DFID Department for International Development

Knowledge And Research
KAR R8064
Theme W5

RIPARWIN
Raising Irrigation Productivity And Releasing Water for Intersectoral Needs
river basin management research in Tanzania

**March 2006**

# RIPARWIN – FINAL TECHNICAL REPORT

## Raising Irrigation Productivity and Releasing Water for Intersectoral Needs (RIPARWIN)

This product is an output from the Department for International Development (DfID) funded Engineering Knowledge and Research Programme (project no R8064).
The views expressed are not necessarily those of DfID.

RIPARWIN Project
Raising Irrigation Productivity And Releasing Water for Intersectoral Needs

Overseas Development Group
University of East Anglia
Norwich, NR4 7TJ, UK
Tel +44 1603 593378
b.lankford@uea.ac.uk

Soil Water Research Group
Dept of Agricultural Engineering
Sokoine University of Agriculture, Morogoro, Tanzania
Tel: +255 23 2601206
Fax:+255 23 2604649
hmahoo10@yahoo.co.uk
riparwin@yahoo.co.uk

International Water Management Institute, Africa Regional Office
Private Bag X 813, Silverton 0127
Pretoria, South Africa
Tel + 27 12 8459110
mccartney@cgiar.org
b.vankoppen@cgiar.org
h.sally@cgiar.org

ODG DEV

IWMI International Water Management Institute

**http://www.iwmi.cgiar.org/Africa/files/RIPARWIN/05/Riparwin.htm**

# RIPARWIN Final Progress Report and Final Technical Report

## Contents List of Project Deliverables

| **Front document** | Final Progress Report |
|---|---|
| **Final Technical Report** | **Main Report** (this document)<br>Contents |
| **Main annex** | **Sub-annex (contained in sub-folders on the CD)** |
| A. Project management | A1 Introduction<br>A2 Administration<br>A3 Staff<br>A4 Inception report<br>A5 Progress reports<br>A6 Letters of appreciation<br>A7 Dissemination strategy<br>A8 Partnerships<br>A9 Timeline of main project events and dissemination activities<br>A10 Other dissemination activities and products<br>A11 Parallel funding and activities<br>A12 RIPARWIN-1 log-frame<br>A13 RIPARWIN-2 log-frame |
| B. General workshops and meetings | B1 Introduction<br>B2 Planning meeting<br>B3 Inception meeting<br>B4 District & stakeholder seminars<br>B5 Ruaha +10<br>B6 Final wrap up workshop |
| C. March 05 EARBM conference | C1 Introduction<br>C2 Conference invitation<br>C3 Description, aims and evaluation<br>C4 Abstracts and titles<br>C5 Participants list<br>C6 EAIRBM Proceedings<br>C7 Presentations |
| D. RIPARWIN citations | D1 Introduction<br>D2 Papers, Research Reports and Working Papers<br>D3 Policy briefs and factsheets<br>D4 Other reports |
| E. Irrigation management, efficiency and productivity | E1 Introduction<br>E2 Factsheets: Irrigation efficiency and productivity<br>E3 Irrigation Excel spreadsheet model<br>E4 IMEP workshops and manuals<br>E5 GoT Research paper<br>E6 Irrigation efficiency paper<br>E7 District Agricultural Dev Plan Irrigation Note<br>E8 Other irrigation efficiency and productivity meetings and papers |
| F. Wetlands and environmental flows. | F1 Introduction<br>F2 Factsheet: Ecohydrology of Great Ruaha River<br>F3 Policy brief: Restoring the wetlands and flows of the Gt Ruaha River<br>F4 IWMI Research Report on hydrological modelling of wetlands<br>F5 Other environmental flow meetings and papers |
| G. Livelihoods and economic benefits, and productivity | G1 Introduction<br>G2 Factsheet: Rice production economics at local and national levels<br>G3 Policy brief: The value of water in paddy and hydropower production<br>G4 IWMI Research Report on the value of water<br>G5 Productivity comparison table<br>G6 Other water economic valuation meetings and papers |

| **Main annex** | **Sub-annex (contained in sub-folders on the CD)** |
|---|---|
| H. Institutional and legal framework | H1 Introduction<br>H2 Factsheet: Institutional and legal framework (ILF)<br>H3 Methodology<br>H4 IWMI Working Paper on water rights and legislation<br>H5 Abraham Haile field study<br>H6 Other institutional and legal framework meetings and papers |
| I. Legal-infrastructure framework for catchment apportionment (LIFCA) | I1 Introduction<br>I2 LIFCA meetings<br>I3 Early development note on water management<br>I4 African Water Laws Conference paper<br>I5 Framework Powerpoint presentations from workshops<br>I6 LIFCA fieldwork study paper<br>I7 LIFCA chapter in community water mgt book<br>I8 LIFCA Concept Note for GoT<br>I9'Water rights decisions' Information sheet PDF Power point,: |
| J. River basin game (RBG) | J1 Introduction<br>J2 Factsheet: River basin game<br>J3 River basin game workshops in Tanzania<br>J4 IWMI Working paper<br>J5 Tracer study – report of uptake<br>J6 DVD and movie clip of river basin game<br>J7 Swahili version of manual<br>J8 WUA formation & registration<br>J9 Other river basin game meetings and papers |
| K. Great Ruaha Basin Decision Aid (RUBDA) | K1 Introduction<br>K2 Factsheet: RUBDA. [PDF]<br>K3 Methodology<br>K4 RUBDA training workshops<br>K5 RUBDA manual<br>K6 RUBDA model v1 (open within folder)<br>K7 RUBDA paper<br>K8 Powerpoint introduction to model |
| L. IWRM and river basin management | L1 Introduction<br>L2 IWMI RR on Expedient Water Resources Management<br>L3 Other WRM meetings and papers |
| M. Dialogue | M1 Introduction<br>M2 Dialogue facilitation skills training<br>M3 Local level dialogue<br>M4 National level dialogue<br>M5 Final Dialogue proposal |
| N. Training modules for WUA | N1 Introduction<br>N2 Report front page, contents list and summary |
| P. Responsive reports and notes | P1 Introduction<br>P2 NAFCO Irrigation Management Transfer<br>P3 Mtera Study<br>P4 Wetlands RNP tradeoff discussion note<br>P5 National Water Sector Development Strategy<br>P6 Country Water Resources Assistance Strategy Tanzania |
| R. Other project reports | R1 Introduction<br>R2 Usangu water allocation analysis<br>R3 Minor field study reports |
| S. Miscellaneous | S1 Selected material on Usangu Basin (from SMUWC)<br>S2 Reference list for RIPARWIN project |

RIPARWIN – FINAL TECHNICAL REPORT

# Raising Irrigation Productivity and Releasing Water for Inter-sectoral Needs

## Main Report Contents

The RIPARWIN Team

**Back row left to right**: Reuben Kadigi, Julien Cour, Bruce .A. Lankford, Miss Grace Moshi, Filbert .B. Rwehumbiza, and Japhet Kashaigili.

**Front row left to right**: Anna Urio, Vumilia Mmbaga, Henry .F. Mahoo, Nganga .I. Kihupi, Kossa .R. Rajabu, Siza .D. Tumbo, and Vanscar .A. Kulanga

## Acronyms used in Report

**CWUA –** Catchment Water User Association
**DADP** - District Agricultural Development Plan
**DFID** – Department for International Development
**EARBM** - East Africa River Basin Management
**FNPP** - FAO/Netherlands Partnership Programme
**GoT** - Government of Tanzania
**IET** - Institution of Engineers, Tanzania
**IMEP** - Irrigation management, efficiency and productivity
**IUCN** – World Conservation Union
**IWMI** - International Water Management Institute
**IWRM** - Integrated water resources management
**JICA** - Japanese International Cooperation Agency
**LIFCA** - Legal Infrastructure Framework for Catchment Apportionment
**MAFS** - Ministry of Agriculture and Food Security
**MATII** – Ministry of Agriculture Training Institute at Igurusi
**MOWLD** - Ministry of Water and Livestock Development
**MSC** - Mkoji sub-catchment
**NAFCO** National Agricultural Food Corporation
**ODG** - Overseas Development Group, UEA
**PI** - Principal Investigator
**PWAIS** – Productivity of Water in Agriculture and Interacting Systems
**RBM** – River basin management
**RBMSIIP** – River Basin Management & Smallholder Irrigation Improvement Project
**RBG** – River basin game
**RBWO** – Rufiji Basin Water Office
**RIPARWIN** - Raising Irrigation Productivity And Releasing Water For Inter-Sectoral Needs
**RLF-1 or -2** - RIPARWIN log-frame 1 or 2.
**RNP** - Ruaha National Park
**RUBDA** - Great Ruaha River Basin Decision Aid
**SHARDI** – Southern Highlands Agriculture Research and Development Institute
**SMUWC** - Sustainable Management of the Usangu Wetlands and its Catchment
**SUA** - Sokoine University of Agriculture
**SWMRG** – Soil-Water Management Research Group
**TANAPA** - Tanzania National Parks Authority
**TANESCO** - Tanzanian Electricity Supply Company
**TIIP** – Traditional Irrigation Improvement Project
**UEA** - University of East Anglia
**UGR** – Usangu Game Reserve.
**VETA** – Vocational Education Training Academy
**WREP** - Water Resources Engineering Programme
**WWF-** World Wildlife Fund for Nature
**WUA –** Water User Association
**ZIO** - Zonal Irrigation Office

## RIPARWIN Executive Summary and Key Findings

(Note: The Final Progress Report written in a short DfID format is contains a good summary of the RIPARWIN project. The file is located with this FTR at the front end of the CD).

### Background

- RIPARWIN ('Raising Irrigation Productivity and Releasing Water for Intersectoral Needs') was a research project working in the Great Ruaha Sub-basin in Tanzania implemented by the University of East Anglia, Sokoine University of Agriculture and the International Water Management Institute (IWMI). It was funded by DfID's KAR programme ( R8064) and IWMI, and ran from November 2001 to March 2006. It was based primarily at the village of Igurusi in the Usangu Basin, a major component of the Great Ruaha sub-basin.
- RIPARWIN afforded the opportunity of studying river basin management (RBM) in sub-Saharan context subject to rapid growth in the demand for water, competition for water within and between sectors, and a large degree of climatic and hydrological variability. In the area, the Government of Tanzania was managing the basin via the Rufiji Basin Water Office, a recipient of the World Bank funding under the River Basin Management & Smallholder Irrigation Improvement Project (RBMSIIP).
- RIPARWIN followed on from the DfID funded SMUWC project (Sustainable Management of the Usangu Wetlands and its Catchment) which was established to determine the causes of recent hydrological change in the Gt Ruaha, a river that prior to the 1990's was perennial and since then has dried up for several months of the year as it passes through the Ruaha National Park. Both projects studied water management in the Gt Ruaha Sub-Basin and made recommendations. The findings and recommendations outlined below relate primarily to work conducted by RIPARWIN and supports earlier findings by SMUWC.

**Findings and recommendations**

1. The project believes that the Ruaha river can be returned to perennial flow because trade-offs exist between sectors that do not necessarily impinge on core livelihood or environmental well-being, provided that water is managed optimally within the Usangu Basin. The presence of rice-fallow crop rotation on many of the farms that exist on the perennial catchments feeding the wetland is the main reason that potential to reduce agricultural water use during the dry season exists.
2. The 'environmental flows' studies found that approximately 6 to 7 cumecs should flow into a wetland of 90 $km^2$ to generate an exit flow of 0.5 cumecs. A flow of 6 to 7 cumecs is perhaps too large an amount of water to source from the Usangu Basin without affecting productive livelihoods upstream. An environmental flow of 4 to 5 cumecs is more manageable and could be found (bearing in mind that during the period 1999 to 2000 SMUWC found that on the Usangu Plains no water was entering the Ihefu wetland during the late dry season).
3. A lower flow of 4-5 cumecs would necessitate a smaller wetland of approximately 70-75 $km^2$ to ensure an outflow, and this would require a managed retreat of the wetland, possibly by instigating a co-management plan of the grazing, fishing, wildlife and water channelling through the wetland to convey water to the exit. Co-management implies working with local resource users rather than against them so that their knowledge of the wetland is applied to the task of conveying water to the wetland exit.
4. A dry season flow of 4-5 cumecs would stem primarily from a canal and intake regulation on the main perennial rivers (Mbarali, Ruaha, Ndembera and Kimani), combined with reduced water rights during that season in order to meet domestic and minor productive uses found on those rivers.
5. The project found that the determination and allocation of environmental water requirements for wetlands and rivers was complex and challenging, and will have to be approached very carefully, requiring stakeholders' participation through dialogue and consultation (see below).
6. The sale of the NAFCO farms to the private sector also represents an opportunity to reduce the wet season water rights for the farms, helping to reduce the volumetric cap of abstraction

during that season. Such a reduction need not impinge on production if water efficiency and land productivity were to increase accordingly, and studies show that this is certainly feasible. Smallholders at the tailend of indigenously owned systems are able to grow approximately 3-4 tonnes of rice with about 950 mm water, whereas topend smallholders grow 3-5 tonnes rice with 1500 mm water, and NAFCO commercial growers produce 2-4 tonnes rice with 2500 mm water. If all rice in Usangu were to be grown using approximately 1000 mm rice, then calculations show that this would 'save' approximately 7 cumecs of water over an 8 month period (the main growing season). This could either be allocated downstream, or be used to expand irrigation beneath the intakes already extracting that water.

