

**EFFECTIVENESS OF RIVER BASIN GAME IN FACILITATING  
EQUITABLE ALLOCATION OF WATER IN MKOJI SUBCATCHMENT  
OF GREAT RUAHA RIVER IN TANZANIA**

**BY  
WILFRED CLEMENT KAYOMBO**

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## ABSTRACT

The Great Ruaha River (GRR) basin is one of the four basins in Tanzania that make up the Rufiji river basin, in which Mkoji subcatchment drains. This subcatchment harbors multisectoral water uses that experience inequitable water allocation due to severe water shortage. River Basin Game (RBG), a tool that aids decision-making process, was implemented in order to improve equitable allocation of water (EAW) in the subcatchment. A field study was carried out in two river systems with RBG and two without RBG to assess the effectiveness of RBG in facilitating EAW in Mkoji subcatchment. In order to generate empirical information to address the problem, a questionnaire from a sample size of 130 respondents was adopted, and key informants were interviewed. Data analysis was done using Statistical Package for Social Sciences (SPSS). Cross tabulation designs and test statistics were used to determine levels of significance. Key findings indicated that communities with RBG had implemented 66.6% of strategy to improve local water management institutions. However, despite significant differences in improving intakes ( $p < 0.01$ ), and reduction in number of Livestock ( $p = 0.04$ ) there was no significant difference in implementing strategies on improving performance of infrastructure and water saving for EAW. It was concluded that RBG was effective in creating awareness and improving local water management institutions. Since local institutions are the core for EAW, it is recommended that the use of RBG should be intensified in communities with RBG. Communities without RBG should be exposed to RBG. There is a need to explore possibilities of promoting RBG for among others promoting local institutions for sustainable management of river water resources in small river basins of Tanzania.

**DECLARATION**

I, Wilfred Clement Kayombo, do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is my own original work, and has never been submitted for a higher degree in any other University.

Signature.....

Date.....17/11/2007.....

**Wilfred Clement Kayombo**

Signature.....

Date.....18/11/2007.....

**Prof. P.K.T. Munishi**

**(Supervisor 1)**

Signature.....

Date.....18/11/2007.....

**Dr. S.D. Tumbo**

**(Supervisor 2)**

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This work is dedicated to my wife Emelita Kaspar Ngailo and my late sister Susana Kayombo. My wife for the trouble she took towards the fulfilment of my education program. And my sister for her paves that led to this achievement. God bless them.

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### **LIST OF ABBREVIATIONS**

<b>BBC</b>	<b>British Broadcasting Cooperation</b>
<b>DALDO</b>	<b>District and Livestock Development Officer</b>
<b>DANIDA</b>	<b>Danish International Development Agency</b>
<b>EAW</b>	<b>Equitable Allocation of Water</b>
<b>FAO</b>	<b>Food and Agriculture Organization of the United Nations</b>
<b>GRR</b>	<b>Great Ruaha River</b>
<b>GWP</b>	<b>Global Water Partnership</b>
<b>IWMI</b>	<b>International Water Management Institute</b>
<b>IWRM</b>	<b>Integrated Water Resource Management</b>
<b>LARP</b>	<b>Live Action Role Playing</b>
<b>MAFS</b>	<b>Ministry of Agriculture and Food Security</b>
<b>MATI</b>	<b>Ministry of Agriculture Training Institute</b>
<b>MMORPG</b>	<b>Massive Multiplayer Online Role Playing Games</b>
<b>MoWLD</b>	<b>Ministry of Water and Livestock Development</b>
<b>MSC</b>	<b>Mkoji sub catchment</b>
<b>NARCO</b>	<b>National Ranching Cooperation</b>
<b>NGO</b>	<b>Non Government Organization</b>
<b>RBG</b>	<b>River Basin Game</b>
<b>RBMSIIP</b>	<b>River Basin Management and Smallholder Irrigation Improvement Project</b>
<b>RBWO</b>	<b>Rufiji Basin Water Office</b>
<b>RIPARWIN</b>	<b>Raising Irrigation Productivity and Releasing Water for Intersectoral Needs</b>
<b>RPG</b>	<b>Role Playing Games</b>
<b>SNAL</b>	<b>Sokoine National Agriculture Library</b>
<b>SWMRG</b>	<b>Soil Water Management Research Group</b>
<b>SMWUC</b>	<b>Sustainable Management of Water in Usangu and its Catchments</b>
<b>SUA</b>	<b>Sokoine University of Agriculture</b>
<b>TANESCO</b>	<b>Tanzania National Electricity Supply Company</b>
<b>URT</b>	<b>United Republic of Tanzania</b>

**VEO**      **Village Executive Office**  
**WUA**      **Water User Associations**

## CHAPTER ONE

### INTRODUCTION

#### 1.0 Background

Water is a basic natural resource, which sustains other resources and provides for various needs but is unevenly distributed (De Wrachien and Fasso, 2002). Often, we cannot find water in the right place, at the right time, and in the right quantity and quality. Giving proper regard to this, the second World Water Forum acknowledged the pivot role that integrated water resource management plays in the process of sustainable development. The term “integrated” embraces planning and management of water resources: conventional and non-conventional (De Wrachien and Fasso, 2002). IWRM requires that there should be awareness and equity in water management. The equity aspects of water resource need to be brought on board, especially in the semi-arid areas of the developing world where majority of households are devoid of water.

Equitable allocation of water (EAW) is a step forward towards an integrated approach; it takes into account the economic, social and ecological factors as a whole and aims for a balance (McCaffrey, 2001). In the context of small river basins, which are major sources of water for, among others; irrigation and livestock sectors in Tanzania, deliberate participatory efforts are needed to enable stakeholders be part of the decision making process. There are several constraints and potentials for intersectoral water management in Tanzania (Kashaigili *et al.*, 2003). Major driving factors are a growing population, economic development, improved living standards and increasing demands. These call for the need to improve EAW. EAW depends on

cooperation and partnership between water use communities that share common water source as for small river basins. This can be exemplified by irrigation and livestock communities of the Great Ruaha River Basin in Mkoji subcatchment (Tanzania). GWP (2000) argued that meaningful participation occurs when local water users come together to formulate supply, management and use choices.

To change the distribution of water between sectors in river basins needs the resolution to among others; establish a strategy for water allocation. In this context a strategy is a rational river scale development formulate for allocating river water between intersectoral water users. There are several approaches of formulating strategies for allocating water. These include; needs-based approaches, particularly using population, arable land, or historic use parameters; and approaches based on economic definitions of efficiency. These approaches may either be top down or bottom up depending on the execution process. In Mkoji subcatchment, a bottom up approach was undertaken using a dialogue tool, the River Basin Game (RBG), since 2002 (Lankford and Sokile, 2004; RIPARWIN, 2006), which is a role-playing board that has a physical representation of a catchment with upstream and downstream intakes. Participants attempt to hoard glass marbles, acting as flowing water, as they seek to gain a livelihood, often depriving downstream users of their 'water' (Lankford and Sokile, 2004). By the end of the game, participants have a good understanding of what is going on, what needs to be targeted and what solutions might be considered. The game becomes highly animated. The play is followed by discussions on lessons learnt from the play, what needs to be done, by whom and how to bring together various institutions to assist in improving EAW. There are four

ways of playing the game (RIPARWIN, 2004a); with students and researchers of water management to teach common property management of water, With local resource users of water to facilitate local decision-making with regard to allocation of water, with higher level decision-makers to reveal the issues facing local users and the beneficial and negative outcomes that their actions might have on them, and with both higher level institutions and local resource users to generate a comprehensive picture of how mutual collaboration, flexibility and support is required to manage water at the basin level.

RBG was invented by Bruce Lankford and initially developed as a teaching tool for students in 2000 at the University of East Anglia (Mabiza, 2006). In 2002 RBG was proposed by the project: Raising Irrigation Productivity and Releasing Water for Intersectoral Needs (RIPARWIN) as a new approach in the country that would involve water users in conflict resolution and finding solutions to problems brought about by dwindling water supplies (RIPARWIN 2004b). RIPARWIN Project designed two versions of the RBG (wooden and metal board). For more than five years now the Mkoji subcatchment of the Great Ruaha River basin has been using RBG for among others to develop strategies for EAW in small river basins. However the effectiveness of RBG on facilitating EAW can have negative outcomes to the strategies, which are being implemented by the water use communities that used the RBG. This can be partitioned by exploring communities with and those without the RBG on the approaches used and strategies developed by each River system. Studies on the effectiveness of RBG in facilitating EAW are very rare. Such a situation

added to the fact that the RBG is a new approach not only in Tanzania but Africa at large.

The aim of this approach was to create a harmonized environment for water users from different sectors to come together and talk about how to share water. At the end of a two days RBG workshop strategies aimed at improving equitable allocation of water were developed by each community that used the RBG. The extent of implementing the practical means of improving EAW according to these strategies is missing from the context. In Mkoji subcatchment there are several river systems that used and others that did not use the RBG. Investigating and comparing the use of RBG strategies in communities with and without RBG can give a picture on the extent of EAW, hence the effectiveness of RBG in facilitating EAW.

Preliminary outcomes have shown a considerable strength and ability of the RBG 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 (Rajabu *et. al.*, 2005). The objective of this study is to present the effectiveness of RBG in facilitating implementation of strategies on EAW, which may help in managing small river basins effectively.

## **1.1 Problem Statement and Justification**

### **1.1.1 Problem Statement**

Water allocation in the Mkoji subcatchment is not equitable. This is as a result of among others, unfair distribution of the scarce water resource. Recent studies

(Lankford and Frank, 2000; SMUWC, 2001; RIPARWIN, 2006) indicated the presence of inequitable water allocation. These studies made efforts to arrest the situation. RIPARWIN used the RBG, which worked well in Rufiji Basin (Lankford *et al.*, 2004; Rajabu, 2005; RIPARWIN, 2006); it encouraged water users, to consider ways to improve equitable allocation of water through gaming. However the effectiveness of RBG on facilitating on ground equitable allocation of water is not well known. The study investigates the effectiveness of RBG in EAW by comparing the extent of implementation of RBG strategies in communities with and without RBG.

### **1.1.2 Justification**

Despite the efforts done by RIPARWIN project where the RBG has been used to develop strategies aimed at improving EAW, yet there is no empirical evidence on the effectiveness of the RBG in implementing strategies, for improving EAW in Mkoji subcatchment. The knowledge of the distinct approaches, outputs and extent to which RBG strategies have been implemented is inadequate. Exploring the RBG approaches and comparing the strategies that were developed from each approach will create a foundation for investigating the extent of implementing RBG strategies for EAW in the localities.

## **1.2 Objectives**

### **1.2.1 Overall objective**

The overall objective of this study was to determine the effectiveness of RBG in facilitating equitable allocation of water among water users in the Mkoji

subcatchment, in order to comprehend its end product as a water conflict management tool.

### **1.2.2 Specific objectives**

- (i) Compare RBG approaches that were used to develop strategies for EAW, so as to identify the strategies developed in each approach.
- (ii) Categorize the RBG strategies for EAW, which were developed using different RBG approaches so as to establish a base for investigation
- (iii) Investigate the implementation of RBG strategies for EAW in communities with and without RBG, so as to establish the effectiveness of RBG on EAW in communities with RBG.

