Ghent University

Faculty of Political and Social Sciences

Academic Year 2011-2012

Sharing Scarce Common Resources

Local Water Governance in Semi-Arid Sub-Sahara Africa

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Dissertation Presented in the Fulfilment of the Requirements for the degree of Doctor of Political Sciences

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Summary

This dissertation examines how scarce common resources are shared. It deals with common water flows that are largely self-governed by the user communities in semi-arid sub-Sahara Africa. More particularly, it studies how Tanzanian smallholder irrigators share irrigation water which is regularly in scarce supply. The dissertation includes three major parts in which different issues related to local water governance and competition over water are addressed.

The first issue that is addressed is the distribution of common pool resources in socially heterogeneous communities. Whereas there is ample literature on the efficiency and sustainability of common pool resource governance in economically heterogeneous communities, little attention is paid to the distribution of resources or to the effect of social differences. Gender and the relative social status of the common pool resource users are two sources of social heterogeneity that relate to the users' positions in their communities' power structure. These social factors not only determine the value the users allot to the resource but also the extent to which the users abide by the prevailing norms that regulate resource distribution. Eventually, these social factors define the users' capability to gain access to the common resource.

This issue is worked out in Part II. A framed field experiment, conducted with actual users of self-governed smallholder irrigation systems in semi-arid Tanzania, is used to examine the effect of users' gender and relative social status on fairness in the distribution of water. Distribution behaviour under conditions of water abundance and water scarcity are looked at. More specifically, Part II investigates whether male and female irrigators share resources in a different way and whether they react differently to water scarcity. Furthermore, it examines if irrigators' social status affects the way irrigators share resources when water is abundant and when it is scarce and whether the effect is similar for male and female irrigators. It also determines to what extent real life observations substantiate the experimental findings.

It is observed that female irrigators distribute water in an altruist way and male irrigators in a fair way when water is abundant in the experiment. A higher social status has a negative effect on the share irrigators propose to others but not so among female irrigators. When water is scarce in the experiment, all reduce the share they propose to others, although irrigators with a higher social status reduce it less substantially. On the whole, male and female irrigators with a relatively low social status propose more than equal shares of water in abundance but they do not when water is scarce. Female irrigators with a relatively high social status distribute water in an altruist way when it is abundant. Even if they reduce their proposed share in scarcity, they remain fair. Male irrigators with a relatively high social status distribute water in a selfish way throughout abundance and scarcity.

It is concluded that equity in the distribution of common pool resources is not evident. Embedded social differentiation linked to gender and social status plays a significant role for the willingness and ability to fairly distribute water in these rural African irrigation systems. Water scarcity further intensifies differences in distribution behaviour. Consequently, the gender- and status-related unfairness in the distribution of resources could challenge the sustainability of self-governed common water flows as it undermines trust, reciprocity, mutual commitment and resource provision. The differential water access that results from it could reinforce gender and status-based inequalities. Water scarcity is likely to exacerbate such drawbacks. Policy that builds on community governance of natural resources but remains blind for structural impediments to a fair distribution of water may fail to attain sustainable and equitable water governance, especially if climate change increases water scarcity.

A second issue that is addressed in this dissertation relates to the local institutions for common pool resource governance. In fact, when natural resources are common property, there are particular ways and specific institutions to deal with resource access and competition. But user communities do not necessarily rely on a fixed set of institutions to govern access and conflict over common pool resources. Part III addresses some persistent fallacies about local resource governance institutions and their evolution by making use of data on how resource conflicts are solved in Tanzanian smallholder irrigation schemes.

Part III starts from the observation that water governance in Tanzania's smallholder irrigation schemes has become ever more challenging because of increasing market penetration, declining predictability of water availability and widening institutional pluralism. Despite these trends, resource conflicts at the local level have generally been avoided. Instead, one observes processes in which actors involved in conflicts make and remake institutions. This renders these irrigation schemes interesting for studying water governance institutions under construction. By documenting how conflicts over water are solved in smallholder irrigation schemes in rural Tanzania, we show that resource conflicts are not necessarily disruptive nor do they inevitably lead to violence. Instead conflicts may prompt processes of pragmatic problem solving through which local resource governance institutions are reproduced.

Another fallacy that is refuted in Part III is that institutional pluralism is systematically exploited in opportunistic ways. Actually, institutional pluralism can be an asset for the making and remaking of local resource governance institutions because it can be used in a creative way to resolve resource conflicts. As such, it can contribute to the development of more sophisticated and locally adapted resource governance institutions.

Part III also shows that pragmatic and creative conflict-solving in institutional pluralist contexts is not an impartial process. Actors' positions in the local power structure play a decisive role in this process, which risks further entrenching existing power imbalances. Therefore, despite its potential, actor-driven development of resource governance institutions can also reproduce deeply entrenched power imbalances and gender roles. As such, it can hinder inclusion of less powerful resource users because the latter do not always have the capability to engage in creative conflict resolution.

The third issue this dissertation deals with relates to resource conflicts. Studying competition for scarce natural resources inevitably leads to the debate on the relation between resource scarcity and violent conflict. Conflicts over water have been at the centre of attention for some time. Not only has a future of inter-state water wars been forecasted, also the internal, civil conflicts that mark the last decennia have been linked to an increasing scarcity of natural resources like water or cropland. While the literature provides bits and pieces of the answer on how resource scarcity and conflict relate, there is little evidence of a relation between resource scarcity and the individual predisposition towards conflictive behaviour.

Part IV provides evidence of the relation between resource scarcity and the individual predisposition towards conflictive behaviour by making use of a framed field experiment. The experiment replicates water appropriation dilemmas in common water flows under circumstances of water abundance and water scarcity. It is conducted with smallholder irrigators from semi-arid Tanzania of whom we have data on their socio-economic characteristics. Three questions guide the analysis of the experimental findings. First, it is examined whether water scarcity induces a reduction of water extraction as the common pool resource thesis predicts; or whether it introduces competition as the resource scarcity conflict thesis predicts. Secondly, it is determined what types of irrigators are more inclined to react in a conflictive way to water scarcity. Thirdly, by putting the findings in a broader perspective, it is evaluated to what extent real life circumstances are such that resource scarcity could engender conflict in Tanzania.

The experiment shows that water scarcity introduces competition. Water scarcity induces selfishness in the experiment despite the strong non-competition norms that regulate water appropriation in the irrigator communities and despite the fact that this is considered conflictive behaviour. But not all react to water scarcity in the same way. By combining experimental evidence and survey data it is found that mainly the poor, the ones with little extensive social networks and the ones for whom irrigation water is critical for agricultural production are more inclined to react in a conflictive way to scarcity by being selfish. Viewed from a wider perspective, it is concluded that circumstances in Tanzania could be conducive to resource scarcity conflicts. The ones who are more likely to react in a conflictive way to water scarcity in the experiment suffer from real economic and political inequalities which could form a basis for mobilisation for more violent ways of competing for scarce

resources. At the same time, water governance institutions entail exclusionary elements that are likely to disfavour the same people. These factors concur with climate change and other socio-economic developments that increase competition for increasingly scarce water.

Acknowledgements

Ik heb doctoreren ervaren als een proces met vele uitdagingen, met tal van hoogtepunten en met enkele dieptepunten. Doctoreren is ook zoveel meer dan het schrijven van het proefschrift. Voor mij betekende doctoreren een kans om een goed gevulde boekenkast vakliteratuur te doorploegen, een kans om mij verder te verdiepen in onderzoek rond ontwikkeling, een kans om mijn organisatorische talenten aan te wenden tijdens het veldwerk, een kans om interessante mensen te ontmoeten en ideeën uit te wisselen op allerhande conferenties en workshops, een kans om kennis over te brengen naar studenten en een kans om mij te engageren voor ontwikkeling in het Zuiden, iets wat ik hoop te blijven doen. Doctoreren is bij tijden een vrij solitair gebeuren. Niettemin is het een proces waarin verschillende invloeden meespelen en waartoe vele mensen op verschillende wijze bijdragen, bijvoorbeeld door input te leveren maar ook door voor aangename afleiding te zorgen. In dit dankwoord wil ik enkele mensen expliciet bedanken voor het steentje dat zij hebben bijdragen.

Vooreerst wil ik Anne Walraet, mijn promotor, bedanken voor haar vertrouwen in mijn aanpak, voor haar kritische en sturende commentaren en voor haar begrip. Koen Vlassenroot wil ik bedanken voor de opportuniteiten die hij mij heeft geboden, voor de aanmoedigingen, voor de feedback maar ook voor de gezellige praatjes.