7. One key alteration to the two NAFCO farms that would reduce non-beneficial losses involves a cessation of use of the sunken tertiary canals in favour of a network of minor tertiaries such as is currently found on the smallholder fields. If smallholders were given improved tenure of plots on the NAFCO fields it is possible that they could invest in the labour needed to generate such a network of canals (thereby improving control of water and shortening the season of rice cultivation).
8. In a river basin context where irrigation is the major upstream sector defining allocation of scarce water, we argue that it is necessary to engage with the detail of farmer knowledge on irrigation and use this to problem-frame ideas to reduce conflicts and competition to alter practices of water use (as facilitated by the river basin game). Key technologies to reduce non-beneficial water depletion and to improve water productivity of rice irrigation go hand in hand with shortening the rice irrigating season from the current 300-320 days down to approximately 220-250 days. At the intake this means regulating down the supply into the irrigation systems. Within the irrigation systems themselves, technologies available to maintain production and reduce water demand to match the lower supply are therefore:
    - Strengthening the water user associations at the apex, system and secondary/tertiary levels so that agreements and bye-laws are meaningfully introduced.
    - Encourage farmers to group into smaller cells networked by tertiary canals so that intra-cell distribution of water improves.
    - Switch to surface-placed tertiary canals from the sunken canals (see above).
    - The addition of more canals could help reduce the depth of water in the top-end areas of the smallholder schemes allowing water to be passed to tailend areas more rapidly when required.
    - Cleaning of canals when necessary.
    - Reduction of mosaic transplanting whereby farmers allow top-end plots to go un-transplanted even though water is passing through those plots.
    - Introduction of varieties where possible that mature in a shorter season, particularly as an option for tailend growers.
    -
9. Improving the efficiency and productivity of water in rice cultivation was the objective of the Government of Tanzania Task Force on Irrigation Management Efficiency and Productivity (IMEP). The RIPARWIN project hopes that the concept note generated by the Task Force is given support by the donor community. In addition, there is ample scope for further work on the measurement and theory of irrigation efficiency using the Usangu case study.
10. Support for allocation decision-making was both created and then investigated by the project. Two key endeavours were the RUBDA model (Gt Ruaha Basin Decision Aid) and the River Basin Game (RBG). The RBG is a participatory dialogue and capacity building tool and has been demonstrated with water users in Rufiji and Pangani river basins in Tanzania with success. Responses and preliminary outcomes have shown that:
    - The RBG is a powerful tool for creating awareness on various water issues and the need to address water problems in a rational manner.
    - The RBG also helps in problem visualisation and adoption of appropriate strategies to address problems and assists in holistic planning that includes different levels of users.

- The RBG has the ability to trigger not only discussions on technical, institutional and socio-economic arrangements for equitable water management, but also behavioural change in the way people regard and use water.
- The River Basin Game could be used as a participatory dialogue tool to engage stakeholders during the formation of water users associations (WUAs). For example, during this process for the Mlowo River System, the RBG was used during investigation and analysis of key water resources issues and problems. The advantages observed while using RBG in the process were that the game facilitated exhaustive deliberations, discussions and resolutions on various issues concerning water availability, use and allocation. The overall results was that the task of preparing action plans to solve the identified problems was made easier.

11. RIPARWIN supported the 'Dialogue' process; engaging various water users and water use sectors in open and transparent discussions and knowledge sharing. This helped management by bridging the gap between the various water use sectors. For example, the Local Level Dialogues conducted in the Great Ruaha River Catchment (GRRC) revealed that the water resources in the GRRC are inadequate to meet all the requirements throughout the year, and demonstrated the value of involving people at the grassroots level in shaping their future.
12. In the course of studying allocation in a river basin context, the project engaged with the use of formal water rights by the Rufiji Basin Water Office (RBWO). We worked closely with the RBWO on this problematic issue, and learnt to appreciate the difficulties involved (i.e. the variability in flows, the ever-changing picture of demand, and the lack of widespread measurement). In the short term, we support the RBWO's plans to review the water rights to match supply, upstream and downstream requirements. Since the concept of 'rights' is sometimes misleading to both right holders and non holders, the change to 'water use licenses' is also welcomed. We support tentative plans for allocating bulk volumes of water to each sub catchment, giving the water user committees responsibility for distributing water (with technical advice and assistance from basin authorities) among authorised intakes in the river system(s) under their jurisdiction. The water use permits should be short-term, renewable (say after every three or five years) and revocable once a holder fails to meet the conditions spelt in the licence or permit.
13. In the longer term, the Legal-Infrastructure Framework for Catchment Apportionment (LIFCA), proposed by RIPARWIN, should be introduced to align water licence quotas (as formal allocative instruments), with informal, customary water agreements and the physical design of irrigation intakes. This synergy will provide an opportunity to help set the upper maximum volumetric cap on irrigation abstraction during the wet season and the upper maximum proportional cap on abstraction during the dry season. LIFCA would require a major donor-supported programme to adjust and rebuild irrigation intakes accordingly. One test case could be selected in the Mkoji Sub-catchment. LIFCA implies collaboration between Ministries where responsibilities for irrigation infrastructure design sits to review and refine intakes that are flexible and basin-focussed together with further interventions in the legal process to formulate water rights that would then fit LIFCA framework. An example of the upper total volumetric cap in Usangu in the wet season would be 50 cumecs, while the upper proportional cap for the dry season period would be 90% on the Mkoji sub-catchment rivers and 50% on the major perennial rivers (Ndembera, Mbarali, Ruaha and Kimani). (Note other rivers in Usangu are seasonal, and so the proportional cap does not apply).
14. Major challenges exist with respect to on-going support for irrigation in the country, particularly via District Agricultural Development Plans (DADP). This reflects the favour that irrigation has found within agricultural growth strategies. Plus, recent press indicates the Ministry of Agriculture and Food Security might look at a 10-fold expansion of irrigation. The theory is that local Districts are best placed to identify where and how to target irrigation. The essential questions are when to support (a) *new irrigation* expansion, and/or (b) the management and productivity of *existing irrigation*, and (c) *how to* cost-effectively support those interventions via institutional strengthening, conflict resolution, physical infrastructure and technical advice. Furthermore, in many situations, local users may well be

better placed than the district to decide when to opt into or keep out of irrigation. There is a risk that Districts' or central services might target quite expensive irrigation growth strategies that are not in step with the direction that smallholders in the locality are or are not exploring. However, with due peer support and review from central irrigation services, (also bringing expertise from outside the country) new infrastructure and resources can 'lever' improved irrigation productivity, administration and better collective water management. RIPARWIN recommends that how DADP-based irrigation plans are rolled out should be discussed by key scientists and decision-makers.

15.

# 1 Introduction

## 1.1 Introduction to the RIPARWIN Project

This document is the main report of the FTR (Final Technical Report) that accompanies the Final Progress Report of the project RIPARWIN (R8064). RIPARWIN stands for 'Raising Irrigation Productivity and Releasing Water for Intersectoral Needs'. It was an action-research project funded by 'Knowledge and Research' of the UK's Department for International Development (under the 'Water and Sanitation' Sector; Theme 'W5 Water for Sustainable Food Production') and also by the International Water Management Institute (IWMI). The project, spanning October 2001 to March 2006, was located in Tanzania, and utilised the case study of the 'Great Ruaha Basin' to research irrigation and river basin management. RIPARWIN was divided into two main projects; RIPARWIN-1 and RIPARWIN-2 which had very similar aims, and in this report we have grouped Purpose and Outputs for that reason.

The title 'Raising Irrigation Productivity and Releasing Water for Intersectoral Needs' (RIPARWIN) encapsulated a topical issue. Our main question was; 'Can river basin managers and other stakeholders raise irrigation efficiency and productivity in order to find savings that can then be released for downstream and other sector needs?' Its topicality stemmed from the prevailing debate about how water can be shared in river basins where little spare water exists and irrigation is the majority user. Here, as it is often contended, water is inefficiently utilised so that savings can be found to deliver water to other sectors. In examining this question, RIPARWIN researched the science of river basin management (RBM) and aimed to assist basin stakeholders by providing analysis, tools, and strategy and policy advice, mainly in Tanzania, but also to a wider audience.

## 1.2 Approach taken in this document

The FTR is marked by several features. Firstly, it is modular in design, with each sub-annex acting as a single section, housing reports and other products associated with an activity that fell under the responsibility of one or two individuals. Each sub-annex was written by these authors. Secondly, the FTR employs hyperlinks in the text to facilitate navigation between the main report and annexes. Thirdly, mindful of the modular navigable structure we have kept text sections within the annexes purposively to the point and brief. This approach allows us to 'write' the report to a CD to take advantage of hyperlinked functionality and to send material to the RIPARWIN website.

This main report is kept brief because the FTR annexes contain a more elaborate discussion of all of RIPARWIN's activities and outputs, including their context, methodology and results. Moreover its impact is enhanced if it is short enough to be accessible as a website report, attachable to email and readable in one sitting. It is worth noting that RIPARWIN did not aim to reproduce SMUWC's work (the earlier DFID project; "Sustainable Management of the Usangu Wetland and its Catchment" that RIPARWIN built upon). Although a brief introduction is given below to the case study and our research site, the report assumes that the reader is familiar with the issues that SMUWC addressed (normally accessed via the website www.usangu.org). Nonetheless, in Annex S we have provided some SMUWC texts with further background material.

## 1.3 Staffing and organisations involved

Three partner organisations delivered RIPARWIN. From the Overseas Development Group (ODG) at the University of East Anglia (UEA), Lankford was the Team Leader of the programme. Mahoo and Tumbo from the Soil Water Management Research Group (SWMRG) at Sokoine University of Agriculture (SUA) managed the programme in Tanzania, while inputs from staff (Van Koppen, McCartney, Merrey, Morardet) from International Water Management Institute's (IWMI) Africa Regional Office in South Africa supported the work with technical inputs. Research Associates (Kossa Rajabu, Japhet Kashaigili, Reuben Kadigi and Charles Sokile) in Tanzania conducted further

fieldwork and organised the programme of meetings. More information on all the staff involved is given in Annex A.

### 1.4 Target Institutions and beneficiaries

Much of our work was targeted at high-level professionals implementing and shaping water and irrigation policy. Examples were River Basin Officers and other Basin staff, District Planners, Zonal and Central Engineers, key academics, consulting engineers, NGO professionals (e.g. WWF-Tanzania) and scientists working in related fields, and selected trainers and educators who are responsible for developing training materials. The immediate target beneficiaries of the Project were thus these higher level stakeholders in water resources management.

By working through these decision-makers, as a result of interventions to improve river basin management, the project's ultimate beneficiaries of the research are the environment and poor people that require water for productive and protective purposes. One example of the latter is the cessation of the sale of the two NAFCO farms in Usangu after intervention by RBWO, following discussions with RIPARWIN. We also supported the RBWO in taking a conciliatory stance towards irrigators despite pressure to reduce irrigation abstraction (see sub-annex P3 on the Mtera Study).

A second part of the work directly addressed some of the needs of local water users; namely the move towards the formulation of catchment level water user associations and inputs to help different systems of water reduce their water use. Both of these were delivered via direct work with communities, using such tools as the river basin game. Sub-annex A8 describes in more detail the partnerships developed.

We also aimed to disseminate and engage internationally and regionally. For example, we hosted an international river basin conference in March 2005, and attended a Regional Seminar on water conflict in September 2005 in Kenya. Individually, many of the RIPARWIN team attended a wide variety of meetings and conferences (e.g. Stockholm Water Week, Mexico World Water Forum, and Waternet sessions). More examples of dissemination activities are given in sub-annexes A9 and A10.

### 1.5 Project deliverables

Accompanying this main technical report are the Final Progress Report, which includes an Output-to-Purpose summary report, and a navigable (hyperlinked) list leading to the annexes of project deliverables/activities. All of these documents are found on the RIPARWIN FTR CD along with, in sub-folders, all project reports, papers and other products. The optimal way to view these products is to load the CD and then use either Windows Explorer, or the 'clickable' navigable contents list (see the starting Table at the beginning of this report).