### **1.2.3 Hypotheses**

- (i) Approaches of RBG for EAW do not differ significantly.
- (ii) There is no significant differences in RBG strategies developed by communities with RBG
- (iii) Implementation of identified strategies for improving EAW in communities with RBG does not differ significantly from communities without RBG.

## CHAPTER TWO

### LITERATURE REVIEW

#### 2.1 Overview

In this chapter, a review of what is known about effectiveness of RBG in facilitating EAW is discussed. The chapter starts by an elaborate survey on the concept of role playing games and their intricacy to water management then orients it to RBG. The concept of RBG is addressed and narrows down to its use in formulating strategies for water allocation in the Mkoji subcatchment. Available studies on water management institutions and how these are applied in the current study are examined. Finally the chapter examines the concept of EAW, and techniques used to evaluate basin management performance.

#### 2.2 Role Playing Games

Role playing games are deliberative processes for decision-making. Like most models role playing games, constitute artificial societies. They share the notions of roles and rules (Odell *et al.*, 2003), the basic entities in the constitution of artificial societies. Role playing games are tools that can be used to explain the process or to develop it as an intermediary object among stakeholders (Focus, 2005), they provide means to reveal some aspects of social relationships by allowing the direct observation of interactions among the players. This may be especially useful when the players are stakeholders. The value over other forms of decision making is argued cogently by Collentine *et al.* (2002) who see intrinsic advantages in increased legitimacy and deliberative democracy and debate particularly over methods that rely

on acceptance or rejection modes of participation. This accord with Barreteau (2003) who believes that games and model simulations help set clear boundary conditions and condense complex issues in both space and time, suggesting long-term issues can be readily captured. Role playing games are a means to reveal some aspects of social relationships by allowing direct observation of interactions among the players and cautions that they need to be carefully managed, be systematic in some respects and encapsulated within formal validation, feedback and follow-up activities Barreteau (2003). Cardenas (2003) exemplified use of joint decision-making exercise to explore the notion that heterogeneity of participants ultimately undermines their ability to enact promises arrived at through common agreement. Games can prevent certain misrepresentations or bad faith behavior especially when users participate in the design of games: this further empowers the users (D'Aquino *et al.*, 2003). Role playing games also help key participants understand key natural and social processes (Hagmann and Chuma, 2002).

There are several known role playing games that include the following; Land use role playing games and role playing games for multi-agent systems as applied in Senegal valley irrigation systems (Barreteau, 2003); Live Action Role Playing (LARP) games ([www.bbc.co.uk](http://www.bbc.co.uk)); Concept design role playing games (Iacucci and Vesterinen, 2000); Bus route, and cards role paying games, as used in environmental planning, and participatory urban planning role playing game (Hornecker, 2000); Fishbanks Game (Meadows and Meadows, 1993), River Basin Game (Lankford, 2005) and Massive Multiplayer Online Role Playing Games (MMORPGs). These MMORPGs (Hardy and Scheufele, 2005) have been used to increase relationships and replay

value of the games that involve people who are geographically distant. RIPARWIN used the RBG to explain the productivity curve of water. Multi-agent based computer based models have also been used to negotiate water demand management on a common property water table in which users establish parameters and decision reflecting various dynamics of demand and drivers.

### 2.2.1 Concept of RBG

In Tanzania there are conflicts over natural resource and such conflicts include Kajembe *et al.* (2003) that in the Usangu plains, between cultivators and pastoralists. RIPARWIN project designed the River basin Game (RBG) with an intention of minimizing water allocation conflicts. RBG is a role-playing tool (Lankford and Sokile, 2004; RIPARWIN, 2004a) for promoting dialogue and decision-making over water resources where irrigation is present. It is a physical (board) representation of a catchment or small river basin (Appendix 4). The board has a slope and uses glass marbles to reflect upstream-downstream flow of water. Upstream abstractors of water are favoured over downstream abstractors and users of water. This difference often gives rise to inequality in water access. The game allows local users to reflect on the distribution of water in various situations and to strategize accordingly by taking up roles such as 'advantaged upstream abstractor' or 'disadvantaged downstream abstractor'. The game then asks players to act both competitively and then co-operatively, and in doing so, helps contrast these responses. This generates discussion on ways to identify wasteful usage and how to manage water more equitably (RIPARWIN, 2006). RBG can Lankford, (2005): (i) Increase the transparency of IWRM; (ii) Change the boundaries of peoples' concept of the system

of water management, aligning it more broadly and closer to hydrological and social realities; (iii) Aid participants in exploring socio-economic and ecological rules of sustainable water use; (iv) Explore future scenarios and options that result from participants' choices in the use and management of water; (v) Deepen participants' knowledge of hydrology, needs of other stakeholders, and other factors; (vi) Establish or help deepen cooperative relationships between stakeholders that potentially help the establishment of more effective water management and use; (vii) Help stakeholders relate to scale; and (viii) Help build trust and shared knowledge between stakeholders.

### **2.2.2 Use of RBG in Tanzania**

RBG has been used at various levels (local to national). According to RIPARWIN (2006) it has been used at local level in Rufiji and Pangani River basins, district, regional and ministerial officials as well as to national policy makers (Table 1). It worked well in Rufiji river basin (Lankford *et al.*, 2004). It encouraged water users to consider ways to improve productivity, reduce water abstraction and improve equity (Sokile, 2005). Stakeholders in Mkoji subcatchment were the frontiers for this innovation. Despite increase in use of RBG and positive conclusions from previous studies (Lankford, 2005), there is an apparent gap on impacts of RBG on EAW. It has also been used Kenya, Nigeria and South Africa (Lankford, 2005; Mabiza, 2006).

**Table 1: Use of the RBG in Tanzania**

DATE	PLACE	TYPE OF PARTICIPANTS	REMARKS
11-12 Nov. 2002	MATI Igurusi	Local level water users from Mkoji sub-catchment	The first RBG workshop in Tanzania
29-30 July 2003	MATI Igurusi	Middle level managers involved in water management (TANESCO, Ministries of: Agriculture, Water, Natural resources management and Tourism, and Mbarali and Mbeya rural district councils	Test and approve the use of the RBG
1-8 Aug. 2003	Nane Nane Grounds in Mbeya	Open participation	Introduction to the RBG and how it can be used In small river basins.
1-8 Aug. 2004	Nane Nane Grounds in Mbeya	Open participation	Introduction to the RBG and how it can be used In small river basins.
4-5 November 2004	RBWO-Iringa	Local level water users from Mambi and Mswiswi river systems	Experts in Irrigation and Water resources from RBWO, District council and SUA also attended
3-4 Feb. 2005	RBWO-Rujewa	Technicians from RBWO and WWF	A RBG Trainer of Trainers Workshop
1-8 Aug. 2005	Nane Nane Grounds in Mbeya	Open participation	Introduction to the RBG and how it can be used In small river basins.
24-25 Oct 2005	Makanya, Pangani	Local level water users, NGO's, Extension officers	The first RBG workshop outside Rufiji river basin
18-19 Nov. 2005	MATI Igurusi	Local level water users from lower Mlowo river system	RBG used in the process of formation WUA's
29 Nov. 2005	Land Mark Hotel-Dar es salaam	Senior officers from ministries; Water(MoW), and Agriculture and Food Security (MAFS)	Workshop designed for policy makers MAFS and MoWLD
1-8 Aug. 2006	Nane Nane Grounds; Mbeya and Morogoro	Open participation	Introduction to the RBG and how it can be used In small river basins.
1-8 Aug. 2007	Nane Nane Grounds; Mbeya and Morogoro	Open participation	Introduction to the RBG and how it can be used In small river basins.

Source: Modified from RIPARWIN, (2006)

### 2.2.3 RBG strategies in Mkoji subcatchment

A great deal of effort has been invested in negotiations between key stakeholders in the exploration of options to develop a range of strategies and visions using the RBG. The tool has enabled stakeholders to form strategies aimed to improve EAW. In Mkoji subcatchment, RIPARWIN (2006) water users in communities with RBG

agreed to implement: (a) Formation of River scale water users organization, (b) Design and implement effective water schedules and bylaws, (c) Reduce the number of infrastructure especially irrigation canals, and (d) Improve productivity of water thus release more water for intersectoral needs.

## **2.3 Water Management Institutions**

### **2.3.1 Concept of institutions**

Most scholars admit that the concept of institutions is a difficult one and subject to considerable definitions to meet their situations (Cleaver, 1999; Mbwilo, 2002; North, 1990; Sokile, 2005). There are many definitions and interpretations of institutions; for example North (1990) defined institutions as rules that shape human interactions and their structure incentives in human exchange, whether political, social or economic. Depending on the context of the application of the term; ranging from “social rules and norms” to more “specific organizations designed to fulfill a given set of functions”. Under common property literature, these are taken as regulatory systems of laws, informal conventions, and norms of behavior, mainly designed to coordinate individual and collective actions for controlling and managing the natural resources (Cleaver, 1999).

Institutional economists, on the other hand, see institutions as a set of rule of the game in a society, or more formally, as the humanly devised constraints that shape human action (North, 1990). North (1990) perceives institutions as analogous to the rule of the game in a competitive team sport. The rules here, gives a structure to the game and defines the scores, rewards for compliance, sanctions and penalties for

violations and faults. In such an analogy, North (1990) pins out an essential part of the functioning of the institutions, which is the costliness of ascertaining violation and the severity of punishment. According to him, the rules also specify the layout of the playground, position of various players and the overall structure of the team, the sense in which institutions cover the organization of the team of players and how they should play the game. Institutions form an important part of any management strategy and is an issue of vital consideration, especially in intersectoral water allocation (Sokile, 2005).

The current study supports institutions as from, North, Cleaver, Mbwilo and Sokile and perceives institutions as water laws, water policy and water administration. According to Sokile (2005) these provide a set of rules, constraints and regulations that guide daily human interactions to ensure peace, tranquility, equity, and sustainability of life. Very recently, in the Usangu plains of the Great Ruaha River Mbwilo (2002) reported the use of local institutions in regulating water and grazing land resources and conflict management.

In this aspect the study has adopted the term (Institution) to the local water management activities in small river basins as; WUA with a major administrative role of organizing water users for among others EAW, Water schedules that are plans or organized set of procedures for allocating scarce water resource and bylaws as water laws or rules for regulating water use and allocation.

### 2.3.2 Water User Associations (WUA)

Of late, water management paradigm has shifted to the realization that Water User Associations (WUA) and other user entities have a great potential of implementing sound water resource management. Efforts are made in many countries to formulate, empower and transfer water rights and water management imperatives to WUA. The basic assumption is that WUA involvement is sine qua non for participation in water resource management (GWP, 2000). Sharma and Minhas (2005) insisted that besides technological advances, peoples' participation, and favorable water use and allocation policies need to be put in place for sustainable use of water. Cooperation of beneficiaries as associations of individual water users may improve water allocation activities e.g. controlling on a river or providing water for emerging farmers or WUA may be multi-sectoral dealing with a variety of water uses within its area of operation.