Ben D'Exelle wil ik bedanken voor de geslaagde samenwerking in Tanzania en erna. Zijn input en feedback zijn enorm waardevol. Zijn professionalisme en enthousiasme werken aanstekelijk.

Met Jeroen Adam voerde ik diepgaande gesprekken over methodologie, ethiek en de keerzijde van zelfstandig onderzoek. Maar we hadden ook luchtige babbels over 'de dingen des levens'. Bedankt hiervoor. Timothy Raeymaekers wil ik bedanken voor zijn feedback en voor de discussies die we voerden.

Kristof, Haidari, Godefroid, Bertine en andere bureaugenoten van kortere of langere duur wil ik bedanken voor de uitwisseling van ideeën, de gesprekjes tussendoor en voor de aangename werksfeer[1]. Mijn collegas wil ik bedanken voor de gesprekken in de wandelgangen en de pauzes in het 'broodjeskot' of in het zonnetje op de binnenkoer bij een broodje en een soepje.

Katleen, een goeie vriendin en een voorbeeld voor mij, wil ik bedanken voor de vele jaren vriendschap. Pascale is een goeie vriendin die altijd voor mij klaar staat en met wie ik graag afspreek om even een pauze te nemen. Bedankt, Pascale, voor je vriendschap en je morele steun. Valerie en

[1] In English: I want to thank Kristof, Haidari, Godefroid, Bertine and other colleagues with whom I shared the office for the exchange of ideas, the talks we had and for the pleasant work atmosphere.

En Français: Je voudrais remercier Kristof, Haidari, Godefroid, Bertine et les autres collègues avec qui j'ai partagé le bureau for les échanges d'idées, pour les conversations et pour une ambiance de travail conviviale.

Riyad, Rudy en Anne-Marie, Jo en Raquel, Joachim en Mujo, Bart en Bernadette, Emelda Ifwagi, Sofie en andere vrienden verspreid over de hele wereld wil ik bedanken voor hun vriendschap, hun aanstekelijke levensvreugde en hun gastvrijheid.

I want to thank Charles Kyando for his insight in how to put research into practice, for his skills as a team leader/facilitator/problem-solver/networker, for his knowledge of 'the rules of the game' of field research, for his entertaining company and for his friendship. I thank Betty Ntambo, Haidari Nawabu and each of the interviewers for their professionalism and their enthusiastic work spirit. My gratitude also goes to Dr. Beatrice Mkenda for reviewing the research proposal and for recommending it. I would like to thank Dr. Faustin Maganga, Dr. Kamaldin Mutabazi and Rehema Tukai for their advice and for sharing their knowledge. I am grateful to Incomet and Mucoba for the logistic support. I want to thank Mr. Mahali for facilitating our stay in Mafinga. I also want to thank the respondents for their contribution to this research and for their time. Shukrani zaidi, napenda kuzitoa kwa wakulima wanaotumia mfumo wa mbinu za asili za umwagiliaji. Nawashukuru sana kwa ushirikiano, na zaidi ya yote kwa muda wao pia.

My gratitude also goes to various people who have been an inspiration, who have introduced me to the essentials of development research or who have confronted me with biases in the course of my career in development. Prof. S. Dercon, Prof. J. Semboja, Prof. J.-P. Platteau, Rafael Mkemwanga, Jonanita Magongo are some of them. I should also include many people I have met in Tanzania, or elsewhere in Africa, who remained anonymous passers-by but who contributed to my understanding of living in a development context.

Mijn dank gaat uit naar de Universiteit Gent, de Faculteit Politieke en Sociale Wetenschappen en de vakgroep Studie van de Derde Wereld voor de mogelijkheden en financiële ondersteuning die deze hebben geboden. I want to thank MICROCON for being an inspiring network and for the financial support without which this research would not have been possible.

Mijn ouders wil ik bedanken voor hun nooit aflatende aanmoediging, steun en vertrouwen in mij. Ik ben hen ook dankbaar voor hun hulp op alle fronten. Mijn moeder wil ik extra bedanken omdat zij altijd klaar staat om mij op alle mogelijke manieren te helpen en om onze kinderen op te vangen wanneer de combinatie werk en gezin weer een organisatorische uitdaging vormde.

Björn wil ik bedanken omdat hij mijn bron van inspiratie, mijn officieuze co-promotor, mijn persoonlijke peer-reviewer, mijn co-auteur, mijn helpdesk voor meer ingewikkelde statistische kunstjes, mijn klankbord bij geklaag en mijn steun en toeverlaat is. Maar bovenal wil ik hem bedanken voor zijn onvoorwaardelijke steun en liefde. Een paragraaf in mijn dankwoord volstaat echter niet om Björn te bedanken voor alles wat hij voor mij betekent...

Mijn kinderen, Lisa en Mauro, wil ik bedanken voor wie ze zijn en voor wat ze voor mij betekenen. Aan hen wil ik dit werk opdragen.

Els Lecoutere, 23 juni 2011

Introduction

This research is about sharing water, which is an essential and scarce common resource in semi-arid development contexts. Water is an intriguing type of good with unique characteristics. Access to and conflicts over water have far-reaching implications for people's livelihoods in development countries. Water is a complicated matter...

The increasing demand for water and the rising competition for it are issues of recent concern. Climate change reduces rainfall and increases variability in rainfall. This puts water governance and equity in the distribution of water under additional strain. Population growth and economic developments, such as a more market oriented rural agriculture, further contribute to a higher demand for water.

These evolutions make that water governance and equity in the distribution of water have become security issues. From a security perspective, it is important to understand the relation between accessing scarce natural resources and conflict. Decentralised water governance is expected to avoid conflict to some extent. But a detailed understanding of how conflicts are generally avoided and what specific local resource governance institutions can accomplish this is lacking. Besides, little is known about individual incentives to react in conflictive ways to resource scarcity even if conflict essentially originates from individuals' behaviour (Verwimp, Justino, & Brück, 2009). Even less is known about how social or economic disparities may produce different incentives. Therefore, an understanding of individual predispositions to conflictive behaviour in response to resource scarcity and insights into local governance of resource conflicts are essential to counter possible water scarcity conflicts, especially in the light of increasing scarcity and rising competition.

The last decennia are also marked by decentralising natural resource governance and building on local governance of natural resources assuming that this will enhance efficient, sustainable and equitable resource use. But this is not necessarily the case. There is a substantial literature on what circumstances and which community characteristics are conducive to efficient and sustainable use of common pool resources use. Equity is not as well researched even if it is essential to maintain trust and reciprocity which are key elements in local governance of common pool resources. Equitable use of natural resources also aids to avoid conflicts that may root in frustrations due to discrepancies in resource access. Therefore, a realistic and convincing account of local natural resource governance will reveal why it does not necessarily produce an equitable distribution of available resources. Such an account will uncover how such inequalities come about and how they are reproduced. This can aid policy makers to more adequately address these issues.

Besides, the distribution of natural resources, especially of essential agricultural production factors like water, is of uttermost relevance from a development perspective. The distribution of water has important implications for livelihood opportunities of semi-subsistence farmers in a development context. The livelihoods of smallholder semi-subsistence farmers tend to be particularly vulnerable to inadequate and insecure water access. In general, their production systems and their livelihoods are heavily dependent on natural resources like water and they have limited access to appropriate technology to deal with high variability in resource access (Orindi & Huggins, 2005). Moreover, uncertainty about adequate water supplies forms an additional risk in the production process. This may lead to ex-ante risk management by choosing less water dependent crops and by abstaining from investment in more water dependent cash crops like tomatoes. Such low risk portfolios typically generate lower return and may contribute to a poverty trap (Dercon, 2005).

This dissertation is structured as follows. The introductory Part I includes a review of theoretical perspectives on access to and conflict over water and a discussion of the methodology and research design. It also elaborates on water resources and water policies in Tanzania. Part II deals with sharing common water flows. It looks at the effect of gender and social status on fair distribution of water in smallholder irrigation schemes by means of a field experiment. Part III treats of local common pool resource governance. It provides an analysis of institutions for conflict resolution in Tanzanian smallholder irrigation schemes. Part IV deals with water scarcity conflicts. It uses a framed field experiment with irrigators in semi-arid Tanzania to analyse the propensity to react in a conflictive way to water scarcity. Part II, Part III and Part IV are separate essays. The dissertation ends with a general conclusion.

