry of Agriculture, Ministry of Energy, and Ministry of Environment and Natural Resources to develop a model for river basin management based on participation of key stakeholders. The stakeholders include the national hydropower company, large-scale irrigation developers, thousands of smallholder farmers, livestock communities, and environmental interests (including national parks). RBMSIIP addresses reforms for strengthening the policy, legal, and institutional frameworks for water management and specific water management challenges in the Rufiji and Pangani River Basins, the two priority basins out of the nine in the country.

To address the multisectoral water-use conflicts, the Government of Tanzania set up the Sustainable Management of Usangu Wetland and its Catchment project (SMUWC), in conjunction with the RBMSIIP, to:

- develop a clear understanding of what is happening and why (hydrology, ecology, land use, water use, and different values in term of resources availability and use);
- involve communities in defining and understanding the problems and to develop the people's commitment to solve the common resource use problems; and
- develop a shared vision for the management of catchment land and water resources.

SMUWC is working with the people of Usangu, creating local land and water use plans, reviewing existing studies, carrying out further investigations, and developing local skills and knowledge to understand and use this information. Based on initial findings from the SMUWC, the World Bank stopped plans for supporting smallholder irrigation improvements in the Usangu catchment. It is now directing the project support to strengthen water management in the basin, is supporting interventions that would lead to improved irrigation efficiency, and is developing alternatives for restoring part of the environmental flows during the dry season (King and Thomas, 2001).

Case 4: the Aral Sea Basin program

Until the 1960s, the Aral Sea was the fourth largest inland body of freshwater, with an area of 67 000 km^2. Its basin is 2.2 million km^2. The Amu Darya and the Syr Darya within the basin have annual flows of 70–80 km^3 and 35–40 km^3 respectively, 60 km^3 of which used to flow into the Aral Sea. Irrigated agriculture had supported a rich, historic culture for over a thousand years. Currently, 40 million people reside within the basin. The Aral Sea area had supported highly diversified flora and fauna, and was an important stopping point for migratory birds. Although irrigation has provided tremendous opportunity, it is the main cause of the precipitous degradation of the Aral Sea and its basin. Irrigated area (mainly for cotton) expanded from 2.5 million ha in 1900 to 7.9 million ha in 1990. About 90% of the Amu and Syr Darya flows have been diverted to support irrigation, and the Aral Sea currently receives only 5 to 10 km^3 of water annually.

The volume of the Aral Sea is 70% less and the area is 50% less than historical levels. The sea has split into a smaller Northern Aral Sea, which still receives some inflow from the Syr Darya, and a larger Southern Aral Sea, which has become hyper-saline and biologically dead. A once-thriving fishery has collapsed. Intensive, poorly managed irrigation has left 28% of irrigated land with high salinity problems, and agricultural yields have decreased by 20 to 30%. Aral Sea salinity increased from about 10 g/l 100 years ago to almost 40 g/l in some areas in 1991. Winds blow away 15 to 75 million tonnes of salt and topsoil each year, some over 500 km throughout the basin. Safe water supplies have become hard to find, and life expectancy has decreased. Since the collapse of the Soviet Union, many irrigation and hydraulic facilities have become inoperable, and institutions and capacity to manage water resources are lacking. Millions of basin inhabitants are facing severe hardship. It is economically, socially, and ecologically impossible to increase flows and restore the Aral Sea to its original condition. A balance needs to be struck between maintaining Aral Sea Basin ecosystems and maintaining agriculture, preventing millions of people from becoming more destitute (GEF, 1998).

Working with the United Nations Environment Programme (UNEP) and the basin countries, the World Bank in 1992 helped develop the Aral Sea Basin Program (ASBP). The ASBP was launched in 1994; the World Bank has been coordinating international support for ASBP. The development of institutions to manage water resources has been a priority. The 1998 GEF Aral Sea Basin Program supports salinity and water management programmes. Efficiency improvements and rehabilitation of irrigation systems should help conserve water to increase environmental flows for the Aral Sea from the Amu and Syr Darya. The wetlands restoration component will strengthen capacity to monitor river flows and water quality (World Bank, 2001c).