There is paucity in literature on operation mechanisms, success or failure of WUA in Tanzania. Experiences from elsewhere however, have celebrated on WUA performance. According to Wester *et al.* (2003), in Mexico for example, the government transferred the government-managed irrigation districts to WUA and consequently reduced the government's expenditure on irrigation. Mexican water laws also recognize the informal WUA. Despite the trust on WUA, Sokile (2005) has warned out that WUA may be dominated by village level elites; those who read and write and express themselves, making their way to the committees thus drag other water users, a phenomenon which may jeopardize WUA performance.

### **2.3.3 Water Schedules**

Water schedules are formalized or informal water rotations or arrangements for water management (Sokile, 2005). He continues to argue that rotations have worked in the upper and middle zone of the Mkoji sub catchment. The difference however, is that while irrigators at the upper catchment have water flowing in almost all intakes and concentrate on rotation within the irrigation systems, in the middle zone the rotation involves inter-intakes allocation. Rotational arrangements, if backed by some sanctions and enforcement, preferably by WUA, can help improve water allocation.

### **2.3.4 Water By laws**

According to Sokile (2005), the Village Land Act No. 5 of 1999 empowers the Village Councils with the right to manage water resources, forests and other natural resources that fall in the boundary of the village and draw up bylaws, as they deem proper. He argues that; to develop local bylaws local water users sit together and agree on the dos and don'ts and the penalties thereof. However, he found that majority of the villagers (67% in Upper Mkoji, 59% in the Middle Mkoji and 83% in the Lower Mkoji) were not well informed, nor knew that they have such a responsibility. Bylaws related to water use indirectly influence the management arrangement.

## **2.4 Equitable Allocation of Water**

### **2.4.1 Concept of EAW**

At the heart of water conflict management is the question of "equity." Equity is a form of reasonable utilization through cooperation in regulating allocation of water;

it implies fairness and justice in allocating water. This justice is not an abstract justice it looks beyond it to principles of more general application (Shaw, 1997). Equitable and reasonable utilization is a step forward towards an integrated approach; it takes into account the economic, social and ecological factors as a whole and aims for a balance (McCaffrey, 2001). Water equity has social, economic, spatial and temporal dimensions. Socially we can understand water equity in terms of differences in access and use. It is not just how much water people have access to but also ease and security access. Equity includes quality of water, security of access, contributions to maintenance of water services, and the role different groups' play in decision-making (Shaw, 1997). The current study established the definition of EAW from Shaw.

One of the least known aspects of application of water is how the applied water is actually distributed by users. Lack of knowledge on the actual water distribution and use can mainly be attributed to the physical and psychological distance between the water users and other actors. The sphere of physical measurements sharply contrasts with a general lack of interest in appreciating what happens beyond upstream water uses. Bringing water users or use representatives to come together and talk about how to share water is one way of improving water allocation among and between intersectoral needs (RIPARWIN, 2006).

#### **2.4.2 Water allocation in river basins**

River basins are common pool natural resources that have to deal with commons management. Kashaigili *et al.* (2005) argued that determination and allocation of

water in a river basin requires coordinated involvement of several stakeholders during various determination and allocation processes. River basins that are managed sustainably can satisfy a wide number of important needs, environmental and aesthetic as well as economic (Schofield *et al.*, 2003). Moore (2005) argued that despite advances in the recognition and understanding of the needs of water systems, water resources continue to be depleted, rivers show signs of drying up, and inefficient water use practices persist in among others agricultural sectors. The basic dilemma that exists is how to improve water allocation among and within different uses. Inter-organizational collaboration is a major stumbling block to Integrated River Basin Management (Margerum and Born, 2000; Jaspers, 2003). Mkoji River has been altered by human uses and transformations mainly due to: over abstraction of water, and increase in the number of improved intakes, that are abused by selfish irrigators thereby depriving downstream users needed water, during the dry season.

#### **2.4.3 Methods used to improve equitable allocation of water**

Diverse methods have been used to promote equity. These include rights-based measures, largely addressed by the international legal community; needs-based measures, particularly using population, arable land, or historic use parameters; and measures based on economic definitions of efficiency. Each of these measures alone cannot incorporate all physical, political, and economic characteristics that are unique to each of the world's waterways. To supplement this approach, a process for cooperative watershed development, based on the guidelines of "dispute systems design," has to be developed. Since 1814, states have negotiated approximately 300 treaties (Dowdeswell, 1998). According to Butts (1997) Israel and Jordan formed

bilateral peace treaty as a strategy to resolve the water dispute between the two states, based on mutual recognition of rightful allocations.

A practical tool (RBG) was used by RIPARWIN with and intention to among others, improve equitable allocation of water (Lankford and Sokile, 2000; Focus, 2005; Lankford, 2005). It brings home a sense of success and achievement when water is more equitably shared. Its foundation lies on encouraging people to build consensus, particularly on strategies so as to start catchment-wide meetings to share water. De Wrachien and Fasso (2002) addressed the optimal and conjunctive allocation of surface and groundwater resources. In this context main aspects and problems concerned with planning, design, construction and management of conjunctive use of water resources together with, technology transfer and institutional strengthening, effective partnerships with governments and stakeholders, and sound financial frameworks were examined. Using this approach the authors advocated that in striving for sustainable development in water resource use and management, the effectiveness of any instrument devised to realize the goal depends ultimately on two factors: the approach adopted and the quality and number of the individuals responsible for pursuing that approach. De Wrachien and Fasso (2002) continue to argue that this approach will also design strategies for maximizing the efficient use and management of available water resources, while preserving or enhancing the buffering capacity of the environment against unexpected stress or negative long-term trends. In addition, engineers, economists, ecologists, planners, along with stake-holders, user associations and all sectors of society must be involved in decision-making process. Failure to do so will increase the risk of opposition to

projects even when they have been designed or constructed. Successful collaboration with an informed and attentive public can lead to more socially compatible uses of water resources and more creative, appropriate and hence sustainable uses of technology for addressing community or regional water resource problems or needs.

According to Ambast *et al.* (2002), Remote sensing techniques are becoming powerful tools for efficient management of water especially in large irrigated areas. Satellite image has been used as a powerful tool for water management. It has been used to capture information on large irrigated area at frequent intervals. Bastiaanssen *et al.* (2000) argues that despite major improvements in the capability of satellite sensing to monitor hydrological conditions of the land surface there are potential limitations of remote sensing in the field of water resource management.

Planning and managing water and related land resource on a river basin basis is now being widely adopted (Gonzales and Arias, 2001). Efficient planning can assist to link stakeholders and their environment in sustainable production (Food and environmental security). Inability to link environmental security, water security and food security is the greatest problem of the future time (Falkenmark, 2001).

Cost sharing arrangements aimed at institutional capacity building has been one economic instrument. This includes paying for river basin management. Cost sharing is a mechanism where the financing of river basin management practices, options, programmes and initiative is spread between beneficiaries. This is governed by, among others, the beneficiary payments. These cost sharing principles have been

applied to river basin management in the Murray Darling Basin with some success in district and throughout the basin at a larger scale (Hooper, 2002; 2005).

Water schedules and bylaws have been a common practice in most water use communities. This is associated with formalized procedures and judicial powers. In Tanzania local agreements on water use are common, but when it comes to practice or using concrete legislative fields e.g. Water Laws and policies, particular local and indigenous forms of water management (water control rights) tend to be denied, forbidden or undermined (Sokile *et al.*, 2003).

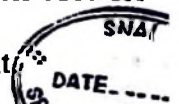
For effective river basin governance it is suggested that an information exchange programme is to be provided to support basin governance. This includes: interactive community education programme, community based river basin information center, a character on the legalities of information sharing, Regional libraries, river basin information system (WebPages and search data bases), and a searchable GIS.

Water productivity has also been observed to be one of the methods that can be used to improve EAW. It not only improves efficiency but as well economic water use (Hatibu, 1999; Kulindwa, 2000) reported that adoption of improved soil and water conservation techniques is necessary for overcoming loss of water. The principle requirement is the improvement of infiltration, water holding capacity and water uptake by plants. For example, it has been shown that water harvesting as for fish farming, sub-soiling coupled with manure can lead to fourfold increase in production. Water productivity is a function of three actions (RIPARWIN, 2004b);

(1) reducing gross water demand by reducing losses that are not usefully recaptured (2) lowering net usage where 'deficit irrigation' cuts water required in greater proportion than yield lost and (3) of boosting the crop growth or response to water by managing crop husbandry, inputs, including the timely scheduling of water. Water productivity depends on effective water management and proper agronomic practices. FAO (2005) explains that as stress on water resources increases, competitions grows between agriculture fighting to retain its water allocations and cities needing to satisfy the rapidly growing population.

Increasing water productivity through deficit irrigation and conservation of water can improve efficiency through deficit irrigation. This is best increased through responsive, sophisticated irrigation scheduling or through predetermined schedules, providing limited water (Sarwar and Perry, 2002). A shift from traditional concept of crop yield per unit of land to production per unit of water may release more water for intersectoral needs. Deficit irrigation can improve productivity and allocation of water (Igbadun *et al.*, 2005). Increasing productivity of water in agriculture plays a vital role in easing competition for scarce waters (Sharma and Minhas, 2005). Sustainable adoption of water conservation practices hand in hand with rules bylaw and policy result to direct tangible benefits of the individuals (Hatibu *et al.*, 1999).

Water saving in agriculture has been suggested to be the solution to meet other sectors' needs. Igbadun *et al.* (2005) advocated "deficit scheduling" as one of the methods in which irrigation farmers can cope with pressure to reduce water used for crop production in order to release more water for other sectors that need it.



## **2.5 Evaluations of River Basin Management Performance**

Bellamy *et al.* (2001) advocates that critical integration issues for evaluating river basin management include; the need for strengthened coordination mechanisms, role specification, clarity in divesting government powers and responsibilities, financing integrated river basin management, community involvement, the need and scope of integration, leadership skills, and information and property rights problems. Thus an integrated approach and adequate data are required. Conventional methods for assessing water delivery performance depend on flow measurement. Adequacy and equity can be evaluated when flow data at various levels are available and reliable. But, in most systems of developing countries, flow measurement is not accorded high priority. Sam-Amoah and Gowing (2001) assessed water delivery performance by analyzing responses from farmers concerning their perceptions. It is possible to use farmer's assessment to establish effectiveness. This study adopted Sam-Amoah and Gowings approach.

Lant (2003) identified five characteristics that watershed based institutional structures must possess to be valuable: (a) Enjoy power and authority with government, as well establish democratically based legitimacy, regional and local government, (b) Have authority and responsibility to manage watershed issues holistically, (c) Rely on more than voluntary measures, (d) Capacity-budget, staff and expertise, and (e) Be generalized across watershed types, scales and political units, with information gathering capacity and protocols for information sharing. Investigation of these was limited by time and budget.

## **CHAPTER THREE**

### **METHODOLOGY**

#### **3.1 Selection of the Study Area**

This study was done in 8 villages and four river systems of Mkoji subcatchment namely: (a) With RBG; Mahongole, and Mwatenga (Mlowo river), and Mambi and Luhanga (Mambi river). (b) Without RBG; Ilongo and Nsonyanga (Mkoji river), and Igurusi and Mpolo (Mpolo river) (Fig. 3.1). Selection of the area was based on the fact that the area used the RBG since 2002. In addition the area is characterized by intersectoral water uses that include irrigation, livestock, hydropower, brick making and fisheries.