Access to and Conflict over Water: Theoretical Perspectives

Water is a productive natural resource that is essential, non-substitutable, renewable, rival, diffuse and not lootable. It has a low marginal value but a high total value. Scarcity makes such resources valuable and raises competition for it (Ekins, Simon, Deutsch, Folke, & De Groot, 2003; Le Billon, 2001; Savenije, 2002).

In particular, this dissertation treats of competition for common water flows. When natural resources are neither private nor public property but are common property, there are particular ways and specific institutions to deal with competition. The literature on common pool resources in new institutional economics tackles such issues. However, this strand of literature pays little attention to the fact that institutions that deal with competition are shaped by the agency of those implicated in the common pool resources. It largely ignores that competition for scarce common pool resources involves contestation among socially and economically differentiated users who can exercise more or less power to shape institutions and to gain access to resources (Leach, Mearns, & Scoones, 1999) (Cleaver, 2002; Mehta, Leach, & Scoones, 2001). Such issues are the domain of the post-institutionalist literature.

Studying competition for water unavoidably leads to the ongoing debate about the relation between renewable natural resources and violent conflict. There are three main lines of thinking. According to the environmental security literature scarcity of renewable natural resources such as water is a likely cause of violent conflict (Homer-Dixon, 1999). The common pool resource (CPR) literature purports that conflicts over scarce resources can be overcome with a suitable set of institutions (Ostrom, 1990). The political ecology literature admits that competition for scarce natural resources can give rise to violent conflict. But it does not necessarily do so. Nor is the relation a direct causal one. This strand of literature argues that conflicts that appear to arise over scarce resources are likely to be embedded in history and in broader social tensions. They are likely to happen in concurrence with other factors that are conducive to violent conflict (Le Billon, 2001; Peluso & Watts, 2001; Turner, 2004).

While the analysis of conflict often takes a macro-perspective, conflict essentially originates from individuals' decisions. A micro-level perspective is more appropriate to understand why individuals, who repeatedly interact with their surroundings, decide to engage in violence, for instance while competing for natural resources (Verwimp et al., 2009).

In the following sections we first describe the particular characteristics of water. Then we review the main contributions of the different strands of literature that deal with access to resources, resource governance and conflicts over resources. We discuss some of the shortcomings and identify the gaps in the literature that will be addressed in this research.

Water: A Special Type of Good

Water has unique characteristics (Savenije, 2002). First, water is essential. Without it there is no life, no economic production and no environment. Besides, water has no substitutes. Secondly, water is scarce. The amount is limited by the amount of freshwater that circulates through the atmosphere in an interconnected system. The fluid and rival nature of water makes that this system risks congestion and is characterised by downstream externalities. Moreover, the fluidness and bulkiness make that water is mostly not freely tradable. Only to some extent water can be traded, for instance in the form of 'virtual water' which is the water used in the production of a good or service (Allan, 2003)[2]. Besides, a market for water would not be homogeneous. Some users, like domestic users and industry, demand a small amount of water and have a high willingness to pay. Other users, like farmers, have higher demand but a lower willingness (and ability) to pay. The environment has no ability to pay. The market may not be the best suited forum to make trade-offs between these different user categories (Savenije, 2002). Besides, treating water as a private, tradable good is objectionable given the fact that water is critical natural capital, is essential and non-substitutable (Ekins, Simon et al. 2003; (Savenije, 2002).

As a good, water shows similarities with public goods because of its low excludability, the societal dependency and the (high) provision costs that result in positive externalities that are not easily remunerated (Savenije, 2002). Water differs from public goods because of its rival nature (Apesteguia, 2006). In most of its forms, water has the characteristics of a common pool resource. A common pool resource is a natural or man-made resource system, whose size or characteristics make it costly, but not impossible, to exclude potential beneficiaries from obtaining benefits from its use (Ostrom, 1990, p. 30).

The Literature on Common Pool Resources in New Institutional Economics

Classical economic theory is well suited to predict the exchange of private goods in full-information, competitive market settings (Cardenas & Ostrom, 2004). But it is ill-adapted to explain interactions over common pool resources or public goods. These are characterised by their low-excludability. Besides , providing public goods and common pool resources (CPR) entail social dilemmas where individual incentives may oppose group incentives (Cardenas & Carpenter, 2008). The behaviour of individuals who contribute to the provision and who use public goods or CPR is not only motivated by economic factors such as material preferences, technology, and endowments. It is also motivated by social and psychological factors such as bounded rationality, social norms or social preferences (Cardenas & Carpenter, 2008). Individuals may be motivated by a combination of self-interest and

[2] Virtual water is defined as the volume of freshwater used to produce the product, measured at the place where the product was actually produced (Hoekstra & Chapagain, 2007).

other preferences, such as altruism, reciprocity, inequity aversion, or conformity (Velez, Stranlund, & Murphy, 2009). The challenge is to construct a theory of human behaviour building on the classical economic model while including a wider range of motivations for individuals' behaviour (Cardenas & Ostrom, 2004).

Ostrom (1990) took on the challenge to build a theory on common pool resources (CPR). This theory refutes Hardin's (1968) pessimistic view on the commons. In this view, open access to common pool resources inevitably leads to unsustainable overuse of the resources. The theory on CPR also counters Olson's (1965) view that rational self-interested individuals will not act in their common interest unless it concerns a small group or unless there is coercion. Such views led to presumptions that only central government should control natural resource systems or else that privatisation should provide incentives for sustainable and efficient resource use.

Ostrom (1990) theoretically and empirically proved that users of common pool resources can make binding contracts to commit themselves to a cooperative strategy. Institutions, as rules of the game, are able to produce commonly beneficial outcomes by substituting for incomplete contracts, by minimising the cost of monitoring others' behaviour and by reducing uncertainty (Mehta et al., 2001; Ostrom, 1990). In fact, institutions as rules of the game transform key elements involved in individual decisions. They have three functions that affect individuals' decisions to cooperate. First, institutions reinforce social norms that are consistent with rules. Secondly, they allow people to gather information about behaviour of others. Thirdly, they entitle people to monitor others' behaviour and reward or punish it by means of (non-)material incentives (Cardenas & Ostrom, 2004).

To understand the dilemmas CPR users are faced with and how institutions can produce commonly beneficial outcomes, it is useful to distinguish between the stock of resources, such as a water reservoir, and the resource units (Ostrom, 1990). Ensuring the provision of CPR requires the construction and maintenance of the resource stock and a regulation of resource unit extraction so that extraction rates do not adversely affect resource itself. Since it is costly to exclude users from the resource system, users may be tempted to free ride and may refrain from contributing to provision.

The willingness to contribute to provision of the resources depends on whether the assignment of access rights and the duties are considered fair, economic, certain and properly enforced (Ostrom, 1990). More specifically, the marginal returns of appropriating resource units and contributing to provision in the CPR system should be higher than the marginal costs. In addition, the risks associated to uncertain access to resources, caused for instance by conflicts over resource access, should be sufficiently reduced so that CPR users can invest in productive activities that otherwise would not be economically viable.

But, to protect access rights of users and to avoid overuse of the resource, CPR users should be able to credibly commit to their rules on appropriation (Ostrom, 1990). At each instance of resource extraction, CPR users may evaluate if following the appropriation rules is their best strategy, given others' strategies and given the potential to be detected and the costs associated to (social) sanctions. Credible commitment is not straightforward. In most CPR systems, there are no external enforcers. Promises of keeping one's commitment if others keep theirs may not suffice. In many CPR systems, credible commitment is ensured via mutual monitoring. The extent to which appropriators will comply with the rules still depends on various factors such as the specific institutions, the physical attributes of the resource system and the user-specific costs and returns associated to resource use and rule breaking.

In developing communities, where the state is often weakly present at the local level, the institutions in place to provide public goods and CPR and to regulate the use of CPR often consist of local norms and rules of conduct (Cardenas & Carpenter, 2008). Such norms and rules of conduct are generally context-specific and may vary with the local economic conditions. Moreover, there is evidence that behaviour in small-scale communities in developing countries is more norm-driven and less sensitive to the strategic environment than in western society (Cardenas & Carpenter, 2008; Joseph Henrich et al., 2006).

Empirical research and theorisation on how institutions interact with behavioural predispositions and economic decision making and on how institutions determine or constrain choices is ongoing (Cardenas & Carpenter, 2008). This implies that various issues are still widely debated.