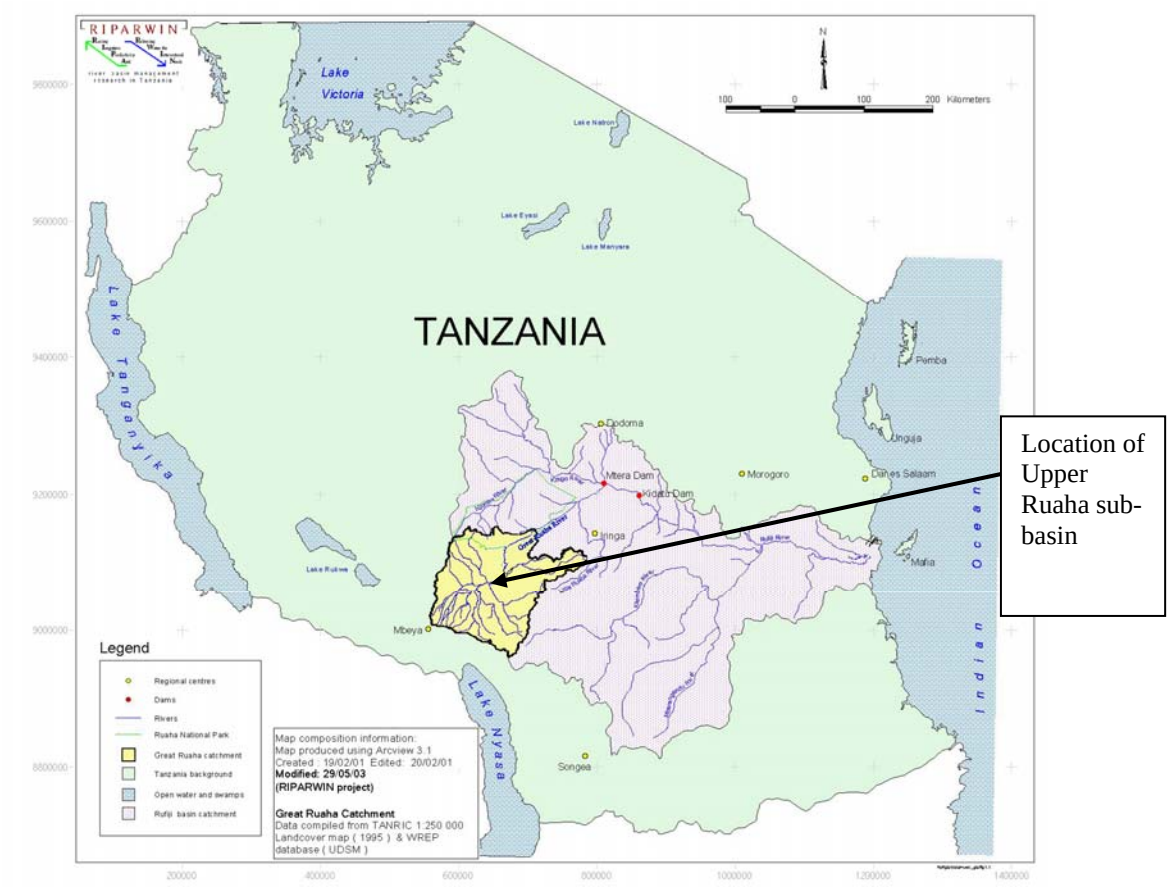
## 2 Background and introduction to Great Ruaha River Basin

### 2.1 Geographical and hydrological context

The geographical context of this study is the Great Ruaha river in the Southern Highlands of Tanzania (Figure 1). The Usangu basin, or Upper Ruaha basin, covers an area of 21,500 $km^2$ and forms the headwaters of the Great Ruaha River, itself a major sub-basin of the Rufiji River. Usangu may be broadly divided into the central plain and a surrounding higher catchment. The plain receives 600-800 mm average annual rainfall with a rainfall gradient to 1500 mm onto the high catchment. Most of the rain falls in one season from mid-November to May.

This basin is of national importance due to the utilisation of its water for significant rice production, maintaining a RAMSAR wetland site, meeting ecological needs for the Ruaha National Park and for the generation of hydro-electric power. Thus, six main water resource users from upstream to downstream can be differentiated as: 1) rainfed farmers and domestic water users in the high catchment; 2) irrigators in the plains at the base of the escarpment; 3) domestic users and rain-fed

maize cultivators in the plains; 4) pastoralists and fisherpeople in the central wetland; 5) wildlife and tourists to the Ruaha National Park that surrounds the riverine reach; and 6) the Mtera/Kidatu hydropower schemes of the Tanzania Electricity Supply Corporation (TANESCO). Below these stations, the river basin has no further significant user, and after meeting the Kilombero river, becomes an open river basin.



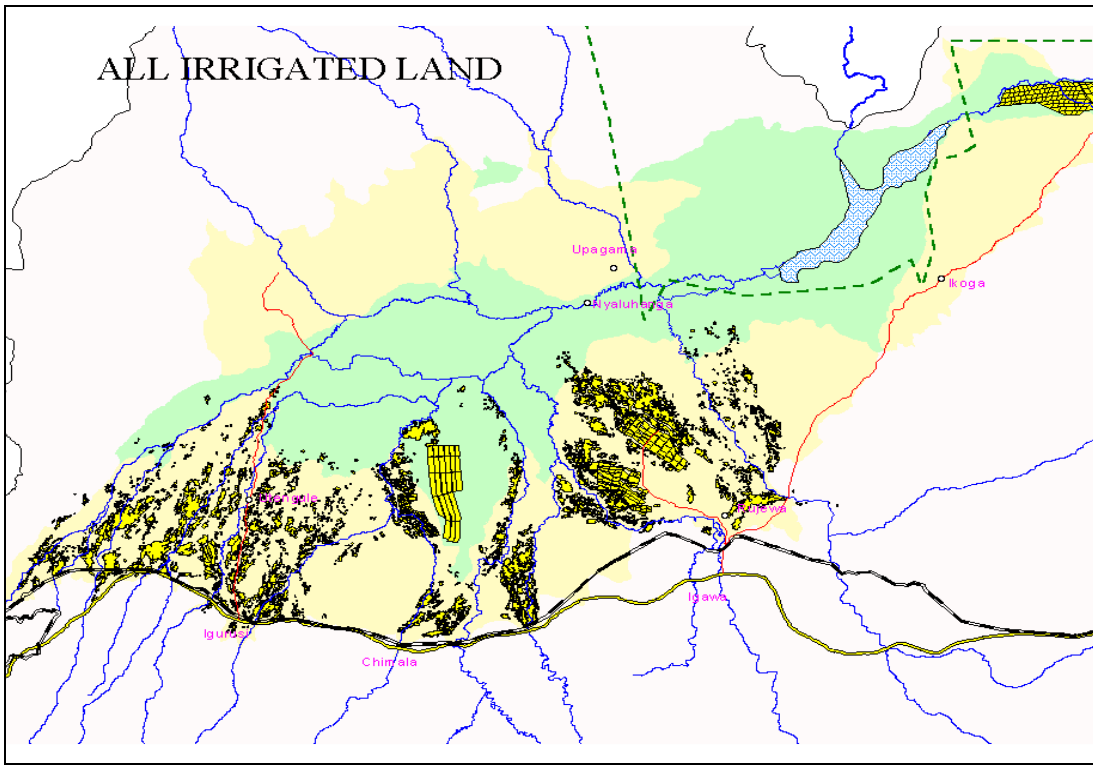

Source: RIPARWIN project

Figure 1. Location of the Upper Ruaha Basin as sub-catchment of the Rufiji Basin in Tanzania

The rationale for the RIPARWIN project, and for the project which it followed: "Sustainable Management of the Usangu Wetland and its Catchment" (SMUWC) arose from national and local concerns about the management of water and other natural resources in the Usangu basin in Southern Tanzania. In particular, national power shortages in the mid 90's were attributed to low flows to the Mtera/Kidatu hydropower schemes from the Ruaha. A reduction in low flows in the Great Ruaha where it passes through the Ruaha National Park was also noted. There has now been a succession of years in which the river in the park has dried up completely during the dry season, and for increasing periods. An increase in competition for water was noted in Usangu itself, leading to conflict and sometimes violence. Concern was also expressed that the wetlands in the project area were diminishing and degrading, and that a valuable natural asset was being lost.

There are five perennial rivers and a large number of seasonal streams draining from the high catchment. Surface flows, rather than groundwater, are used for domestic and agricultural purposes because groundwater is far less in quantity and its location less predictable. Most irrigation is located on the upper parts of the plains (Figure 2) and consists of a number of different types of farms including large scale, state-owned 'farms'; traditional smallholder; improved smallholder; and smallholder peripheral to the state farms. The total irrigated area ranges between 20,000 and 40,000

ha depending on annual rainfall. The large state farms are Kapunga (3000 ha), Mbarali (3200 ha), and Madibira (3000 ha) – these farms also provide domestic water via canals to villages that have grown up within them.




Source: SMUWC project

Figure 2. Location of irrigated lands within the Usangu Plains

Downstream of the irrigated areas, drains discharge into smaller streams and swamps located towards the tail of the alluvial fans. Some streams reach the Ruaha River, the main channel supplying the wetland. Beyond the alluvial fans, the plain consists of savannah, woodlands and seasonal wetlands, and at the deepest point, a perennial wetland. Although the swamp is a maze of channels and lagoons, many of which are at different levels, it is represented conceptually as a simple reservoir with a fixed spillway exit consisting of a rock bar. When the water level in the perennial wetland is low, no water leaves the exit. As the water level rises, water spills over the lip into the Great Ruaha River. After leaving the wetland, a number of ephemeral rivers join the Great Ruaha River as it flows through the Ruaha National Park. Downstream, the Mtera Reservoir collects water from the Great Ruaha and a number of other rivers. Besides having an 80 MW generating capacity of its own, it also acts as a regulating reservoir for the larger 204 MW Kidatu hydropower scheme further downstream. These generate approximately 50% of Tanzania's electricity.

## 2.2 Study site

RIPARWIN conducted its main field research in the Mkoji sub-catchment, which is principally drained by the Mkoji River and is located in the southwest of Tanzania, between latitudes $7^0$48' and $9^0$25' South, and longitudes $33^0$40' and $34^0$09' East (Figure 3). It is a sub-catchment of the Rufiji River Basin and covers an area of about 3,400 km². Most of the sub-catchment lies within Mbarali and Mbeya Rural Districts, while smaller portions of the sub-catchment lie within the Makete and

Chunya Districts in Iringa and Mbeya Regions, respectively. According to the 2002 population census, Mkoji sub-catchment had a population of about 146,000 people with an average annual growth rate of 2.4%. The highest population density is found along the Tanzania-Zambia Highway and in the Southern highlands. Scattered villages are located in the plains.

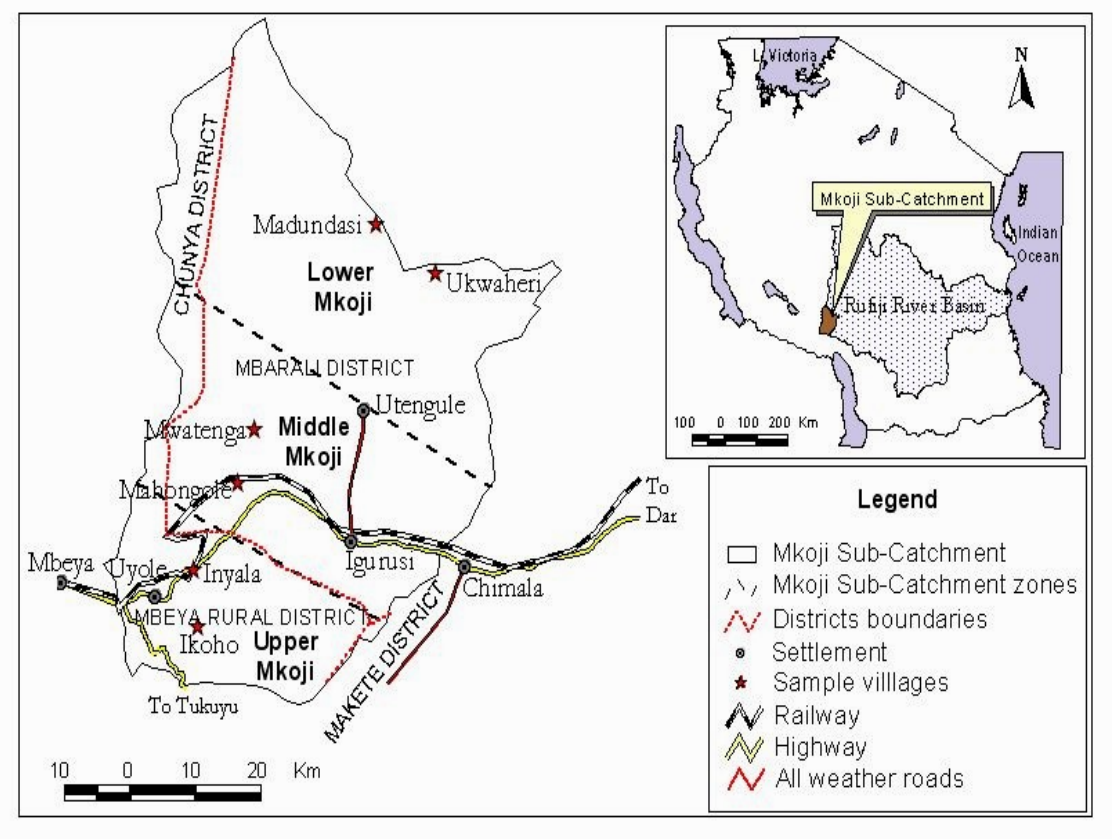



Figure 3. Map of the Mkoji sub-catchment

## 2.3 Recent approaches to river basin management

The recent history of policy-in-action in the area revealed interesting dimensions to river basin management and integrated water resources management. It was these and their impacts which formed the researchable issues that RIPARWIN interfaced with. Three key river basin programmes were devised and implemented under the Ministry of Water and Livestock Development (MoWL) within the last six years. These were:

First, the Rufiji Basin Water Office (RBWO). Basin Water Offices represent the new basin structure that the MoWL is gradually implementing nation-wide, with the Rufuji, the Pangani and Lake Victoria as the first pilot basins. 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.

Second, the River Basin Management and Smallholder Irrigation Improvement Project, RBMSIIP (World Bank, 1996). This project started in 1996 and is funded via a World Bank loan. The aims are (i) to strengthen the government's capacity to manage water resources and address water-related environmental concerns both at the national level, and in the Rufiji and Pangani basins (the river basin management (RBM) component under the MoWL) to help fund activities of the basin offices; and (ii) to improve irrigation efficiency of selected smallholder traditional irrigation schemes in these two

basins principally by the construction of concrete weirs and intake structures with control gates (the SIIP component under the Ministry of Agriculture and Food Security).

Third, the "Sustainable Management of the Usangu Wetland and its Catchment" (SMUWC, 2001). SMUWC started in 1998 and ended in 2002. The direct client of this DFID-funded project was the MoWL (Rufiji Basin Water Office). The project also worked closely with the district administrations of the project area, as well as the Ministry of Agriculture and Food Security. SMUWC investigated the nature and causes of hydrological changes, and assisted the Government of Tanzania and key stakeholders (both local and national) in the development of a sustainable natural resource management strategy.