#### **3.2 Research Approach**

The study took a quantitative approach with an extensive use of key informant interviews, and secondary data. People's perceptions and behaviors in sharing water resource, at river scale, were investigated. There was therefore a need to analyze the uniqueness of the case being studied in order to systematically examine the processes that brought forth the present water allocation practices. This was done by investigating communities with and without RBG in the same location (Middle Mkoji subcatchment of the Great Ruaha River).

#### **3.3 Data Collection**

##### **3.3.1 Research design and sampling procedure**

A non-experimental design was used in this study. Multistage sampling procedure was used to select the sampling units (Appendix 1).



Structured questionnaires were used to collect data on implementation of RBG strategies (Appendix 2). Several questions were asked to respondents to collect data on the following; Extent of implementing strategy to form water management institutions for EAW (WUAs, Water schedules and Bylaws); Implementation of the strategy to improve performance of infrastructure for EAW (Improve capacity of intakes to allocate water, reduce number of inefficient canals and rehabilitate infrastructure); and implement water saving strategies (grow crops that demand less water, water harvesting technologies e.g. fish farming, grow high value crops, reduce number of livestock and farm size)

The questionnaires were pre-tested in two villages of Igurusi ward namely; Mambi and Chamoto villages, to check the validity and reliability of items. Open and closed ended questions were used. It was important to measure this way because there was no water flow data in the rivers at various levels and points. Communities with and without RBG were purposively used to enable comparison. A representative sample size of 130 out of 2600 households (5%) of the total households under study was adopted. Key Informant interviews were used to enrich the information obtained from the questionnaire survey. A checklist of open-ended questions was used. In this regard, key informants included the following; River basin water officers, MATI Igurusi tutors, district officers, village leaders, and ward officers.

### **3.3.3 Secondary data collection**

Secondary data was obtained from SWMRG (SUA), District water office, MATI Igurusi and Sokoine National Agricultural Library (SNAL). Online databases and

documents were also visited as shown in the bibliography. An attempt was also made to revisit, unpublished literature and reports in the district councils, projects and NGOs offices, relevant to the subject matter and the study area.

### **3.4 Techniques of Data /Information Interpretation and Analysis**

#### **3.4.1 Descriptive statistics**

Under descriptive statistics, means, percentages and frequency distribution of different variables were calculated using Statistical Package for Social Science (SPSS). Results from descriptive statistics were used to construct frequency distribution tables important to simplify interpretation of the results.

#### **3.4.2 Developing scales for EAW**

The respondents were asked questions to ascertain their perceptions towards EAW. The responses were recorded in a Likert-style format (Trochim, 2006) as follows: Respondents were asked questions on statements relative to the study that required the following responses, of which each were coded the scale in parenthesis; strongly agree (1); agree (2); undecided (3); disagree (4) or strongly disagree (5). Adding up the scores for the same statements combined the total scores for each statement. Statements with the highest and lowest scores were taken as statements that were accepted or rejected outright by respondents, to compose the scale that was actually used for determination of the perceptions. Responses were grouped into 3 categories namely: Positive, neutral and negative. Statements with intermediate scores were left out since they connoted chances of not being decided.

### 3.4.3 t-statistic

Statistical t-test procedure (Paired t-test) in SPSS was used to compare the means of the intended variables of the two communities. This was necessary because most variables were alphabetic and the test procedure required the variables be numeric. Paired t-test was chosen because communities with and without RBG were compared. Each of which has an irrigation and livestock community that have a unique relationship with each other i.e. the individuals are living in the same ecological environment (Mkoji subcatchment).

Since the two communities had unequal sample sizes (Trochim, 2006), it was assumed that the two sample sizes had the same variances. The statistical significance level associated with the t value is the probability that, under the null hypothesis of equal means, the absolute value of t could be that large or larger just by chance, in other words, it's a two-tailed test. In a small river basin, EAW is highly correlated with organization of water users for water management, at river scale. Positive relation is hypothesized for presence of effective apex organization, water scheduling and bylaws in communities with and without RBG. Positive relationship was also hypothesized between communities with and without RBG on differences in perceptions towards EAW. Water users with higher positive responses were considered to be more innovative than those with lower perceptions. Thus innovative individuals may be more aware of the need to improve EAW and therefore higher affinity of new innovation than non-innovative individuals. Significantly different relations were expected between communities with RBG and without RBG.

## **CHAPTER FOUR**

### **RESULTS AND DISCUSSION**

#### **4.1 Chapter Overview**

This chapter contains three sections with the first section presenting information on RBG approaches for EAW; the second section compares RBG strategies for EAW; and last section provides information on extent of implementation of RBG strategies for EAW. In all cases with and without RBG scenarios are used to ascertain effectiveness of RBG in EAW. Results of the paired t-statistics for testing significant differences on different factors in with and without scenarios, which are given in the different sections are summarized in Appendix 3.

#### **4.2 RBG Approaches for EAW**

In order to be able to identify and understand RBG strategies the current study first explored the RBG workshop approaches. Table 2 shows that both Mambi and Mlowo river systems used the RBG to local level water users. However, the RBG workshop of 2002 differed in composition of participants from those held in 2004 and 2005. Office registers revealed that in 2002 RBG involved local water users that participated in 2004 and 2005, while that in 2004 involved only local water users from Mambi and Mswiswi river systems, and that in 2005 involve water users from Mlowo, river system. Despite the differences in composition of participants for each scenario yet the approaches of RBG workshops were the same. The RBG was used to local water users, in a two days workshop (Lankford, 2005; RIPARWIN, 2002; 2004; 2005) that involved the water users in analysing key water resource allocation

issues and problems in their own sub catchments, and pulled them together to raise consensus strategies for EAW by gaming.

**Table 2: RBG scenarios**

<b>RBG Scenarios</b>	<b>River system</b>	<b>Date</b>	<b>Place</b>	<b>Type of participants</b>
1	Mkoji sub catchment	11-12/11/02	Mbeya	Local level water users
2	Mambi	4-5 /11/ 04	Iringa	Local level water users
3	Mlowo	18-19/11/05	Mbeya	Local level water users

Source: RIPARWIN (2002;2005)

Further investigation revealed Mlowo river system used RBG in formation of Water Users Association (WUA), which comprised irrigation and livestock communities. There are chances that the approaches for establishing strategies and visions by using RBG did not differ for Mlowo and Mambi communities except when used in formation of WUA. It was important to explore RBG approaches in order to disclose RBG scenarios, their composition and purpose so that these can provide a base for further investigation.

#### **4.3 RBG Strategies for EAW**

The current study identified diverse strategies that were arrived at during RBG scenarios, by Mambi and Mlowo communities. Results in Table 3 show; more awareness, formation of WUA, more workshops and need for agronomic information on improvement of water saving and high value crops, water schedules, restriction of irrigated area and size of livestock and control of water supply were the specific strategies suggested for improving EAW by Mambi and Mlowo communities.

**Table 3: Strategies developed by water use communities of Mambi and Mlowo River systems in the first RBG in 2002**

S/No	Strategy
1	Creation of more awareness as regard to water management
2	Formation of a river wide WUA
3	More workshops on water management
4	More agronomic information especially on water saving and high value crops
5	Impose restriction on irrigated area
6	Impose restrictions on size of livestock
7	Control water supply
8	Control water management

Source: RIPARWIN (2002)

Apart from the above scenario, RBG was used by communities of Mambi and Mswiswi river systems, excluding those of Mlowo river system. Eight strategies were developed during RBG workshop for Mambi communities (Table 4). Comparison of these strategies from the ones obtained in the first scenario (Table 3) shows that creation of more awareness, formation of WUA, more workshops on water management, and control water supply and management were missing from the context (Table 4). Furthermore regular cleaning of irrigation canals and diversification to other livelihood supporting activities were included in the context. This suggests that there was a change in the RBG strategies developed when water use communities were separated.

**Table 4: Strategies developed by water use communities of Mambi River system during RBG in 2004**

S/No	Strategy
1	Reduce farm size
2	Adhere to cropping calendar
3	Regular cleaning of irrigation canal
4	Grow alternative drought resistant crops
5	Plant fast growing, short duration seed varieties such as <i>Waiwai</i> rice variety
6	Reduce number of irrigation abstraction canals
7	Diversification to other livelihood supporting activities

Source: RIPARWIN (2004c)

When RBG was used for Mlowo water users alone, there was a slight difference in the specific strategies for EAW. Table 5 shows that there were more strategies developed by Mlowo communities than Mambi communities. Strategies that were uncommon for Mambi included formation of WUA, construction of drainage systems and improved intakes.

Evaluation of the RBG workshop outputs shows that there was a need for creation of more awareness and workshops on water management when the RBG was used with both Mlowo and Mambi communities (Table 3). When the approach was changed to involve communities that shared water from a common river (Mambi or Mlowo River system), specific strategies for improving EAW differed. RBG workshop for Mambi communities excluded the need for WUA and included the need for diversification, growing drought resistant crops, planting fast growing crops, use simple water saving irrigation methods, and increase the size of reservoirs (Table 4).

**Table 5: Strategies developed by water use communities of Mlowo River system during the RBG in 2005**

S/No	Strategy
1	Form an irrigation and livestock water use association
2	Implement defined water schedules
3	Implement defined bylaws to control water abstraction
4	Improve water saving; especially decrease farm size and livestock
5	Canal cleaning
6	Construct drainage systems that return water flows into the main river
7	Dig wells to harvest water
8	Establish and use cropping calendars
9	Use improved seed varieties
10	Construct modern intakes
11	Decrease unnecessary infrastructure

Source: RIPARWIN (2005)

While the RBG workshop for Mlowo communities included the need to construct drainage systems, dig wells to harvest water, conserve water sources and construct modern intakes (Table 5). Basing on individual merits, strategies developed by Mlowo and Mambi communities differed. Mlowo communities developed 87% of the total strategies while Mambi communities developed 60% of the total strategies (Appendix 6). However, both communities developed most of the strategies.

Detailed investigation of the RBG strategies, for Mambi and Mlowo communities', yielded three common major RBG categories namely; improve local water management institutions, improved performance of infrastructure and improved water saving, for EAW (Table 6). The current study revealed that local water management institutions for EAW performed the following; administration for water use (WUA), planning for water allocation (schedules) and rules for monitoring water management (bylaws).

Improved performances of infrastructure encompassed all activities aimed at efficient performance of the infrastructure and improve water saving; all activities that aimed at more production per water use so as to release more water for intersectoral needs (Table 6). The RBG strategies for Mambi and Mlowo river systems of middle Mkoji subcatchment were grouped because the subgroups aimed at similar fulfillments e.g. WUA, water schedules and bylaws are institutions. The major strategies were used for both communities with and without RBG in order to enable comparison, i.e. communities without RBG were the control of the study.

