RESEARCH
REPORT

110

From Integrated to Expedient: An Adaptive Framework for River Basin Management in Developing Countries

Bruce A. Lankford, Douglas J. Merrey, Julien Cour and Nick Hepworth

International Water Management Institute

DEV ODG

FUTURE HARVEST
IWMI is a Future Harvest Center supported by the CGIAR

Research Reports

IWMI's mission is to improve water and land resources management for food, livelihoods and nature. In serving this mission, IWMI concentrates on the integration of policies, technologies and management systems to achieve workable solutions to real problems—practical, relevant results in the field of irrigation and water and land resources.

The publications in this series cover a wide range of subjects—from computer modeling to experience with water user associations—and vary in content from directly applicable research to more basic studies, on which applied work ultimately depends. Some research reports are narrowly focused, analytical and detailed empirical studies; others are wide-ranging and synthetic overviews of generic problems.

Although most of the reports are published by IWMI staff and their collaborators, we welcome contributions from others. Each report is reviewed internally by IWMI's own staff and Fellows, and by external reviewers. The reports are published and distributed both in hard copy and electronically (www.iwmi.org) and where possible all data and analyses will be available as separate downloadable files. Reports may be copied freely and cited with due acknowledgment.

Research Report 110

From Integrated to Expedient: An Adaptive Framework for River Basin Management in Developing Countries

Bruce A. Lankford, Douglas J. Merrey, Julien Cour and Nick Hepworth

International Water Management Institute
P O Box 2075, Colombo, Sri Lanka

IWMI receives its principal funding from 58 governments, private foundations, and international and regional organizations known as the Consultative Group on International Agricultural Research (CGIAR). Support is also given by the Governments of Ghana, Pakistan, South Africa, Sri Lanka and Thailand.

The authors: Bruce Lankford is a Senior Lecturer in Natural Resources at the School of Development Studies at the University of East Anglia, Norwich, UK. He has recently completed a five-year collaborative research program (RIPARWIN) in Tanzania with the International Water Management Institute (IWMI) and the Sokoine University of Agriculture, from which this paper stems. Douglas J. Merrey was Director for Africa, then Principal Researcher for Policies and Institutions at IWMI when the research for this paper was done. He is currently Director of Research at the Food, Agriculture and Natural Resources Policy Analysis Network (FANRPAN), based in Pretoria, South Africa. Julien Cour is a PhD student in Natural Resources at the School of Development Studies at the University of East Anglia, Norwich, UK. He was a research associate on the collaborative research program (RIPARWIN) in Tanzania with the International Water Management Institute and the Sokoine University of Agriculture. Nick Hepworth is conducting PhD research in East Africa with the School of Development Studies, University of East Anglia, UK. His work explores the role of 'regulatory personality' in water resource management, integrated or otherwise.

Acknowledgements: This paper is a product of the project RIPARWIN (Raising Irrigation Productivity and Releasing Water for Intersectoral Needs), a four-year research program funded by UK's DFID (Department for International Development) and also supported by the International Water Management Institute. We have used the studies conducted under the project to retrospectively deliberate on the nature of river basin management (RBM). The contribution of the full team towards discussions on RBM is acknowledged. We also acknowledge that some of D. J. Merrey's time in finalizing this paper was supported through Project 47 on African Models of Transboundary Governance of the CGIAR Challenge Program on Water and Food, and subsequently by the Food, Agriculture and Natural Resources Policy Analysis Network (FANRPAN) of Southern Africa. Hugh Turral (IWMI) provided a detailed critical review of the several drafts of this paper which has helped us clarify some of our ideas and reign in initial over-enthusiasm. Thanks are also given to external reviewers of the paper, who helped us craft a final version. The authors however remain fully responsible for the contents.

Lankford, B. A.; Merrey, D. J.; Cour, J.; Hepworth, N. 2007. *From integrated to expedient: An adaptive framework for river basin management in developing countries*. Colombo, Sri Lanka: International Water Management Institute. 44 pp. (IWMI Research Report 110)

/ water resource management / river basin management / water allocation / Africa South of Sahara /

ISSN 1026-0862
ISBN 978-92-9090-661-2

Cover photographs by Bruce Lankford. 'Montage of Usangu photos' (clockwise from top left): The dried up Great Ruaha River; The Upper Catchment; An improved irrigation intake; The river basin game.

Please send inquiries and comments to iwmi@cgiar.org

Contents

Abstract

This paper examines management responses to environmental and hydrological change related to growing water scarcity. It draws on experiences in the catchment of the Great Ruaha River in Tanzania to reflect on the theory and process of creating effective and workable goals and strategies for river basin management. We find that various gaps occur in the pursuit of normative 'integrated water resources management' (IWRM) that can be attended to by applying a focused expedient approach to address identified problems in three states of the water availability regime: 'critical water', 'medial water' and 'bulk water'. In exploring this expedient approach, the paper presents an adaptive framework for river basin management and considers some implications for the science of river basin management as a whole. We suggest that while IWRM provides a language to describe river basin management, it does not readily generate the necessary responses to deal with identified problems. Moreover, we argue that the heart of this framework both fosters, and is comprised from, rigorous social and technical learning.

From Integrated to Expedient: An Adaptive Framework for River Basin Management in Developing Countries

Bruce A. Lankford, Douglas J. Merrey, Julien Cour and Nick Hepworth

Introduction

The management of water in large river basins represents a highly challenging task. It assembles a wide range of activities within a connected physiographic unit in order to move basin stakeholders, usually many thousands of them, collectively to new patterns of water use and allocation that provide for varying degrees of economic and environmental enhancement and protection. This requires the adjustment of fluctuating quantities and qualities of water supply to disparate users whose water demands tend to increase, and who derive from water a wide variety of benefits and outputs. River basin management entails complex 'project management activities' such as: establishing goals, policies and strategies; implementing decision-making frameworks; monitoring and enforcing compliance; promoting participation; improving infrastructure; leveraging finances; recovering costs; and monitoring outcomes in order to make necessary changes.

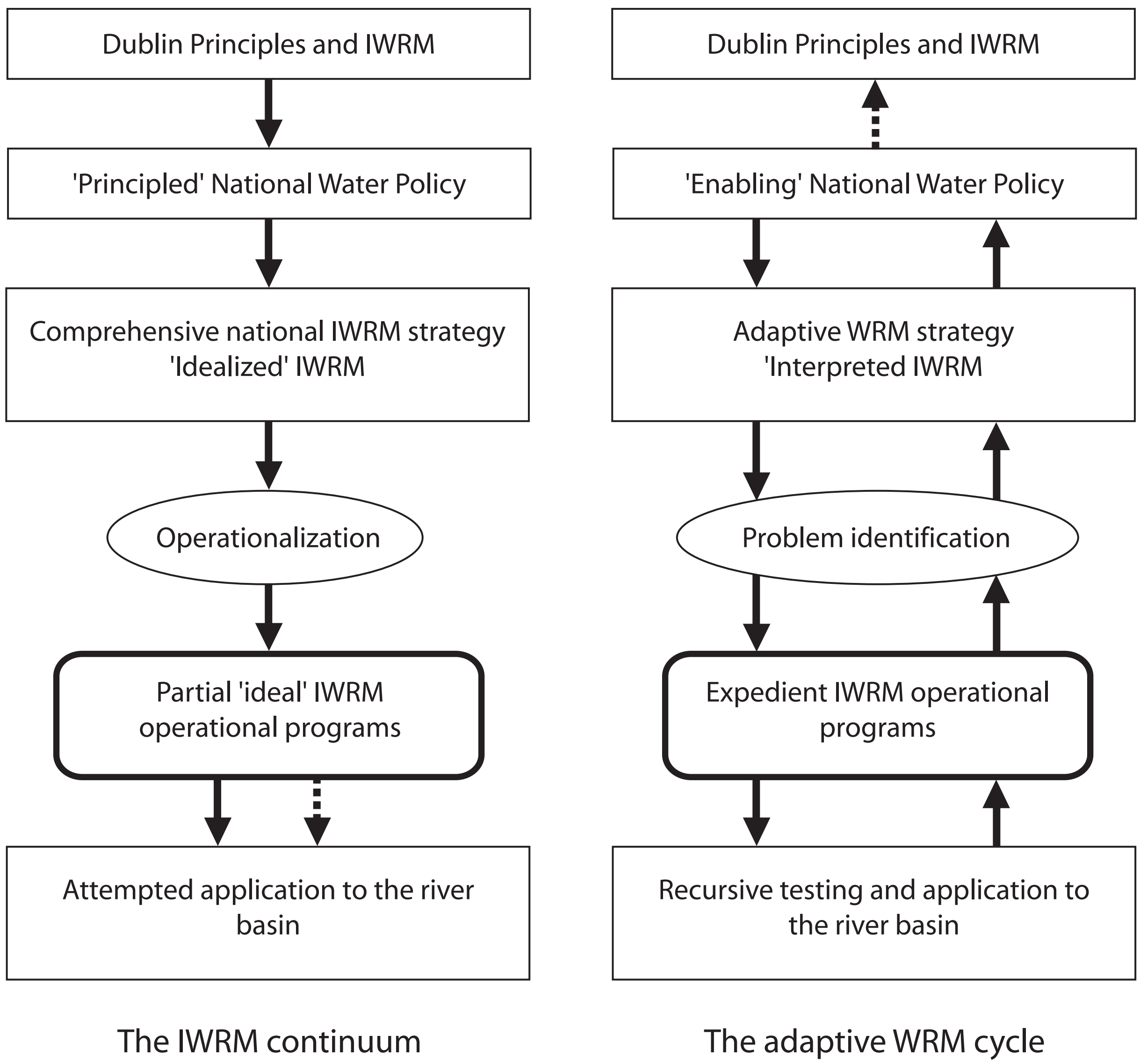
Reflecting these multiple challenges, 'integrated water resources management' (IWRM)[1] has entered the lexicon of water managers and stakeholders as the mainstream approach to water management. IWRM in an idealized form denotes a set of principles, usually accompanied by a package of tools and practices, designed to match and accommodate the complex and 'mosaic' nature of the problem. IWRM gives managers a long list of activities to execute, many of them simultaneously. Based on this perspective, the World Bank's influential strategy booklet in 1993 led to projects being established that embodied this integrated thinking, also termed as a 'comprehensive approach' (World Bank 1993). This paper utilizes one particular case study in southern Tanzania and the literature to examine IWRM, to explore its evolving nature and to reflect on recent discussions regarding its design.

We contribute to the debate by proposing a model which focuses relentlessly on 'problems' on the ground rather than on IWRM principles to be articulated. The framework for our paper can be referred to in figure 1, which contrasts two systems of designing and incorporating integrated water resources (or river basin) management. On the left hand side, we outline the manner in which governments and donor projects have in the recent past attempted to operationalize normative comprehensive IWRM programs (van Koppen et al. 2004; World Bank 1996) that incorporate the Dublin Principles (ICWE 1992). A defining feature of contemporary river basin management is the 'IWRM continuum' from the

[1] This paper examines IWRM applied to river basin management in a sub-Saharan context.

Dublin Principles, to the statement of National Water Policy, leading to a National Water Strategy, in turn leading to a strong connection between this strategic level of comprehensive thinking and the operational programs that are effected. Clearly, these operational programs differ from the comprehensive template because they cannot, without considerable funding, capture the whole picture. This is largely understood amongst most informed scientists; in large river basins, the constraints associated with scale, data availability, policing, knowledge, logistics, variability and systemic interfaces invalidates the pursuit of a complete 'integrated water resources management' as defined by the Global Water Partnership (GWP 2000), the European Commission (EC 1998) and others. Yet, we take the thinking further. On the right hand side of figure 1 we propose that the comprehensive framework of IWRM should *not* be the starting point for drawing up water operations, and that instead the main frame of reference should be the problems identified in the catchment, and the ongoing iterative relationships with stakeholders in the catchment.

FIGURE 1.
The deployment of IWRM policy and operations – a partial ideal or expedient?



Thus, in this paper, we argue that the challenge is not to attempt to deploy the comprehensive list of integrated solutions or to partially apply components if they do not fit the situation, but to formulate precise interventions to solve existing or foreseen problems in the pursuit of stated goals. We have termed this an 'interpretive, expedient process', which requires the capacity to generate new kinds of thinking, the identification of solutions that work effectively, the confidence to implement them, and the need to question some basic assumptions that underpin water resources management (WRM). Expedient WRM can be defined as 'advisable on practical rather than principled grounds'[2] – thus emphasizing a shift towards problem identification and solution, and away from the adoption of accepted norms – including the Dublin Principles. Under this approach, the national water policy and strategy would be purposively cast to be more comprehensive than expedient basin operational plans and yet allow for local context to be fully 'expressed'. Our approach has clear links to "adaptive management," an approach found more often in North America and Europe than in developing countries (discussed further below).

Thus, while Biswas (2004) is correct in critiquing the vagueness of the concept of IWRM, the distinction between strategy and operation provides a mechanism for discussion, a point that Mitchell (2004) makes in his response to Biswas' paper. This distinction is well illustrated by reference to the UK and other 'northern' countries as well as to Australia and even South Africa, where despite considerable financial resources, implementation of full IWRM remains elusive. In these countries, using the IWRM concept to inform strategy, operational mechanisms have been created to steer water management to be increasingly integrated, with for example environmental management and land-use planning, and to manage and minimize water conflicts. When Biswas claims that the concept's use has been "indiscernible in the field" and that IWRM's "impact to improve water management has at best been marginal" he overlooks that it forms the central pillar of the European Water Framework Directive (WFD)(EC 1998). The WFD is widely accepted as the most significant piece of water legislation produced in the past 20 years and although still in its infancy in terms of implementation, it looks set to bring increasingly integrated decision-making and 'better' water outcomes (Fox et al. 2004).

The WFD is based on a model of integrated catchment management long used in the UK, which has a track record of bringing measurable environmental, social and economic benefits, for example, improved water quality, flood prevention and drought management, re-colonization by indicator species such as salmon and otters, the reversal of ecological decline, and economic regeneration and tourism benefits as documented by Wood et al. (1999) and the Environment Agency (2002). Thus, there is a strong case for the positive impact of the IWRM paradigm. However, success has been based on the gradual adaptation of existing management activities to tackle real problems such as the setting and monitoring of water quality objectives; the statutory consultations of water managers and local stakeholders on planning applications and regional strategic plans; targeting of investment programs on local priority issues; the issuing and policing of permits or temporary notices to control activities posing a risk to water use; and, the regular development of ostensibly 'participatory' integrated catchment management plans. Of course, this field-informed success must be contextualized, being driven by a requirement to meet EU legislation, made possible by significant infrastructure investment by privatized water companies, and overseen by a powerful regulator in the form of an Environment Agency with over 11,000 staff and an annual expenditure of £867 million (approximately US$1.6 billion) (Environment Agency 2005) – a luxury affordable only by very few wealthy nations. Nevertheless, a model of

[2] The Oxford Dictionary defines 'expedient' as 'advisable on practical rather than moral grounds' and as 'means to attain an end'.

expedient WRM is provided. Perhaps, Biswas is frustrated at the failings of IWRM implementation where countries lacking the necessary capacity and financial resources have tried to map 'full IWRM'; this has led him to question the usefulness of the IWRM concept itself rather than addressing contextualization and interpretative issues, where scope for creativity and accuracy lies.