The World Bank's Syr Darya Control and Northern Aral Sea Phase I Project includes both structural and institutional components. The project will finance a dyke to contain freshwater flows from the Syr Darya into the Northern Aral Sea to stabilize water levels and salinity and restore some ecosystem viability. A fisheries component will reintroduce species with commercial and biodiversity value. In addition, upstream hydraulic structures on the Syr Darya are being repaired to prevent flood overflows to ensure greater flow for the Aral Sea and wetlands and lakes in the river's delta. The institutional component will continue building capacity for water resources management and increasing coordination between the independent basin states.

Case 5: managed floods in the Senegal River Valley

The World Bank's Regional Hydropower Development Project involves Manantali Dam in the Senegal River Basin and this summary draws heavily on Acreman (in press). The World Bank's involvement in the Senegal River Basin dates back to the 1960s. In 1972, the Organization pour la Mise en Valuer du Fleuve Senegal (OMVS) was created by the riparians to promote economic development through irrigation, power supply, and navigation. In 1979, the World Bank disagreed with OMVS on the rationale and potential impacts from the construction of Diama and Manantali Dams and withdrew its support of the projects. It was feared that cessation of floods, through dam operation, would have a devastating effect on livelihoods. OMVS built the dams with the support of other donors. Diama, a barrage at the head of the Senegal River Delta, prevents saltwater intrusion upstream and has raised the river levels to make year-round irrigation more accessible and cheaper for the valley residents. It has also provided water supply for local livestock and for Dakar. Manantali Dam, 1200 km upstream from Diama on the Bafing River, a major tributary of the Senegal, has a much larger storage capacity to hold annual flood waters and supply water for irrigation and hydropower production. Under the original project, irrigation has been developed on about 100 000 ha out of a potential of 375 000 ha, which has stemmed emigration from the drought-stricken valley. A fishery has developed on the Manantali Reservoir leading to settlements. The original programme, however, did not install a power station at Manantali, although hydropower was implicit in the dam design (World Bank, 1997).

In 1989, the original donors and OMVS invited the World Bank to participate to help ensure a technically sound development programme for the project's power component and additional irrigation schemes in the Senegal Valley. The World Bank agreed to participate because the dams and associated benefits had a large influence on the countries' economies. The complex economic and dam operating issues also required careful coordination among the three countries. The World Bank could facilitate this, since it was already involved with a number of other sectors, including power, in all three countries.

The World Bank finalized the Regional Hydropower Development Project in 1997 to develop 200 MW of generating capacity and associated transmission works for the completed Manantali Dam. The project also provided an opportunity to address some of the difficult environmental and social issues that accompanied the original project, especially impacts of the altered flood regime. Heavy seasonal rains in the upper basin from April to October historically flooded the Senegal River Valley for about two months every year. The inundation supported up to 250 000 ha of flood recession agriculture, grazing of livestock, fuelwood and construction materials, fisheries, and wildlife habitat. The estimated economic value of the floodplain was: recession agriculture, \$56–136 per hectare; fishing, \$140 per hectare; and grazing, \$70 per hectare. The floods also recharged shallow aquifers for village water supplies and supported wetlands maintenance in the delta downstream of the Diama (GEF, 2001; Acreman, 2003).

Manantali filled in 1991 with its outlet structures operational. Without the constraint of power generation for the release regime, OMVS provided managed flood releases on an experimental basis to enhance the flow-dependent benefits for the downstream communities. In subsequent years, OMVS made managed flood releases to inundate 50 000 ha. This requires around 7500 million m^3 of water (giving a value of about US\$2 per 1000 m^3 for agriculture, fishing, and grazing). Early efforts at better management of ecological flows from dams have had impressive results for the poor communities. Fishermen in the Senegal River in Mauritania, for example, saw their annual catches increase from 10 tons a year to 110 tons after the operating rules allowed for artificial floods. Maximization of power production will conflict with the simulated natural flooding. Important components of the World Bank project are to conduct studies to gain a better understanding of the benefits from the artificial floods and costs to its cessation and to develop reservoir management and operating rules that will balance power production needs with

maintenance of the simulated flood regime. The World Bank's assistance to finance the installation of turbines at Manantali in 2001 was conditional on the basis that OMVS retain the managed floods as a possible long-term option.