**Table 6: Major RBG strategies for communities with RBG**

S/No	Strategies
1	Improve local water management institutions for EAW <ul style="list-style-type: none"> <li>• Water users association</li> <li>• Water schedules</li> <li>• By laws</li> </ul>
2	Improve performance of infrastructure for EAW <ul style="list-style-type: none"> <li>• Construction of modern intakes</li> <li>• Maintenance of infrastructure</li> <li>• Reduce number of unnecessary infrastructure</li> </ul>
3	Improve water saving for EAW <ul style="list-style-type: none"> <li>• Reduce farm size</li> <li>• Reduce number of livestock</li> <li>• Grow crops that demand less water</li> <li>• Grow high value crops</li> <li>• Diversification of irrigated agriculture</li> </ul>

#### **4.4 Implementation of RBG Strategies for EAW**

##### **4.4.1 Improve local water management institutions for EAW**

###### *Formation of WUA*

Majority of communities with and without RBG were implementing strategy to form Water User Associations (WUA). As indicated in Table 7, more than 61% of communities with and without RBG implemented strategy to form WUA for irrigation and livestock communities. This indicates that by virtue of having a WUA there is a great potential that communities with and without RBG had some arrangements for organized water management. Despite the higher responses for communities without RBG than communities with RBG, key informant interviews revealed that, there were a handful of WUA in Mkoji subcatchment that was mainly operating in the villages, and particularly in irrigation schemes. In addition out of Mambi, Mlowo, Mpolo and Mkoji river systems it was only the Mlowo WUA, which was constructed by both livestock and irrigation communities. Thus there are

chances that RBG may have influenced implementation of WUA for Irrigation and livestock communities in Mlowo River system.

### *Water schedules*

The current study revealed that WUA in communities with RBG used water schedules more than communities without RBG. Table 7 shows that 83.6% of communities with RBG and 71.7% of without RBG used water schedules. The difference of the positive responses was significant ( $p=0.037$ ). Moreover, there were more negative responses in communities without RBG than with RBG.

Since communities with RBG had a WUA, which operated at river scale, it is plausible that they performed better in river water scheduling. Apart from this, office registers in Mahongole village office revealed that the schedule for water allocation was as follows: Monday and Tuesday; Motombaya intake, Wednesday and Thursday; Langwira farm, Friday; Mhwela village, Saturday and Mwatenga village, Kilambo village and NARCO on Sunday. The results suggest that water users may have improved water distribution. Therefore it is plausible that RBG was effective in facilitating implementation of water schedules.

### *Bylaws*

Implementation of rules (bylaws) for regulating water schedules was higher in communities with RBG. Table 7 shows that 85.2% of communities with and 73.5% of communities without RBG implemented bylaws. Implementation of bylaws did not differ significantly between communities with and without RBG ( $p=0.083$ ).

However, the higher positive responses in communities with and higher negative responses in communities without RBG suggest that it is plausible RBG was effective in facilitating implementation of water schedules.

**Table 7: Responses to improvement of local water management institutions in the Mkoji subcatchment of GRR in Tanzania**

Response	With RBG		Without RBG	
	Frequency	Percent	Frequency	Percent
<b>Formation of WUA</b>				
Positive	50	61.8	35	71.4
Undecided	7	8.6	3	6.1
Negative	24	29.6	11	22.5
Total	81	100	49	100
<b>Implementation of water schedules</b>				
Positive	61	83.6	33	71.7
Undecided	3	4.1	3	6.5
Negative	9	12.3	10	21.8
Total	73	100.0	46	100.0
<b>Bylaws for managing water</b>				
Positive	69	85.2	36	73.5
Undecided	3	3.7	3	6.1
Negative	9	11.1	10	20.4
Total	81	100.0	49	100.0

#### 4.4.2 Improve performance of infrastructure for EAW

In this context improved performance of infrastructure refers to improved intakes, maintenance of infrastructure so as to improve water sharing between water users/uses.

##### *Improved intakes*

The study revealed more improved intakes were constructed in communities with RBG than without RBG. Table 8 shows that 72.8% of communities with RBG and

57.1% of communities without RBG constructed improved intake structures. Moreover, the negative responses for communities without RBG were higher than those for communities with RBG. There is a significant difference in implementation of the strategy to “construct improved intakes” between communities with and without RBG ( $p < 0.01$ ). These results explain that the institutions in communities with RBG were more effective in improving infrastructure for partitioning water than communities without RBG. The results suggest that together with improvements in the software (institutions), the hardware (intake) in communities with RBG facilitate improved water management. This is supported by Kalinga (2005) that improvement of the hardware and software in irrigation systems has a positive influence on water management.

Besides presence of improved intakes, field observations revealed that there were five improved intakes, for communities with RBG and one for communities without RBG. Improved intakes in communities with RBG were; Ipatagwa, and Motombaya and Langwira intakes of Mlowo river system, and Rwanda Majenje and Majengo intake of Mambi river system, while communities without RBG had one improved intake (Meta-lunwa intake) of Mpolo river system. However, key informant interviews revealed that these intakes were constructed before 2002 study period.

### *Inefficient canals*

The number of inefficient canals was highly reduced in communities with RBG than without RBG. Table 8 shows that 44.4% of communities with RBG and 36.7% of communities without RBG reduced number of infrastructure. There was no

significant difference in reduction of number of inefficient canals ( $p=0.21$ ). Apart from this, most of the respondents in both communities had higher negative than positive responses. This suggests that RBG may not have been effective in implementation of strategy to reduce number of canals.

### *Maintenance of infrastructure*

There was a high involvement in maintenance of infrastructure in communities with and without RBG. Table 8 shows that about 71.0% of communities with and without RBG responded positive to maintenance of infrastructure. However, there was no significant difference in response to maintenance of infrastructure. Despite the high perceptions in maintenance of infrastructure, these results suggest that it is plausible RBG was not effective in facilitating maintenance of infrastructure.

**Table 8: Responses to improvement of performance of infrastructure in the Mkoji subcatchment of GRR in Tanzania**

Response	With RBG		Without RBG	
	Frequency	Percent	Frequency	Percent
<b>Improved intake structures</b>				
Yes	59	72.8	28	57.1
No	21	26.0	20	40.8
Missing	1	1.2	1	2.1
Total	81	100.0	49	100.0
<b>Reduction in number of canals</b>				
Positive	36	44.4	18	36.7
Undecided	8	9.9	5	10.2
Negative	37	45.7	26	53.1
Total	81	100.0	49	100.0
<b>Maintenance of infrastructure</b>				
Positive	58	71.6	35	71.4
Undecided	8	9.9	7	14.3
Negative	15	18.5	7	14.3
Total	81	100.0	49	100.0

#### 4.4.3 Improve water saving for EAW

##### *Farm size*

Communities without RBG had reduced farm size more than communities with RBG. Table 9 shows that 43.8% of communities without RBG and 41.0% of communities with RBG perceived implementation of reduction in farm size to be high. However, there was no significant difference in implementing reduction in farm size ( $p=0.11$ ). From these results it is suggested that both communities had not effectively reduced their farm size. There are chances that RBG was not effective in promoting water saving through reduction of farm size.

##### *Livestock*

There was a high reduction in number of livestock in communities with and without RBG. Table 9 shows that 51.3 % of respondents in communities with RBG and 52.1% in communities without RBG perceived reduction in number of livestock to be implemented. Perception to lower rate of implementing reduction in number of livestock was more significant in communities with than without RBG ( $p=0.04$ ). Basing on these results it is plausible RBG was effective in facilitating implementation of the strategy to “reduce number of livestock”. However, key informant interviews and field observations showed that there was a government order that obliged all livestock keepers to reduce their herd to a maximum of 50 per household. This could have positively influenced responses on the number of livestock. It is plausible that respondents were reluctant to indicate the real number of livestock that they owned.

### *Crops that demand less water*

Field observations showed that the major farming activity in the area was wet season paddy farming. Table 9 shows that about 35.1% of communities with RBG and 43.8% of communities without RBG responded to grow crops that demanded less water. There was no significant difference in response to grow crops that demand less water ( $p=1.00$ ). However, field observations revealed that there were few farmers' who had embarked to growing cassava in Mambi and Mlowo river systems. It is plausible that the RBG has not been effective in implementing the strategy to grow crops that demand less water.

### *High value crops*

Most of communities with and without RBG were not involved in growing high value crops. Table 9 shows that 15.6% of communities with RBG and 12.5% without RBG had implemented strategy to grow high value crops. Despite these results being too low yet there was no significant difference in growing high value crops ( $p=0.716$ ). However, field observations revealed that there were few farmers who had started picking up Paprika farming. This is a crop in the Solanacea family that is scientifically known as *Capsicum annum*. The crop is a raw material for spice industries.

Field observations revealed that irrigators in Mambi river system especially Rwanda Majenje irrigation system were replacing rice fields with Paprika. Paprika fetched higher income than any other crop in the area; about 1200/= per kilo and one acre gave about 40 bags (each 30 kgs) and is used as a domestic vegetable and as a raw

material in spice industries (Igurusi ward extension officer, personal communication).

### *Fish farming*

Majority of the communities with RBG were implementing fish farming than communities without RBG (Table 9). However the high responses to implementation of fish farming were not significant. During surveys the current study observed that it was uncommon to find fish farming in the area.

However, Mambi river system was taking up fish farming, which replaced paddy fields. Since 2004 Mambi river system has invested on 40 fishponds as a strategy to save water and there is a high potential for fish farming in the area. (Mambi Village Executive Officer, personal communication).

**Table 9: Responses to improvement of water saving in the Mkoji subcatchment of GRR in Tanzania**

Response	With RBG		Without RBG	
	Frequency	Percent	Frequency	Percent
<b>Reduction of farm size</b>				
High	32	41.0	21	43.8
Moderate	22		17	35.4
Low	24	30.8	10	20.8
<b>Total</b>	<b>78</b>	<b>100.0</b>	<b>48</b>	<b>100.0</b>
<b>Reduction in number of livestock</b>				
High	40	51.3	25	52.1
Moderate	11		11	22.9
Low	27	34.6	12	25.0
<b>Total</b>	<b>78</b>	<b>100.0</b>	<b>48</b>	<b>100.0</b>
<b>Grow crops that demand less water</b>				
High	27	35.1	21	43.8
Moderate	36		19	39.6
Low	14	18.2	8	16.7
<b>Total</b>	<b>77</b>	<b>100.0</b>	<b>48</b>	<b>100.0</b>
<b>High value crops</b>				
High	12	15.6	6	12.5
Moderate	31		17	35.4
Low	34	44.1	25	52.1
<b>Total</b>	<b>77</b>	<b>100.0</b>	<b>48</b>	<b>100.0</b>
<b>Implement fish farming</b>				
High	18	22.4	10	20.8
Moderate	15	18.8	9	18.8
Low	47	58.8	29	60.4
<b>Total</b>	<b>80</b>	<b>100.0</b>	<b>48</b>	<b>100.0</b>

## CHAPTER FIVE

### CONCLUSION AND RECOMMENDATIONS

#### 5.1 Overview

The main objective of the study was to determine the effectiveness of RBG on facilitating equitable allocation of water in Mkoji subcatchment of the Great Ruaha River in Tanzania. The previous chapter presented this information. This chapter presents the conclusion and recommendations.

#### 5.2 Conclusion

The following conclusions are made from the current study:

- (i) Averages of nine strategies were identified in RBG that was executed in three scenarios and can be categorized into three main categories all that aimed at EAW namely: improve local water management institutions, improve performance of infrastructure and improve water saving so as to release more water for intersectoral needs
- (ii) Communities with RBG differed significantly in implementing strategies on improvement of local water management institutions and performance of infrastructure for EAW, thus RBG seemed effective in implementing these strategies.
- (iii) Improvement of fish farming was significantly higher in communities with than without RBG. Generally there was no significant difference in improvement of water saving and performance of infrastructure, which may imply that there are chances RBG was not effective on strategies to improve productivity of water and performance of infrastructure during the current study.