Understanding the process by which operational programs arise has implications for the science of water resources management. In discussing, not the translation of strategic IWRM into operational IWRM, but an adaptive-expedient approach, we propose a more practical framework which relies on designing activities against stated and relatively short term (5-10 year) goals of allocation. Granted, equally important is political expedience; IWRM represents an opportunity to make political choices about allocation (Allan 2003; Swatuck 2005) and to influence stakeholders in that quest. While the authors acknowledge that water management at the river basin scale is an endeavor that is political[3], we argue that river basin management can also be examined in scientific terms. This is a valid exercise because, although appearing to be a 'comprehensive' science, IWRM reveals, we argue, some scientific errors made in the pursuit of sensible outcomes. The problem is that river basin management is political and economic in nature, and is often constrained by a legal and institutional apparatus that cannot be transformed quickly. Thus, we agree it is possible to critique IWRM as a politically naïve discourse as Allan (2003) persuasively does, but in addition one can explore the scientific naivety of IWRM – in both theory and practice – and then ask how this further shapes the scope for political interpretation.

On a more critical note, analysis of actual IWRM operations manifests itself as critiques of integrated water management or of specific and generic concerns regarding the appropriateness of river basin institutions to developing countries. For example, Shah et al. (2005) and Carter (1998) are concerned with the applicability of river basin management institutions and approaches that work in rich countries to resource-poor situations, and conclude that there are many risks in copying normative, fully-fledged IWRM to local situations. Shah et al. (2005) point out that the physical, social, institutional and economic conditions characterizing developing countries are totally different than those in the rich temperate zone countries, and also the objectives are usually completely different. An engagement with the size of the IWRM task has also been explored by Moriarty et al. (2004) where 'light' IWRM refers to its application by individuals, communities and sub-sectors, whereas 'full' IWRM envisions a sector-wide overhaul leading to a much greater level of coordinated application. Based on detailed field research in South Asia, Moench et al. (2003) conclude that attempts to implement classic IWRM are not likely to be successful as people focus on constraints and immediate tasks, and not on integration of numerous factors that may have an influence. Merrey et al. (2005) criticize the focus on environmental concerns and demand management at the expense of poverty issues in developing countries, especially underdeveloped areas such as sub-Saharan Africa (SSA). Jonker (2006) in a recent paper has described the "perceived failure of implementing IWRM in South Africa." While South Africa has expended considerable effort to get the principles right, "conceptual shortcomings" as well as capacity limitations are inhibiting actual implementation. In the follow-up to the 1993 strategy, the World Bank 2002 review (Pitman 2002) identifies shortcomings in rolling out IWRM; however, this reads more as an eclectic list of 'lessons-learnt' rather than being grounded in a structure of how to generate meaningful operational strategies.

[3] Indeed, Wester and Warner (2002) note the entire concept of river basin management ignores the inherently political nature of such an exercise.

Some of these practical concerns are being captured in an emerging body of research and theory around the term ‘adaptive water resources management’ (National Research Council 2004; Swanson et al. 2004) that in turn mirrors developments in adaptive natural resources management (NRM)(Hagmann and Chuma 2002; Stankey et al. 2005; Tompkins and Adger 2004). Nonetheless, as Stankey et al. (2005) conclude, even though adaptive NRM implies practical action, it “remains primarily an ideal rather than a demonstrated reality” (p. 56). Although effective and accurate practice remains an uncertain outcome, we attempt here to define strategic characteristics that foster pragmatism. One insight, that has parallels with the literature, is the central role of learning and social communication as drivers for adaptation.

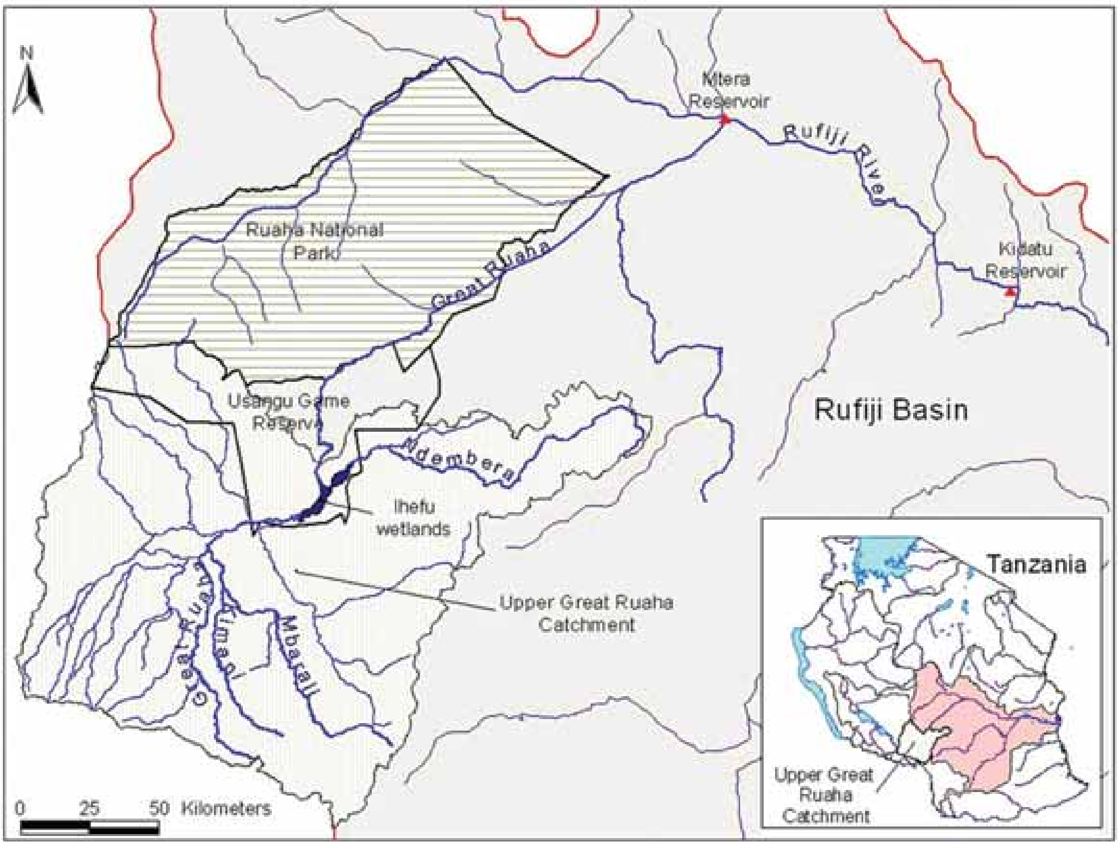
In the next section, we introduce the case study, which we believe is representative of the characteristics of many basins in sub-Saharan Africa and some Asian countries. We complete our critique of IWRM as practiced in many developing countries, and explain our ‘expedient water management framework’ under four headings: achieving basic understanding as a basis for intervention (acquiring knowledge); development of expedient water goals (creating goals); water management as an expedient response (establishing strategies); and social water management learning (guiding and enriching the WRM cycle). The final section reflects on the implications of the proposed framework for management of river basins in developing countries.

Case Study: The Great Ruaha River Basin

The geographical context of this study is the Great Ruaha River Basin in the southern highlands of Tanzania, an area of 68,000 km^2 (figures 2 and 3). The basin contains the Upper Great Ruaha, synonymous with the Usangu Plains catchment, covering an area of 21,500 km^2 and forming the headwaters of the Great Ruaha River. The Great Ruaha Basin itself is a major sub-basin of the Rufiji River, and the subject of numerous studies (e.g., Danida/World Bank 1995; USBR 1967; FAO 1960). The Ruaha River Basin is a good candidate for research on the science of river basin management on the basis of its size, complexity, national significance, competing users and history of river basin initiatives (Hazelwood and Livingstone 1978). The case study is described in a number of articles (Baur et al. 2000; Lankford and Franks 2000; Lankford 2004; Franks et al. 2004). Much of the research we draw upon was carried out with the support of two successive projects supported by the UK’s Department for International Development (DFID): ‘Sustainable Management of the Usangu Wetland and its Catchment’ (SMUWC) and ‘Raising Irrigation Productivity and Releasing Water for Intersectoral Needs (RIPARWIN - McCartney et al. 2007). The scientific research done under these projects has helped increase understanding of the underlying causes of contentious problems such as perceptions of a conflict between water used for irrigation and water to generate electricity, causes of the drying of Usangu Wetland during the dry season, and why a project designed in part to address these issues, the River Basin Management and Smallholder Irrigation Improvement Project (RBMSIIP - World Bank 1996) in its initial conceptualization addressed the wrong issues.

The basin has a single rainy season but the rains are irregular, localized and spatially variable—in other words unreliable. The mean

FIGURE 2.
Location of Upper Great Ruaha Catchment in Tanzania.

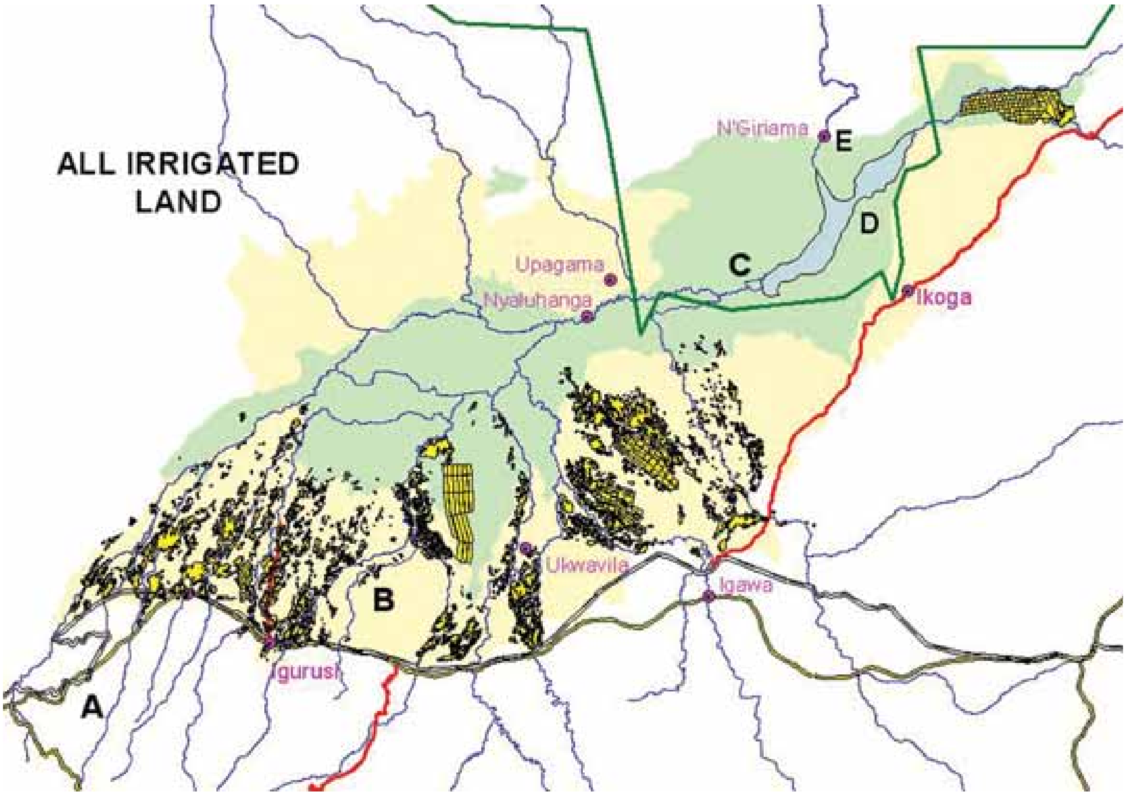


Source: RIPARWIN project.

annual rainfall in the mountains is 1,600 mm, but only 700 mm in the plains, while mean annual evapotranspiration is 1,900 mm. The river is perceived as “drying up”: the wetland is shrinking, and the previously perennial Ruaha River has become seasonal over the last decade, with dry periods lasting from 3-10 weeks. In the upstream areas on the alluvial fans above the wetlands, irrigated rice production has expanded rapidly to about 45,000 ha today. There are two large rice farms owned by the state, and increasing numbers of smallholder irrigators. The Usangu produces 14 percent of the total rice crop in Tanzania, about 60-80,000 tons worth $16 million per year. About 30,000 households depend on irrigated rice for their livelihoods. However, the expansion of irrigation in the upstream areas has led to increasing conflicts with downstream users, especially the wetland and National Park, and hydropower. As in many other developing countries, managing wetland ecosystems is a new concern for Tanzania, a signatory of the Ramsar Convention. Also in common with many other countries, Tanzania is developing and implementing water and policy reforms based on IWRM principles—but unlike many others it is also encouraging rapid expansion of irrigation. The size of the basin creates huge logistical problems.

A more detailed review of institutional development in the area can be read in van Koppen et al. (2004), from which certain highlights are given here. In the early 1990s work by the World Bank lead to the planning of the River Basin Management and Smallholder Irrigation Improvement Project (RBMSIIP) that started in 1996 with a loan from the Bank. This program funded the Rufiji Basin Water Office (RBWO) in Iringa, which represented the new basin approach that the Ministry of Water,

FIGURE 3.
Location of Irrigated Lands within the Usangu Plains.



Source: SMUWC 2001.

Note: With regards to figure 3 and table 4:
A = upstream river supply; B = allowable irrigation abstraction; C = target downstream flows; D = losses in wetland; E = downstream river flows in the Ruaha National Park (RNP). Irrigated areas are shown in yellow.

Livestock and Development (MoWLD) gradually implemented, with the Rufiji, the Pangani and Lake Victoria as the first pilot basins[4]. RBMSIIP also helped develop a new National Water Policy (MOWLD 2002; Mutayoba 2002), followed by the National Water Strategy (MOWLD 2004) (See Appendix A of this report for further information).

These characteristics are broadly representative of many river basins in the semi-arid tropics, especially in sub-Saharan Africa[5]; therefore lessons learned here provide important insights for solving similar problems in other basins. We provide further insights into the characteristics of the basin in the following sections to illustrate more general points.

[4] A sub-office for the Usangu Plains in Rujewa, Mbarali District, was opened in 2001. The main activity of this sub-office is the issuing of water rights to irrigators.

[5] Another reasonably well-studied example is the Upper Ewaso Ng'iro North Basin in Kenya; see Gichuki (2002) and references therein. Similarly the Mara River is the focus of a WWF water management program.