Besides these programs, the Mbarali District Government with the support of the Ministry of Natural Resources and the Ruaha National Park pursued far-reaching land use measures to control livestock on the plains. These actions aimed at the conservation of the Usangu Wetland and restoration of perennial flows in the river Ruaha. For example, in 2000, the seasonally and permanently flooded areas south of the Ruaha National Park were gazetted as the Usangu Game Reserve. This implied that, formally, all human activity is prohibited. In the permanent wetland, force was applied since 2001 to oust pastoralists and poor fisher families.

# 3 RIPARWIN overview

## 3.1 Introduction

RIPARWIN focussed primarily on selected research topics of basin and sectoral water management (such as the study of environmental flows), achieving institutional and technical progress in water management in the Upper Great Ruaha, and on knowledge dissemination related to Government strategies on Water and Irrigation. The latter allowed us to tackle some particularly significant issues, notably; that without further improvement formal water rights do not function satisfactorily as a 'demand management' tool. Conventional viewpoints about irrigation productivity and management were also tackled though more remains to be done here. Thirdly, institutional reform related to service provision is an issue that we highlighted in several papers and discussions but which remains work for the future. With respect to our fieldwork in the field, we provided direct support to catchment communities to manage water themselves using the river basin game and in supporting the establishment of the Water User Associations. In this respect we linked closely with the Rufiji River Basin Water Office and WWF-Tanzania Ruaha programme.

## 3.2 Rationale for the project: national objectives for the Ruaha River

RIPARWIN was a research project that arose out a previously-funded DFID project called SMUWC (see Annex S). These and other activities in the basin closely matched the DFID and GoT goal of restoring the Great Ruaha River to year-round flow by 2010. This directly related to the statement by the Prime Minister of Tanzania, Frederick Sumaye, in London, (6th March 2001), made with PM Blair for the Rio+10 Summit; "*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.*" Achieving year-round flow would be, from a number of perspectives, a marker of success in achieving integrated water management in the Basin and in turn is a reflection of the wider water resources initiatives being implemented in Tanzania and regionally in East Africa.

## 3.3 Project methodology

### *General approach*

The project utilised a log-frame to guide its implementation. The log-frame and our analysis of progress attained is given in the next section. In addition, the team and stakeholders wanted RIPARWIN employ a process project – working with stakeholders in developing questions, responding to new issues and iteratively checking and adjusting solutions and options. This stance allowed us to gain greater access to decision-makers and helped sustain uptake.

Figure 4 pictorially represents the relationship between activities and the Gt Ruaha Basin case study. Research Associates and supporting technical scientists worked on components of RIPARWIN (e.g. a study of environmental flows or the institutional and legal framework) to cover key issues in the Basin. This modular approach enabled individual studies to make good progress and complement the process of doctoral research that the RA's were involved in. Some of these studies worked at the national and basin scales, while others targeted smaller scales, sectors or certain parts of the river basin. RIPARWIN also completed studies and delivered tools and models for basin stakeholders to use in facilitating the challenge of altering water allocation patterns. In addition our programme of an international conference, meetings, workshops and support for the 'Dialogue for Food, Water and Environment', helped generate awareness, receive feedback and build consensus.

### *Generating and meeting client needs*

As a priority, RIPARWIN wanted to contribute to the operational needs of our clients who requested activities and tools related to decision-making and conflict resolution over water at various levels of scale. Here we give two examples:

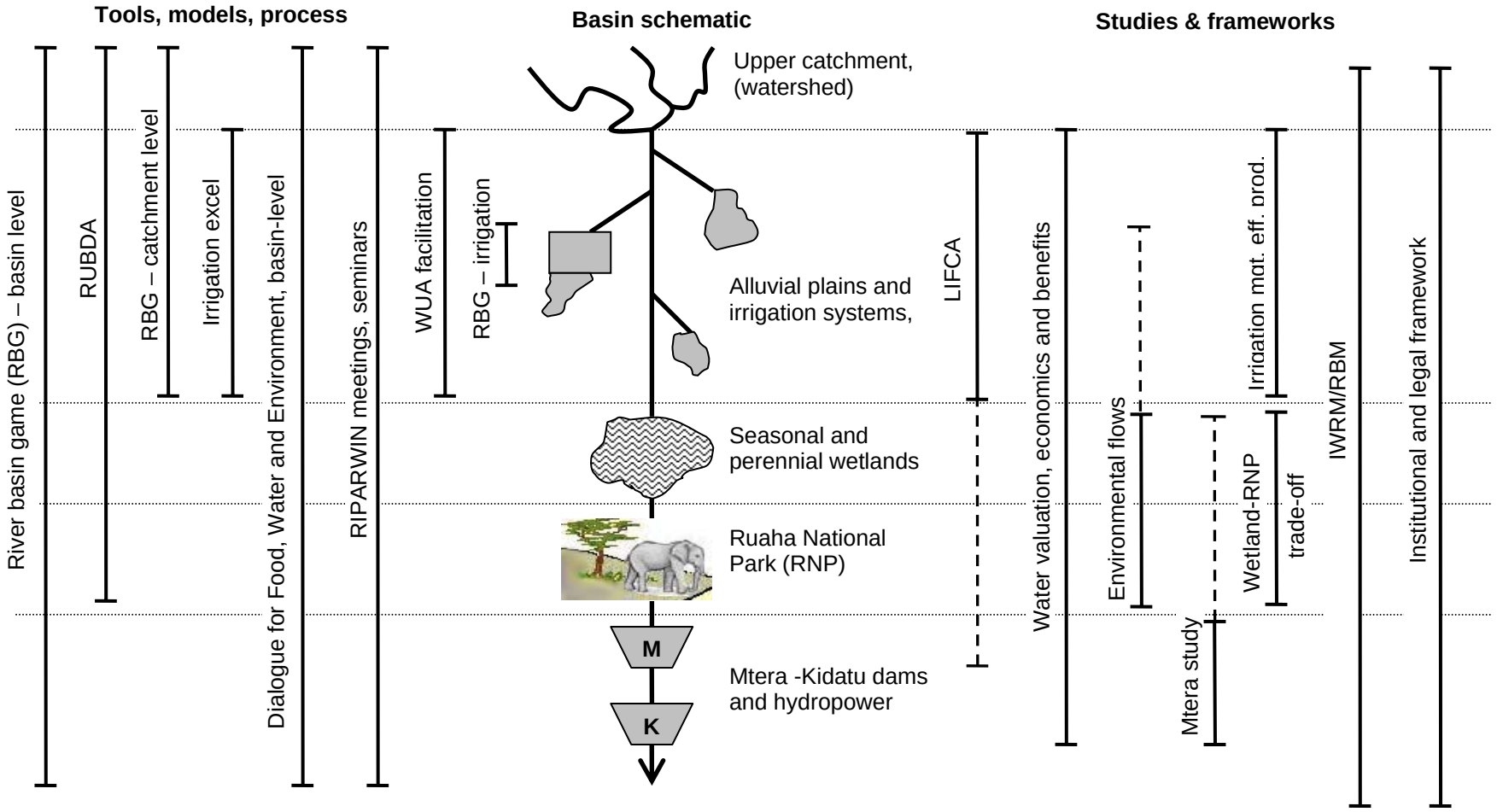
1. Replication of the river basin game, a conflict resolution tool, was sought by the Rufiji Basin Water Office to help resolve conflicts at the sub-catchment scale.
2. The Ruaha River Basin Decision-Aid (RUBDA) was directly requested by the RBWO to help it compare water availability with current and future water permits.

### *Component research design*

In the sub-annexes, individual reports and papers describe the methods used for the specific studies and process tools delivered. Researchers used an array of accepted procedures for conducting field work, including households surveys, utilising a cross-section sampling research design in which data were collected using questionnaires and checklists. Group work was undertaken plus field transect walks, and other participatory rural appraisal (PRA) techniques. For more technical studies, river flows were mainly gauged using flow meters, but also float methods. Stage discharge relationships were developed for some more permanent monitoring points. Rainfall stations were established and monitored. Areas were analysed with perimeter walks using GPS equipment.

Process products such as the river basin game and the basin decision-aid were generated iteratively from interviews, initial pilot testing and observations of their use. For example the river basin game was first trialled with local water users before being taken further. Details of how these products and outputs were developed are given in the relevant annexes.

Figure 4. Scalar coverage of RIPARWIN project process, outputs and products




(Notes: RBG – river basin game; LIFCA - Legal Infrastructure Framework for Catchment Apportionment)

# 4 Log-frame of project

## 4.1 Introduction

This section describes the log-frame of the project, and in particular brings together the two log-frames from RIPARWIN-1 (Table 1) and RIPARWIN-2 (Table 2), as they are similar. Sections 4.2 to 4.4 present and describe the log-frame, and Sections 4.5 and 4.6 explain how we progressed according to the log-frame. This includes a log-frame that points the reader to the relevant annex that supports the Output in question (Table 3).

## 4.2 Goal and Purpose

The Goal was "Improved Availability of Water for Sustainable Food Production and Rural Development". This was the same for both parts of RIPARWIN.

The Purpose for RIPARWIN-1 log-frame (RLF-1) was "Benefits for poor people, the environment and other river basin stakeholders increased by application of new knowledge to the enhancement of productivity of irrigation and transference of water to meet other sectoral needs." The Purpose for RIPARWIN-2 log-frame (RLF-2) was "Benefits for poor people, the environment and other river basin stakeholders increased by application of strategic planning and new knowledge in irrigation and river basin management." This was modelled on the logframe for the first project, but was adjusted so that it better reflected knowledge-management rather than water distribution outcomes.

## 4.3 Outputs

The five Outputs of RIPARWIN 1 and three Outputs of RIPARWIN 2 are joined here:

1. This Output is concerned with irrigation management. RLF-1 reads "Enhanced understanding by stakeholders of water management, competition, use and irrigation productivity under different management, climatic and seasonal scenarios & variability". This is similar to RIPARWIN-2 log-frame Output (2) "Enhanced understanding of irrigation management and assessment within a river basin context)".
2. This Output is concerned with water needs and management of other sectors than irrigation. RLF-1; "Enhanced understanding by stakeholders of water demands of other sectors (e.g. environment, domestic, and livestock); both net and gross demands under different management, climatic and seasonal scenarios. Special recognition taken of water needs of poor people". This Output was not reproduced in the RIPARWIN-2 log-frame.
3. This Output is concerned with water management and allocation in the basin as a whole. RLF-1; "Greater understanding by stakeholders of means and potential to transfer water between sectors on the basis of improved irrigation management and productivity, and by using other water management tools and processes. Greater understanding of impacts arising out of water transfer away from irrigation particularly on poor people". In the RIPARWIN-2 log-frame, the first Output is similar; (1): "Enhanced understanding by stakeholders of and increased focus for water development visions and strategies for river basin, water allocation and integrated water management". In addition at a lower scale, Output (3) of the RIPARWIN log-frame also is related to water allocation and distribution: "Enhanced capacity of local resource users to discuss and manage water at the irrigation & sub-catchment scale, supported by various agencies and NGO's."
4. Output (4) of RIPARWIN-1 log-frame deals with a decision-aid: "Enhanced understanding by water professionals of river basin characteristics, climatic & allocation means, risks and typologies within semi-arid climates through production of a river basin management decision-aid".
5. Output (5) of RIPARWIN-1 log-frame focuses on "Enhanced capacity of Tanzanian water-related researchers & professionals in irrigation and water management within a multi-sectoral environment. As a result of greater capacity for managing water, water needs for poor people recognised and planned for".

Table 1. RIPARWIN 1. Log frame

| Narrative summary | Measurable indicators | Means of verification | Important assumptions |
|---|---|---|---|
| Goal: Improved Availability of Water for Sustainable Food Production and Rural Development | By 2004, analyses of water management activities, policies and measures related to rice productivity and outputs from other water-using sectors in selected case study areas. | Strategy reports of key institutions (local and national) Analyses of rice production and importation for Tanzania. | |
| Purpose: Benefits for poor people, the environment and other river basin stakeholders increased by application of new knowledge to the enhancement of productivity of irrigation and transference of water to meet other sectoral needs. | a) By 2004, savings of irrigation water where possible, re-allocation of this water to other sectors, maintenance or enhancement of rice production from the Usangu area to at least average of 1995-2000.<br>b) Measurement of impacts of water allocation on irrigated sector, particularly poor people.<br>c) By Jan 2002, dissemination strategy outlined. | a) Analyses of Mbarali District rice and other district/stakeholder production figures and RBWO river flows downstream for given climatic conditions, analysis of sectoral needs met<br>b) Research in command areas of irrigated systems of impacts. Research in other sectors of impacts of water allocation.<br>c) A dissemination strategy planned in the inception report | Effective dissemination of results to target communities and institutions<br>Policy environment encourages a more careful management of water between multiple users |
| Outputs:<br>Enhanced understanding by stakeholders of water management, competition, use and irrigation productivity under different management, climatic and seasonal scenarios & variability.<br><br>Enhanced understanding by stakeholders of water demands of other sectors (e.g. environment, domestic, and livestock); both net and gross demands under different management, climatic and seasonal scenarios. Special recognition taken of water needs of poor people.<br><br>Greater understanding by stakeholders of means and potential to transfer water between sectors on the basis of improved irrigation management and productivity, and by using other water management tools and processes. Greater understanding of impacts arising out of water transfer away from irrigation particularly on poor people.<br><br>Enhanced understanding by water professionals of river basin characteristics, climatic & allocation means, risks and typologies within semi-arid climates through production of a river basin management decision-aide.<br><br>Enhanced capacity of Tanzanian water-related researchers & professionals in irrigation and water management within a multi-sectoral environment. As a result of greater capacity for managing water, water needs for poor people recognised and planned for. | a) By 2004, more open, widespread and use of appropriate analyses of farmer irrigation management by user, policy and research stakeholders b) By 2004, chosen irrigation productivity and related indicators described and explained for the years of the study.<br><br>By 2004, user, policy and research stakeholders have improved understanding of other sector water demand from other sectors in river basins.<br><br>By 2004, a) by-laws being created by farmers in selected irrigation systems to improve water management. b) Flexible strategies being developed by RBWO/RBMSIIP. c) Monitoring of impacts, particularly on poor people, as a result of moving water out of irrigation.<br><br>By 2004, river basin management decision-aide and risk assessment analyses completed, and used by water professionals in Tanzania<br><br>By 2004, written proposals and outputs of water researchers and professionals in Tanzania reflect improved understanding of water resources allocation and irrigation productivity, plus water needs for poor people recognised in this. | a) Reports on irrigation management and terms used at local and national scales. b) Analyses and measurements of water flows, rice production and economic benefits.<br><br>Reports of water demand from other water-using sectors produced by collaborating organisations<br><br>Records of research proposals, meetings, working policy statements. Records of the Usangu Environmental Management Plan meetings and final document. Records of the SRMP and DANIDA's ASPS community engagement. Analysis of records of RBMSIIP and RBWO meetings and policy documents.<br><br>Reports of RIPARWIN outputs on decision-aide, briefing notes, meetings schedules, papers, website<br><br>Reports of researchers and professionals in Tanzania reviewed and analysed | (Output to purpose)<br>Conditions in Tanzania encourage professionals in Tanzania to accept and build upon findings that address the balance of multi-sectoral needs and provide for inter-disciplinary methods of intervening in irrigation water management. These conditions are affected by other donor agencies, projects and programmes that address water resources. Although this project can address these other viewpoints, it does not have control over their direction. |