Generally, the assumption of rational agents is relaxed in new institutional economics and in the CPR literature (Cardenas & Carpenter, 2008). It is recognised that agents make decisions in complex and uncertain situations, characterised by asymmetric information, market imperfections and self-enforcing mechanisms. Agents are seen as boundedly rational. This means that agents face cognitive limitations since they cannot grasp all necessary information, for instance on others' actions and others' discount rates. Agents can also make systematic cognitive errors and biased judgments. Besides, it is acknowledged that agents' behaviour is socially embedded and mediated by social relations

While the social embeddedness and the influence of social relations on individuals' behaviour are acknowledged in this literature, in general an instrumental view on social capital is adopted. Social capital commonly refers to the mechanism of social relationships as such networks, norms and trust to induce people toward cooperation (Hayami, 2009). Not only is this literature criticised for being 'undersocialised', it is also blamed for being depoliticised (Leach et al., 1999). Institutions function as coordinating devices as well. This means institutions can harmonise otherwise conflicting preferences

and actions that result from self-interested behaviour (Platteau, 2005). The CPR literature is criticised for not taking into account that institutions take shape while agents, with conflicting interests and with different degrees of power, bargaining strength and influence, negotiate over scarce resources (Leach et al., 1999; Saleth & Dinar, 2004). It also tends to overlook that agents' decisions over resources are embedded in their community's power relations (Leach et al., 1999; Mehta et al., 2001).

Lastly, this literature generally focuses on efficient and sustainable use of CPR. It devotes little attention to equity in the entitlement to resources even while it recognises that a resource distribution that is regarded fair by the users is important to sustain trust, reciprocity, mutual commitment and CPR provision (Baland & Platteau, 1998; Ostrom, 1990).

The Post-Institutionalist Literature on Common Pool Resources

While appreciating the advances made in understanding collective action and CPR governance, the post-institutionalist literature argues that the CPR literature ill-reflects the complexity and dynamics of institutions and presents a depoliticised and undersocialised picture of institutions for resource governance. It raises several points of critique.

A first point of critique concerns the effect of community heterogeneity on CPR governance and resource entitlements. The CPR literature is mainly dealing with the effect of economic heterogeneity on shared beliefs, shared norms and sanctioning mechanisms and the consequences for the sustainable use of CPR (e.g. (Baland, Bardhan, & Bowles, 2007; Ruttan, 2008). The post-institutionalist literature focuses on other sources of community heterogeneity. It looks at heterogeneity linked to social factors, to the prevailing power structure or to the different functions that CPR have for different users. Ultimately, this literature is interested in the entitlements to resources that result from CPR governance and the equity thereof. It starts from the contested nature of resource claims. It argues that the fact that actors are positioned differently in social and power relations in their communities makes that some claims may prevail over others (Bogale & Korf, 2007; Leach et al., 1999; Mehta et al., 2001).

Secondly, the post-institutionalist literature criticises the new institutional economics and CPR literature for disregarding the dynamic relationship between individuals and institutions (Cleaver, 2002; Mehta et al., 2001). In fact, post-institutionalists link structure and agency and argue that people's actions shape structural mechanisms like institutions (Long & Long, 1992). In their view, structure, rules and norms emerge as the result of people's practices and actions, intended or unintended. These structures, rules and norms shape people's actions through orientation. They constrain and enable certain possibilities (Giddens, 1984). Hence, in this literature institutions are not viewed as the rules themselves, but as the regularised patterns of behaviour that emerge from

underlying structures or sets of 'rules in use' (Leach et al., 1999, p. 237). Rather than existing as a fixed framework, institutions are constantly made and remade through people's practices (Berry, 1989). Such a view allows understanding the dynamics that originate from institutional and legal pluralism, which are a reality in many development contexts (Leach et al., 1999; Meinzen-Dick & Pradhan, 2002). Such an actor-oriented approach of understanding institutions approach also allows to take into account the influence of social difference and of power relations on the way institutions take shape (Leach et al., 1999). Cleaver (2002) elaborated on this.

Cleaver (2002) argues that social power plays an important role in processes of institutional shaping. Some individuals are freer to act and less bound by constraints. This depends on their characteristics like their wealth, gender or status in society. Otherwise, social power can be strategically used by putting more weight on shaping the rules to favour one's interests. Since institutions, as coordinating devices, take shape while actors with conflicting interests and with different degrees of social power negotiate over scarce resources, entitlements to resources are likely to be skewed by differences in social power as well.

It is necessary therefore to recognise differences in social power amongst resource users and to understand the origin and determinants of such inequalities. But one should be aware that social relations and power relations are dynamic and that the degree of individuals' social power is not necessarily reflected from specific social roles or productive identities (Cleaver, 2002).

Cleaver's (2002) stance on agency is in between the assumption that individuals are (boundedly) rational and the more sociological, 'oversocialised' view that leaves little room for actors' choices (Granovetter, 1985). She portrays individuals as agents who are embedded in their cultural environment and in the social structure of their communities and who act, consciously and unconsciously, upon circumstances that confront them. While doing so, they borrow, blend or reinterpret (elements) from 'informal' and 'formal' institutions. In an ad-hoc way, their practices shape institutions, i.e. the regularised patterns of behaviour.

Thirdly, the post-institutionalist literature not only highlights dynamism in the institutions but also in the environment itself. Institutions undergo changes through people's practices but also under influence of other factors beyond their control like policy or market changes. The environment and the resource systems undergo changes under the influence of more or less exogenous forces like climate change but also via the way they are governed by the community. This implies that the outcome of institutional design on the environment and on entitlements is unpredictable (Leach et al., 1999).

The post-institutionalist literature is appreciated for adding nuance to the CPR literature and for emphasising the contested nature of resources and the endogenous and socially embedded nature of local institutions for CPR governance. Yet, it is faced with some important challenges some of which will be addressed in this dissertation. First, the post-institutionalist framework for analysis, like the one presented by Leach et al. (1999, p. 234), holds too many endogenous relationships between too many variables on too many scales and entails too many dynamics so that it becomes next to impossible to formally test any hypothesis (Figure 1). Therefore, in this dissertation only some of the relations presented in this framework are analysed (Dotted circles in Figure 1). This research looks at the way endowments are transformed to entitlements while taking into account the effect of social differentiation. The analysis is limited to institutions for common pool resources governance at a micro-level and meso-level. The dynamics of such institutions are studied by looking how they are shaped while solving resource conflict in the wake of increasing market penetration, increasing climate variability and greater institutional pluralism. The effect of one particular ecological dynamic, namely scarcity, is taken into account.

Secondly, post-institutionalists assume agency of individuals within the constraints of their cultural and social context and its institutions. But they seem to avoid any model in which they can systematically observe individuals' decisions and in which they can uncover such constraints. In this research a framed field experiment is used to address this shortcoming (in Part II and Part IV).

Thirdly, other major challenges lie in the fact that the post-institutional theoretical framework is not grounded in solid empirical proof that could convince the ones they criticise, being new institutional economists, practitioners and policy makers involved in resource management. In the remainder we specify the empirical shortcomings of the post-institutionalist literature and explain how these issues are tackled in this research.

A first empirical shortcoming relates to the role of social power and social differentiation in negotiations over entitlement to resources and in the shaping of institutions (Cleaver, 2002; Leach et al., 1999; Mehta et al., 2001). While warning for measuring social identity and social power by merely looking at specific social roles or at certain productive identities, no measurable indicators are suggested for these main variables. In this dissertation two indicators of structural social inequalities embedded in the communities, gender and social status, are singled out. One's relative social status in the community is used as a proxy indicator for one's social power in the community (See p. 39 for a definition). A direct measure of actors' relative social status is used, based on the perception of community members.