### **5.3 Recommendations**

The study recommends the following:

#### **5.3.1 Communities with RBG**

- (i) Although communities with RBG already provide a platform for being involved in water management at river scale there is a need for this to be geared towards intensification of sustainable EAW.
- (ii) Any planned interventions which provide water from rivers, must cooperate with the communities in this context.
- (iii) Efforts have to be made to encourage investment on awareness education and more RBG scenarios should be used, hand in hand with other strategy to review and shape plans for implementing EAW. Moreover local best awareness education practices such as traditional meetings, local government meetings, and family groups should be encouraged.
- (iv) RBG strategies need be developed by specific water use groups to suit their environment and not copied from any other communities. Thus communities, which benefit from a common river, should organize themselves for their own good.
- (v) Communities with RBG should intensify actions on improving EAW. Activities that emerged from the RBG should be investigated in detail so as to judge their role in promoting water conservation and income generation in local communities that share small river basins.

### 5.3.2 Communities without RBG

- (i) As the strategies for improving EAW take place, communities without RBG should learn from those with RBG. They should promote EAW by encouraging inter-river water use negotiations for planning on how to improve EAW.
- (ii) A gap exists on performance of EAW between communities. It is proposed that there is a need to bridge this gap and raise awareness of communities without RBG.
- (iii) Future investment for water development should base on a process of stakeholder dialogue that incorporates tools and methodologies for EAW. Research into possibilities of improving river scale water management in communities without the RBG is necessary.
- (iv) Awareness on the need for sound EAW should be created in communities without RBG starting with the strategically potential local leaders e.g. village leaders, leaders of traditional groups, and water management leaders.
- (v) A WUA should be formed at river scale in communities without RBG. This would bring together all stakeholders.
- (vi) The GVT should embark on dissemination of RBG approaches in the country.

## REFERENCES

- Ambast, S.K., Keshari, K.A and Gosain, K.A. (2002). Satellite remote sensing to support management of irrigation systems: concepts and approaches. *Journal for Irrigation and Drainage* 51: 25-39.
- Barreteau, O. (2003). The joint use of role-playing games and models regarding negotiation processes: Characterization of associations. *Journal of Artificial Social Simulation* 6(2): 34-42.
- Bastiaanssen, W.G.M, Molden D.J and Makin, I.W. (2000). Remote sensing for irrigated agriculture. Examples from research and possible applications. *Journal of Agriculture Water Management* 46: 137-155.
- BBC (2006). Live action role playing games. [[www.bbc.co.uk/dna/h2g2/A\\_264340](http://www.bbc.co.uk/dna/h2g2/A_264340)] site visited on 29/8/2007
- Bellamy, J.A., Walker, D.H., McDonald, G.T. and Syme, G.T. (2001). A system approach to the evaluation of natural resource management initiatives. *Journal of Environmental Management* 63(4): 407-423
- Butts, K.H. (1997). The strategic importance of water. *Parameters* (U.S. Army War College Quarterly), Spring: pp. 65-83.
- Cardenas, J.C. (2003). Real wealth and experimental cooperation: Experiments in the field lab. *Journal of Development Economics* 70(2): 263-289.
- Cleaver, F. (1999). Moral ecological rationality, institutions and the management of common property resources, Paper presented at the African Environments Conference., 5-7 July 1999. Oxford, London 18pp
- Collentine, D., Forsman, A., Galaz, V. Bastviken, S.K. and Stahi-Delbanco, A. (2002). Decision support for stakeholders in catchment areas. *Water Policy* 4(5): 447-463.
- D'Aquino, P., Le Page, C., Bousquet, F. and Bah, A. (2003). Using self designed role playing games and a multi-agent system to empower a local decision making process for land use managers: The self cormas experiment in Senegal. *Journal of Artificial Societies and Social Simulation* 6(3):87-95.
- De Wrachien, D. and Fasso, A.C. (2002). Conjunctive use of surface and ground water: overview and perspective. *Journal of International Commission of Irrigation and Drainage* 51(1): 1-15.
- Dowdeswell, E. (1998). Where peaceful waters flow. *Journal of Water International* 23(1): 13-16.

- Falkenmark, M. (2001). The greatest water problem: the inability to link environmental security, water security and food security. *Water Resource Development* 17(4): 539-554.
- Focus (2005). The River basin game. [<http://www.innovationandresearchfocus.org.uk/ mailing/feedback/asp>] site visited on 20/11/ 2006.
- Food and Agricultural Organization (FAO) (2005). Deficit irrigation scheduling practices. Helping to build a world without hunger. [<http://F:/Spotlight%20Water% 20use%in%agriculture.htm>] site visited on 31/5/2007.
- Global Water Partnership (GWP) (2000). Integrated Water Resource Management. Global Water Partnership/Technical Advisory Committee. Background Paper No. 4, 76p.
- Gonzales, A.C. and Arias, C. (2001). The incorporation of integrated management in European water policy, *Iahs Publication* 272: 69-74.
- Hagmann, J. and Chuma, E. (2002). Enhancing the adaptive capacity of the resource users in natural resource management. *Journal of Agriculture Systems* 73(1): 23-39.
- Hardy, B.W. and Scheufele, D. A. (2005). Examining differential gains from internet use: comparing the moderating role of talk and online interactions. *Journal of Communication* 55: 1-5.
- Hatibu, N., Lazaro, E., Mahoo, H. F., Rwehumbiza, F. B. and Bakari, A.M. (1999). Soil and water conservation in semi arid of Tanzania: national policies and local practices. *Tanzania Journal of Agricultural Sciences* 2(2): 151-169.
- Hooper, P.B. (2002). Design and implementation experience of an Australian prototype catchment information exchange program. *Water International* 27(4): 568-577.
- Hooper, P. B. (2005). *Integrated River basin Governance: Learning from International Experiences*. IWA publishers, Alliance house, London. 306pp.
- Hornecker, E. (2004). Role Playing a design game on participatory urban planning for system evaluation. Position paper for PDC 2004 workshop, Hands-on experiences with design games in collaborative design "Vienna university of technology, Argentinier. [[http://www.ehornecker.de/Papers/PDC04\\_games\\_workshop.pdf](http://www.ehornecker.de/Papers/PDC04_games_workshop.pdf)] site visited on 29/8/2007.
- Iacucci, G., and Vesterinen, E. (2000). Role playing games for concept design of mobile services: A participatory design session to envision with users future mobile services. Poster presentation at Nordich 2000. Royal Institute of Technology, Stockholm, Sweden, 23-25 October 2000.

- Igbadun, E. H., Mahoo, F. H., Tarimo, A. K. P. R. and Salim, A. A. (2005). Productivity of water and economic benefit associated with deficit irrigation scheduling in maize. Proceedings of East Africa Integrated River basin Management Conference 7-9 March 2005. SUA Morogoro Tanzania. 447pp.
- Jaspers, F.G. (2003). Institutional arrangements for integrated river basin management. *Journal of Water Policy* 5: 77-90.
- Kajembe, G.C., Mbwilo, A.J., Kidunda, R.S. and Nduwamungu, J. (2003). Resource use conflicts in Usangu plains, Mbarali district, Tanzania. *International Journal of Sustainable Development and World Ecology* 10: 333-343.
- Kalinga, G.M. (2005). Irrigation management, efficiency and productivity in Tanzania. Issue No. 4. p.16.
- Kashaigili, J. J., Kadigi . R. M. J., Sokile, C. S. and Mahoo, H. F. (2003). Constraints and potential for intersectoral water allocation in Tanzania. *Journal of Physics and Chemistry of the Earth* 28: 20-27.
- Kashaigili, J.J., Kadigi, R.M.J, Lankford B.A, .Mahoo, H.F and Mashauri, D.A. (2005). Environmental flows allocation in river basins: Exploring allocation challenges and options in Great Ruaha River basin in Tanzania. *Journal of Physics and Chemistry of the Earth* 30: 689-697.
- Kulindwa K. (2000). Economics of water resources: Key issues and challenges. *Tanzanian Journal of Population Studies and Development* 7 (1&2): 17-35).
- Lankford, B. A. and Franks, T. (2000). The sustainable co-Existence of wetlands and rice irrigation; a case study from Tanzania. *Journal of Environment and Development* 9(2): 199-137.
- Lankford, B., Sokile, C.S., Yawson, D., Levite, H., Sally, H. (2004). The River basin Game: A role-playing board game for initiating discussions on visions and strategies of water allocation: Workshop report on water resource management for local development. November 7-11, 2004. Aventura, Loskopdam, South Africa. 15pp.
- Lankford, B.A and Sokile C.S (2004). The River basin game manual. IWMI Working Paper No. 75. Colombo: International Water Management Institute.
- Lankford, B. (2005). The River basin Game: A role-playing board game for problem-framing and discussing visions and strategies of water allocation: IPTRID Research Training. 7 December 2005, at ICE Hall, SUA, Morogoro, Tanzania. p.4.
- Lant, C. (2003). Water shed governance in the United States: The challenges ahead. *Water resources update* 126: 21-28.

- Mabiza, C.C. (2006). River basin Game workshop held in Pretoria and Sekororo. South Africa 22 – 25 March 2006. River basin game report p.1-2
- Margerum, R.D. & Born, S.M. (2000). A coordination diagnostic for improving integrated environmental management. *Journal of Environmental Planning and Management* 43(1): 5-21.
- Mbwilo, A.J.T. (2002). The role of local institutions in regulating resource use conflict management: The case of Usangu plains, Mbarali District, Tanzania. Dissertation for award of MSc. Degree at Sokoine University of Agriculture, Morogoro Tanzania 134 pp.
- McCaffrey, S.C. (2001). *The Law of International Watercourses: Non-navigational uses*, Oxford University Press, London. 345pp.
- Meadows, D. and Meadows, D. (1993). *Fish Banks*. Durham, NH, USA: Fish Banks news. University of New Hampshire. p 18.
- Moore, B.M. (2005). Perceptions and interpretations of environmental flows and implications for future water resource management: a survey study. Proceedings of, East Africa Integrated River basin Management Conference. 7-9 March 2005. SUA Morogoro Tanzania. 447pp.
- North, D. (1990). *Institutions, Institutional Change and Economic performance*, Cambridge University Press. Cambridge. 28pp.
- Odell, J., Van Dyke P. H. and Fleischer, M. (2003). The Role of roles. *Journal of Object Technology* 2: 39-51.
- Rajabu, K. R. M., Lankford, B. A. and Mahoo, H. F. (2005). The river basin game as a dialogue and conflict resolution tool in integrated water resources management - a case study of the great Ruaha river basin in Tanzania. RBG poster presentation. WWF. p 6-7.
- RIPARWIN (2002). RBG dialogue with local level water users from Mkoji subcatchment held at Ministry of Agriculture Training Institute Igurusi, Mbeya, Tanzania 11-12 November 2002. River basin game report No. 1. p.5.
- RIPARWIN (2004a). Water Use in the Mkoji Sub Catchment: A Report for the Study Carried out for FAO/ Netherlands Partnership Project. Sokoine University of Agriculture. p. 52.
- RIPARWIN (2004b). Economic water productivity irrigation: Proceedings irrigation efficiency and productivity training workshop: Mbeya Peak Hotel, Mbeya, Tanzania 24-26 May 2004.  
<http://www.iwmi.cgiar.org/Africa/files/RIPARWIN/05> site visited on 28/04/2006.