From Integrated to Expedient Water Resources Management

The changing debate on integrated water resources management

Via lessons learnt in the past few years, and the debate surrounding integrated water resources management (IWRM), many commentators are becoming increasingly aware of the need to refine the concept so that it delivers effective outcomes. There are two key aspects to this debate. The first aspect is the relationship between an ideal and the actual – and indeed IWRM is usually discussed by comparing ideal IWRM (listing principles and what should be included) to actual IWRM (listing problems and what a project omitted to do). Thus, IWRM is defined by the Global Water Partnership as a process that promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems (GWP 2000). The World Bank (1993: 10) has a similar definition: "[IWRM] … is the adoption of a comprehensive policy framework and the treatment of water as an economic good, combined with decentralized management and delivery structures, greater reliance on pricing, and fuller participation by stakeholders."[6] van Hofwegen (2001: 141), as an example of the ideal, examines frameworks of IWRM, and explains that 'ideal IWRM' comes from the theory of IWRM and its principles. His paper outlines in detail the many requirements that constitute IWRM.

By contrast, implementation is a balancing act, on the one hand reflecting the ideal and on the other hand reflecting the problems found. In an early analysis, Mitchell (1990: p.4) realized this pitfall, writing, "At the strategic level, a comprehensive approach should be used to ensure that the widest possible perspective is maintained. In contrast, at the operational level, a more focused approach is needed." He went on to argue that at the operational level, attention should be directed to a smaller number of issues that account for most of the problems. Even the World Bank's comprehensive approach in 1993 acknowledged that "the complexity of the analysis would vary according to the country's capacity and circumstances, but relatively simple frameworks can often clarify priority issues" (p.10). Tapela (2002: 1003) felt that IWRM needs to relate to context: "the prospects for river basin institutions achieving the envisaged outcomes of IWRM are more strongly determined by the embedded contexts than by institutional conformity to a given set of organizational criteria."

A second aspect of IWRM reveals that water management is often seen as a meta-theory; that it is multi-dimensional rather than single-dimensional in nature. Water management is 'framed' within an integrated approach that is constituted from many different sub-theories—as reflected in the quoted World Bank definition that includes, for example, pricing as a necessity for IWRM, or that water should be approached in an integrated fashion: "Integrated water resources management expresses the idea that water resources should be managed in a holistic way, coordinating and integrating all aspects and functions of water extraction, water control and service delivery so as to bring sustainable and equitable benefit to all those dependent on the resource" (EC 1998: 215).

Bringing those two aspects together, we argue that the nesting of sub-theories within an integrated framework gives rise to opportunities to partially reflect the comprehensive viewpoint by selecting some sub-theories without tailoring them to the situation on the ground. Thus, the act of operationalizing IWRM can be via partial selection of unadulterated application of some

[6] Hooper (2005) quotes other definitions of IWRM and 'integrated river basin management,' IRBM, all quite similar.

component theories, giving an appearance of choice and focus. This is discernible in Tanzania when the Basin Office was unable to institute many components of WRM such as water quality control, and yet did administer a fixed water rights system against payment in the expectation that it would drive re-allocation; "the use of a water user fee as a means of encouraging efficient use of the resource and for meeting the cost of regulatory functions" (World Bank 1996 – see Appendix A of this report). A more fundamental starting point for drawing up an efficient and effective set of water management activities begins by analyzing the baseline, and determining local problems framed against regional and national priorities, and being informed by that. This then is our 'recursive, expedient' theoretical framing of water resources management, in contrast to an 'IWRM-continuum' framing.

Expedient water management

We have used our fieldwork to reflect on a process of building expediency into water management. Although there are formulations of strategies of water management, few papers explicitly examine the process by which operational river basin activities are developed from or refer to the comprehensive template of IWRM.

Figures 4 and 5 and table 1 propose an expedient approach to developing a water management program. Figure 4 combines with figure 5 to give the matrix in table 1, which represents the proposed framework. In Figure 4, we argue that the challenges of basin water management alter dramatically with changing 'wetness' and that this dynamic can be best reflected by a flow duration curve (FDC) whereby the basin's water resources can be divided into three water states or 'phases'[7]: 'critical', 'medial' and 'bulk'. The 'x axis' is frequency and the 'y axis' is a measure of water availability, represented here as river flow rate. This three-state analysis creates a simple classification of relative availability that allows managers to understand the situation of, and specify goals for, each state and as will be seen later on, to generate state-specific activities to fulfill these goals.

'Critical water' is that required for vital needs such as health and domestic purposes, especially in drought situations. Medial water, particularly important during dry seasons and dry years, has to be shared among a number of sectors, including the environment and agriculture. Bulk or 'storable' water, which occurs during high-flow periods such as the wet season in many tropical river basins, provides ample amounts of water for a variety of purposes, including topping up of natural and artificial storage bodies. Strategies for bulk water allow inter-annual or at least inter-seasonal responses to demand and crisis, and therefore responses in one state (e.g., bulk) can affect how water is managed in another state. Table 1 explains in more detail the nature of the three states. Figure 5 is the cycle of management that applies to each of them to ensure that the goals, needs and problems arising in different sectors are met.

The shape of the FDC line relative to the position of the three states or phases is important: although demand is not represented here, the shape reveals the degree of aridity of the basin (for example, given by the flow at 50% exceedence) and the extent to which the basin changes between states of extreme wetness and dryness. While frequency of exceedance does depict a mathematical reliability of a flow being exceeded in hydrologic terms, we wish to emphasize that interpreted correctly, regime analysis reminds scientists of the 'unreliable' nature of water inherent in sub-Saharan hydrology measured in terms of social and managerial expectations. In other words, it is important to distinguish between floodplain river regimes in a

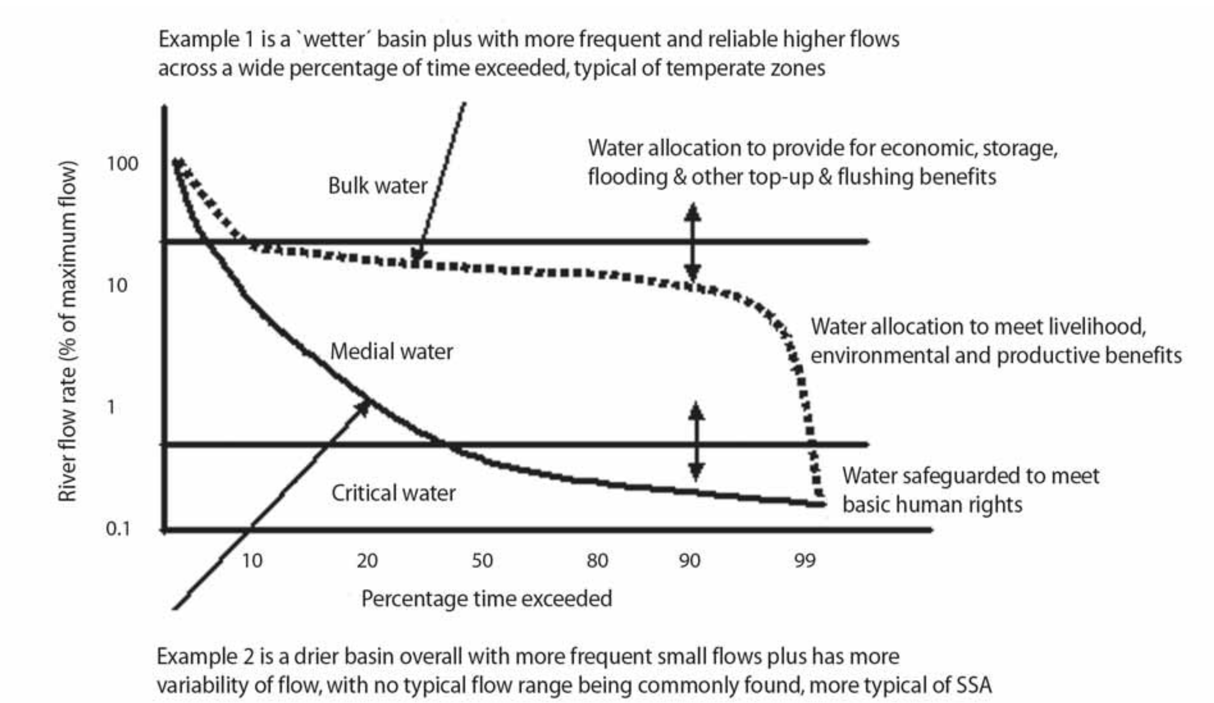
[7] We recognize that these states may succeed each other as 'phases' but this is not universally so; hence, we have adopted the term 'state.'

temperate zone with baseflows supported by groundwater (giving a flat curve for much of the exceedance time) and a floodplain river in semi-arid climates where there is a low probability of very large flows, a much higher probability of low flows during dry periods and a sloping curve between the two extremes. It is possible to interpret water management in each state, and to facilitate transitions between the three states – i.e., via uses of water that might come from extra storage. On the graph in figure 4, line 1 shows a wetter basin while line 2 shows a drier one. While both basins might benefit from more storage, in Basin 2, the purpose of that storage would more likely be related to fulfilling livelihood and domestic needs during the longer and more frequent periods of low flow. The key argument being made here, with respect to water resources management, is to incorporate these natural behaviors into our thinking – our observations of responses in Tanzania lead us to suspect that formal institutions, in politically emphasizing a development agenda, have seen dryness as a temporary inconvenience rather than a normal state of affairs (Lankford and Beale 2007).

Operationally, a failure to appreciate the inherent transient nature of supply, as exemplified by line 2 in figure 4, was seen in selling fixed water rights/permits (e.g., of 250 liters/second) to users established under the RBMSIIP program.

In figure 5, the cycle of expedient water management is divided into four main stages, discussed below. In keeping with our critique of the science of river basin management, these four translate into a science of 1) understanding and characterizing the land, water, people and institutional behaviors of the basin; 2) establishing goals; 3) developing a management response to those goals, and 4) generating activities that lead to and drive the first three steps. We have grouped the first two into a 'vision process', because in the Tanzanian case we noticed that consensus in understanding the causes of hydrological change is linked with a consensus on solutions and a goal of future water allocation and its role in achieving social and economic objectives. Figure 5 puts the fourth stage, the social learning, at the center of the other three. This is a critical part of how goals and responses are derived, and although it is the fourth stage, it

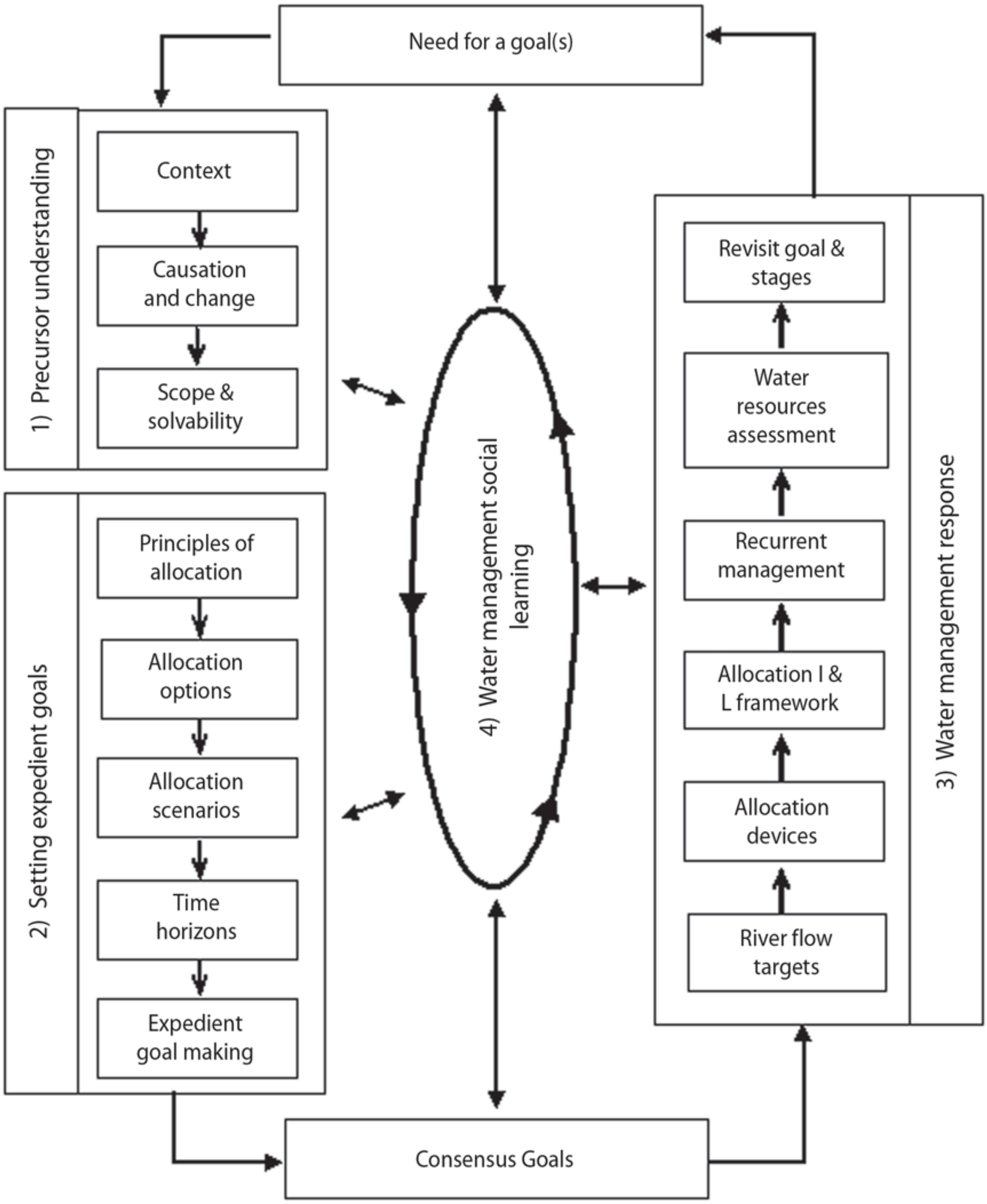
FIGURE 4.
The three-state challenge of creating goals and managing river basins.



might easily have been discussed first or as part of the second stage. Figure 5 emphasizes an iterative cycle of development – these components do not work in a linear manner. In particular, participatory processes can be used to both steer and affect river basin activities throughout the cycle.

Clearly, 'expedient' water management is a specific application of what is called "adaptive management" (e.g., MacDonald et al. 1999) and

FIGURE 5.
Adaptive cycle of expedient water management.



Note: I & L refers to Institutional and Legal framework.