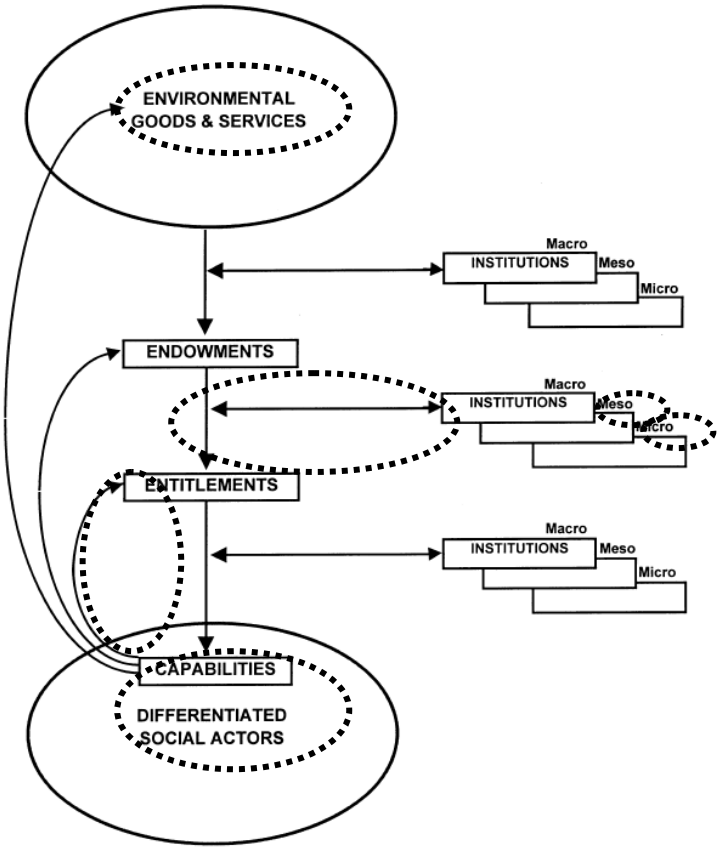


Figure 1: Environmental Entitlements Framework (Leach et al., 1999, p. 234)[3]

There is a second empirical challenge. Post-institutionalists emphasise the need to examine the layer of property practices. This means the way resource governance institutions are shaped through contestation, reproduction and transformation should be uncovered while studying the role of social power. Additionally, the way social power is played out during negotiations that transform resource claims into entitlements should be examined (Bogale & Korf, 2007; Cleaver, 2002; Leach et al., 1999). Often such analyses are based on ex-post interpretations of processes of institutional shaping and on ex-post observations of (differentiated) entitlements (Cleaver, 2002; Sehring, 2009). Possibly, a lot of information is lost in this way, for instance on the inception and dynamics of such processes. It could also introduce a selection bias as only cases will be observed where agency shaped institutions and where power relations played a role.

In this research a case-based approach was adopted to provide empirical evidence on the layer of property practices. In Part III, it is analysed how disputes over resources are solved while observing how those involved in the disputes borrowed from different sets of institutions, blended rules and norms or used new styles of thinking. By explicitly relating such processes of institutional shaping to individual characteristics that link to structural social inequalities embedded in the communities, it

[3] Dotted circles are added to indicate the aspects covered in this dissertation.

was shown that this happened in a socially embedded way. Additionally, in Part II, individual behaviour in a framed field experiment was related to individual characteristics like gender and social status. This provided empirical evidence that social differentiation can put (internalised) constraints on individual decisions on resource sharing.

A third empirical challenge lies in studying the dynamic nature of institutions and the environment. Studying dynamics requires specific research methods. With the case-based approach adopted in this research some of the local dynamics of institutions could be uncovered (Part III). By introducing resource scarcity in a framed field experiment some of the (exogenous) dynamics of the environment could be replicated. As such, we could study the effect of resource scarcity on individual resource sharing behaviour and on (conflicts over) entitlements (Part II and Part IV).

Access to and Conflicts over Resources from a Political Ecology Perspective

Political ecology arose as a critique against the apolitical perspectives adopted in environmental and developmental research. It argues that the transformation of nature into commodities is a political process. This process of transformation involves contestation and negotiation over control and access to natural resources and over the means to turn them into commodities. Contestation and negotiation happen within political arenas in which power constellations, social relations and social identities may play a decisive role. The process of transformation of nature into commodities can happen in a peaceful, cooperative way, but it can also happen in an atmosphere of conflict. This depends on the pattern of social relations and the quality of the institutions (Le Billon, 2001).

From this perspective, political ecology criticises the environmental security literature, the literature on post-cold war armed conflict and the common pool resource literature for having a simplistic, a-historical and depoliticised view on the relation between resources and violent conflict (Le Billon, 2001; Peluso & Watts, 2001; Turner, 2004). Political ecology scholars argue that providing answers on the causes of resource-related conflicts requires an analysis of related and underlying factors. It requires that the physical aspects of resources, the political economic features and the moral and material incentives behind resource-related conflicts are analysed. It also requires an understanding of how resource-related conflicts are embedded in history and in broader social tensions (Le Billon, 2001; Turner, 2004).

Political ecology points to some other weaknesses in the literature on resource-related conflicts. First, while the environmental security literature purports there is a causal relation between resource scarcity and conflict (Homer-Dixon, 1999), the literature on post-cold war armed conflict links resource abundance to conflict (Paul Collier & Hoeffler, 2000). But in fact, it depends on the type of resource whether resource abundance or resource scarcity potentially lead to conflict (Le Billon,

2001). When it concerns point resources that are easily lootable and have a high marginal value, abundance may be a driver for conflict. When it concerns diffuse, non-lootable resources with a low marginal value, scarcity may lead to conflict. But, neither abundance nor scarcity of resources is a necessary or sufficient driver of conflict.

Secondly, physical scarcity (or abundance) is often pointed out to be the main cause of resource-related conflicts. The political ecology literature states that such conflicts develop as social phenomena. While physical availability is one aspect, the relative abundance or scarcity of resources is partly socially constructed as it depends on livelihoods, markets and commodity chains (Le Billon, 2001). Turner (2004) argues that at first sight conflicts may seem to relate to resource scarcity. But a closer look may reveal underlying social tensions, protection of moral issues, different views on resource commoditisation or longer-term strategic motives. Or, resource-related conflicts can have roots in feelings of marginalisation and frustration about corruption and injustice (Benjaminsen, Maganga, & Abdallah, 2009).

Thirdly, another critique on the environmental security literature is that it is empirically grounded in the analysis of cases where environmental scarcity coincided with (political) violence. Cases with environmental scarcity but no violence have been neglected. This selection bias and the a priori attention to scarcity as causal mechanism make it difficult to make out why violent conflict occurs in some and not in other cases (Bogale & Korf, 2007; Turner, 2004).

To approach resource-related conflicts from a political ecology perspective, the following issues should be addressed (Turner, 2004). First, it is essential to study both cases of conflict and cooperation (Bogale & Korf, 2007). Secondly, a distinction should be made between scarcity-induced or availability-induced conflicts because the underlying logic behind scarcity-induced and opportunity-driven competition is different. Thirdly, it should be determined whether conflicts are actually over natural resources or if these are social conflicts in which resources are implicated. Fourthly, if indeed the conflict concerns competitive struggles over resources, it is essential to discern to what extent it is an ad-hoc scramble or it is part of more strategic contests over maintaining access to resources in the future. In this regard, one should acknowledge that access to resources is constantly negotiated in small scale communities (Berry, 1989). While there will always be conflicts of interests over resources, violence is generally not the preferred option to deal with this (Turner, 2004). Hence, where access and use of resources are contested, it is necessary to explore all kinds of political action that are applied to deal with this. While examining resource-related conflicts, it is important to uncover how social power is exercised in the negotiations that follow conflict of interests and to assess how moral claims, historical precedent, and community norms are invoked. It is also necessary to investigate how different accounts of the conflict may serve certain interests. Finally, an

analysis that looks at the social roots of resource-related conflicts requires a thorough understanding of the social and political hierarchy in small scale communities.

This research partly embraces a political ecology perspective. First, water scarcity is a real issue in our case study sites. Besides, trends like increasing market penetration and climate variability potentially increase scarcity and competition for accessing the resource. Yet, while disputes arise in the cases studied here, they do not lead to violence. Secondly, this research examines to what extent community norms, factors linked to structural inequalities and (social) power can explain how resources are shared and how disputes over resources are resolved. While political ecology sticks to a more ethnographic approach, this research combines this with a micro-economic and institutional economic approach.

A Micro-Level Analysis of Conflict

In the last decennia there has been a growing interest in the economic literature to understand the drivers of violent conflict. Much of the literature on the drivers of violent conflict have an international, national or regional focus (Verwimp et al., 2009). Yet, cross-country studies are not suited to capture triggers or stops of violence that are only visible at the micro-level. It is impossible to make inferences about individual decisions to start or participate in violence. Within country, cross-regional studies that relate indicators or predictors of violence to local economic conditions are an improvement (Blattman & Miguel, 2010). But such analyses often suffer from data quality and endogeneity problems. They may also face a selection bias if data on violence is collected from western, English media. As with cross-country studies, no inference is possible on individual motivations to join in or start violence. Besides, there may be problems of reverse causality in the sense that conflict may cause poverty but poverty may be a driver for conflict as well.