In the Senegal River Basin, a GEF project has been approved to assist the OMVS states (Mali, Mauritania, and Senegal) to develop a basin-wide framework to integrate national water resources activities within an environmental action programme. An important aspect of the project will be assessing impacts to the seasonal floods from changes to the flow regime due to Manantali Dam and integrating this information into the environmental action programme (GEF, 2001). In May 2002, the Heads of State of Mali, Mauritania and Senegal signed a Water Charter—a new framework governing the OMVS that also explicitly provides for an artificial flood, which is guaranteed annually (except in extraordinary circumstances) and minimal environmental flows.

DISCUSSION OF THE CASE STUDIES

The above cases demonstrate the difficulties in addressing downstream issues. The World Bank experience in addressing upstream issues focusing on resettlement for people, is more advanced, and its experience in addressing downstream issues is rapidly advancing. Determining downstream impacts and their socioeconomic impacts is complex. The area impacted and the population at risk are not easily defined, as was evident in the Lesotho case. The impacts may vary considerably during different seasons, may affect people differently, may not manifest themselves immediately, and may be disbursed over a wide area, affecting different populations. This makes redressing the impacts far more challenging.

The hydrologic and ecosystem consequences of environmental flow components

The cases reveal the complex nature of environmental flows issues and that environmental flows involve many different components of a river's flow regime. In the most extreme case, the rivers' annual discharge into the Aral Sea was reduced by over 90%, affecting all types of environmental flows with devastating consequences. Low flows or dry season flows are vital to Lesotho, the Mekong, and Usangu, even though in Usangu they constitute a negligible portion of annual flow. Diminished flood flows are the main concern for the Senegal River and for the Mekong's Tonle Sap. The Mekong case also demonstrates that environmental flows to maintain ecosystem viability can be both an issue of saltwater inflows as well as freshwater outflows, which underscores the importance of addressing freshwater, coastal, and marine resources as part of a linked management continuum.

The cases also reveal that impacts from changes to environmental flows may have little to do with water in the river channel. Wetland and estuary ecosystems figure prominently in the Aral Sea, Usangu, Senegal and Mekong. In the case of Daima Dam in Senegal, and the Aral Sea, hydraulic structural improvements and managed operating regimes provided improvement to the existing ecosystem conditions.

Costs and benefits of environmental flows

Most importantly, the cases highlight the intricate web of socioeconomic impacts and demonstrate that altering environmental flows is a matter of redistributing costs and benefits with winners and losers. The Usangu, Aral Sea, and Senegal involve shifting flows for irrigated agricultural production. In Usangu, farmers who now have access to irrigation have benefited and economic growth has taken place, yet the pastoralists, fishermen, and local downstream villagers have all suffered, and interestingly, it was the powerful power company (TANESCO) that protested the most about the reduced flows. In the case of Senegal and in Lesotho, many of the people dependent on flood flows that live downstream are surviving at subsistence level, and changes to the flow regime mean significant livelihood impacts. The Aral Sea represents a redistribution of flows that was unsustainable for all basin stakeholders, with a socioeconomic system and ecosystem that are no longer viable.

All the cases have biodiversity implications, which have direct and indirect human consequences. Fishery losses in the Aral Sea and Senegal floodplain directly affect livelihoods. The loss of biodiversity can have important implications for tourism revenue and the local economy but the consequences of these biodiversity impacts are

more difficult to quantify in financial terms or gauge in terms of livelihood impacts. Biodiversity losses may result from the reallocation of environmental flows, yet the flows diverted for power generation, irrigation, and water supplies produce many direct and indirect benefits to residents within and outside of the respective river basins. Successful development requires understanding the distribution of benefits and services provided from all flows, assessing the trade-offs, and making decisions to maximize benefits and ensure equity.