RIPARWIN 1 log-frame cont.

| | | | |
|---|---|---|---|
| Activities:<br>1. Dissemination strategy produced.<br><br>2. Literature review of inter-sectoral allocation.<br><br>3. Excel-based, schematic & conceptual models and explanations of multi-sectoral water use and allocation under conditions of variable water supply in Ruaha river basin.<br><br>4. River basin decision-aide. Generic methodology & decision-aide for assessing opportunities to enhance irrigation productivity and move water from irrigation to other sectors within river basins with associated risks acknowledged.<br><br>5. Provision of reports, advice leaflets, analyses and communications to assist processes of policy discussion and institutional arrangements regarding water management practices.<br><br>6. Training sessions, workshops & meetings with user, research and policy stakeholders in Tanzania.<br><br>7. Journal articles and website hosted for international exposure of this work | 1. By Jan 2002, draft dissemination strategy produced, to be continually modified during the project.<br>2. By Jan 2002, literature review completed.<br>3. By Nov 2002 draft model completed. By Dec 2003, verifiable models tested with field results. Explanation of processes and results of Excel/other software models. Understanding of processes at work and their implications agreed with local stakeholders.<br><br>4. By July 02, 1st draft completed, By Nov 2003 generic methodology published in report. Agreed reports with recommendations and software for decision-making<br><br>5. On-going, generation of information regarding water management<br><br>6. By December 2001 1st workshop completed<br>By August 02, 2nd workshop completed.<br>By February 04, 3rd workshop (conference) completed.<br><br>Agenda and minutes of meetings, training leaflets, evaluation forms of training<br><br>7. By 2004, between 3 and 6 journal articles and research output,<br><br>By July 2002 website produced for further updating. | 1. Reports produced by researchers<br><br>2. Reports produced by researchers.<br><br>3. Reports available of excel and other models<br><br>4. Reports available of decision-aide and methodology<br><br>5. Reports available of, and containing, dissemination materials<br><br>6. Reports and evaluations available of meetings<br><br>Journal articles produced. Website can be visted | (Activity to output)<br>Fieldwork proceeds smoothly.<br><br>Costs, e.g. fuel and transport remain within tolerable limits.<br><br>Staff remain available for fieldwork when required.<br><br>Climatic conditions (sufficient rain) provide good opportunities for research of surface water.<br><br>Climatic and other data made available for study<br><br>The Project Sustainable Management of the Usangu Wetlands and its Catchment (SMUWC) is extended or given a second phase as this provides important dissemination routes and instigates activities which promote water management and require researching. |

Table 2. RIPARWIN 2. Log frame

| **Narrative summary** | **Measurable indicators** | **Means of verification** | **Assumptions** |
|---|---|---|---|
| Goal: Improved Availability of Water for Sustainable Food Production and Rural Development | | | No input required |
| Purpose: As defined in 1.b)<br><br>Benefits for poor people, the environment and other river basin stakeholders in the region increased by application of new knowledge in irrigation and river basin management. | (10 lines)<br><br>By 2006, identifiable adjustments and inclusions made and added to various strategy documents regarding water management in Tanzania & regional countries. | (10 lines)<br><br>Analyses of strategy documents and workshop proceedings | (Purpose to goal) F1):<br><br>Effective dissemination of results to clients. Policy environment encourages wide and uptake of discussion and ideas |
| Outputs:<br>1. Enhanced understanding by stakeholders of and increased focus for water development visions and strategies for river basin, water allocation and integrated water management.<br><br>2. Enhanced understanding of irrigation efficiency, management and assessment within a river basin context.<br><br>3.Enhanced capacity of local resource users and support agencies to resolve water conflicts at the irrigation & catchment scale. | 1) By March 2006, workable, flexible strategies being developed by MOWLD, RBWO/RBMSIIP<br><br>2) By March 2006, uptake of new understandings into irrigation strategy documents and guidelines for the Ministry of Agriculture and Food Security.<br><br>3) By 2006, Minutes and evaluations of and agreements being created by users in selected sub-catchments to improve water management. | Reports on irrigation management and terms used at local and national scales.<br><br>Analyses of local-level user institutions, reports, meetings<br><br>Reports of RIPARWIN outputs on decision-aid, briefing notes, meetings schedules, papers, website | (Output to purpose)<br>Conditions encourage professionals address the balance of multi-sectoral needs and provide for inter-disciplinary methods of intervening in irrigation water management. These conditions are affected by donor & Govt agencies & programmes that address water resources. Although this project can address these viewpoints, it does not have control over their direction. |
| Activities: | | | (Activity to output) |
| 1. Schedule of meetings with user, research and policy stakeholders in Tanzania and East Africa on irrigation efficiency and productivity<br>2. Schedule of meetings on river basin infrastructure and legislation<br>3. Working with local communities, NGO's, RBWO and WWF to generate conditions and structures for conflict resolution and productivity improvements.<br>4. River basin decision-aid continues to be worked on where necessary.<br>5. Limited further research to feed into dialogue between project and stakeholders<br>6. Joint writing of reports, papers, advice leaflets, analyses and communications to assist policy discussion & institutional strengthening regarding water management practices.<br>7. Journal articles and website hosted for international exposure of this work. | 1,2,3) See separate table for schedule of workshops and meetings. Review of policy docments.<br><br>4) By Mar 2006 RUBDA completed.<br><br>5) Field research records<br><br>6&7) By March 2006 between 3 and 6 journal articles and research outputs. By March 2006 website further updated.<br>By March 2006, CD of RIPARWIN ouputs, video-clips and other media produced. | Agenda and minutes of meetings, training leaflets, evaluation forms of training. Reports produced by researchers and partners (e.g. WWF-Tanzania), journal articles produced. Website can be visted | Fieldwork proceeds smoothly.<br><br>Costs, e.g. fuel and transport remain within tolerable limits.<br><br>Staff remain available for fieldwork when required.<br><br>Climatic and other data made available for study<br><br>Computer data secure |

In retrospect the log-frame could have been simplified because there are three main 'Outputs' – knowledge related to water in the irrigation sector; knowledge related to water in other sectors and knowledge related to the allocation of water between sectors, as encapsulated by the concept integrated water resources management pursued via a river basin approach.

The log-frame also reflected aims that fitted 1) the new Water Resources Strategy being co-developed by GoT and the World Bank, 2) the long-proposed National Irrigation Policy to be implemented by the Government, and 3) the need for dialogue and implementation at the local and national levels. RIPARWIN was an action-research process-led project that engaged key stakeholders in dissemination products and workshops that brought them firstly, via new research and thinking, knowledge regarding water management, and secondly new ways of discussing and operationalising water-sharing visions. In many ways these outputs are not separate from each other, each contributing to the other two.

### 4.4 Activities

Activities are best referred to by viewing the contents list, Table 3 and annexes, rather than reproducing them here (see below).

### 4.5 An annex-referenced log-frame

Table 3 provides a comprehensive exposition of the project's achievements in terms of log-frame outputs and activities. Against each Output listed on the left, we have inserted activities and products listed on the right that lead to the relevant annex.

### 4.6 OVIs for the Outputs

The Outputs for RIPARWIN are explored in this section. As discussed above, the Outputs relate to knowledge and capacity-building in water management.

*Output 1 is: Enhanced understanding by stakeholders of water management, competition, use and irrigation productivity under different management, climatic and seasonal scenarios & variability.*

a) Reports on irrigation management and terms used at local and national scales.
b) Analyses and measurements of water flows, rice production and economic benefits

Success here is taken from feedback from participants of the Irrigation Efficiency and Productivity Seminar held in Mbeya in May 2004. Before describing the outcomes of this seminar, it is worth reporting that participants wished to know more about water productivity, and that their dominant belief regarding irrigation efficiency was that it is around 15%. The seminar set out to address knowledge gaps and this belief (which was at the heart of the rationale for the considerable loan for the RBMSIIP programme by the World Bank). We believe that the seminar tackled this and related notions by explaining;

- Water productivity and efficiency is the culmination of many facets of water inputs and activities, and that a single number should be interpreted very carefully.
- Water re-use below irrigation systems by other irrigators increases productivity.
- Measurements taken by SMUWC and RIPARWIN reveal that efficiency is within the range 45 to 65%.
- Water is managed by smallholders in many ways that indicate their care and value for water.
- High efficiency figures are attainable by improving this management of water, rather than by switching to sprinkler and drip systems.

Annex E4 contains part of the proceedings of the seminar to demonstrate further its outcomes. This work helped ensure that more conditional understanding of irrigation management was fostered amongst specialists working in this field.

Table 3. RIPARWIN log-frame.

| **Outputs and objectives (From RIPARWIN 1 and 2 Log-frames** | **Activities of project and Annex location** |
|---|---|
| RLF-1 (1) Enhanced understanding of water needs and management of irrigation<br>RLF-2 (2) Enhanced understanding of irrigation management and assessment within a river basin context). | E: Irrigation Impact Excel model<br>E: Irrigation management, efficiency and productivity (IMEP) meetings,<br>E: Task Force formation and GoT Research Paper on Irrigation<br>J: Facilitation for WUA formation & registration leading to Apex formations<br>K: RUBDA model, design process, training and manual<br>L: River basin game<br>N: Training modules for WUA<br>P: NAFCO Irrigation Management Transfer |
| RLF-1 (2) Enhanced understanding of water needs and management of other sectors | F: Wetlands and environmental flows.<br>G: Livelihoods and economic benefits, and productivity studies<br>K: RUBDA model, design process, training and manual<br>L: River basin game<br>P: Mtera study and Wetlands RNP tradeoff discussion note |
| RLF-1 (3) Enhanced understanding of means of intersectoral allocation.<br>RLF-2 (1): Enhanced understanding by stakeholders of and increased focus for water development visions and strategies for river basin, water allocation and integrated water management.<br>RLF-2 (3): Enhanced capacity of local resource users to discuss and manage water at the irrigation & sub-catchment scale, supported by various agencies and NGO's). | H: Legal and institutional framework analyses and inputs<br>I: LIFCA study, process and dissemination<br>K: RUBDA model, design process, training and manual<br>L: IWMI/RBM studies<br>L: River basin game<br>M: Dialogue meetings<br>P: Country Water Resources Assistance Strategy Tanzania<br>P: National Water Sector Development Strategy<br>R: Usangu water allocation analysis |
| RLF-1 (4) Enhanced understanding by water professionals of river basin characteristics, climatic & allocation means, risks and typologies within semi-arid climates through production of a river basin management decision-aid. | K: RUBDA model, design process, training and manual |
| RLF-1 (5) Enhanced capacity of Tanzanian water-related researchers & professionals in irrigation and water management within a multi-sectoral environment. | A: Timeline of major dissemination activities<br>A: Other dissemination activities<br>A: Partnerships<br>A: General workshops and meetings<br>C: March Conference.<br>D: RIPARWIN citations of documents, reports and papers produced. |

Note: RIPARWIN-1 and -2 log-frames (RLF-1 and RLF-2) brought together in this table.

*Output 2 is: "Enhanced understanding by stakeholders of water demands of other sectors (e.g. environment, domestic, and livestock); both net and gross demands under different management, climatic and seasonal scenarios. Special recognition taken of water needs of poor people".*

Research in the chosen Mkoji sub-catchment (MSC) quantified net and gross demands (see below) while sessions of the river basin game with local and support agency users illuminated the need to meet water needs of various sectors by enhancing local dialogue opportunities. There is no irrigation or intermediate agriculture in the lower MSC because all rivers flowing to that part dry up in the dry season. During that time even domestic and livestock water demand is seldom met; causing water problems. (The potential for using ground water exists but it has not been adequately studied and exploited). The river basin game brought this problem to the attention of upstream users, and resulted in more water being delivered downstream (Annex J).

Among the different water users in the MSC, agriculture is the leading consumer under both rain-fed and irrigated production systems. Under these two domains, it was estimated that they use 78 million cubic meters of water during the wet season. The other major water users include livestock (1.5 million cubic meters) and domestic (0.9 million cubic meters). During the dry season, total water use by the different sectors (agriculture, livestock, domestic and brick making) was 13 million cubic meters.