- RIPARWIN (2004c). RBG dialogue with local level water users from Mambi and Mswiswi held at River basin Water Office, Iringa Tanzania 4-5 November 2004. RBG Report No. 2. p.5.
- RIPARWIN (2005). RBG dialogue with local level water users from Mlowo water users. 18-19th November 2005, Social Hall, Ministry of Agriculture Training Institute Igurusi, Mbeya, Tanzania. RBG Report No. 3. p.5.
- RIPARWIN (2006). Raising Irrigation Productivity and Releasing Water for Intersectoral Needs final wrap up workshop. 7, 8th February 2006, ICE Hall, Sokoine University of Agriculture.
- Sam-amoah, L.K. and Gowing, W.J. (2001). Assessing the performance of irrigation schemes with minimum data on water deliveries. *Journal of Irrigation and Drainage* 50: 31-39.
- Sarwar, A and Perry, C. (2002). Increasing water productivity through deficit irrigation: evidence from the Indus plains of Pakistan. *Journal of Irrigation and Drainage* 51: 87-92.
- Schofield, N., Burt, A. and Connel, D. (2003). *Environmental water allocation: principles, policies and practices, Land and Water*. Australia Product No. PR030541, 38 pp.
- Sharma, B.R., Minhas and P.S. (2005). Strategies for managing saline/alkali waters for sustainable agricultural production in South Asia. *Journal for Agricultural Water Management* 78: (12). 136-151.
- Shaw, M.N. (1997), *International Law*, Cambridge University Press: Cambridge. 86pp.
- SMUWC (2001). Final report, irrigation water management and efficiency supporting report 8. Directorate of water resources, Dar es Salaam, Tanzania. 117pp.
- Sokile, C.S. (2005). *Improvement of institutional frameworks for intersectoral water management: the case of Mkoji sub catchment of the great Ruaha river in the Rufiji basin, Tanzania*. Dissertation for award of doctor of philosophy (Development Studies) of the University of Dar es salaam. 361pp.
- Sokile, C.S., Kashaigili, J.J. and Kadigi, R.M.J. (2003). Towards an integrated water resource management in Tanzania: The role of appropriate institutional framework in Rufiji Basin. *Journal of Physics and Chemistry of the Earth* 28: 20-27.

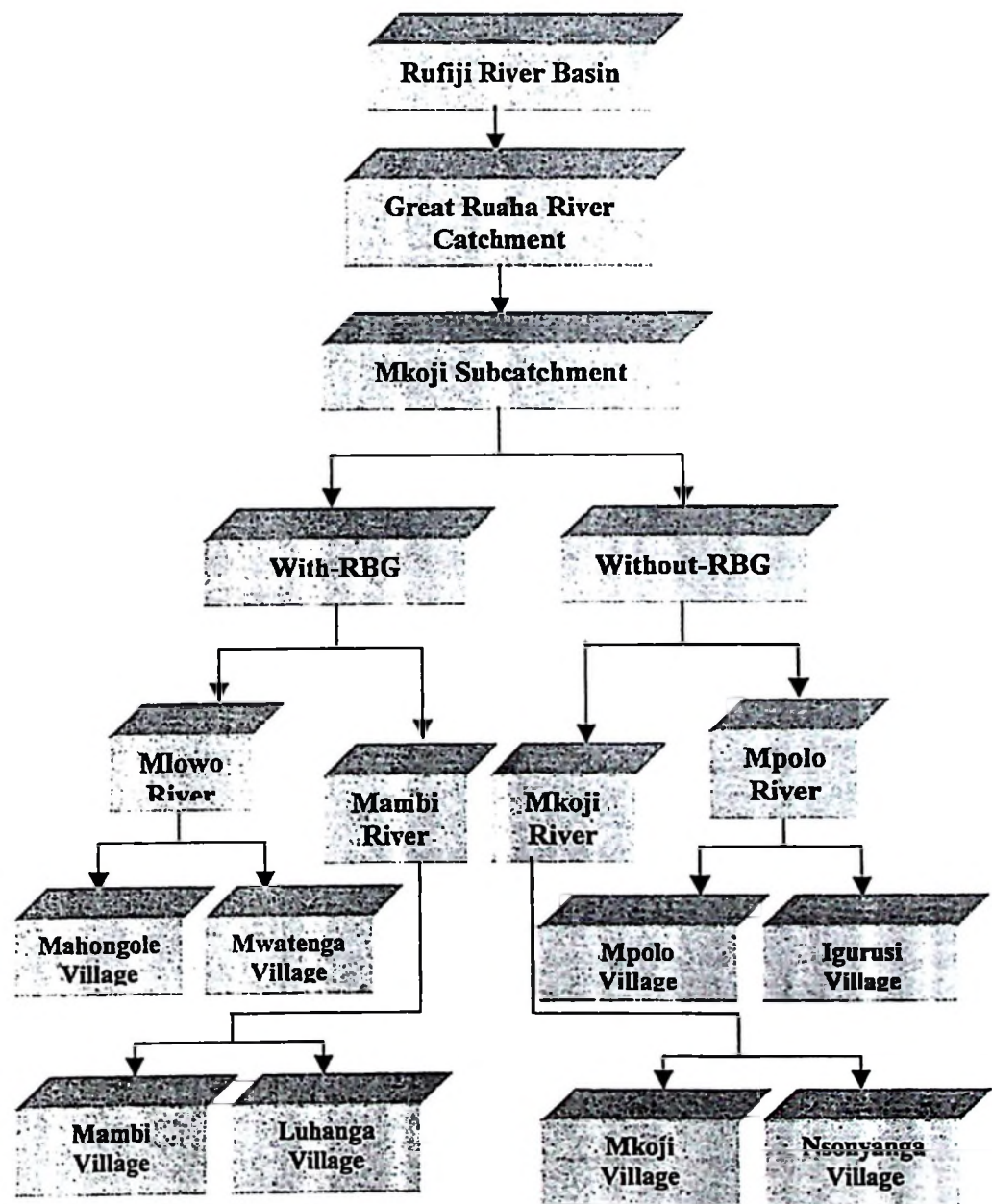
Trochim, M.K.W. (2006). Social research methods.

[[www.socialresearchmethods.net](http://www.socialresearchmethods.net).] site visited on 4/5/2007.

Wester, P., Merrey, D. and De Lange, M. (2003). Boundaries of consent: stakeholder representation in river basin management in Mexico and South Africa. World Development Reports. p 24.

## APPENDICES

Appendix 1: Sampling scheme for questionnaire survey



## Appendix 2: Sample Questionnaires

### A. Household Survey

#### A.1 General Information

1. Date of interview..... 4. Ward .....
2. Name of enumerator..... 5. Name of Division.....
3. Main River ..... 6. Name of Village .....

#### A.2 Background Information

##### Household Information

1. Sex of respondent:
  - (a) Male [ ] (b) Female [ ]
2. Age of respondents in years (If possible estimate the age group).
  - (a) 20-35 [ ] (b) 36-51 [ ]
  - (c) 52-67 [ ] (d) above 67 [ ]
3. What is your education level?
  - (a) Primary [ ] (b) Under primary [ ]
  - (c) Never went to school [ ]
4. Ethnic group of the household member [ ]
  - (a) Nyakyusa (b) Sangu (c) Bena (d) Wanj (e) others
5. Provide the size of your household
  - (a) 1-3 (d) 4 -7 (c) More than 7 [ ]

##### Land availability and land use

6. Give the total land owned by your household ..... (acres)
7. Give land area (acres) under different use systems
  1. Crop production [ ] 3. Land rented [ ]
  2. Fallow [ ] 4. Unfit land [ ]
8. What is the total land allocated for the for the given crops in 2006/07 dry season irrigation
  1. Maize [ ] 2. Beans [ ] 3. Vegetables [ ] 4. Others [ ]
9. What is the model of the acquired land
  1. Purchasing [ ] 3. Inherited [ ]

2. Given by relatives [ ] 4. 2. Allocated by village government [ ]

10. Give the average crop yield for the following

Crop	Average Yield	
	1998-2001	2001-2006
Maize		
Beans		
Vegetables		
Others		
Total		

11. Provide the type of livestock that you own

1. Cattle [ ] 2. Goats [ ] 3. Sheep [ ] 4. Donkeys [ ] 5. Pigs [ ]

12. If you are keeping livestock, what is the number?.....

## B. Implementation of RBG strategies for EAW

### B.1. Improve local water management institutions for EAW

#### *Formation of WUA*

13. How many times have you attended/ done the following on issues pertaining to equitable water sharing

1. FAO meetings [ ] 6. KATC meetings [ ]  
 2. RBMSIP meetings [ ] 7. SUA wksp/Seminars [ ]  
 3. Village campaigns [ ] 8. MATI Igurusi Meetings [ ]  
 4. Visits of ZIO staff [ ] 9. Visits of Researchers [ ]  
 5. Visits of DWO staff [ ] 10. Organized tours [ ]

14. Do you know the meaning of water users or farmers organization?

1. YES [ ] 2. NO [ ]

15. If YES explain.....

16. Do you have any water users' organization at the river scale?

1. YES [ ] 2. NO [ ]

If YES when was it formed? .....

If YES how many villages are involved? (Explain).....

17. Formation of a water users' organization at river scale has been adequately implemented.

1. Strongly agree [ ] 2. Undecided [ ] 3. Disagree [ ]

**Water schedules**

18. Give the major level of water management that you are in

1. Basin or Furrow level [    ]    4. Diversion level [    ]  
 2. Distributary level [    ]    5. River scale level [    ]  
 3. Main conveyance level [    ]

19. Give the mode of water allocation

1. Scramble for water [    ]    3. Supervision of local government [    ]  
 2. Steal water [    ]    4. Water scheduling [    ]

20. Circle one number basing on whether you strongly agree (SA), agree (A), Undecided (UD), disagree (DA), or strongly disagree (SD) that water was available to tail enders during the given years

Scenarios	SA	A	UD	DA	SD
1998 - 2001					
2002-2006					

21. Circle one number basing on whether you strongly agree (SA), agree (A), Undecided (UD), disagree (DA), or strongly disagree (SD) statement.

Items	SA	A	UD	DA	SD
All levels of water management are well coordinated					
Water managers of the livestock communities are happy with the status of EAW					
Water managers of the irrigation communities are happy with the status of EAW					
Farmers and livestock keepers understand the importance of EAW					

22. Do you know the meaning of equitable water allocation?

1. YES [    ]    2. NO [    ]

If YES explain what it means.....

If YES explain how we can acquire equitable water allocation.....