Essentially, the decision to participate in violent conflict or to behave in a violent way is made at the individual or household level (Justino, 2009; Verwimp et al., 2009). What is needed is a micro-level analysis of the motives of individuals, households or groups to participate in violent conflict or to react with violent confrontation. But there is little systematic theoretical or empirical research that links behaviour of individuals, households, or groups with processes of violent conflict, with support to armed groups or with participation in collective violence (Verwimp et al., 2009). Recently, some advances have been made in this field. We review some of that literature in Part IV.

One of the problems of a micro-level analysis of violent conflict is confronted with, is data collection (Verwimp et al., 2009). Security, ethical and logistical problems complicate data collection during conflict. Some use data collected before and/or after the conflict whether or not collected purposely. They then relate individual or household characteristics to other data on conflict. Many focus on post-

conflict consequences for livelihoods. Others link individual or household characteristics to perpetration in the genocide in Rwanda (Verwimp, 2005) or to recruitment into armed groups (Guichaoua, 2009; Humphreys & Weinstein, 2008).

Furthermore, while there is evidence that material incentives are not always a (major) factor in individual decisions to fight, there is a better theorisation of potential economic motivations for conflict than of psychologically and socially related motivations (Blattman & Miguel, 2010). Some argue that moral, ideological or ethnic grievances play a bigger role in the decision to use violence or to participate in violence. But in analyses linking non-material incentives to violent behaviour often crude measures for non-material factors, like political grievances or marginalisation, are used. There is a need to improve on such measures and to test their association with actual behaviour. Recent behavioural and experimental economic research has shown that non-material incentives like fairness and grievances are salient in decision making. For instance, it has been shown that individuals are willing to punish others for breaking social norms at a considerable private cost. Experimental economics is one of the ways forward to shedding a light on individual decisions to participate in violence.

In this research some of the issues raised here are addressed. A micro-level analysis is adopted. The individual decisions to react with conflictive behaviour to water scarcity are studied using a framed field experiment. The experiment permits to evaluate the importance of material incentives like payoffs and other incentives like fairness norms to explain behaviour. In addition, individual behaviour is related to individual characteristics that are of a material and non-material nature, such as the individual's social status position in the community. Another quality of experiments is the ability to elicit a reaction to different circumstances by the same people. Observational data cannot provide the same information as people may not be able or not be willing to answer to (hypothetical) questions about the likelihood behaving in a conflictive way in various circumstances. The predictive value of an ex-ante assessment of individuals' potential conflictive or violent behaviour measured in an experiment could be called into question. Yet it may provide some answers to why some individuals behave in confrontational way and others do not.

Sharing Scarce Common Resources: Research at the Crossroads

Studying common water flows and conflicts over water while having a background in micro-economic development research while pursuing a PhD in political sciences challenged us to engage in multi-disciplinary research. The topic of our research led us to the new institutional economic literature and to the literature on micro-level analysis of violent conflict, both situated in the economic sciences. It also led us to the post-institutional literature and political ecology literature that are rooted in political and social sciences. New institutional economics and post-institutionalism both provide

important insights in how local social order comes about and how it coordinates actors' preferences and actions. Micro-level analysis of violent conflict and political ecology both provide a framework for understanding conflicts over resources. But each framework has its shortcomings. Economic models have the advantage of both using solid models for empirical analysis and being able to formally test hypothesis. But they have been criticised for having too little attention for the social reality in which actors make decisions as well as for being depoliticised. Sociology has been at the forefront for theorising about interdependencies between social reality and actor's decisions but most models have an 'oversocialised' view (Granovetter, 1985). Sometimes a formal analytical framework is lacking. The literature grounded in political sciences and development studies provides insight in power. The idea that power drives development processes is not new, but explicitly integrating power as a parameter in these processes is relatively recent (Eyben, Harris, & Pettit, 2006). Another idea that has entered development thinking is that power and differentiation linked to the social structure of the community have a serious impact on actors' capabilities and their access to resources (Collinson, 2003; Leach et al., 1999). But the need to develop a formal framework for analysing how power relations shape institutions and influence actor's decisions in non-polity domains remains.

The focus and methods of each of the theoretical frameworks discussed above differ and different questions are asked. But each framework contributes to understanding competition for scarce common resources. The lack of bridging between these theoretical frameworks and the fact that none of these went far enough to get the whole, complex picture have been a personal frustration. We agree that the undersocialised and depoliticised analyses in new institutional economics and in micro-economic analyses of violent conflict miss out on some important explanatory variables. And while the post-institutional literature and political ecology literature pose the questions we want to address, we are concerned with their empirical shortcomings. Their analyses are not always empirically validated in such a way that they can convince new institutional or development economist and policy makers who are used to rigorous (statistical) analysis and who sometimes doubt the replicability and generalisability of qualitative research (King, Keohane, & Verba, 1994).

That is why, in this research, we address questions similar to the ones posed in the post-institutional and political ecology literature. These deal with the influence of social structural differences like gender, social status and power relations on sharing common resources, on entering into conflict over scarce resources and on resolving resource conflicts. But to answer these questions, we adopt a multidisciplinary approach for theory and empirics and use more rigorous and quantitative methods for empirical validation. We keep a micro-level perspective while doing so.

Data and Methodology

Selection of the Case Study and Sampling Procedures

The topic of this research is access to and conflicts over water in a development context. The research is defined to studying access to and conflict over productive water that is derived from common water flows. More particularly, this research looks at productive water derived from commonly governed smallholder irrigation schemes. The choice for irrigation water is motivated by its contribution to agricultural livelihoods in development contexts. The choice for smallholder irrigation schemes is motivated by the fact that governance of irrigation water can be allotted to a well-defined community.