The value of water for domestic use in Mkoji was estimated using willingness-to-pay surveys, and calculated to be 1000 Tsh (i.e. 1.0 US$) /m3 water (see Table 5).

Table 5: Values of water used for domestic purposes in MSC

| Mkoji zones | Household consumption (m3/hh/day) | Domestic water (Mm3/year) | Value of water (Mm3/year) | Value of water (Tsh/m3) | Value of water (billion Tsh/year) | Value of water (TSh/person/year) |
|---|---|---|---|---|---|---|
| Upper | 0.131 | 0.76 | | | | |
| Middle | 0.175 | 0.73 | | | | |
| Lower | 0.143 | 0.23 | 1.7 | 1000 | 1.7 | 12 000 |

Productivity of water in brick making was calculated. The market price was reported to average Tsh 20 per brick during the dry season. Although the price can go up to Tsh 35 per brick particularly during the wet season when brick supply is limited to the quantity carried forward from the last dry season, most of the bricks are normally sold during the dry season when weather allows construction of houses. Therefore the dry season prices were used to value productivity of water. According to the estimates done, water productivity for brick making was estimated at Tsh 1.08, 0.94 and 0.93 per m3 for the upper, middle and lower MSC. The differences were due to variations in the magnitude of variable costs such as wages paid for labourers, fuel (fire wood or rice husks), increased cost of water (in terms distances to water sources and hence labour costs).

Assessment of water for the environment was dependent on the boundaries chosen. Here we limited ourselves to the target of year-round flow for the Ruaha, and by working backwards, to calculations of flows in rivers that feed the wetland. The minimum target set was to have at least some flow passing through the Ruaha National Park to maintain rock pools. This represented a net requirement of above 100 l/sec, requiring, as discussed above, gross flows of between 5-7000 l/sec entering into the wetland. These flows are double the current dry season flows, and might only be sourced from the major perennial rivers with the exception of the Mkoji subcatchment rivers which are much smaller and highly utilised for various purposes. Annex F gives further information.

*Output 3 is: "Greater understanding by stakeholders of means and potential to transfer water between sectors on the basis of improved irrigation management and productivity, and by using other water management tools*

*and processes. Greater understanding of impacts arising out of water transfer away from irrigation particularly on poor people".*

In meeting this Output, a number of activities took place with marked success. The first, also mentioned above, was a series of workshops designed to inform key scientists and professionals on an improved understanding of water productivity and management (see Annex E). Partially related to this new understanding of water management in irrigation, the Rufiji Basin Water Office requested RIPARWIN to write a proposal that the NAFCO state farms inherit a management structure that improves water use efficiency (see sub-annex P3).

The second consisted of the river basin game, devised by RIPARWIN, which flagged and articulated multi-sectoral needs arising in different parts of the Ruaha Catchment, and identified the means to attain this agreement. The degree of community involvement in these sessions was notable. The game generated important opportunities for social learning amongst farmers and other water users so that they were able to arrive at solutions that resolved water conflict through improved water management. The river basin game was felt to be a considerable success, influencing participants who made the following resolutions after the training:

- A November-February time frame (start and end of transplanting) was agreed to tighten up water supply and productivity. This depends on the start of rain season, which is the main driver for the availability of sufficient river flows for irrigation diversion.
- Further research on different rice varieties was requested.
- Restriction on irrigated area for each farmer was to be explored.
- Farmers acknowledged appropriate bund sizes for retaining only the required amount of water at the same time allowing excess water to the neighbouring field plots.
- The introduction of field canals to supply all farmers without waiting until the upstream farmers have irrigated their fields could reduce water conflicts.

Similarly, a conflict resolution workshop was held using the river basin game for two days in November 2004. This resolved water problems arising in the Mswiswi sub-catchment and led to the formation of the Mswiswi apex body (a catchment user committee). Associated with the river basin game and our work with local users, RIPARWIN contributed to the development of the WUA committee training guidelines. We also introduced this game to Ministry of Agriculture Training Institute at Igurusi who incorporated it into their curriculum.

Part of our work employed 'Dialogue for Food, Water and Environment' meetings and workshops to bring together selected staff from various relevant institutions to discuss water management. We also held the successful Ruaha+10 seminar in December 03 to mark 10 years of the drying up of the Ruaha river.

The fourth activity involved collaborating with MOWLD on water legislation. This resulted in the 'Legal Infrastructure Framework for Catchment Apportionment' or LIFCA, in concept note form which was circulated to Ministries for possible funding. This note argued that river-centred infrastructure for dry season flow management should be promoted as a policy solution. Various discussions were held with partners about the role of infrastructure in intersectoral allocation. Whereas storage represents a real benefit during a period of the year when the volumes of water are simply too small to be effectively shared in a conflict-free manner, improving intake design should also allow small amounts of water to be shared between sequential intakes on a river.

There were many other meetings between RIPARWIN staff and professionals in and around Tanzania that have helped build a mutual understanding of river basin management and water allocation. Examples of these are:

- RIPARWIN attended a mini-workshop in June 2003 at the University of Dar es Salaam on "Sustainable development of Inland Wetlands in Southern Africa: a livelihoods and ecosystem approach" (FAO, IWMI, IUCN-ROSA).

- Various meetings were held including two with the staff associated with World Bank-initiated programme on environmental flows in the Ruaha in 2002. In addition, RIPARWIN met the Usangu Basin Water Use Committee several times, and with various smaller units within the Ministry of Agriculture related to food security and with the Tanzanian Meteorological Authority.
- RIPARWIN work was presented to the Mbarali District Technical Committee in May 03 and to staff of the Southern Highlands Agricultural Research Institute (June 03).
- RIPARWIN was well represented at the "Catchment Management and Poverty Reduction (CAMP) Project" Consultation Workshop in Morogoro.
- RIPARWIN was present at the Ruaha Water Programme workshop in Iringa, August 03, being organised by WWF.
- RIPARWIN tackled the perception that upstream irrigation played a role in the electricity powercuts during the nineties in Tanzania. This was achieved via two papers given at Hydro Africa 2003 International Conference on Hydropower, Tanzania, November 2003
- RIPARWIN was present at the launch of the Country Water Partnership (CWP) and the consultations for the Framework For Action (FFA) to achieve the water vision in Dar es Salaam.
- RIPARWIN was well-presented at three conferences in Tanzania in late 2002 including the WATERNET/WARFSA Symposium 'Water Demand Management for Sustainable Use of Water Resources'.

*Output 4 is: "Enhanced understanding by water professionals of river basin characteristics, climatic & allocation means, risks and typologies within semi-arid climates through production of a river basin management decision-aid".*

The Project handed over the Great Ruaha Basin Decision Aid (RUBDA) version 1 to RBWO in December 2005, with the completion of two training sessions. The progress here was not as fast as hoped for principally because of considerable software clashes arising from the adoption of the original Usangu Basin Model (UBM) obtained from Ministry of Water, having partially been completed under the SMUWC project and written in Fortran. The design of the decision-aid was agreed amongst the team, and the staff member responsible for the decision-aid worked closely with Ministry of Water staff so that it met their expectations. A second version is planned for by March 2006.

*Output 5 is: "Enhanced capacity of Tanzanian water-related researchers & professionals in irrigation and water management within a multi-sectoral environment. As a result of greater capacity for managing water, water needs for poor people recognised and planned for".*

On reflection, this Output was a consequence of the four other Outputs and associated activities being met. The RIPARWIN project also supported directly the tertiary education of five researchers (Cour, Kadigi, Rajabu, Sokile and Kaishaigili) who have each worked on and delivered various outputs. The subject areas include; Evaluation of Livelihood and Economic Benefits of water Utilization in the Great Ruaha; Hydrological Analysis of the Great Ruaha; Assessment of Hydrological and Production Roles of Wetlands in Usangu Plains; Evaluation of Institutional and Legal Frameworks for Water Resource Management in the River Basin; and the development of the Ruaha Basin Decision Aid (RUBDA).

Various consultants and NGO's working on Water and Environmental Policy have requested findings and facts derived from the RIPARWIN research[1]. We saw the benefits of working closely with WWF

[1] Dr. Suma Kaare, a Policy Analysis Consultant and the Capacity Building Coordinator with the Economic and Social Research Foundation (ESRF) requested such findings. Dr. Stigmata Tenga, the Managing Director for the ST Associates requested for the findings on the Institutional set up in the Rufiji basin. Ms. Harrieth Karua, the Director for Karua & Associates Co, requested information on how international aid- multilateral and bilateral

Tanzania, WWF East Africa and WWF UK to liase on their Ruaha Programme on integrated water management in the upper Ruaha. At various meetings (including Ruaha+10 and one-to-one meetings), we provided information that helped steer their project, including water management demonstrations on the NAFCO state farms and agreements on mitigating the effects of the partial canal closure programme. WWF have been particularly supportive in adopting the river basin game as a tool to support water dialogue amongst basin and catchment uses.

We also bring DFID's attention to various other dissemination activities:

- RIPARWIN posters were produced for presentation at the Waterdome, Johannesburg 2002 Summit. Copies were made for DFID and other organisations.
- We submitted the Upper Gt Ruaha case study as a Global Water Partnership Toolbox Case Study (number 121), also in time for the Johannesburg 02 Summit.
- We submitted RIPARWIN as a World Water Action case study for the World Water Council.
- The project was registered with the UNESCO HELP programme

A complete list of knowledge dissemination activities is given Annexes A9 and A10.

# 5 Technical findings

## 5.1 Introduction

In this section we present a brief synthesis of RIPARWIN's work. The Annexes also contain a considerable number of studies and analyses related to the components of RIPARWIN, and the reader is referred to some of these which contain useful syntheses (in particular F4, IWMI Research Report on hydrological modelling of wetlands; G4, draft IWMI Research Report on the value of water; H4, IWMI Working Paper on water rights and legislation; and R2, Usangu water allocation analysis).

## 5.2 Water allocation and productivity analysis

The two OVI's from the RIPARWIN logframe that require a water allocation and productivity analysis are;

- *OVI (a) "By 2005, savings of irrigation water where possible, re-allocation of this water to other sectors, maintenance or enhancement of rice production from the Usangu area to at least average of 1995-2000".*
- *OVI (b) "Measurement of impacts of water allocation on irrigated sector, particularly poor people".*

This discussion below is in draft form, and requires some further analysis.

*Rice Production*

The discussion of the agricultural production OVI is divided into wet and dry seasons. The analysis of wet season rice production was not straightforward because of large swings in output due to wet and dry years (see Figure 5). Rice production for the period 1995 to 2000 was about 56000 metric tonnes, representing a productivity of about 2.16 t/ha. Two low production years occurred in 1999 and 2000, but in the year 2001 and 2002, production increased to 82 000 and 85 000 metric tonnes, representing an increase of about 50% on the average of 1995-2000. In 2003, the relatively low production of 44250 tonnes was negatively affected by drought, which then recovered in 2004 to 96250 tonnes, which was the highest level seen to date.

---

influenced water management in the study area. Ms. Rehema Tukai, the Research and Programme Officer with Water Aid (T) requested some findings on how the poor, especially women have been included or excluded by the present water management institutions. Ian Anderson who was putting together WG2 (Working Group 2 of Task Force 1 of the Agricultural Sector Development Programme of MAFS) requested various information outputs from the project.

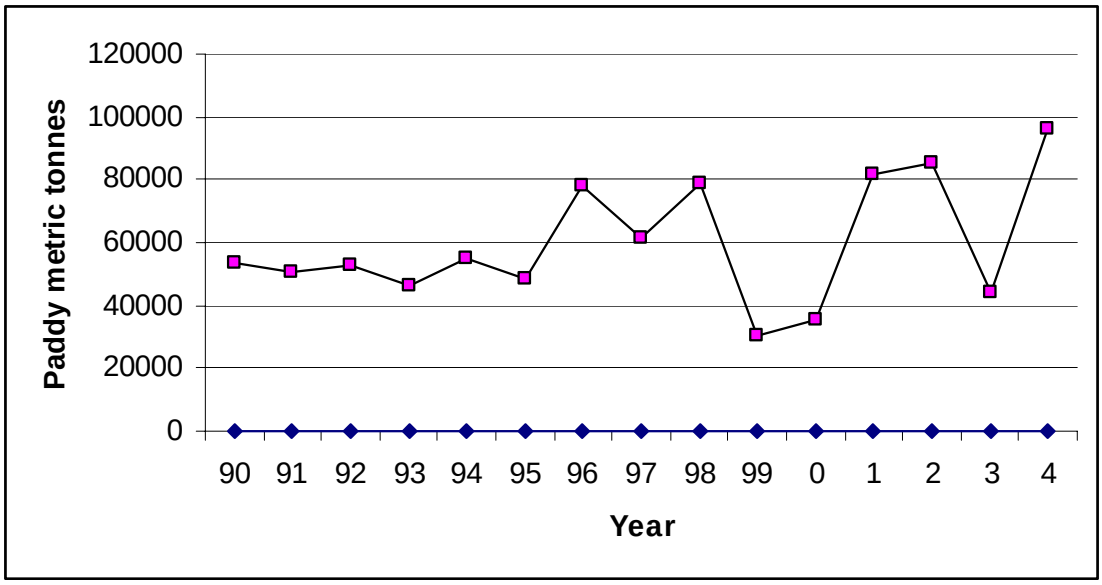



Figure 5. Production trends in Mbarali District

Production is mainly a function of climate, but our findings indicated that during the wet season, over the last five years, the irrigated sector increased its capacity to abstract surface waters in the Basin, mainly via the construction of new intakes and upgrading of traditional intakes. We estimated that this probably resulted in a total of 50 cumecs abstracted, an additional 5 cumecs above the year 2000 estimate of 40-45 cumecs, supporting an additional 5000 hectares and therefore about 5000 families. Although, this appeared beneficial because irrigated livelihoods continue to be a mainstay of many people in the basin, this allocation therefore subtracts from water moving downstream to the wetland and reservoirs, plus this growth made throttling of demand during the dry season that much more difficult.