TABLE 1.
Framework for expedient water management of river basins.*

Stage of framework	Sub-stage and aspects	Water availability state		
		Bulk water	Medial water	Critical water
1) Precursor understanding	Main supply function and priorities of this phase	To top up storage bodies (artificial, natural, surface, sub-surface), to flush systems	Meet agricultural, livelihood and ecological needs, protecting minimum flows	Meet living and drinking needs
	Main period during year	Wet season	Dry season	Throughout year, but dry season is critical
	Sectors associated with phase	Agricultural, hydropower, environmental,	Agriculture, industry, environmental	Domestic, urban
	Amounts of water	Medium to large flows >500 l/sec	Small stream flows, 10 to 500 l/sec	Very small amounts of water, 25-300 l/day/pp
	Timeliness and timing	Seasonally important	Daily to weekly	Required daily
	Quality of water	Medium quality, sediments in flood water	Medium to high quality	Highest quality required
	Change and causality	Investigate trends of water supply and demand, and study of driving factors within each phase		
	Scope for further change	Investigate scope for productivity and efficiency gains within each sector in each phase		
2) Setting expedient goals	Principles that steer allocation	Water as an environmental, productive and economic good	Water as an environmental and productive right	Water as a human/domestic right
	Examples of scenarios	Pro-industry and power, pro-agriculture	Pro-agriculture, pro-environment	Pro-poor connection
	Examples of water goals	"Ensure a 50 cumec cap on irrigation abstraction"	"Aim for year round flow"	"80% of rural users connected"
3) Water management response	Routing the water	Routing bulk water	Routing medial water	Amounts of water required at a given time
	Type of cap**	Total volumetric abstraction cap	Proportional abstraction cap	Volumetric, set by capacity of supply infrastructure
	Infrastructure associated	Intakes, dams, barrages	Irrigation intakes, boreholes, weirs, dividers and control structures	Village boreholes, pipes, taps, bowsers
	Allocation institutions	Catchment and basin WUA	Irrigation water user association and sub-catchment WUA	Village borehole committee, water company or NGO
	Type of rights closely associated with phase	Formal water permit (volumetric)	Customary agreements/ rights (proportional, time schedule basis)	Customary agreements (village and household related)
	Economic instruments	Various permutations, payment or non-payment for water rights, proportional shares and drinking water are possible, though a locally situated analysis might inform how best such a framework is designed.		

(Continued)

TABLE 1. (Continued)
Framework for expedient water management of river basins.*

Stage of framework	Sub-stage and aspects	Water availability state		
		Bulk water	Medial water	Critical water
4) Water management social learning	Social learning is a process that cuts across all activities in all phases, and is underpinned by consultative and participatory processes. Given below are some state-specific activities.			
	Institutional connections, participation and deliberation	Basin Office facilitates and mediates basin negotiations	Intake to Intake representatives of irrigation water user associations plus outside mediation	Autonomous units around the infrastructure supplying water
	Other tools of decision-making	Reservoir operation, office decision-aids	Field and office based decision-aids	Village and user level decisions

Note: *While some of the points made in this table refer to Usangu only, most are broadly applicable to sub-Saharan African river basins. Issues and solutions best applicable to one state can be applied to others.

** Setting or quantifying 'caps' represents a delineating of quantities for a given sector, and is not necessarily an activity of forcing down demand or use of water.

"participatory action research" (e.g., Whyte et al. 1989) in the literature. Adaptive management and participatory action research both have as their central drivers the adoption of a social learning approach: working with key stakeholders, identifying and prioritizing problems, designing possible management solutions, implementing, monitoring and evaluating, adjusting based on lessons learned, etc. We recognize the difficulties inherent in implementing participatory approaches, especially on large river basins with many thousands of people with few resources, in a context where communication systems and institutional linkages are weak. Nevertheless, our basic assumption is that for long-run sustainable and equitable social and economic development, there are no practical alternatives to participatory approaches: taking an expedient approach, the reliance on, and types of, participation necessarily has to be focused and fitted to the problems being faced[8].

Application of the Framework for Expedient Management

Part 1: Precursor: Integrated understanding

Context

We argue that to pursue expedient water management requires an accurate understanding of the context and problems found in the river basin. Although we agree that political expediency, despite the targeted advising of policymakers, may lead to interpretations of causes and solutions that are not supported by studies (Lankford et al. 2004b), the scientific endeavor of capturing the nature of the hydrological and environmental change in an area the size of Usangu should not be

[8] Experience in Usangu shows that the nature of local user participation in river basin management changes from sub-catchment to sub-catchment as influenced by catchment characteristics and objectives (Lankford 2001).

underestimated.[9] In this regard, Hillman (2006) unpacks differing perceptions over context for accurately tailoring river basin management programs to situations; he found, echoing Briscoe (1997) that "context matters (a lot!)" when fitting water management to a given situation.

Context covers an understanding of the biophysical nature of the challenge. The Great Ruaha River Basin reflects some biophysical conditions characteristically found in sub-Saharan Africa. These conditions have been noted by other authors (e.g., Carter 1998) as posing special risks for the application of IWRM. The size of the sub-basin (68,000 km^2) poses logistical problems for managing water by formal rights alone that require monitoring and policing. Multi-point, dispersed monitoring of both supply and demand is expensive, and to reduce these costs and to manage conflicts at the sub-catchment scale suggests that meaningful forms of subsidiarity are required—for example, engaging users in determining their own means of assessing water distribution. The basin experiences a single rainy season, when rivers swell, but they shrink during the dry season between May and November, a period that suffers from water scarcity relative to demand, and conflict. In addition, the area experiences climate variability typical of sub-Saharan Africa, giving rise to periodic floods and droughts. This dissimilarity in water availability versus demand and associated dynamics suggests that flexibility is critical; that the three phases of critical, medial and bulk water exist here; and that the dry season needs special care when there is insufficient water to cater to demand from all sectors. In addition, the lack of aquifer buffering and re-routing in Usangu prevents downstream users in accessing water that is used in inefficient ways upstream. In other words, storage of water in aquifers for use in the dry season is not an option for geological reasons, and water that is used inefficiently by "formal" users like state rice farms is largely captured by "informal" users or evaporates unproductively and does not return to the river.

As well as the physical attributes of a river basin, its 'political economy' has a major influence on water management. Formulating an effective response shows up inevitable gaps between legislation, institutions, organizations and desirable outcomes of water management – this has long been understood in river basin management. For example, Moss (2004) examines institutional gaps in river basin management and argues that strategies should recognize that land use affects water use. Cleaver and Franks (2003), based on detailed field research in the Ruaha Basin, argue that the embeddedness of local institutions in complex livelihoods renders designing institutions for water management highly problematic. As economic development continues, layers of complexity can be added. In Chile (Bauer 1998), the trade-off in uses is between irrigation and hydropower, which is arguably relatively straightforward compared to balances to be found between water pollution, protection of minimum flows, inter-basin transfer and groundwater management.

Further, if IWRM strategies are to address issues that are of importance "locally", this can only be achieved by understanding the socio-political context and especially the conflicts that characterize the area. These conflicts are driven by the differential objectives and interests of the various stakeholders. The latter represent all the issues that matter to the different stakeholders and can be defined as "values" (Keeney 1994). As stated by Hermans (2001: 183), "if these values are not characterized, analysis efforts by hydrologists and other experts are likely to have very little impact on actual decision making". By defining the values that motivate different actors in each of the three flow phases, alternatives can be generated when defining articulated water goals and therefore lead to an expedient response.

[9] In Usangu, this was achieved by the application of SMUWC (Sustainable Management of the Usangu Wetland and its Catchment) and RIPARWIN (Raising Irrigation Productivity and Releasing Water for Intersectoral Needs) surveys and analyses lasting more than five dry and wet seasons, conducted by more than 20 scientists from various disciplines who in turn interacted with local stakeholders.

Causation – examining hydrological change

Investigations play a critical role in determining and isolating the factors affecting water distribution so that appropriate policies may be crafted. The studies we envisage goes beyond simply monitoring water flows to make the exercise explicitly part of ‘problem-orientated’ vigilance. This focus on simple monitoring of flows explains the fact that although the Ruaha River dried in the early 1990s, the causes of that change could not be explained until the SMUWC project began its work in 1999. In addition, the responses to the problems, perceived and real, illustrate the need to arrive at a consensus understanding of the causes of the changes (Lankford et al. 2004b).

The SMUWC and RIPARWIN projects found that the main reason for hydrological change was the increased abstraction of water into irrigation intakes during the dry season. This water meets important livelihood needs but also leads to much non-beneficial depletion. The ability to abstract more water arose from the increasing number of intakes constructed and changes in the design of intakes: new ‘full-sill weirs’ allowed uppermost intakes to abstract all the water during low-flow periods (Lankford 2004). This observation conflicted with other theories about hydrological change, some of which play a minor role. Good science was critical here; and although it need not be highly sophisticated, it should at the very least be underpinned by field observations. Work under the RIPARWIN project on the plains with flow-gauging equipment, satellite imagery and a GPS (Global Positioning System) revealed where the main losses of water were occurring on the rivers; something that until that moment, has remained a conjecture.

Scope for water re-allocation – efficiency, productivity and storage

When demand for water either globally or seasonally exceeds the available supply, re-allocation of water from one use (say, agriculture) to another (say, ecological flows) becomes necessary. Moving to a consensus on how water is to be allocated and shared requires knowledge on the solvability of the proposed re-allocation; whether water is ‘available’ either within the hydrological record for storing[10], or within the net or gross demands of a particular water sector for saving and re-allocation. Water availability is not only assessed from the hydrograph of supply against consumption but also from developing a picture of ultimate goals, for example, of where water is working ‘hardest’, i.e., more productively and efficiently. Thus, the goal-making process is informed by a ‘productivity maximization’ perspective. Poverty reduction or equity in either water supply or benefits from water is another possible goal with rather different implications. Similarly, scoping must include a cost-benefit analysis to determine the economic gains and costs of pursuing various strategies.

An important precursor is to determine whether water exists to be re-allocated on the basis of either subtracting from the net needs of a donor sector or from savings made within the gross water usage of that sector. The science underlying the ‘scope’ for re-allocation is critical – it is this that the experienced water manager is attempting to ascertain. In irrigation, a commonplace theory is that efficiency is low enough and gross volumes of water used high enough for ample savings to be made to provide water to other sectors. This logic is not certain,

[10] Storage is an allocation device, and expands the opportunities for re-allocation between sectors. Storage holds water that otherwise would generate environmental goods in providing a range of natural flows downstream. The ‘donating’ sector in this case is the environment during the wet season.

not least because the theory of irrigation efficiency is dependent on boundary conditions and its detailed measurement is rare (Lankford 2006). Conceptual work by the International Water Management Institute (IWMI)(Molden 1997; Perry 1999) shows that local losses need not be seen as consumptive losses from the basin. In other words, the real efficiency of all irrigation within a basin may already be high, and savings are unlikely to be forthcoming. Furthermore, even if possible, the outcome of transferred water is not guaranteed because of social costs involved and because local irrigators may recapture 'spare' water.

The case study in Usangu provides an example of the errors in scientific understanding of irrigation efficiency. The River Basin Management and Smallholder Irrigation Improvement Project (RBMSIIP) (World Bank 1996) was based on the premise that the project could raise efficiency from 15 to 30 percent, allowing substantial re-allocation of water, as the quote below from the Appraisal Report explains, and that this would be achieved by improving intakes and training farmers. Yet, closer measurement indicates that effective efficiency was probably in the region of 45 to 65 percent precisely because of reuse of drain water by tailenders (Machibya 2003). The errors contained in this quote are that: a) the efficiency was very low; b) the losses were depleted from the basin; c) improving intakes would reduce losses; and d) savings would automatically move downstream to the hydropower reservoirs. The failure to ground-truth some of these assumptions is evident in that the project went ahead as planned.

> *"In order to illustrate this effect, the "savings" in water which result from the improvement of some 7,000 ha of traditional irrigated area under the project (this includes both basins) are valued using their capacity to generate electricity in the downstream turbines. An average "in the field" requirement of 8,000 m^3 of water, for one ha of rice production, implies withdrawal of 53,300 m^3 from the river, with an irrigation efficiency of 15 percent. Following improvements in irrigation infrastructure and an increase in irrigation efficiency to 30 percent, the withdrawal requirement from the river drops to 26,700 m^3 per hectare. This releases some 26,700 m^3 for every hectare of improved irrigation, to be used for hydropower generation downstream. For this exercise, the water is valued at 5 US cents per m^3, the valuation for residential electricity use (34 percent of all electricity use, and intermediate point between the two alternate values)"* (World Bank 1996: 42).

Part 2: Development of expedient water goals

The second part of the framework generates goals of water allocation. The question is whether in a covertly (or overtly) political process, there is a science of creating goals for water allocation. By making this an open question, key problems can be addressed. First, breaking 'goal-making' into stages provides a more transparent knowledge-based approach. Second, the stages reveal where the 'principles of IWRM' (e.g., "water is a basic right") reside in this process. This allows us to, third, articulate goals that result in operable water management strategies but which might be quite disassociated with principles of IWRM. This step-change is solved by iteratively formulating expedient water goals, as is explained below.

Principles of allocation

The conflicting range of principles of water allocation, and the priority and scale that they best apply to, make goal-articulation difficult – often it is not easy to discern what criteria are being pursued. Yet, at the same time, being aware of these principles, even *ad hoc* historical legacy types, is an important part of the debate about river basin management objectives – in this respect, this is one of the few places where our framework refers to some of the key thinking that underpins IWRM.
Table 2 gives a number of drivers and principles in tension and lists the ways in which goals of water allocation can be argued for, including the

TABLE 2.
Principles of water allocation within river basins.

Principle	Explanation and definition
As before	*A priori* rights determined by historical legacy may affect water use. This principle is behind riparian rights that allow users to claim water by dint of their location close to a river. "Grandfather rights" meant that water rights could not be revoked unless new water laws were passed.
Precipitation-based	The Helsinki Protocol states that water may be allocated in accordance with rainfall amounts found within parts of the river basin.
Higher economic utility (Principle of water as an economic good)	Often cited to be the main reason for re-allocation, water should flow to its highest value user to maximize economic utility for the river basin/nation. An example is of water allocation out of agriculture (a low value user), and into industry or power generation (a high value user) or from low value to high value agriculture. A similar case, or sub-clause, is that water is redistributed to ensure higher water productivity.
Drinking, health and sanitation, and scalar effects (Principle of water as a basic need)	The principle that water is vital for life is often enshrined in domestic water rights that usually have the highest priority call on available water. Growing domestic demand from towns and cities scale up this demand requiring re-balanced allocation.
Higher or wider livelihood utility (Principle of affordability)	A concept arguing that water should be safeguarded for poverty-focused productive livelihoods; e.g., water for irrigated agriculture. The argument is that poorer sectors cannot afford expensive water yet poverty results in high social externalities and costs, whereas higher value sectors are better placed financially to afford more expensive water-saving or water-finding solutions.
Environmental needs (Changing functional or value priorities and principle of societal values)	Humans determine changing priorities of water use. The clearest example here is of the supply for environmental needs, which in the last 10-15 years has come to be recognized as an important if not priority demand for water. Thus, water in a river basin need not be fully allocated in order for re-allocation to be required.
Conflict resolution	A class of change in priorities mentioned above, has special mention because of increasing occurrence, significance and need for resolution. Here lie a complex interaction of behavior, fears and norms surrounding perceptions of demand, needs, wants, costs and benefits.
Principles of equity (Fixed versus proportional, and value derived)	Issues related to scarcity of water and nature of the water body. Physical division according to supply or value associated with the use of water. Or division according to proportions of available water (%'s).

commonly held notion that water should flow to users that generate the highest economic utility for the water used. This paper contends that these principles do not lend themselves to a more refined articulation of goals; rather, they retrospectively shore up goals that have been otherwise derived and then applied to different phases of the water supply regime.