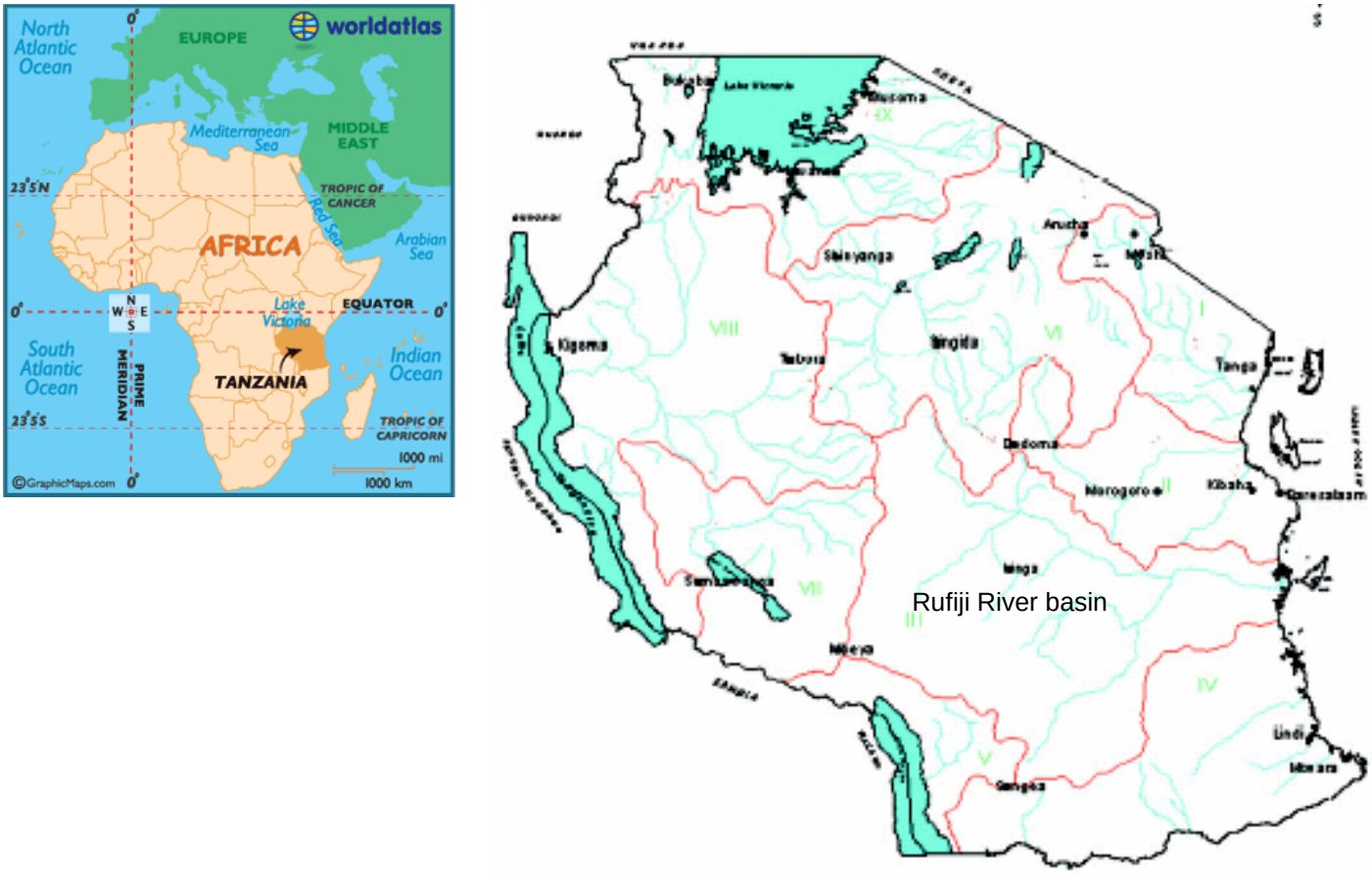
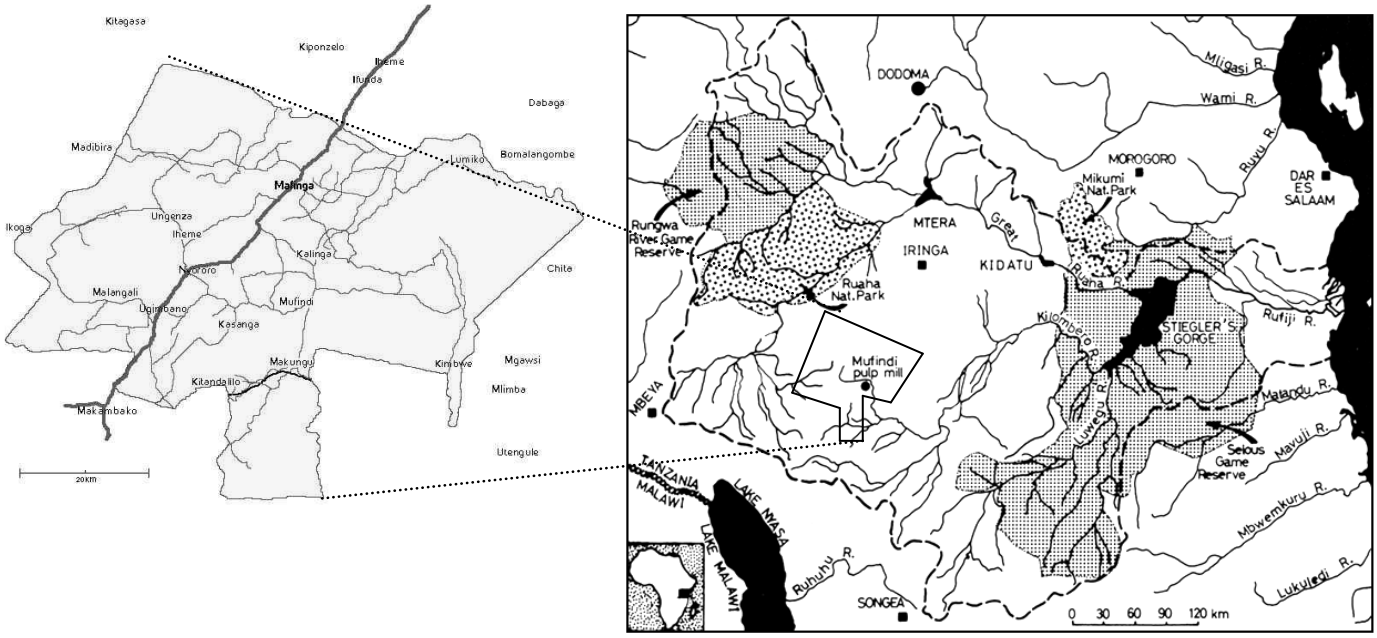


Figure 2: Tanzania and the Rufiji River Basin (United Republic of Tanzania, 2002, p. 49; World Atlas)[4]

[4] Red lines represent basin boundaries, blue lines are rivers and blue areas are water bodies.

Access to and conflicts over water in semi-arid sub-Sahara Africa, more particularly in semi-arid areas of Tanzania, are studied (Figure 2). Semi-arid sub-Sahara Africa has been chosen because its changing 'landscape' provides an interesting background. Many countries in sub-Sahara Africa adopted or renewed their policies for governance of water and other natural resources, their policies for agricultural development and their policies for decentralisation (Ribot, Lund, & Treue, 2010). In many sub-Sahara African countries, economic development brings about an increasing integration of the village level in regional, national and global markets (Reardon & Barrett, 2000). Other changes with a significant impact are population growth and climate change (United Nations Development Programme, 2006). Another reason to choose semi-arid sub-Sahara Africa is the fact that the discourse that links water scarcity to violent conflict puts it in the centre of attention (United Nations Development Programme, 2006).

The reasons to choose Tanzania are twofold. First, Tanzania provides a representative example of the changing landscape in sub-Sahara Africa. The second reason is pragmatism. Thanks to two and a half years of work experience in the country, both in rural and urban Tanzania, we could rely on the network we had built up in the Tanzanian NGO and research community. Besides, our knowledge of the local language, Swahili, proved to be an indispensable asset in conducting field research.



Mufindi District Rufiji River basin

Figure 3: Mufindi District in the Rufiji River Basin (Bernacset, 1981)

Yet, the topic is central in this research. Therefore, this research could have been done in another development setting. This does not mean that conducting the research in a different setting would

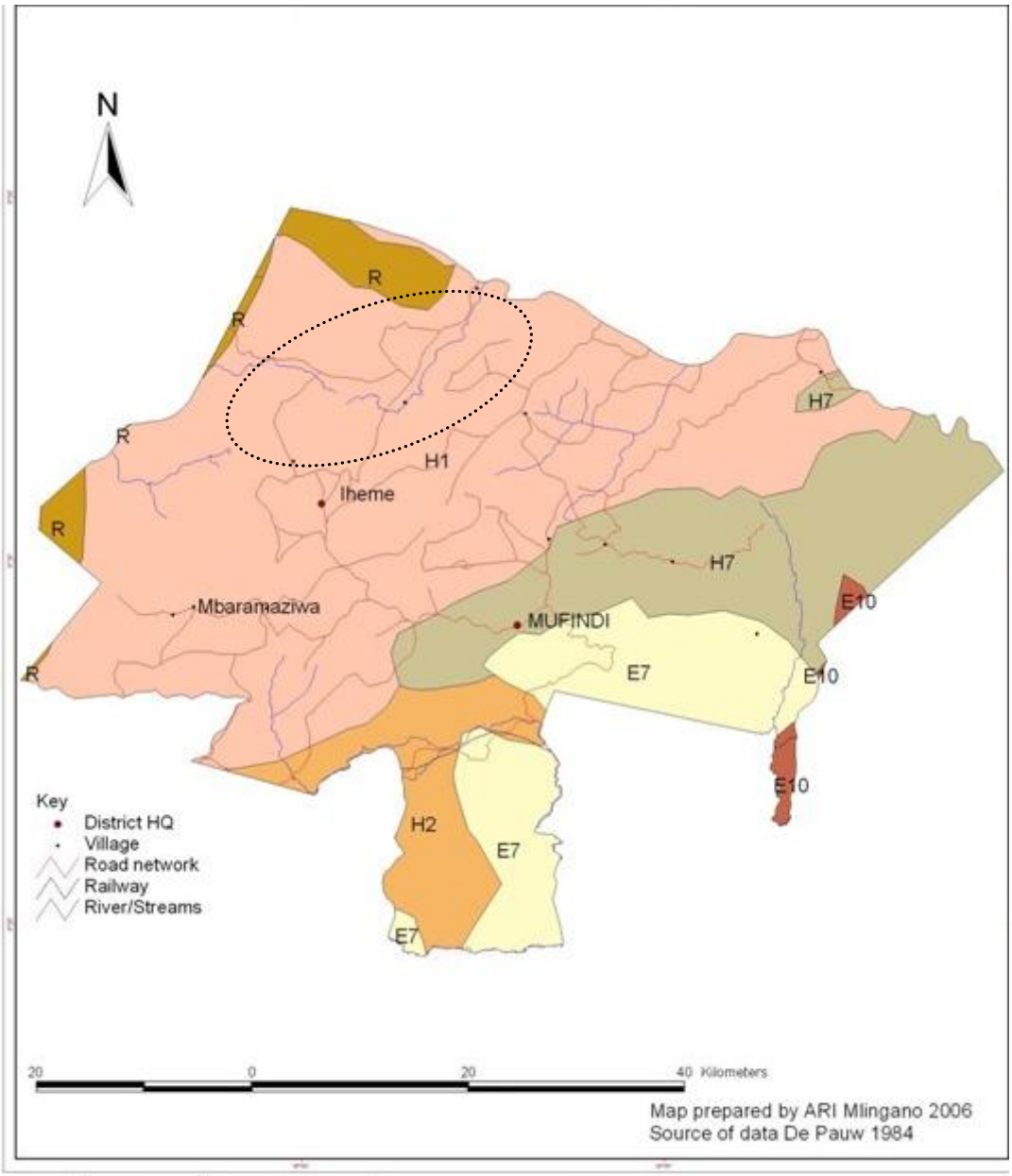
have produced exactly the same results. The context of Tanzania is expected to have had a significant influence on the findings because of the socially and culturally embedded nature of resource governance institutions.