Although increased production (as evidenced by a general upward trend in Figure 5) came with greater water use, by comparing different types of irrigation systems, RIPARWIN uncovered that savings of water are achievable. The large state farms in Ruaha use about 2300 mm of water to provide a net rice requirement of 1100 mm giving an efficiency of about 45%, while the smallholders in tail-end areas who are amongst the most efficient (approximately 70%) with their water use, deplete about 1700 mm of water to meet their net requirements of 1100 mm. These findings were disseminated to stakeholders so that accepted wisdoms such as “the modern (state farms) systems are efficient while smallholders are inefficient” could be discussed. Without the ownership of the NAFCO farms resolved, these savings could not be tackled and so realised for downstream or other irrigators benefit.. Without parallel throttling at the intake (or the less likely alternative of draining water back to the river), this water usually is re-used in extending the area under cultivation. Thus a choice exists here for stakeholders; the benefits of productivity gains need to be discussed and acted upon. RIPARWIN believed, as mentioned above, that it is these productivity opportunities that enable rice cultivation in Usangu to be maintained while ensuring water is delivered downstream to meet the perennial flow target.

*Downstream allocation*

Clearly the key indicator of performance of river basin management that the three organisations RBWO, WWF and RIPARWIN found of interest in was the number of days of zero flow through the Ruaha National Park. As Table 6 and Figure 6 shows, these varied around a mean of 62 days over the last ten years. There is no discernible trend, but there is widespread agreement that the most recent year of 2004 did show a marked decrease.

Table 6. Days of zero flow in Great Ruaha River for the period from 1994 to 2004.

| Year | Date flow stopped | Date flow started | Period of no flow (days) | Annual rainfall (mm) |
|---|---|---|---|---|
| 1994 | 17 November | 15 December | 28 | na |
| 1995 | 19 October | 23 December | 65 | 388** |
| 1996 | 17 October | 16 December | 60 | 401 |
| 1997 | 20 September | 22 November | 63 | 815 |
| 1998 | 18 November | 9 March 1999* | 87 | 392 |
| 1999 | 21 September | 20 December | 90 | 527 |
| 2000 | 17 September | 22 November | 66 | 960 |
| 2001 | 12 November | 23 December | 41 | 706 |
| 2002 | 2 November | 24 December | 52 | 619 |
| 2003 | 21 September | 16 January 2004* | 104 | 532 |
| 2004 | 3 November | 4 December | 31 | 550-650 |

Source: Sue Stolberger's records at Jongomero Camp in the Ruaha National Park (UTM: 679147E 9127828N)
NOTE: * with some intermediate start and stop to flow, ** incomplete records, na not available

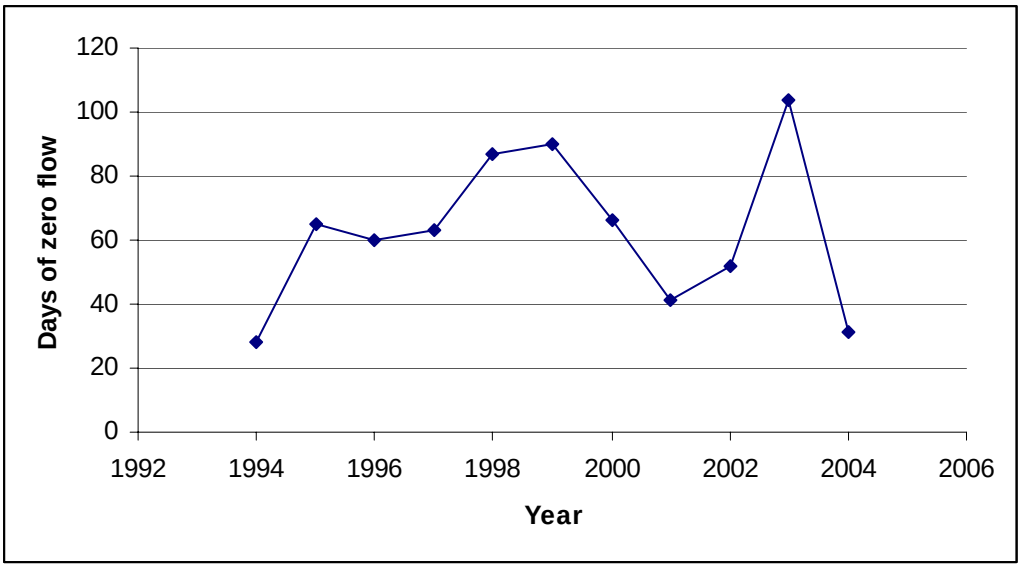



Figure 6. Days of zero flow in the Gt Ruaha River in the Ruaha National Park

During the dry season, the partial canal closure programme was introduced to raise productivity and ensure more water went downstream[2]. This programme did not diminish irrigation production in the

[2] The analysis applies to Mbarali intake. The Mbarali intake supplies a population of about 31,000 people. Daily net demand quantities are in the order of 2 627 $m^3$/day measured at source, together with an assumed twelve hour water gathering time gives a required flow in the canal of 152 l/s per 24 hours for domestic use, livestock watering and brick making. This works out to be about 0.0836 $m^3$/day/person, or 84 litres per day per person (including livestock needs), or about 0.0048 l/sec/person per day.

In addition about 100 ha of land was being irrigated for dry season crops, all other land was simply being wetted up. This sets up a demand for about 120 l/sec. Thus, total net demand is about 120.0048 l/sec. We suggested that in total 350 l/sec might be reasonable to assist in reticulating the net supply allowing for losses, but also allowing for the presence of boreholes.

Catchment. However evidence was gathered that without delivering borehole or piped water supplies to those communities affected by the closures, there were increases in water shortages and related incidences of greater distances to walk to collect water (see sub-annex R3 for a student dissertation on this topic). Negotiation with the RBWO and large state farms did increase water supply so that downstream communities are provided for. In addition, discussed by resource users at the river basin game, canal cleaning would ensure that more water released at the headworks reaches tail-end users within irrigation systems. In the Mkoji sub-catchment there was now evidence that, because of decisions-taken as a result of the river basin game, dry season flows were reaching water users situated further down the sub-catchment.

Prior to the intake regulation programme the length of time that there was zero flow in the river was steadily increasing over time. Since the introduction of the programme (in 2001) the length of the dry season zero flows has fluctuated around 20-40 days, and shows no sign of a trend. The last two years showed some grounds for optimism since the start date of the zero flow occurred later in the year. However, to have greater impact, discussions and analyses pointed to the need to begin closing the selected intakes sooner in the cycle, and re-directing water that would otherwise be lost through evaporation in one of the small upstream swamps (called Ifushiro) through Kapunga irrigation canals or to an old river channel so that losses in the swamp are minimised. In total, RIPARWIN identified (see Table 7) that a possible 2000-7000 l/sec might be saved during the dry season for supply to the Usangu wetland in order to provide an outflow that might then constitute year-round flow.

Table 7. Estimated average discharges to Ihefu due to savings from canal closures

| River | Average discharges to Ihefu (l/s) | | | | | |
|---|---|---|---|---|---|---|
| | June | July | Aug | Sept | Oct | Nov |
| Kimani | 1700 | 1100 | 710 | 600 | 500 | 100 |
| Mbarali | 4300 | 4100 | 3500 | 2000 | 1000 | 700 |
| Ndembera | 1500 | 1000 | 700 | 500 | 400 | 300 |
| Makambalala | 150 | 150 | 150 | 100 | 100 | 100 |
| Total | 7650 | 6350 | 5060 | 3200 | 2000 | 1200 |

Further evidence of downstream allocation can be seen at the sub-catchment level. For example, monitoring of river flows and water abstractions in Mbarali and Kimani rivers showed that whereas Mbarali River recorded 13 days of zero flow in November 2003, the river never dried in 2004. This was due to close monitoring and regulation of water abstractions by RBWO. As a result of these measures the average dry season abstractions from Mbarali River dropped from 1.454 $m^3/s$ (52.4% of the river flow) in 2003 to 0.577 $m^3/s$ (17.3% of the river flow) in 2004 (Table 8), despite the fact that more water was available in the river in 2004 as compared to 2003 and the area under paddy cultivation was more as compared to 2003. The same trend was observed in Kimani River whereby, the average dry season abstractions dropped from 0.914 $m^3/s$ (63.2 % of the river flow) in 2003 to 0.580 $m^3/s$ (43.2 % of the river flow) in 2004.

Table 8. Dry season discharges upstream and downstream of irrigation (Mbarali and Kimani rivers)

| | Mean daily discharges ($m^3/s$) Mbarali and Kimani rivers | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Mbarali U/S | Mbarali D/S | Amount abstr. | CA (%) | Kimani U/S | Kimani D/S | Amount abstr. | CA (%) |

In contrast abstraction into the Mbarali intake during that survey period was found to be 2000-4000 l/sec. Thus much more water (by an order of 10) was being taken than was being productively used.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **2003** Average (May-Nov) | 2.753 | 1.299 | 1.454 | 52.37 | 1.470 | 0.556 | 0.914 | 63.21 |
| **2004** Average (May-Nov) | 4.099 | 3.522 | 0.577 | 17.30 | 1.456 | 0.876 | 0.580 | 43.22 |

CA = Coefficient of abstraction, the proportion of water abstracted between upstream and downstream gauges. U/S = Upstream; D/S = Downstream, below all abstractions.

In summary, the findings generated through RIPARWIN research were used by RBWO for implementation, and this resulted in improving water allocation and management as well as control and regulation of water abstraction. RBWO managed to allocate water downstream during the dry season through the canal closure programme while rice production in the catchment has continued to rise, demonstrating increased productivity, in the face of a dynamic rainfall pattern and set against a highly variable rainfall-runoff response.

## 5.3 Recommendations

As a part of our technical findings, we present below and in Figure 7, a collation of recommendations contained in various component reports and annexes. The purpose of these is to develop the institutional and technical capacity of stakeholder organisations to deliver flexible and effective governance structures that could lead to the Great Ruaha River returning to year round flow within five to ten years. Figure 7 presents these options as building blocks, composed of technical solutions on the left and institutional and strategic solutions on the right. Elaborating this schematic briefly, the following recommendations are made:

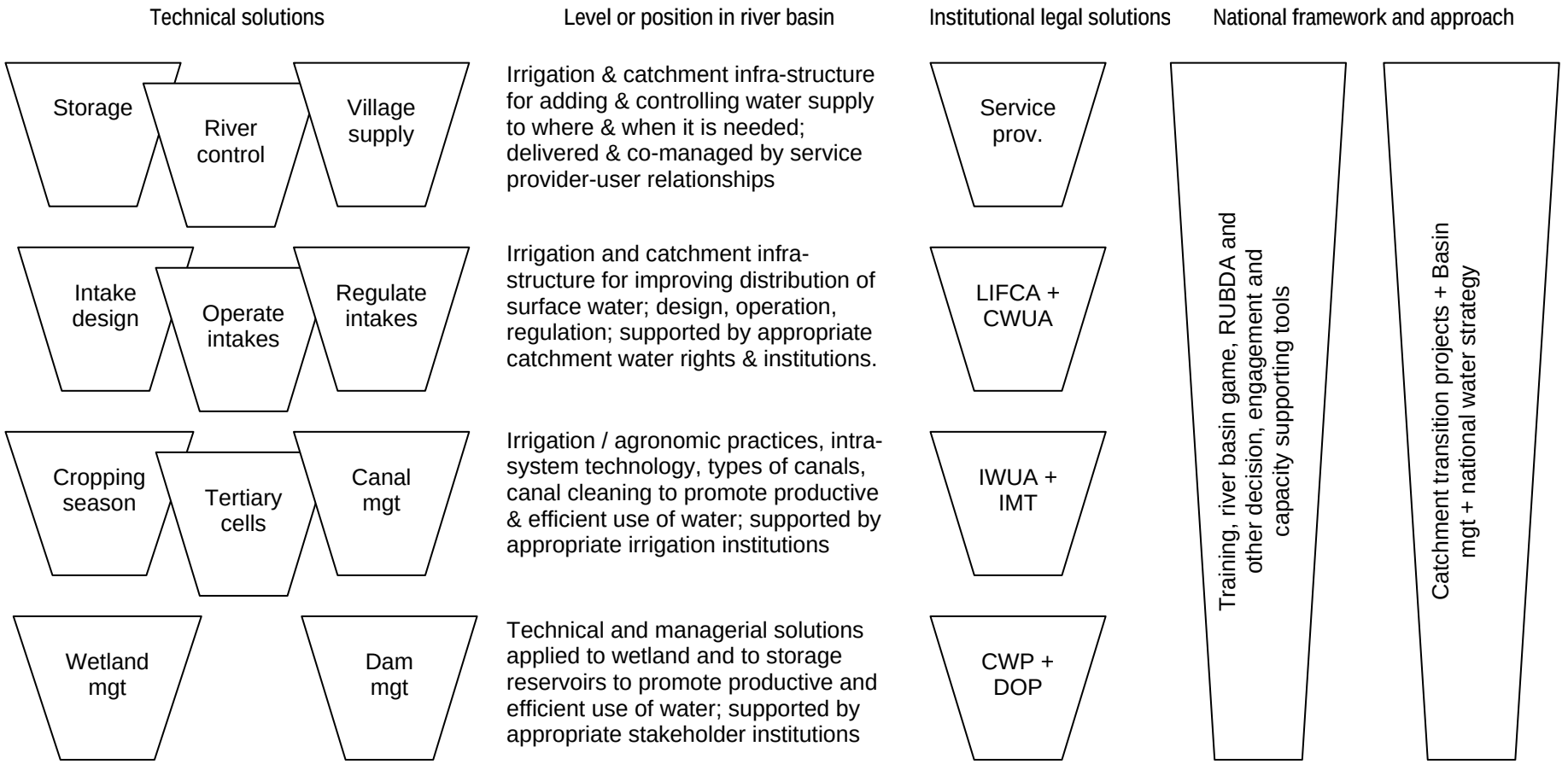
- RBWO continues with its programmes of engaging with stakeholders of revising water rights, and regulating intakes. New institutional agreements for sharing water are instigated by deploying the river basin game which leads to farmers managing water better. Basin authorities promote apex body catchment organisations with the particular aim of delegating the responsibility for sharing out a single water right.
- A new project is funded to implement Legal Infrastructure Framework for Catchment Apportionment (LIFCA). RIPARWIN recognises that much of the infrastructure that affects the manageability of the distribution of water between sectors requires rethinking. Conventional upgrading of irrigation intakes prioritises single irrigation systems to the detriment of the ability to share water at the catchment scale. New approaches need to be considered that adapt ideas from irrigation design of sequential intakes so water can be apportioned between irrigation systems and other sectors.
- Catchment Water User Associations (WUA's) are organised so that they pay for Government, NGO, District services to support WUA's to manage water and land more productively. Training is determined by the farmers with advice from specialists rather than determined by GoT. The scaling up of the river basin game training and support to catchment water user associations is instrumental to this programme.
- Irrigation management is enhanced by strengthening irrigation-level WUA's, using the river basin game. The cropping season is controlled to minimise low-productive rice. Additional canals are installed by farmers. Field trials of improved water management and canals in Kapunga and Mbarali to are handed over to WWF.
- NAFCO farms are handed over to smallholders for the benefit of poor people. This would assure tenancy and bring improved in-field water management to the farms, thereby saving water. The farms would require their central main system management to be of a high standard in order to deliver the benefits of the management transfer.
- Usangu wetland community plan developed, managed by Ruaha National Park and District with one aim of managing water in the wetland to flow through to RNP. This would increase access to the wetland resource by poor people but simultaneously foster its sustainable management.
- Various supply infrastructures considered: River infrastructure to improve control of the Gt Ruaha in the Usangu Plains (a weir at the head of the old Ruaha channel) would give basin