Allocation options

River basin science also requires an explicit definition of the allocation options to assist the process of creating goals for water allocation. Table 3 provides some of the allocation options, including basin-wide allocation. Classifying allocation in the Great Ruaha, we argue that it is a basin-wide approach in assessment terms, but is implemented in sub-basins. As explained under section 'Expedient goal-making,' it seeks a return to year-round flow via partial re-allocation amongst sectors, employing cross-basin and local solutions.

Allocation scenarios

Allocation scenarios therefore provide a series of 'future options' where the main emphasis is on influencing economic patterns in the basin that emanate from the current water distribution pattern rather than by formulating a water distribution plan that strictly adheres to safeguarding idealistic IWRM 'principles' of water

TABLE 3.
Options for water distribution and allocation.

Issue	Comparative options	
Allocation	*Capture*. Water shares change as a result of de-facto growth of allocation to one sector without forward planning.	*Re-allocation*. In cross-sectoral allocation or re-allocation, water is actively moved out as a result of employment of allocation devices.
Unit	*Hydrological*. Usually the river basin or sub-basin, see below.	*Political boundary unit*. A political boundary (e.g., region or district) is used as the unit of management; this may cut across river basins (international rivers) or be part of a river basin.
Hydrology	*Surface water*	*Sub-surface*
Scale of river basin or water body boundary	*Large scale*. The river basin is the unit of management or alternatively, a given aquifer is the unit of management.	*Smaller scale*. Sub-basin or minor catchment. Part of a hydrological body is the unit of management.
Basin versus local response to water shortages	Basin response *Intra-basin transfer.* Water is moved within one basin from one user to another. *Inter-basin transfer*. Water is moved out from or into a basin from a neighboring basin or aquifer.	Local response *User relocation*. The user relocates in order to find water, thereby acquiring it. Acquisition of irrigation supplies by growing cities in Asia. *Local supply solution*. The user obtains water from the hydrological cycle; desalinization; boreholes, reservoirs – often this involves using water that was stored that in the longer run might have played an environmental role.

allocation. Allocation categories or scenarios can encapsulate in words, new arrangements or goals of water use. One scenario is 'status quo' or 'business as usual', while another is 'ad hoc'. As an example, Shin (1999) developed a scenario-consequence analysis, based on economic growth forecasts, to assess alternatives for water management in a northern China river basin. Another issue is that future allocation scenarios seem to underplay natural variability and security of supply. The Ruaha Basin Decision Aid (RUBDA), which can be set to reflect hydrologic variability, can be used to generate three main scenarios. These are termed 'Balanced' (ensuring year round flow through the Ruaha National Park, but also allowing water for rice and hydropower), 'Hydropower' (providing more water for Mtera-Kidatu Reservoir) and 'Irrigation' (favoring upstream irrigation to the detriment of downstream flows). We argue that scenario planning (in terms of one choice over another) for water is rarely implemented – instead it is economic planning and activity that tends to lead here. Instead, we suggest that water scenario planning helps inform the identification of more specific expedient goals (see below).

Time horizons

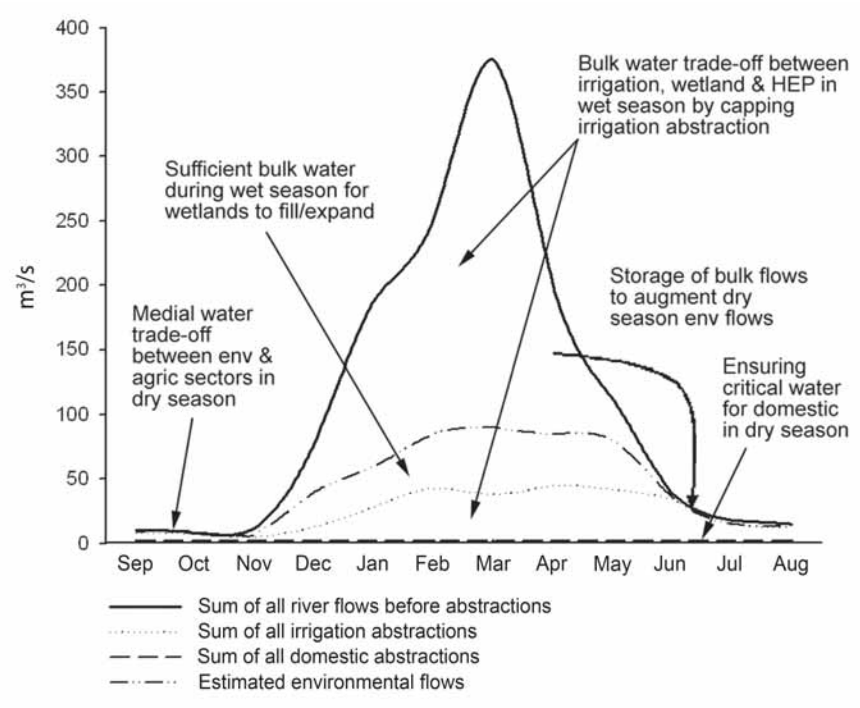
From the literature, scenarios are utilized to generate pictures of long-term consequences, and rarely are placed within a time frame, largely because the latter is a separate exercise initiated by political and institutional interests. For the Ruaha, the target of year-round flow has been set politically at 2010 (see next section). Time horizons necessarily provide stimulus for action, and although this is a target that might generate winners and losers, or may not in the end be realistic, the setting of a time horizon does enable a strategy to be developed that works towards that goal. In this respect, it provides a useful device for coordinating various players and institutional developments.[11]

[11] It should be noted that nine years passed between it first being articulated and set as a target, rather than the time period now left.

Expedient goal-making

In Ruaha, the agreed water allocation goal is to return the river to year-round flow by 2010. This follows from the statement made by the Prime Minister of Tanzania, Frederick Sumaye, in London in March 2001, for the Rio+10 Summit[12]. Yet, how have the principles, options and scenarios translated into this articulated goal? It is difficult to see the linkages here, but the notion of expedient goals seems to answer this if we break down river basin management into three phases (figures 4 and 6). Expedient goal-making in the case of Ruaha functions by fitting goals to the likelihood of success in altering patterns of water use within each phase, and by finding that across all three phases, niches of water demand exist that cater for various principles and scenarios of water allocation. Thus, achieving year-round flow is seen as a ‘medial’ water goal that, while politically motivated in this instance, meets Tanzania’s emerging environmental concerns but need not jeopardize agriculture and hydropower because it is predominantly a dry season goal. As figure 6 shows, the return to year-round flow means that the substantial use of non- or low-beneficial water in dry season agriculture has to be curtailed, something that is possible in the larger perennial sub-catchments given the predominant rice-fallow cropping pattern. In other smaller perennial sub-catchments, high value agriculture non-rice crop rotations are more normal.

FIGURE 6.
Adapting water goals to fit water supply and demand patterns.



[12] “I am delighted to announce that the Government of Tanzania is committing its support for a programme to ensure that the Great Ruaha River has a year round flow by 2010. The programme broadly aims at integrating comprehensive approaches towards resources planning, development and management so that human activity does not endanger the sustenance of the Great Ruaha ecosystems.” (N.B. ‘Programme’ here refers to government and non-government initiatives).

It is possible to articulate other goals and related principles; in the wet season, ample 'bulk' water could be apportioned between agricultural needs (giving water as a pro-poor livelihood right), environmental needs and hydropower storage, the latter fulfilling the principle of water as an economic good.

Meeting small, timely and much-needed freshwater needs during the 'critical' state of the driest part of the dry season is a considerable challenge for basin authorities and often marks a period of intense conflict. In the dry season, critical water goals, (meeting the principle of water as a basic right) would come from a program of boreholes and piped supplies rather than the coarser instrument of attempting to adjust allocation via the current system of irrigation water rights and intake improvement. Improved secure village water supplies as 'replacements' for surface water could provide incentives for stakeholders to discuss surface water distribution. A nexus between village water supply and catchment management can then be made, hitherto often the remit of separate local authorities and river basin offices, respectively.

Part 3: The expedient response – water management

In this section, and following figure 5, under a number of headings, we give examples of the expedient response by developing a multi-stage strategy for managing the Ruaha River Basin to achieve the vision of returning the river to year-round flow.

River flow targets – routing the water

Having derived the expedient goals of water distribution in the basin, it is necessary to specify how they can be achieved. For each sub-catchment, this means specifying how much water is required in volume, time and place for a particular use/user. In this discussion, we use only medial water during the dry season as an example.

We term this exercise 'routing the water.' It involves mapping out mathematically and geographically a cascade map to ensure water physically moves through the landscape from sources to users (tables 4 and 5 and figures 7, 8 and 9). In order to provide year-round flow for the Ruaha through the national park, target flows for the supply of the wetland in upstream perennial sub-catchments have been identified for each month of the dry season. Working backwards, this gives the allowable irrigation abstraction from the supply of water running off the high catchment. The same exercise can be conducted for a dry or wet year of rainfall, and for the wet season, if flows downstream for the hydropower reservoirs are required. The river basin decision-aid RUBDA (Cour et al. n.d.) based on hydrological modeling (Kashaigili et al. 2006), is ideal for this target creation for a given scenario, and can be compared to the current situation (table 4 and figure 8). Understanding uncertainty and risk is central to such scenario development.

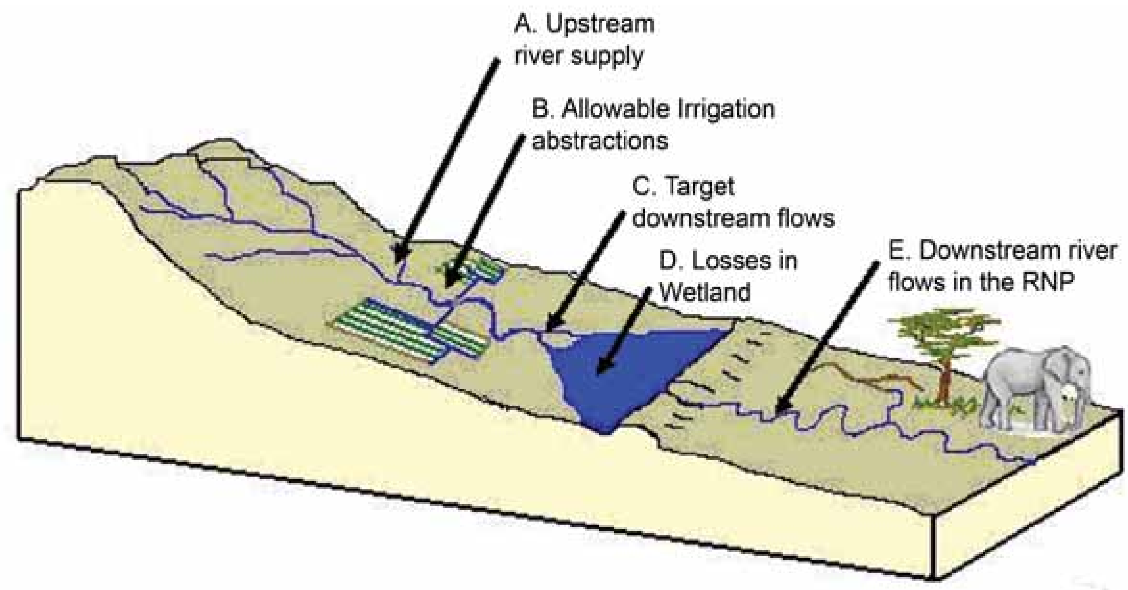
Table 5 and figure 9 indicate that in order to maintain a flow in the Ruaha National Park, approximately 5 to 7 cumecs on average need to be released below the irrigation intakes during the dry season (July through to November). Two factors relate to this. First, this is partly dependent on whether the wetland can be kept topped up during the latter part of the wet season, and therefore intake and canal regulation is also important in this season. Second, by revealing shortfalls, tables 4 and 5 allow us to determine whether storage is required to capture excess wet season water to augment dry season flows.

The target of 5 to 7 cumecs can be compared to the pre-2001 situation where river flows of less than this target were recorded below the irrigation intakes entering the wetland during the latter half of the dry season (SMUWC 2001)[13]. In effect, it becomes increasingly less

[13] One of the co-authors, Lankford, was the irrigation specialist on the SMUWC project and helped record these observations and measurements.

likely to find spare water above 4 cumecs, in effect requiring that water flowing into the irrigation systems is reduced, thereby curtailing productive and livelihood activities within the command areas of those systems. In the absence of additional storage, one solution would be to opt for 4 to 5 cumecs as a target flow, but to channel a portion of this through the wetland so that about 0.5 cumecs flows to the exit onward to the Ruaha National Park. This would entail a tradeoff in environmental benefits between the wetland and the National Park.

FIGURE 7.
Target flows in rivers and allowable abstractions to meet Ruaha goal.



Note: See figure 3 for location of A, B, C, D and E.

TABLE 4.
Irrigation and wetland losses in the catchment leading to zero flows (1998-2003).

	June	July	Aug	Sept	Oct	Nov	Dec
A. Natural Upstream river supply (cumecs)	18.74	11.98	9.73	8.12	7.01	7.15	17.86
B. Recent irrigation abstraction (cumecs)	9	8	7.5	7.5	6.7	6.7	14
C. Downstream flows (cumecs)	9.74	3.98	2.23	0.62	0.31	0.45	3.86
D. Losses in wetland (cumecs)	6	1.98	1.23	0.62	0.31	0.45	0.62
E. Downstream river flows in RNP (cumecs)	3	2	1	0	0	0	3.24

Source: Average monthly flows between 1998 and 2003, Kashaigili et al. (2006).

TABLE 5.
Calculations of water required to provide a perennial flow in the Great Ruaha.

	June	July	Aug	Sept	Oct	Nov	Dec
A. Natural upstream river supply (cumecs)	18.74	11.98	9.73	8.12	7.01	7.15	17.86
B. Allowable irrigation abstraction if downstream targets are met (cumecs)	2.78	1.67	1.37	1.15	0.95	0.99	2.36
C. Target downstream flows to meet wetland losses and exit flows (cumecs)	15.96	10.31	8.36	6.97	6.06	6.16	15.5
D. Modeled losses in wetland (cumecs)	11.55	8.1	7.02	6.13	5.34	5.44	11.05
E. Target downstream river flows in RNP (cumecs)	4.41	2.21	1.34	0.84	0.72	0.72	4.45

Allocation management framework

In the previous section, a routing exercise indicated where and how much water was required. This quantifies the water goals. In this section, we explore a number of ways in which these goals can be met. We argue that rather than defining them in the normative language of IWRM, it is more relevant to build an "expedient response" in keeping with the three states of water flow.