23. Give the status of EAW

1. St-Equitable [    ]    3. Not equitable [    ]  
 2. SW-equitable [    ]

24. Where did you get information on EAW

1. Seminars/wks [    ]    4. VEO's [    ]    7. Family [    ]  
 2. NGO's [    ]    5. Meetings [    ]    8. Peers [    ]  
 3. Training [    ]    6. Leaders [    ]    9. Farmer gps [    ]

25. Do you have any defined water schedules for water management at river scale?

1. YES [ ] 2. NO [ ]

If YES explain? .....

26. Water allocation is done through defined water schedules

1. Strongly agree [ ] 2. Undecided [ ] 3. Disagree [ ]

27. Has water in the river ever dried completely?

1. YES [ ] 2. NO [ ]

28. Which of the following are most important water uses for you ?

Category of activity	Tick	Type of water use	Rank
Agriculture		Agriculture	
Livestockkeeping		Livestock	
Fisheries		Fisheries	
Brick making		Domestic use	
Agriculture/livestock		Environmental	
Others (mention)		Hydropower	
		Brick making	

29. Suppose you have more than one water source, which would you prefer most?

Water use	Water source			
	Tap water	Wells	River	Ponds/dams
Domestic use				
Irrigated agriculture				
Livestock keeping				
Fisheries				
Brick making				

30. Circle one number on whether you strongly agree (SA), agree (A), undecided (UD), disagree (DA) or strongly disagree (SD) statement

Item	SA	A	UD	DA	SD
1. EAW provides water for Hydropower production					
2. EAW provides water for irrigated agriculture					
3. EAW provides water for Livestock					
4. EAW provides environmental water requirements					
5. EAW provides water for brick making					
6. EAW provides water for domestic use					
7. EAW minimizes conflicts over water					
8. EAW may help to improve weather conditions					
9. EAW does not increase pressure to land that is closer to the catchment					
10. EAW helps to improve income of communities at river scale					

31. How do you recognize there is shortage of water for irrigation and/ livestock?

1. Less than
2. one third of the required water is available [    ]
3. Less than half of the need is available [    ]
4. Less than a quarter of the need is available [    ]
5. No water completely [    ]

32. In case there is water shortage, are you ready to use water less than your need so as to provide for other downstream water users?

1. YES [    ] 2. NO [    ]

If No give any reason(s) why?.....

If YES, how much are you ready to reduce?

1. a quarter [    ] 2. one third [    ] 3. half [    ] 4. three quarters [    ] 5. one quarter [    ]

32. Are there any government officials who visit you to advise or provide services on water allocation?

1. YES [    ] 2. NO [    ]

If YES explain.....

***Bylaws***

33. Do you have any defined bylaws for water management at river scale?

1. YES [    ] 2. NO [    ]

If YES explain? .....

33. Bylaws are being implemented

1. Strongly agree [    ] 2. Undecided [    ] 3. Disagree [    ]

35. Which of the following are the most three used to facilitate EAW

(Assign No's 1-3) with increase in importance

1. Mutual agreements between inds [    ]
2. Farmers organization and bylaws [    ]
3. Village Government [    ]
4. Ward government1 [    ]
5. District water office [    ]

36. Have you ever been involved in conflict for water?

1. YES [    ] 2. NO [    ]

If YES explain the cause of water conflict.....

Is there any security in accessing water from the river?

1. YES [ ] 2. NO [ ]

If YES explain.....

**B.2. Improve performance of infrastructure for EAW**

*Improved intakes*

37. Are there any improved intake structures at your river scale?

If yes how many.....

38. Do you prefer improved intakes to traditional intakes?

1. YES [ ] 2. NO [ ]

If NO explain.....

If YES explain.....

39. Which of the following are the most three constraints in EAW? (Assign no.s 1-3; where 1 is the most constraint)

Constraint	1	2	3	4	5
Institutional					
Infrastructure					
Policy					
Financial					
Education					
Environmental					

40. Rate the following causes of EAW using scales 1 – 6 whereby 6 is the highest.

1. Farmers organization [ ]

2. Water scheduling [ ]

3. Many water users and or uses [ ]

4. Improve infrastructure [ ]

5. Government involvement [ ]

6. Seminars on water sharing [ ]

41. How do you rate the performance of improved infrastructure?

1. Very high [ ] 4. Low [ ]

2. High [ ] 5. very low [ ]

3. Moderate [ ]

42. Reduction in number of canals has been implemented

1. Strongly agree [    ] 2. Undecided [    ] 3. Disagree [    ]

43. Rehabilitation/maintenance of infrastructure has been adequately implemented.

1. Strongly agree [    ] 2. Undecided [    ] 3. Disagree [    ]

44. Rate the following causes of EAW using scales 1 – 6 whereby 6 is the highest.

1. Farmers organization [    ]

2. Water scheduling [    ]

3. Many water users and or uses [    ]

4. Improve infrastructure [    ]

5. Government involvement [    ]

6. Seminars on water sharing [    ]

### B.3. Water saving strategies

45. Which out of the following are the most widely implemented water saving strategies? Rank them using 1 – 6 where 6 is the most used strategy.

1. Fisheries [    ] 4. Rehabilitate infrastructure [    ]

2. High value crops [    ] 5. Grow crops that demand less water [    ]

3. Decrease farm size [    ] 6. Reduce number of livestock [    ]

46. What is the distance from your farm or Livestock shade to the water source or watering point?

Distance (Km)	1990's	2002-2006
1. 0 – 1km		
2. 2 – 3 km		
3. 4 – 5 km		
4. more than 5km		

**Checklist for District Officers/Ward/Village/Agriculture Officers**

1. What are your views on the current status of equitable water allocation in Mkoji subcatchment?
2. What are the currently water sharing approaches used in this area?
3. For how long has water management, at river scale, been promoted in this area?
4. What extension approaches do you think would be appropriate in helping to promote equitable water allocation in this area?
5. What constraints do you face in implementing water management extension work?
6. What constraints do farmers face in sharing water in this area? What do you recommend do be done for equitable water allocation in this area?
7. What was the target group in the village as far as promotion of equitable water allocation
8. Mention two of the most important approaches that you think have had a positive influence to EAW in Mkoji subcatchment
9. What are three major recommendations to improve EAW in Mkoji subcatchment

**Checklist for Ward/ Division/Village Leaders**

1. Is there any extension worker in your area of governance?
2. What is or are his/her main activities?
3. Has there been any government involvement activity related to water in this village?
4. If yes, what type of involvement?
5. Are there any non-governmental organizations involved in water allocation?
6. Who were the target group in the village as far as promotion of water allocation is concerned?
7. In your view (s) what do you think are the main causes of the current status of water allocation among water users and uses in your area?
8. Does the village have any bylaw to protect water allocation and or water management?
9. If YES what does it advocate? .....

10. How do you rate its effectiveness on implementation?.....
11. Is there any committee in the ward/village government concerned with water management or allocation?
12. What is your recommendation for the success of water sharing among water users and uses in this area?

**THANK YOU VERY MUCH**

### Appendix 3: T-test statistic results

#### Paired Samples t-Test

Pairs	Variable	Mean	Std.Dev.	Std. Error Mean	df	Sig. (2-tailed)
Pair 1	Formation of common WUA	0.65	0.997	0.152	42	0.000
Pair 2	Water schedules	0.22	0.652	0.102	40	0.037
Pair 3	Bylaws	0.14	0.510	0.077	43	0.083
Pair 4	Reduce no. of canals	0.16	0.824	0.123	44	0.212
Pair 5	water saving	0.24	0.675	0.110	37	0.037
Pair 6	Maintenance of intakes	0.62	0.924	0.152	36	0.000
Pair 7	Fisheries	0.49	0.702	0.119	34	0.100
Pair 8	Reduce farm size	0.29	0.784	0.171	20	0.110
Pair 9	Crops that demand less water	0.00	0.679	0.182	13	1.000

\* Significantly different (P<0.01). \*\*Significantly different (P<0.05)

**Appendix 4: RBG board and role playing**



First version of RBG board, in Tanzania. Source: SWMRG. (2006)



Water users using second version of RBG (role playing). Source; SWMRG (2006)



How water users in Mkoji subcatchment used the RBG to develop strategies aimed to improve equitable allocation of water. Source; SWMRG (2006)

## **Appendix 5: Summary of results from key informant interviews**

The key informants who were basically the elderly and some knowledgeable people in the study area were contacted for detailed clarification of the issues that arose from RBG workshops and household questionnaires.

### **1.0 District/Ward/Village Agriculture Officers**

- (i) Generally water allocation is not equitable but some communities e.g. Mlowo are aware of the need for EAW
- (ii) Local arrangement and influence of the district river basin water office are the major approaches used in the area to promote water sharing. The river basin, among others ensures closure of all intakes, which do not have water rights.
- (iii) FAO (Usangu village irrigation project) has been organizing irrigators to form water users for rehabilitated irrigation systems in Mswiswi, Mlowo, Mambi and Mpolo river system in which a National water user association expert (Mr. Gurrung) took the leading role. These associations did not link schemes; each scheme formed its own WUA.

RBMSIIP influenced farmers to form their own WUA in Rwanda Majenje (Mambi river system) and Ipatagwa irrigation scheme

Mbarali river basin water office used the RBG to form Mlowo WUA.

- (iv) Constraints include dry season irrigation done by improved irrigators in improved intakes that were meant for wet season irrigation, conflicts between irrigators and livestock keepers, lack of transport for day to day field visits.
- (v) Major constraints in sharing water include irrigation communities being favored in terms of location (located upstream), water demand greater than available water in the dry season, lack of adequate extension services on water allocation, lack of knowledge on water management.
- (vi) Farmers need more exposure to water allocation knowledge.

## 2.0 Ward/Division/Village Leaders

- (i) Each of the studied wards had an extension worker
- (ii) Major duties of the extension workers included water management and in particular infield water management for improved crop production. However, river basin water allocation was not part of their day to day activities.
- (iii) The government has been involved in water management activities since 1980's. Major type of involvement was on promoting water availability for rice production and organizing irrigators to form associations for water management at scheme level.
- (iv) Local arrangements are the major causes of the current status of water allocation at river scale. At scheme level, water rights are not provided unless the farmers are organized into an association. Generally, results revealed most water users comply with local associations than those advocated by the government. Local informal associations are influential, powerful and attractive to the local communities.
- (v) Bylaws are in place but not being followed. There are some few observations on by laws being followed in Mlowo river system.
- (vi) Mlowo river system has a river scale water user association. Mambi, Mpolo and Mkoji rivers do not have associations that involve livestock keepers.
- (vii) Most respondents recommended training to water users and leaders for success of water sharing among water users and uses

**Appendix 6: Comparison of strategies developed by different river systems**

Strategy	Mambi river	Mlowo river
Reduce farm size	√	X
Grow alternative drought resistant crops	√	√
Plant fast growing, short duration seed varieties such as <i>Waiwai</i> rice variety	√	X
Diversification to other livelihood supporting activities	√	√
Form an irrigation and livestock water use association	X	√
Implement defined water schedules	X	√
Implement defined bylaws to control water abstraction	X	√
Improve water saving; especially decrease farm size and livestock	√	√
Canal cleaning	√	√
Construct drainage systems that return water flows into the main river	X	√
Dig wells to harvest water	X	√
Establish and use cropping calendars	√	√
Use improved seed varieties	√	√
Construct modern intakes	X	√
Decrease unnecessary infrastructure	√	√

√ = developed strategy X= did not develop this strategy