managers the option of routing water direct to the Usangu wetland rather than have much water lost in an intermediate swamp and sink zone. Storage could be considered on the Ndembera River to provide water to the wetland. Village boreholes and pipes to supply water during dry season. This would negate the need to abstract large amounts of surface water to meet demonstrably small quantity of domestic usage.

Considering the above in terms of an over-arching water management strategy, we recommend that:

- Major policy-influencing stakeholders (e.g. GoT, World Bank, EU, GTZ) critically engage with IWRM and irrigation growth programmes so that projects' effectiveness improve on the basis of lessons learnt. Dissemination of main findings from RIPARWIN and similar projects discussed (e.g. LIFCA)
- Irrigation & subcatchment transition programmes are packaged together so that irrigation is not undertaken as a sole sectoral endeavour either at the national level or via District Agriculture and Development Plans (DADP) but is instead viewed as a single system.
- Irrigation-emphasised training courses on river basin management and IWRM are given.
- Two-week irrigation training programme is delivered to enhance uptake of integrated view of irrigation management, efficiency and productivity.

Figure 7. Recommended building-blocks (buckets?) for flexible equitable water allocation in the Gt Ruaha river basin




Notes: LIFCA - Legal Infrastructure Framework for Catchment Apportionment; CWUA – Catchment Water User Association; IWUA; Irrigation Water User Association; IMT – Irrigation Management Transfer (NAFCO); CWP – Community Wetland Programme; DOP – Dam Operating Procedures; RUBDA – Gt Ruaha Basin Decision Aid.

# 6 Conclusions

We believe that the work of RIPARWIN exceeded expectations by achieving not only most of its original objectives but also by completing activities not originally envisaged. We judge this not necessarily by a shift in allocation measured on the ground (although some progress is discernible), but by examining our role and contribution towards more flexible and appropriate strategies. Using a process approach, we unpacked several key components of irrigation and basin management (e.g. determined the magnitude of required environmental flows and brought fresh ideas on irrigation efficiency and management) and brought new tools for facilitating management at various scales (e.g. the river basin game and RUBDA).

Mention must be made of the benefits of running a 4 ½ year programme that allowed long-term engagement by our team with partners and the issues involved. DFID funding was instrumental in allowing us to work consistently over this period, and combined with the IWMI contribution, in providing the resources to tackle a diverse range of issues.

There are also good signs of future sustainability. For example, the LIFCA framework was requested by the World Bank and by MOWLD, as being potentially the kind of project that might be funded. On a more regional scale, the International Water Management Institute in South Africa requested that the River Basin Game is demonstrated in a 'Training of Trainers' followed by a two day workshop with Farmers. Both sessions will be guided by Lankford and completed before the end of the RIPARWIN project in March 2006. This represents an excellent uptake of the RBG tool by IWMI, a key research partner in RIPARWIN. IWMI also has possible future plans for the game in other project areas subject to its performance in South Africa.

Finally, we argue that RIPARWIN delivered innovative and original research that was presented and discussed in an international arena. (Annex D gives a complete list of citations of our approximately 75 publications). In one example of innovation; building on the legal and institutional analysis conducted by RIPARWIN, the project went on to explore the interface between formal and informal legislation to improve the workability of formal water rights. These rights, as designed, appeared to be awkward attempts at associating a value with water so that users utilise less of the resource. RIPARWIN's research showed that the opposite is the case; that the introduction of water rights into catchments increased water demand for irrigation (see Annex H). Formulating a framework that sought to improve the existing rights system rather than rejecting it was particularly innovative and interesting – this new framework is contained in Annex I.

# 7 Acknowledgements

This report was compiled and edited by Bruce Lankford, Henry Mahoo, Matthew McCartney, Siza Tumbo, Kossa Rajabu, Japhet Kashaigili, Reuben Kadigi and Vanscar Kulanga. These authors greatly appreciate the assistance of others in the RIPARWIN team in discussions, technical support and encouragement; Charles Sokile, Barbara van Koppen,, Doug Merrey and Sylvie Morardet.

# 8 Selected bibliography, Tanzania and Gt Ruaha Basin

Bashagi, W. (1998) *Sustaining a Small Holder Irrigation Improvement Package in the Districts of Kilosa, Iringa and Mpwapw: A proposed strategy for sustaining momentum of TIP activities in Iringa, Kilosa and Mpwapwa after phasing out RNE funding*. A Discussion Paper, October 1998, Traditional Irrigation Improvement Programme (TIP), Dar es Salaam, Tanzania.

Baur, P. Mandeville, N. Lankford, B and Boake, R. (2000) Upstream/downstream competition for water in the Usangu Basin, Tanzania. In, *Proceedings of the British Hydrological Symposium, Seventh National Hydrology Symposium, University of Newcastle 6-8, September 2000*. BHS National Hydrology Symposium Series.

Baur, P. Mandeville, N. Lankford, B and Boake, R. 2000, Upstream/downstream competition for water in the Usangu Basin, Tanzania. In, *Proceedings of the British Hydrological Symposium, Seventh National Hydrology Symposium*, University of Newcastle 6-8, September 2000. BHS National Hydrology Symposium Series.

Danida/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*. Dar es Salaam, Tanzania: Rufiji Basin Water Office, Ministry of Water, Energy and Minerals.

DANIDA (1998) *Smallholder irrigation improvement*. Agricultural Sector Programme Support. Project Preparation Report. Dar es Salaam, Tanzania.

DANIDA (2001A) *Terms of Reference for Consultancy on Preparation of the Legal Framework for Irrigation Development.* Agriculture Sector Program Support, Irrigation Component. Ministry of Agriculture and Food Security, Dar es Salaam, Tanzania.

Danida, (1998). *Smallholder irrigation improvement*. Agricultural Sector Programme Support. Project Preparation Report. Dar es Salaam.

DANIDA/JICA (2001) *Proceedings of the 1st National Irrigation Conference, Morogoro, Tanzania, 20th to 22nd March, 2001. Theme: "Irrigated Agriculture for Food Security and Poverty Reduction". Volumes I and II.* Funded by DANIDA/JICA. Ministry of Agriculture and Food Security, Dar es Salaam, Tanzania.

DFID (1998) *Project Memorandum. Sustainable Management of the Usangu Wetland and its Catchment*, for River Basins Management and Smallholder Irrigation Improvement Project (RBMSIIP) and Ministry of Water, Water Resources Department, Government of Tanzania. Department for International Development, London.

DFID (1998). *Project Memorandum. Sustainable Management of the Usangu Wetland and its Catchment*, for River Basins Management and Smallholder Irrigation Improvement Project (RBMSIIP) and Ministry of Water, Water Resources Department, Government of Tanzania. Department for International Development, London.

FAO Report 1269 Rome, 1960. *Hydrology and Water Resources in the Rufiji Basin*, Tanganyika. Report to the Govt of Tanganyika.

Faraji S.A.S. and Masenza, I.A. (1992) Working paper. *Hydrological study for the Usangu Plains with particular reference to flow entering the Mtera Reservoir and Water Abstractions for Irrigation*. Insitutional support for Irrigation development, Ministry of Agriculture and Livestock, Tanzania.

Gowing, J.W. & Tarimo, A.K.P.R. (1994) Influence of Technology & Management on the Performance of Traditional and Modernised Irrigation Schemes in Tanzania, In *Proceedings of XII World Congress on Agricultural Engineering.* Milan, Italy. August-September, 1994. pp.360-368.

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

Irrigation - Africa WER (1993) *Kimani Irrigation Project*, Summary report, End of Phase I Report, KIP. Tanzania.

JICA/MAFS. (2001). *The Study on The National Irrigation Master Plan in the United Republic of Tanzania*. Japan International Cooperation Agency, Ministry of Agriculture and Food Security October 2001. Dar es Salaam, Tanzania, 55 pp.

Kikula, I.S., Charnley, S. and Yanda, P. (1996). *Ecological Changes in the Usangu Plains and their Implications on the Down Stream Flow of the Great Ruaha River in Tanzania*. Institute of Resource Assessment, University of Dar es Salaam, Tanzania.

Koopman, J., Kweka, R., Mboya, M., and Wangwe S.M. 2001. *Community Participation in Traditional Irrigation Scheme Rehabilitation Projects in Tanzania: Report of a Collaborative Research Project*. 88 pages. Broadening Access and Strengthening Input Market Systems (BASIS) Publication. University of Wisconsin-Madison, USA.

MAFS. (1999) Report On The Selection Of District/Pilot Schemes In Smallholder Traditional Irrigation In The Mbeya Region. Prepared By The District And Zonal Irrigation Offices, Ministry of Agriculture and Food Security, Mbeya Region, Tanzania.

MAFS. (2001) *Agricultural Sector Development Strategy*, October 2001. Ministry of Agriculture and Food Security, Dar es Salaam, Tanzania.

Masija, E. H. (1993). Irrigation of wetlands in Tanzania. In Kamukala, G.L. and Crafter, S.A. Wetlands of Tanzania, Proceedings of a Seminar on Wetland of Tanzania, Cambridge: IUCN, pp. 73-83.

MWLD. (2001) *National Water Policy. Draft*. Ministry of Water and Livestock Development. Dar es Salaam, Tanzania.

Potkanski T. and Adams W.M. (1998) Water scarcity, property regimes and irrigation management in Sonjo, Tanzania. *J Development Studies*, 34 (4): 86-116.

Riddle P.J. and Issae A.E.R. 1993. *Irrigation water supply characteristics at Mbarali State Farm Report*. Department of irrigation and Food and Agriculture Organisation, Rome, 11pp

SMUWC (2000) *Interim Report Supporting Volume A Water, Supporting Report 2, Water Management*, for Directorate of Water Resources, Ministry of Water, Government of Tanzania, The SMUWC Project, Mbeya Region, Tanzania. pp 119. (Authors: Baur, P., Mandeville, N., Lankford, B.A., Gillingham, M., Devitt. P)

SMUWC (2001) *Final Project Reports*. Directorate of Water Resources, Ministry of Water, Government of Tanzania. Dar es Salaam, Tanzania. Cited on www.usangu.org.

SMUWC 2000a, *Interim Report, Towards a Management Strategy for The Usangu Catchment*, for Directorate of Water Resources, Ministry of Water, Government of Tanzania, The SMUWC Project, Mbeya Region, Tanzania. pp 107.

SMUWC 2000b, *Interim Report, Supporting Volume A Land, Supporting Report 2, Livestock*, for Directorate of Water Resources, Ministry of Water, Government of Tanzania, The SMUWC Project, Mbeya Region, Tanzania. pp 80.

SMUWC 2000b, Water Resource Management Strategies for the Usangu Catchment, In *Working Papers June 2000*, for Directorate of Water Resources, Ministry of Water, Government of Tanzania, The SMUWC Project, Mbeya Region, Tanzania. 9 pp. (Author: B. Lankford).

SMUWC 2000c, *Interim Report Supporting Volume A Water, Supporting Report 2, Water Management*, for Directorate of Water Resources, Ministry of Water, Government of Tanzania, The SMUWC Project, Mbeya Region, Tanzania. pp 119.

UVIP (1993) Progress Report, Usangu Villlage Irrigation Project, UVIP, URT/91/005, Phase II, Igurusi. Tanzania.

World Bank, 1996, River Basin Management and Smallholder Irrigation Improvement Project – Staff Appraisal Report, World Bank, Washington DC, USA.