Key rivers in critical periods

An initial step is to identify key rivers where activities can lever as much benefit as possible (Lankford 2001). In 2001, the Rufiji Basin Water Office (RBWO) initiated an intake regulation program designed to ensure a reduction in dry season abstraction from the three key rivers feeding the wetland. To this end, negotiations with three large state farms led to reductions in their water supply during the dry season to give enough water for domestic use rather than for irrigation of fields that were visibly not producing crops of any type. This clearly focused on a 'medial water' problem. Lately, the RBWO has regulated intake flows during the latter part of the wet season to help keep the wetland topped up leading to both more wetland evaporation and higher downstream flows; a focus on 'bulk water' with a knock-on effect on the dry season.

Infrastructure for river basin management

Water allocation is strongly mediated by the presence of infrastructure, often playing multiple roles in augmenting supply for one sector and reducing demand from another. For example, on the Usangu Plains, pipes to villages are a supply solution for domestic use but, in reducing the need to abstract water through the canals, they are also a demand solution for irrigation which leaves more water for in-stream environmental benefits. In problem-focused water management, infrastructure is added, removed or adjusted within sub-catchments to meet their target allocations. This is framed within each of the three phases of water supply, as table 6 shows. For example, in Usangu, there are few sites for cost-effective capture of bulk water using large reservoirs, though a case might be made on the Ndembera River for water supply to the Ruaha National Park during the dry season, a water-scarce period. Thus, bulk water would be taken from the wet season and re-allocated during the dry season to

FIGURE 8.
Dry season depletion in the Usangu catchment leading to zero flows (1998-2003).

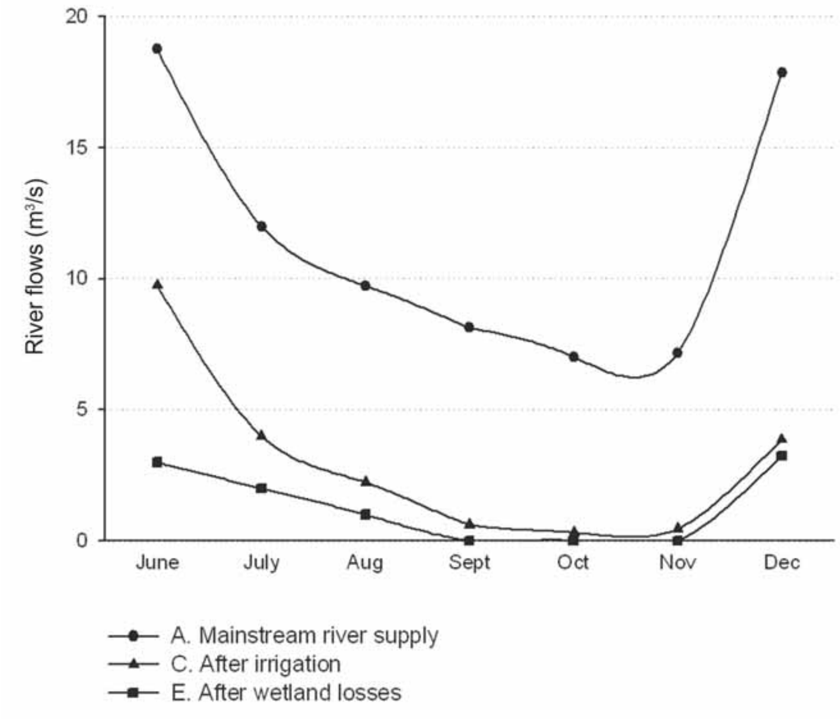
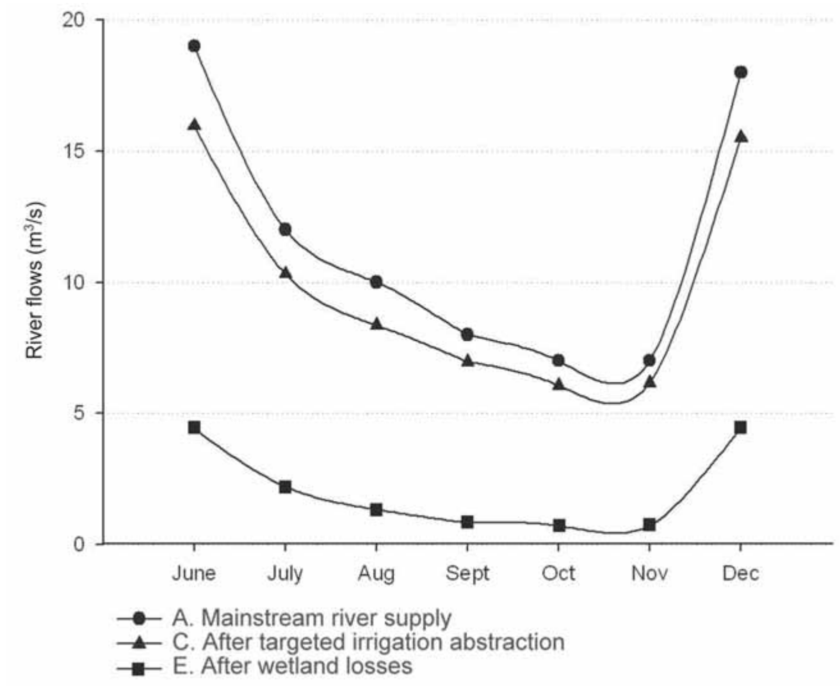


FIGURE 9.
Future adjustments to irrigation depletion to provide perennial flow.



the environment, making more water available on other tributaries for productive use.

The design of irrigation intakes by RBMSIIP and other programs (UVIP 1993; WER Engineering 1993) influences water allocation. Where conventionally designed 'full-sill weirs' are installed upstream, downstream users are subjected to extreme low flows in the dry season as a result of the uppermost intakes abstracting all the water. These conventional types of intake aggravate a delicate situation where dry season flows of only 100-200 l/sec have to be shared between intakes and in-stream users. One possible solution is to adjust the intake design so that, first, a volumetric cap allows excess 'bulk' water to flow downstream during the wet season, and second, a proportional cap allows sharing of medial water during the dry season (Lankford and Mwaruvanda 2006).

Tanzania proposes to establish Apex Bodies (the term for sub-catchment water user associations) to decide how water should be shared within the catchment and released downstream. One model (MOWLD 2004) represents an ideal by providing an institutional body for each river level. However, disadvantages arise from the requirement for four layers: 1) basin, 2) sub-catchment forums, 3) sub-catchment water user associations (WUA, i.e., 'Apex Bodies'), and 4) irrigation WUAs. In addition, user fees are required to support these institutions. A more serious critique is the comprehensiveness of the 'social engineering' underlying these proposals, i.e., the assumption that wholly new institutional frameworks can be imposed from outside without considering the inherently political, contingent and un-predictable nature of institutional reform processes; see for example, Cleaver and Franks (2003) and Merrey et al. (2007). Instead of imposing such an overarching structure, it is more relevant to consider which of the tiers are most necessary (or indeed energetic), and thus how water management should be supported at this chosen level, allowing that tier to determine and evolve its institutional design and relationships with other tiers or organizations. It may be a matter of timescales and deployment; while the four-tier structure makes sense in the long-term, there is

TABLE 6.
Classification of river basin infrastructure.

Water flow state	Examples and sub-types	Definitions and notes
Critical flows	Technology for poverty-focused water acquisition (taps, pipes, boreholes, rainfall harvesting)	This class of infrastructure attends to critical flows that meet and safeguard domestic and environmental objectives
Medial flows	Irrigation intake design for water sharing, proportional capping. In-stream weirs	Water acquisition and sharing of medial flows between intakes Protecting major source of income for many people (irrigation) In-stream and storage environmental protection
Bulk water flows	Irrigation intake design for volumetric abstraction cap. Large reservoirs	Capping of maximum amount of water taken by irrigation Reservoirs capture floodwater for storage and release for beneficial use during medial or critical water periods

Organizational and institutional set up

A pragmatic approach indicates that institutional design should be questioned and refined. Although handing over to the correctly-identified group, invoking the principle of subsidiarity, is seen as an integral part of integrated water management – the manner in which this group is supported and is provided with institutional space is critical to the success of that provision.

little in the national strategy of how the current institutional structure in different sub-catchments will be the basis for development.

Legislative framework

A review of the water policy, strategy and legislation of Tanzania indicates a tendency for water legislation to put into 'legalese', or to encode, notions and principles of IWRM without examining how water is actually managed. This legal framework appears to foster a situation where water management is framed in terms of principles to be applied. Thus, the policy-strategy-law continuum is internally coherent but in that continuum the strains that water rights and fees place on the governance of surface water management are not recognized. Thus, irrigation water in Tanzania legally attracts an annual 'economic water user fee,' a regulatory device that, as outlined below, either has no effect, or simply increases demand. In another example, institutional space for informal water rights is provided but no detail on their relationship to and precedence over formal water rights is given. It may be several years before this relationship is described by any further legal refinements. Expedient water management seeks much greater traction here and encourages local users to formulate byelaws and customary agreements to minimize conflict and to distribute water accordingly. The scalar challenge is to marry these agreements with formal water laws and with users further downstream who might not be represented, so that such agreements are allied to intra and inter-sectoral allocation needs. As explained in the next section, a proposal by Lankford and Mwaruvanda (2006) gives one way in which this might occur.

Economic instruments

In Ruaha, the theory that formal economic instruments influence water allocation by costing the demand for water has been problematic, even perverse in its outcome (van Koppen et al. 2004). Fixed fees have not acted to dampen demand or associate a value with water use, as was intended, nor could they have since the fee is not directly linked to water use. Indeed they may have supported demand for water by augmenting perceptions of a 'right' as a result of having "paid for the water" that conflicts with the needs of downstream (paying) users. On the other hand, some farmers in Usangu have discussed and implemented their own land-based tax to help restrict overdevelopment of land. This contrast between the formal economic instruments and the self-introduction of informal charges informs an expedient approach in which water users are not against demand management incentives; their formulation and the means by which they are introduced and supported is more likely to produce a desired outcome.

Building on current water permit legislation, Lankford and Mwaruvanda (2006) propose a framework of wet and dry season abstractions. During the wet season, the formal permit would fit the maximum abstraction through the cumulative intake capacity that curtails the irrigation use of bulk water (termed the volumetric cap). Adjusting the volumetric cap would require the intakes to be re-configured so that when set at their maximum opening, their discharge fits with the targets on bulk water abstraction[14]. During the remainder of the year, local users could negotiate informal rights as shares of medial water during the dry season, either as proportions of the river flow or as time scheduling.

[14] Although infrastructure can be circumvented, observations in Usangu show that physical limitations of abstraction tend not to be exceeded. Instead, new intakes are built. Yet, when playing the River Basin Game, local users opined that a catchment-wide representative body should halt the development of new intakes and reconcile existing ones so that they function better cumulatively and in sequence.

Recurrent water management

With regards to the practical implementation of the framework, this section describes two issues that feed into the day-to-day management of that framework. We omit other factors that support daily management such as logistics, finance, personnel, administration, training and resources, as they are adequately covered elsewhere in the literature.

Cross-compliance mechanisms: Cross-compliance defines mutual agreements for progressively implementing an agreed schedule of initiatives between two or more partners (See for example, DEFRA 2006[15]). Cross-compliance wraps all parties in such agreements, motivating and leveraging further action out of the parties involved. Appropriately designed conditionalities, such as the establishment of a water user association, are attached to project benefits. Thus, for example, water users 'comply' with some responsibilities in response to or parallel to work being completed by Government or NGO offices. However, the deployment of both the project benefit (the intake) and the facilitation and monitoring of the conditional response from the users requires us to consider the role and nature of 'service providers' under conditions of fiscal restraint, structural adjustment and governmental capacity (Batley 2004).

In the new Tanzanian Water Resources Strategy (MOWLD 2004), the role of the Government is worth examining. In the draft document, the Government believes that it should no longer be a service provider[16] (Section 3.1.3, page 14). However, under a cross-compliance framework this downscaling has to be thoroughly interrogated; the Government has to be a service provider, albeit a strategic and tactical one, because water users in Usangu are paying fees for water, and 'service return' becomes necessary for ongoing fee collection. Enhanced service provision does not automatically assume *more* time and money spent in the field by Government, but instead resources facilitate a range of other government and non-governmental services or agreements, some of which will be purchased[17]. We envisage the following possibilities: bulk water rights to a single catchment on the assumption that the WUA will distribute it to users; sourcing conflict resolution facilitators; coordinating infrastructural changes to improve water management at the catchment level; sourcing funds to improve water source security (e.g., dams and boreholes); clarifying legislation for local user groups; locating specialists able to provide GIS and mapping services; and resolving water rights issues. Thus, the basin office collaborates with a given sub-catchment WUA to move it through various stages of water development.

Cross-compliance applies to both the river basin and sub-catchment scale, but also, importantly to irrigation systems. Irrigation has special significance because, although government and donor institutions should be cautious about rolling out more irrigation schemes, there is a case for their involvement to facilitate improved water management. However, rather than this occurring because engineers dictate that irrigation efficiency is 'low' with little dialogue with users as has happened in the past (World Bank 1996), it is better framed as a response to

[15] "There is no longer a link between production and support. Instead, to receive payments, you are asked to demonstrate that you are keeping your land in Good Agricultural and Environmental Condition (GAEC) and complying with a number of specified legal requirements relating to the environment, public health and plant health, animal health and welfare, and livestock identification and tracing (SMRs). Meeting these requirements is described in the Common Agricultural Policy (CAP) legislation as 'cross compliance'". (Advice to UK farmers on page 7, Cross Compliance Handbook for England, DEFRA 2006).

[16] The term 'service provider' covers many activities, including power generation; here we restrict ourselves to the governmental activities of the river basin office, zonal irrigation office and district council, supported in turn by central administrators in Dar es Salaam. Service provision is clear in the context of irrigation. In the context of basin management, what service is being received and how is it linked to payment.

[17] A simple calculation shows that farmers could afford a more organized approach to purchasing services. One percent of the value of Usangu rice sold from a 1,000 ha system is about 10,000 dollars (one 80 kg bag of rice sells for 30 US dollars).

requests by farmers who genuinely identify and verbalize water distribution problems. Such an approach has the important dimensions of being problem-focused, service-oriented, responsive, and demand-led. Various activities are envisaged; partnership engineering, facilitation sessions, game and role-playing, farmer training, problem ranking and participatory institutional analysis. It is likely that such an approach will further strengthen participatory skills amongst engineers whose current training tends to focus on conventional methodologies. The international community can play a role in facilitating such capacity reform and sharing of lessons among countries and regions, and in ensuring that existing budgets are partly used for these activities – implying little additional cost here.