Challenges to moving forward with EFA and EFR

Although this paper focuses on activities of the World Bank, World Bank client countries are ultimately responsible for development, including water resources. World Bank clients face constraints with regard to the EFA and EFR, which the World Bank needs to help them overcome. Comprehensive EFA is very expensive and time-consuming. In the case of the Lesotho Highlands project, the EFA study took over two years, required 27 experts, and cost about US$2 million. The cost, however, is not significant if one compares it with the total cost of Phase 1 investment, which is over US$4 billion.

Although EFA and development of EFR can take several years, if EFA is not incorporated into project development at the beginning of the process, possible problems arise. First, findings from the EFA will come too late to influence project development. Second, if the EFA delays project gestation, this can impose significant costs and reduce revenues for resource-constrained countries. Third, if the findings from the EFA cause mid-term changes to the project, this can also impose significant costs.

EFA is an emerging science, and even in the developed world capacity is limited. Not many people can execute the necessary analysis, especially within an integrated biophysical and socioeconomic framework that is essential for assessing trade-offs. Accordingly, EFA capacity development, along with project development in World Bank client countries, is essential. Capacity development allows local people to perform EFA for subsequent development projects, and avoids reliance on foreign experts. Local capacity engenders local ownership of the EFA and EFR development process, and helps ensure adequate monitoring and follow-through on EFA activities once the 'experts' have left the country. Developed local capacity is less expensive than foreign assistance, which will reduce EFA costs for subsequent projects. Lastly, developed local capacity and appreciation of EFA issues will help influence the institutional framework to mainstream EFA and EFR concerns into domestic water resources management and development policies.

Rigorous EFA and EFR development is a complex technical process that requires management and coordination. Few agencies in the developed world have the institutional capacity to manage the process, and this institutional capacity is lacking in many World Bank client countries. Additionally, if the EFA process is managed by environmental agencies in developing countries, these agencies are often weak and resource-constrained compared to agencies responsible for hydropower, irrigation, or municipal water supply that may have fewer incentives for effective EFA. Institutions must also be able to incorporate the information provided through EFA into water allocation decision-making. This is both a matter of the institutions having procedures and capacity to process the information and assess the trade-offs between competing uses, as well as a matter of EFA information being provided in a manner that water managers can easily use and translate in operating rules and policies.

Effective EFA and development of EFRs include both a technical and social process that should engage stakeholders in the water allocation decision-making process. Institutional mechanisms need to be in place that can facilitate the stakeholder participatory process along with the technical process for informed water allocation. An educational component is usually necessary for understanding EFA and EFR issues and effective decision-making. World Bank support to facilitate these enabling institutional conditions is vital to move EFA and EFR forward.

Finally, pursing effective EFA and EFRs in countries that lack capacity, institutions, and resources for a modestly effective framework for overall water resource management poses a great challenge. EFA and EFR are at the high end of sophistication for water resources management, and most developed countries are still uncertain of how to address the issues technically or in policy. This underscores the importance of World Bank work that strengthens the overall water management capacity in its client countries, which must take place concomitantly with any EFA or EFR agenda.

Table I. Factors to enhance EFA effectiveness in development projects

- The environmental flow assessment process is started at the earliest stage of preparation for a proposed development programme or project.
- The scope of the EFA provides for wide coverage of the major potential issues and places them in a broader development context.
- The options analysis is undertaken at an early stage and includes evaluation of development, site, and technical alternatives.
- The economic value of resource degradation from flows is incorporated in the project cost–benefit analysis and decision-making. In cases where monitization is difficult or uncertain, detailed, quantified description of possible biophysical and socioeconomic impacts and their distribution should be presented to decision-makers.
- The methods used to assess and predict the impacts are robust and well selected.
- Results from the EFA study are available in a timely manner and used effectively by decision-makers and the public in their consideration of the proposed project.
- Institutional and management capacity is developed along with technical capacity to conduct EFA and implement EFRs.
- Mitigation and monitoring plans are realistically designed and can be implemented under local conditions with an identified funding source and feedback mechanisms into project operation.
- Local officials are fully engaged in every part of the process and put in a position of authority to oversee and develop the EFA and resulting EFR.
- Assessment is conducted for implementation activities and arrangements are in place to oversee environmental aspects of implementation.