Working with local detail: Expediting allocation relies on marrying higher-level incentives with the cumulative outcomes of detailed water management at the field and irrigation intake level and a willingness to engage with and foster local knowledge. This is an important point in sub-Saharan Africa where formal and governmental processes of re-allocation are difficult to apply in the kinds of circumstances found (e.g., large distances, disparate many users, lack of government resources). Furthermore, detailed knowledge underpinned by field validation allows higher-level policies to be appropriately drafted and gives space for local users to explore their own methods for improving the productivity of water (Lankford 2006).

RBMSIIP (River Basin Management and Smallholder Irrigation Improvement Project) envisaged re-allocation coming about because of a combination of water rights and efficiency gains – yet with regards to the latter, the RBMSIIP program revealed a lack of engagement with detail, believing that Usangu irrigation systems depleted water via seepage within the hierarchical canal system. This is understandable given that most irrigation engineers are trained to conceive irrigation efficiency as being a product of canal-level efficiencies multiplied together. Yet, losses in Usangu irrigation schemes, which are not hierarchically canalized in nature, do not arise during the supply of water to the crop but rather because of evaporation before and after the window of evapotranspiration during crop growth.

We believe that working with detail also solidifies agreements made between stakeholders and then helps take things forward incrementally, so binding in progress. Stankey et al. (2005) identify that incremental progress is a key feature of adaptive natural resource management. Thus, for example in Usangu, farmers first consider canal cleaning as a first step, prior to implementing other water saving agreements.

Working with detail can be achieved in several ways, including by devolving responsibility for water management to farmers. Farmers are concerned about wasteful water practices that they themselves define and observe each day. For example, the River Basin Game (Lankford et al. 2004a) generates considerable discussion of what constitutes waste and what to do about it. These discussions build on an agreement that productivity of rice need not be reduced. In addition, some farmers, independently of the IWRM solutions forwarded by the Government, have explored economic solutions to demand management – they agreed to a land-based byelaw that encourages people to manage a few acres of land that can then be supplied with water rather than optimistically clearing land that remains dry (SMUWC 2001). The comparison between the Government-fixed charges for water rights and the marginal rules promoted by farmers speaks loudly about the ability of different ‘players’ to craft solutions based on intimate knowledge of how to dampen water demand in the face of shortages of supply. Benefits are gained from having experienced water professionals provide inputs here, but this is entirely different from a government call to provide training to farmers on water management as this is unlikely to reach the level of detail required by experienced irrigators that changes from place to place and over time.

Water resources assessment and monitoring

Water resource assessment (WRA) and monitoring observes the efficacy of water management and is a critical part of the framework, enabling adjustment of the goals and devices. However, ways need to be found to obtain data sustainably and transparently on flows and supply and demand, for example, by eventually involving local users in the recording and utilization of those flows. Although this has not been tried in Usangu, there may be some appetite for exploring such a move. Sessions with the river basin game demonstrated that users, in the face of water scarcities, are increasingly interested in monitoring each other's water use, and that monitoring need not start with flow discharge measurement, but rather with simple depth recordings. WRA, and its costs and benefits, should be part of the water social learning by both users and professionals.

Revisit water goals

The final part of the framework for expedient water management involves revisiting the water goals in order to pragmatically adjust it or add details that incorporate other principles of allocation. This accords with the finding by Stankey et al. (2005) that nearly all theories around adaptive natural resource management includes some notion of incremental adjustments.

Part 4: Social learning in water

The previous sections describe the three stages of acquiring knowledge, establishing goals and creating water strategies. We posit that a fourth, social learning within a water-competitive environment, is at the heart of these. We understand that vibrant social learning selects appropriate activities and programs to expose issues, mediate conflict and deploy solutions. On the other hand, a dysfunctional social learning arises from inappropriate or infrequently held activities. Thus, at the center of expedient water management is the development of capacity and skills through iterative social and technical learning by all water stakeholders. Iterative learning and devices and tools to support it is also a feature of adaptive NRM (Natural Resources Management)(Tompkins and Adger 2004; Stankey et al. 2005; Hagmann and Chuma 2002).

A review of RIPARWIN's experience in Ruaha, and of the literature, points to some key elements of social learning in water: the cautious use of experts but a wider discussion of their findings; the use of inclusive stakeholder deliberative tools and processes (e.g., workshops based around the River Basin Game); support to the Basin Office via a river basin decision-aid that gives options for managing water and water rights while allowing the operator to see the outcomes of what-if scenarios without being overly didactic; and providing 'social learning' opportunities to local groups using educational and conflict resolution tools as well as farmers' own experimentation and observation as a means to determine perspectives on water sharing and management. Experimentation on a catchment scale is also to be considered (see also Gunderson 1999, on connections between experimentation and adaptive management), and might generate insights regarding how to share water, as evidenced by the experiments in the Mkoji sub-catchment facilitated by the RIPARWIN project (Vounaki and Lankford 2006). The River Basin Game has considerable potential here, as it elicits many suggestions, for example, on saving water while maintaining rice production. With respect to new (or adjustments to) devices to adjust allocation (e.g., infrastructure), these can be openly part of a locally negotiated process to sub-catchment water security.

On the other hand, learning is curtailed when a particular water resources strategy is held up as 'finished'.[18] One antithesis to social learning, therefore, is an over-reliance on

[18] SMUWC was completed in 2.5 years, although it was originally envisaged to run for four years at the minimum. Mills and Clark (2001) describe a nine-month river basin study expanded to five years as complexity of the issues became clearer.

short-term consultancies framed within the pace of project progression dictated by donor agency schedules requiring demonstration of quick results. Combined, these create difficulties in developing long-term partnerships and expedient strategies that need to be seated within a dialogue between users and service providers. Indeed, it is the pace of programming that results in 'idealized' IWRM as compared to a slower and more reflective pragmatic and adaptive water resources management. How to develop relevant skills in social learning of all, or a necessary majority of the many stakeholders involved, is a question with few easy answers because serious challenges exist in moving from consultation of stakeholders to an adequate representation of their opinions (Wester et al. 2003).

Conclusions

Although the term 'integrated' in IWRM denotes a pragmatic and broad approach, IWRM becomes ideological in two ways at the operational level if, as can be observed all too often, it is not adapted to the circumstances. First, ideology is maintained if 'integrated' becomes the guiding principle to establish an all-encompassing holistic approach, precluding a more expeditious and sometimes even mono-disciplinary 'objectives-guided' approach. Second, 'component ideology' occurs by applying a strand of IWRM theory without first determining if it is fit. In Tanzania, an example of misfit is the application of formal water rights designed (poorly) to act as an economic tool (van Koppen et al. 2004). Returning to our example of the Water Framework Directive implementation in Europe, we can also find evidence that supports a cautionary view of ideological IWRM. Here, the pursuit of public participation in river basin management, a core requirement of the WFD in line with IWRM ideology, was revealed during piloting as being potentially wasteful of significant resources that might be better spent on the task of managing the environment (Fox 2004[19]). The UK WFD pilot phase concludes in support of an 'expedient' approach, promoting processes which fit the task and urging that the nature of local issues should determine the techniques employed and stakeholders to be engaged within the basin (Fox et al. 2004).

We posit that it is the choice of the starting point that determines how appropriate the subsequent iterations of water management become. Starting with and then aiming to institutionalize *principles* of water management (in other words refining ideal IWRM to craft operational IWRM) may not be sufficiently accurate or efficient. On the other hand, refraining from utilizing 'ideal IWRM' as a starting template but attempting to expedite effective strategies in water resources management that resolutely examine the conditions found in the river basin, might become more efficient, and requires and defines an adaptive process. Following this, the paper contains a practical framework to guide the interpretive, adaptive process of creating meaningful expedient water management programs.

[19] Public participation activities in the WFD Ribble Pilot Project cost £150,000, whilst only 14% of the general public were interested in involvement and, significantly, the majority of these were existing members or supporters of organizations already represented in pre-existing arrangements for stakeholder engagement (e.g., Recreational Fishing Clubs, the World Wide Fund for Nature and the Royal Society for the Protection of Birds). The process has not obviously shifted priorities in terms of river basin management or brought new thinking in terms of solutions.

Literature Cited

Allan, T. 2003. *IWRM/IWRAM: A new sanctioned discourse?* Occasional Paper 50. SOAS Water Issues Study Group, School of Oriental and African Studies/King's College London, University of London, London, pp. 27.

Batley, R. 2004. The politics of service delivery reform. *Development and Change* 35(1).

Bauer, C. J. 1998. Slippery property rights: Multiple water uses and the Neoliberal model in Chile, 1981-1995. *Natural Resources Journal* 38(1): 109-155.

Baur, P.; Mandeville, N.; Lankford, B.; Boake, R. 2000. *Upstream/downstream competition for water in the Usangu Basin, Tanzania*. British Hydrological Symposium, Seventh National Hydrology Symposium. BHS National Hydrology Symposium Series, University of Newcastle.

Biswas, A. K. 2004. Integrated Water Resources Management: A Reassessment. *Water International* 29(2): 248-256.

Briscoe, J. 1997. Managing Water as an Economic Good. In: *Water: Economics, Management and Demand*, eds. Kay, M.; Franks, T.; Smith, L. E. London: E & FN Spon. pp. 339-361.

Carter, R.C. 1998. Prospects for sustainable water management policy in Sub-Saharan Africa, with special reference to the northeast arid zone of Nigeria. In: *Water Resource Management: A Comparative Perspective*, ed. Vajpeyi, D. K. Praeger, New York. pp. 107-127.

Cleaver, F.; Franks, T. 2003. *How institutions elude design: River basin management and sustainable livelihoods*. Paper read at The Alternative Water Forum, Bradford, UK.
Available at http://www.brad.ac.uk/acad/bcid/GTP/CleaverFranks.pdf (Accessed October 24, 2005).

Cour, J.; Lankford, B. A.; Yawson, D. n.d. *The Ruaha Basin Decision Aid*. IWMI Working Paper. Colombo, Sri Lanka: International Water Management Institute. Forthcoming.

Danida (Danish International Development Agency)/World Bank. 1995. *Water resources management in the Great Ruaha Basin: A study of demand driven management of land and water resources with local level participation*. Rufiji Basin Water Office, Ministry of Water, Energy and Minerals, Dar es Salaam, Tanzania.

DEFRA (Department for Environment, Food and Rural Affairs). 2006. Single Payment Scheme. *Cross Compliance Handbook for England.* Department for Environment, Food and Rural Affairs. DEFRA Publications, London.

Environment Agency. 2002. *Rivers and Estuaries – A decade of improvement*. Environment Agency, Bristol, UK.

Environment Agency. 2005. Annual Reports and Accounts 2004-05, Stationary Office, London.

EC (European Commission). 1998. Guidelines for water resources development co-operation. *Towards sustainable water resources management: A strategic approach*. Brussels: European Commission.

FAO (Food and Agriculture Organization of the United Nations). 1960. *Hydrology and Water Resources in the Rufiji Basin, Tanganyika*. Report to the Government of Tanganyika. Report No.1269, FAO, Rome.

Fox, P. 2004. *Early experiences of public participation during the River Ribble Pilot.* Paper presented to the Ripple Effect Conference, Wigan, October 23, 2004, Environment Agency.

Fox, P.; Bond, D.; Orr, P.; Madeira, N.; Riley, C.; Rees, Y.; Davis, M. 2004. *Public Participation in River Basin Planning – Early Experiences*. Environment Agency, North West Region.

Franks, T.; Lankford, B. A.; Mdemu, M. 2004. Managing water amongst competing uses: The Usangu Wetland in Tanzania. *Irrigation and Drainage* 53: 1-10.

Gichuki, F. N. 2002. Water scarcity and conflicts: A case study of the Upper Ewaso Ng'iro North Basin. In: *The Changing Face of Irrigation in Kenya: Opportunities for Anticipating Change in Eastern and Southern Africa,* eds. Blank, H. G.; Mutero, C. M.; Murray-Rust, H. Colombo, Sri Lanka: International Water Management Institute.

GWP (Global Water Partnership). 2000. *Integrated Water Resources Management*. GWP Technical Committee Background Paper 4. Stockholm: GWP.

Gunderson, L. 1999. Resilience, Flexibility and Adaptive Management - Antidotes for spurious certitude? *Conservation Ecology* 3(1): 7.

Hagmann, J.; Chuma, E. 2002. Enhancing the Adaptive Capacity of the Resource Users in Natural Resource Management*. Agricultural Systems* 1(73): 23-39.

Hazelwood, A.; Livingstone, I. 1978. *The Development Potential of the Usangu Plains of Tanzania.* Commonwealth Fund for Technical Co-operation, The Commonwealth Secretariat, London.

Hermans, L. M. 2001. *Using stakeholder analysis to increase the effectiveness and relevance of water resources systems modeling*. Regional Management of Water Resources (Proceedings of a symposium held during the Sixth IAHS Scientific Assembly at Maastricht, The Netherlands, July 2001). IAHS Publ. no. 268, 2001:183. International Association of Hydrological Sciences.

Hillman, M. 2006. Situated justice in environmental decision-making: Lessons from river management in Southeastern Australia. *Geoforum* 37(5): 695-707.

Hooper, B. 2005. *Integrated River Basin Governance: Learning from International Experience.* IWA Publishing, London.

ICWE (International Conference on Water and the Environment). 1992. The Dublin statement on water and sustainable development. Dublin: International Conference on Water and the Environment.

Jonker, L. 2006. *Integrated Water Resources Management: The Theory Praxis-Nexus*. Paper presented at the 7th WATERnet/WARFSA/GWP-SA Symposium 'Mainstreaming IWRM in the development process', Lilongwe, Malawi, November 1-3, 2006.

Kashaigili, J. J.; McCartney, M. P.; Mahoo, H. F.; Lankford, B. A.; Mbilinyi, B. P.; Yawson, D. K.; Tumbo, S. D. 2006. *Use of a hydrological model for environmental management of the Usangu wetlands, Tanzania*. IWMI Research Report 104. Colombo, Sri Lanka: International Water Management Institute.

Keeney, R. L. 1994. Creativity in decision making with value-focused thinking. *MIT Sloan Management Review* 35(4): 33-41.

Lankford, B. A. 2006. Localizing irrigation efficiency. *Irrigation and Drainage Systems* 55: 345–362.

Lankford, B. A. 2004. Irrigation improvement projects in Tanzania: Scale impacts and policy implications. *Water Policy* 6(2): 89-102.

Lankford, B. A. 2001. Red routes on blue rivers: Strategic water management for the Ruaha River Basin, Tanzania. *Water Resources Development* 17(3): 427-444.

Lankford, B.; Sokile, C.; Yawson, D.; Lévite, H. 2004a. *The River Basin Game: A Water Dialogue Tool*. Working Paper 75. Colombo, Sri Lanka: International Water Management Institute.

Lankford, B. A.; van Koppen, B.; Franks, T.; Mahoo, H. 2004b. Entrenched views or insufficient science? Contested causes and solutions of water allocation; insights from the Great Ruaha River Basin, Tanzania. *Agricultural Water Management* 69(2): 135-153.

Lankford, B. A.; and Beale, T. 2007. Equilibrium and Non-equilibrium Theories of Sustainable Water Resources Management: Dynamic River Basin and Irrigation Behaviour in Tanzania. *Global Environmental Change* 17: 168-180.

Lankford, B.; Franks, T. 2000. The Sustainable Coexistence of Wetlands and Rice Irrigation: A Case Study from Tanzania. *Journal of Environment & Development* 9(2): 119-137.

Lankford, B. A.; Mwaruvanda, W. 2006. Legal infrastructure framework for catchment apportionment. In: *Community-based water law and water resource management reform in developing countries*, eds. van Koppen, B.; Butterworth, J.; Juma, I. CABI Publishing.

MacDonald, G. B.; Fraser, J.; Gray, P. 1999. *Adaptive Management Forum: Linking Management and Science to Achieve Ecological Sustainability*. Proceedings of the 1998 Provincial Science Forum. Peterborough, ON, Canada: Natural Resources Information Centre, Ministry of Natural Resources (Available at http://www.for.gov.bc.ca/hfp/amhome/INTROGD/intro.htm

Machibya, M. 2003. *Challenging established concepts of irrigation efficiency in a water scarce river basin: A case study of the Usangu Basin, Tanzania*, PhD Thesis, University of East Anglia, Norwich.

McCartney, M. P.; Lankford, B. A.; Mahoo, H. 2007. *Agricultural water management in a water scarce catchment: Lessons from the RIPARWIN project*. IWMI Research Report, Colombo, Sri Lanka: International Water Management Institute. Forthcoming.

Merrey, D. J.; Drechsel, P.; Penning de Vries, P.; Sally, H. 2005. Integrating 'livelihoods' into integrated water resources management: Taking the integration paradigm to its logical next step for Developing Countries. *Regional and Environmental Change* 5: 197-204.

Merrey, D. J.; Meinzen-Dick, R.; Mollinga, P.; Karar, E. 2007. Policy and Institutional Reform: The Art of the Possible. Chap. 12 in *Water for Food, Water for Life*, ed. Molden, D. The Comprehensive Assessment of Water Management in Agriculture. UK: Earthscan Publications.

Mills, T. J.; Clark, R. N. 2001. Roles of research scientists in natural resource decision-making. *Forest Ecology and Management* 153: 189-198.

Mitchell, B. 1990. *Integrated water management: international experiences and perspectives*. Belhaven, London.

Mitchell, B. 2004. Discussion Note: Comments by Bruce Mitchell on Water Forum Contribution "Integrated Water Resources Management: A Reassessment" by Asit K. Biswas. *Water International* 29(3): 398-405.

Moench, M.; Dixit, A.; Janakarajan, S.; Rathore, M. S.; Mudrakartha, S. 2003. *The Fluid Mosaic: Water Governance in the Context of Variability, Uncertainty and Change*. Synthesis Paper. Kathmandu, Nepal: Nepal Water Conservation Foundation, and Boulder, CO, USA: Institute for Social and Environmental Transition.

Molden, D. 1997. *Accounting for Water Use and Productivity*. SWIM Paper 1. Colombo, Sri Lanka: International Irrigation Management Institute.

Moriarty, P.; Butterworth, J.; Batchelor, C. 2004. *Integrated Water Resources Management and the domestic water and sanitation sub-sector*. IRC Thematic Overview Paper. The Netherlands: IRC International Water and Sanitation Centre.

Moss, T. 2004. The governance of land use in river basins: Prospects for overcoming problems of institutional interplay with the EU Water Framework Directive. *Land Use Policy* 21(1): 85-94.

MOWLD (Ministry of Water and Livestock Development). 2002. National Water Policy (NAWAPO). P. O. Box 456, Dodoma, The United Republic of Tanzania. 88pp.

MOWLD. 2004. National Water Sector Development Strategy (Circulation Draft), Ministry of Water and Livestock Development, The United Republic of Tanzania, Dar es Salaam.

Mutayoba, W. N. 2002. *Management of water resources in Tanzania through Basin Management.* 3rd Waternet/Warfsa Symposium: Water Demand Management for Sustainable Development, Dar es Salaam, October 30-31, 2002.

National Research Council. 2004. Adaptive Management for Water Resources Project Planning, Panel on Adaptive Management for Resource Stewardship, Committee to Assess the U.S. Army Corps of Engineers Methods of Analysis and Peer Review for Water Resources Project Planning, National Research Council, 138 pages, 6 x 9, 2004. Viewed at: http://www.nap.edu/catalog/10972.html

Perry, C. J. 1999. The IWMI water resources paradigm - definitions and implications. *Agricultural Water Management* 40(1): 45-50.

Pitman, G. K. 2002. *Bridging Troubled Waters: Assessing the World Bank Water Resources Strategy*. The World Bank: Operations Evaluation Department, Washington, 116 p.

Shah, T.; Makin, I.; Sakthivadivel, R. 2005. Limits to Leapfrogging: Issues in Transposing Successful River Basin Management Institutions in the Developing World Chap. 3 in *Irrigation and River Basin Management: Options for Governance and Institutions*, ed. Svendsen, M. London: CABI and IWMI. pp 31-50.

Shin, P. K. S. 1999. Planning for water management in the Daqinghe River Basin, northern China. *Environmental Management* 24(1): 85-97.

SMUWC (Sustainable Management of the Usangu Wetland and its Catchment). 2001. Talking About Usangu. Video and Leaflet. Project: SMUWC, Directorate of Water Resources, Ministry of Water, Government of Tanzania, Dar es Salaam.

Stankey, G. H.; Clark, R. N.; Bormann, B. T. 2005. *Adaptive management of natural resources: Theory, concepts, and management institutions*. General Technical Report PNW-GTR-654. Portland, OR: United States Department of Agriculture, Forest Service, Pacific Northwest Research Station. 73 p.

Swanson, D.; Barg, S.; Venema, H. D.; Pinter, L.; Ashford, G. 2004. *Adaptive Policies and Projects for Water Resources*. Canada: IISD (International Institute for Sustainable Development).

Swatuck, L. A. 2005. Political challenges to implementing IWRM in Southern Africa. *Physics and Chemistry of the Earth* 30: 872–880.

Tapela, B. N. 2002. The challenge of integration in the implementation of Zimbabwe's new water policy: case study of the catchment level institutions surrounding the Pungwe-Mutare water supply project. *Physics and Chemistry of the Earth*, Parts A/B/C, 27(11-22): 993-1004.

Tompkins, E. L.; Adger, W. N. 2004. Does adaptive management of natural resources enhance resilience to climate change? *Ecology and Society* 9(2): 10.

USBR (United States Bureau of Reclamation). 1967. Rufiji River Basin: United States Bureau of Reclamation. Washington DC: USAID (United States Agency for International Development).

UVIP (Usangu Village Irrigation Project). 1993. Progress Report, UVIP, URT/91/005, Phase II, Igurusi, Tanzania. Rome: Food and Agriculture Organization of the United Nations.

van Hofwegen, P. 2001. Framework for Assessment of Institutional Frameworks for Integrated Water Resources Management. In: *Intersectoral Management of River Basins*, ed. Abernethy, C. L. Proceedings of an International Workshop on "Integrated Water Management in Water-Stressed Rivers Basins in Developing Countries: Strategies for Poverty Alleviation and Agricultural Growth," Loskop Dam, South Africa, October 16-21, 2000. German Foundation for International Development (DSE), International Water Management Institute (IWMI), Colombo, Sri Lanka. pp. 137-158.

van Koppen, B.; Sokile, C. S.; Hatibu, N.; Lankford, B. A.; Mahoo, H.; Yanda, P. Z. 2004. *Formal water rights in rural Tanzania: Deepening the dichotomy?* Working Paper 71. Colombo, Sri Lanka: International Water Management Institute.

Vounaki, T.; Lankford, B. A. 2006. Feasibility of a legal-infrastructural framework: insights for the dry season from the Mkoji-Sub Catchment, Tanzania (Fieldwork Report for the RIPARWIN project).

WER Engineering. 1993. Kimani Irrigation Project, Summary report, End of Phase I Report, KIP, Dar es Salaam, Tanzania.

Wester. P.; Warner, J. 2002. River Basin Management Reconsidered. In: *Hydropolitics in the Developing World: A Southern African Perspective*, eds. Turton, A.; Henwood, R. African Water Issues Research Unit, University of Pretoria, South Africa. pp. 61-72.

Wester, P.; Merrey, D. J.; de Lange, M. 2003. Boundaries of Consent: Stakeholder Representation in River Basin Management in Mexico and South Africa. *World Development* 31(5): 797-812.

Whyte, W. F.; Greenwood, D.; Lazes, P. 1989. Action Research in the 21st Century: Participation, Reflection and Practice. *American Behavioral Science* 32: 513-551.

Wood, R.; Handley, J.; Kidd, S. 1999. Sustainable Development and Institutional Design – Example of the Mersey Basin Campaign. *Journal of Environmental Planning and Management* 42(3): 341–354.

World Bank. 1993. *Water Resources Management*. A World Bank Policy Paper. IBRD, Washington, USA.

World Bank. 1996. River Basin Management and Smallholder Irrigation Improvement Project (RBMSIIP) - Staff Appraisal Report. Washington D.C.

Appendix A

Further Information on Water Policy, Institutions

Quote from World Bank, 1996. River Basin Management and Smallholder Irrigation Improvement Project (RBMSIIP) - Staff Appraisal Report, Annex A, page 3.

Among several considerations to be included in the review of the existing policy and legislation are: (1) the allocation of water as a public good and as an economic good with a value in all its competing uses; (2) the use of a water user fee as a means of encouraging efficient use of the resource and for meeting the cost of regulatory functions; (3) the need for a definition of stakeholders in water resource management; (4) clear recognition of stakeholder rights and the need for their participation in water management activities, especially the women; (5) provisions for stakeholder representation in Basin Water Boards; (6) clear indications that there will be periodic reviews on the fee, charges and fines to discourage water pollution and other forms of misuse; (7) a clear statement that indicates moving basin management operations towards self-financing; and (8) the need for strengthening the Basin Water Offices and other institutions charged with monitoring water quality and with managing the legal and incentive framework to induce efficient water use and maintenance of water quality. Some issues to be addressed are as follows:

The Rufiji Basin Water Office (RBWO) was established in September 1993, under Act No. 10 of 1981 which amended the Act No. 42 of 1974. The RBWO roles cover:

- allocating water for various water users from water bodies in the basin
- controlling pollution of water in the basin
- overseeing all matters concerning water resources use and regulation as stipulated in Act 42 of 1974 and its subsequent Amendments of Act No. 10 of 1981, Act No. 17 of 1989 and Act No. 8 of 1998.

Accordingly, the main activities of the RBWO include:

- regulating, monitoring and policing of water use in the Rufiji Basin
- issuing of water rights
- monitoring operations of hydropower generation reservoirs
- assisting in the formation of water users associations in the basin
- constructing control gates on irrigation furrows
- collection of water fees
- awareness creation to water users regarding water resources management
- monitoring and control of water pollution in water bodies in the basin
- participation in activities of water related projects in the basin

Source: from SMUWC 2001.

Research Reports

97. *Strategies to Mitigate Secondary Salinization in the Indus Basin of Pakistan: A Selective Review.* M. Aslam and S. A. Prathapar. 2006.

98. *Multiple-Use Water Services to Advance the Millennium Development Goals.* Barbara van Koppen, Patrick Moriarty and Eline Boelee. 2006.

99. *Irrigation and Schistosomiasis in Africa: Ecological Aspects*. Eline Boelee and Henry Madsen. 2006.

100. *The Reliability Improvement in irrigation Services: Application of Rotational Water Distribution to Tertiary Canals in Central Asia*. Iskandar Abdullaev, Mehmood Ul Hassan, Herath Manthrithilake and Murat Yakubov. 2006.

101. *Carbon, Land and Water: A Gobal Analysis of the Hydrologic Dimensions of Climate Change Mitigation through Afforestation/Reforestation.* Robert J. Zomer, Antonio Trabucco, Oliver van Straaten and Deborah A. Bossio. 2006.

102. *Informal Irrigation in Urban West Africa: An Overview.* Pay Drechsel, Sophie Graefe, Moise Sonou and Olufunke O. Cofie. 2006.

103. *Malaria Mosquito Resistance to Agricultural Insecticides: Risk Area Mapping in Thailand.* Hans. J. Overgaard. 2006.

104. *Use of a Hydrological Model for Environmental Management of the Usangu Wetlands, Tanzania.* Japhet J. Kashaigili, Matthew P. McCartney, Henry F. Mahoo, Bruce A. Lankford, Boniface P. Mbilinyi, Daniel K. Yawson and Siza D. Tumbo. 2006.

105. *An Irrigated Area Map of the World (1999) Derived from Remote Sensing.* Thenkabail, P. S., Biradar, C. M., Turral, H., Noojipady, P., Li, Y. J., Vithanage, J., Dheeravath, V., Velpuri, M., Schull, M., Cai, X. L., and Dutta, R. 2006.

106. *Assessing the Outcomes of IWMI's Research and Interventions on Irrigation Management Transfer.* Meredith A. Giordano, Madar Samad and Regassa E. Namara. 2006.

107. *An Assessment of Environmental Flow Requirements of Indian River Basins.* V. Smakhtin and M. Anputhas. 2006.

108. *Water Saving Technologies: Myths and Realities Revealed in Pakistan's Rice-Wheat Systems.* Mobin-ud-Din Ahmad, Hugh Turral, Ilyas Masih, Mark Giordano and Zubair Masood. 2007.

109. *Costs and Performance of Irrigation Projects: A Comparison of Sub-Saharan Africa and Other Developing Regions.* Arlene Inocencio, Masao Kikuchi, Manabu Tonosaki, Atsushi Maruyama, Douglas Merrey, Hilmy Sally and Ijsbrand de Jong. 2007.

110. *From Integrated to Expedient: An Adaptive Framework for River Basin Management in Developing Countries.* Bruce A. Lankford, Douglas J. Merrey, Julien Cour and Nick Hepworth. 2007.

Postal Address
P O Box 2075
Colombo
Sri Lanka

Location
127, Sunil Mawatha
Pelawatta
Battaramulla
Sri Lanka

Telephone
+94-11-2787404

Fax
+94-11-2786854

E-mail
iwmi@cgiar.org

Website
http://www.iwmi.org

International Water Management Institute

FUTURE™ HARVEST
IWMI is a Future Harvest Center supported by the CGIAR

ISSN 1026-0862
ISBN 978-92-9090-661-2