RECOMMENDATIONS FROM POLICY AND PRACTICE EXPERIENCE

World Bank experience and the case studies provide lessons that can increase the effectiveness of the World Bank's and other development institutions' treatment of environmental flows. First, although emerging as a distinct field of technical expertise, EFA and EFR are in many ways both a subset of environmental assessment and water resources management. Table I recommends actions for improving the effectiveness of EFA based on the environmental assessment experience.

The use of EFA, similar to World Bank safeguard policies, should move from a reactive to a proactive orientation. EFA as a diagnostic tool should not be limited to only identifying, mitigating, or minimizing project impacts, but should be an active input to the development process to make projects more effective and equitable. An important part of this is improving the tools and methods at the decision-maker's disposal. As Lesotho demonstrates, EFA for meaningful EFRs is a complex process, but it can improve project performance. Project proponents should be aware of the required resources for effective EFA and build this into project development. More research on methods is needed, especially for ecosystems and socioeconomic systems relevant to World Bank client countries. As more research is conducted and the field matures, the tools and capacity to integrate EFA into project development will increase.

EFA and the development of EFR need to be moved from the project or post-project level to sectoral assessment, strategic assessment, or basin planning. In the worst case, the Aral Sea demonstrates the extreme biophysical and socioeconomic consequences and limited remedial options when environmental flows are considered only after they have created problems. The Mekong River Commission, by contrast, is taking an approach to develop flow allocation rules prior to extensive development of water resources.

The World Bank is engaged on many levels and in different capacities with its client countries, and the client countries may have varied hydrologic, socioeconomic, and institutional conditions. No one approach or set of mechanisms will work to mainstream environmental flow concerns into water resources management, but the World Bank and other development agencies need to address environmental flow issues through the range of instruments and opportunities available. Often, this is through project development, but raising awareness and influencing local, national, and transnational policy with regard to environmental flows is also vital. This requires not only developing capacity within client countries, but also developing capacity within the World Bank and other development institutions to address environmental flows. The implementation of the new World Bank water resources sector strategy with a renewed emphasis on developing water resources infrastructure for growth and poverty alleviation in an environmentally and socially responsible manner provides an impetus for mainstreaming and upstreaming

environmental flow assessment in water resources planning and management decision making and environmental impact assessment at the regional, transboundary, national and basin level projects and programs.

The World Bank's Environment Strategy recommends a strategic framework for actions on water to achieve the broad objective of systematically mainstreaming environmental quality objectives into water resources planning, development, and management programmes and investments. It calls for a set of complementary measures to strengthen environmental management capacity, including the following.

- Promoting a comprehensive approach to water resources management that includes: (a) improving the integration of environmental quality objectives into regional and national water resources management strategies, river basin planning, investment projects, and policy reforms and actions; (b) changing the safeguard orientation from 'do no harm' to 'promotion of improved development'; and (c) adopting environmental sustainability criteria for the water sector.
- Supporting water sector reforms that are complemented by effective regulatory frameworks and incentive structures for managing the water resource base and ensuring its sustainability.
- Recognizing ecological uses of water. EFA should be conducted as an integral part of water resources operations, including environmental assessments.
- Improving transboundary water management (World Bank, 2001b, pp. 160–161).

The implementation of the World Bank's Environment Strategy provides an important vehicle for systematically addressing the downstream impacts of World Bank projects, and thereby institutionalizing lessons from the varied and innovative experiences into ongoing and future water sector investments.

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