Within Tanzania, Mufindi district has been selected. Mufindi district is located in the Southern Highlands in Tanzania. Its water sources are part of the Rufiji River basin (Figure 3). Mufindi district is chosen because of the relative importance of irrigated agriculture for both food and cash crops (Majule & Mwalyosi, 2005; Mkavidanda & Kaswamila, 2001). More particularly, the field study has been conducted in the lowlands of the district (altitude between 1,500 and 2,000 meters). These are characterised by a semi-arid climate with an average annual rainfall between 600 and 700 mm that is concentrated in one rainy season that lasts from (end) November till April (Chang'a, Yanda, & Ngana, 2010; United Republic of Tanzania, 1999, 2006b). This makes that farmers and irrigators are confronted with a recurrent seasonal scarcity of water.

In the semi-arid lowland areas of Mufindi district, five sites have been selected where "traditional", smallholder irrigation is practised (Figure 4). The objective was not to have a sample of irrigation schemes representative for the district. Nevertheless, the five irrigation schemes are similar to other irrigation schemes in the semi-arid lowlands of Mufindi district and in the wider region. The irrigation schemes have been selected according to our research requirements and in accord with the Mufindi district authorities. Local experts on smallholder irrigation have helped in selecting the sites.

"Traditional" smallholder irrigation schemes in Mufindi district typically consist of a system of canals diverted from a river (Figure 5). Most irrigation schemes can be attributed to a specific village or neighbourhood[5] (Koopman, Kweka, Mboya, & Wangwe, 2001; Majule & Mwalyosi, 2005; Mkavidanda & Kaswamila, 2001). Most irrigation schemes could be easily demarcated using participatory mapping (see further).

[5] Obviously, there are downstream users and upstream users located outside the villages or communities to which the irrigation schemes can be attributed. But as our research focuses on allocation and conflicts within the community, we did not collect data on (problems with) external downstream and upstream users.



Aez_code	Altitude(masl)	Rainfall(mm/year)	Physiography
E10	400-600	1400 - 1600	Flat alluvial plains with complex sedimentation pattern
E7	750-1300	800 - 1000	Flat to rolling plains, locally hilly strongly dissected uplands and low hills
H1	1500-2000	600 - 700	Flat to undulating and rolling plains and plateaux developed on granites, gneiss
H2	1500-2100	1400 - 1600	Undulating to rolling plains and plateaux at high altitude developed on granites
H7	1500-2300	800 - 1000	Undulating to hilly plateau crests strongly dissected crests
R	Not applicable	Not applicable	Rocky terrain

Figure 4: Agro-ecological Zones in Mufindi District (Dotted Circle Indicates Field Study Area) (United Republic of Tanzania, 2006b)

Via participatory mapping, inventories of all irrigators cultivating a plot in each of the irrigation schemes were obtained. From these inventories random samples of irrigators were drawn to participate in the different data collection exercises. The samples of irrigators from each of the irrigation schemes are representative for the scheme in question.

Some data was collected via group exercises. To ensure that different types of irrigators were represented in the group exercises a mixed group of irrigators was invited via the village chairman or village executive officer. It was seen to it that the group was mixed with regard to gender, upstream and downstream location in the irrigation scheme, age, size of the irrigated plot and economic well-being. Data has been collected in two rounds. The first round of data collection took place from June until August 2008. The second round took place in May 2009.

Figure 5: Smallholder Irrigation Scheme

The Relationship between Access to Water and to Land

Generally, access to water depends on access to land. One could argue therefore that appropriation of land and conflicts over land should also be treated in this research. Yet, competition for water follows a different dynamic and a different logic.

More particularly, in the irrigation schemes studied here, competition for irrigation water arises more frequently than competition for plots of land. Once irrigable land is acquired, people will want to extract water on a regular basis. While extracting, people will compete with other water users. Besides, the dilemma of sharing irrigation water differs from competing for land. Irrigation water is common pool resource and land is a private good. Therefore, accessing water and land are subject to

different conditions and different transactions. For instance, entitlement to land may depend on inheritance and entitlement to water may depend on contributions to maintenance of irrigation canals.

In the context of commonly governed smallholder irrigation schemes like the ones studied here, the transactions involved in water appropriation are also less elaborate than those involved in land acquisition. Generally, water is appropriated by directing the water flow to one's plot of land in the irrigation scheme. This normally happens without many structured transactions. Land in such irrigation schemes is generally acquired via inheritance, via allocation by the village or traditional leaders and occasionally via sale or rent. Land acquisition involves more structured transactions.

The focus of this research is on competition for water. Therefore, it deals with users' frequent interactions over extracting a share from a common water flow and conflicts that (could) arise over this. Competition for land is dealt with indirectly. Part III of this dissertation, which deals with resource conflicts and their resolution, treats some cases where disputes have arisen over land in the irrigation schemes. In most cases, the distribution of land in the irrigation schemes is a given fact when disputes over water crop up. Land distribution in the irrigation schemes is exogenous in the analyses based on a framed field experiment (Part II and Part IV). The experiment measures how irrigators distribute the common irrigation water presuming that they can access water via a plot of land that borders an irrigation canal. Being an upstream or downstream user in the experiment was independent of the irrigators' actual position in the irrigation schemes.

The Position of the Researcher

Research and data collection does not happen in a vacuum and in one way or another it has an impact on the communities and individuals implicated in data collection. Several measures have been taken to minimise the risk of a negative impact on the research subjects and to minimise possible uncontrollable interferences of the researcher and the research team on the data collected. These measures include informed consent, assurance of anonymity, risk assessment and a careful selection of the research team.

First, all data was collected with informed consent from the research subjects. At the onset of every data collection exercise, research subjects were informed that the research was conducted for Ghent University in Belgium with permission from the Tanzanian Commission for Science and Technology, the Mufindi District Council, the village chairman and the village executive officer. The purpose and the limits of the research were explained. To avoid raising expectations of future interventions it was important to make clear that the research would not bring direct changes in the village. Understandably, research subjects counted on the research to have some impact. It was guaranteed that the findings and policy recommendations of the research would be shared with government

authorities and non-governmental bodies at village, district and national level while respecting anonymity. This was effectively done during the second round of data collection in May 2009. Based on the data collected in 2008, a feedback workshop was held in the district capital Mafinga in May 2009 with district officials and NGO workers and a draft report was distributed. As every village was revisited during the second round of data collection the opportunity was taken to briefly give feedback to the village chairman. Additionally, copies of the participatory maps of each of the irrigation schemes were handed over. Furthermore, findings and draft papers were shared with REPOA, a Dar es Salaam based research institute, and the Tanzanian Commission for Science and Technology.

Secondly, anonymity of research subjects was assured. At the start of every data collection exercise, research subjects were guaranteed that their names and names of other villagers would not be shared with third parties. The names of individuals and villages do not appear in the databases nor in any output this research produced. Names have been changed by codes. The coding and identity of respondents are kept in separate files by the principal researcher.

Thirdly, there was a possibility that sharing resources and conflicts over resources were contentious issues in the studied irrigation communities. As a measure of risk management, the research team had considered possible opportunities for dialogue and mediation if data collection endeavours would have provoked tensions. If security risks would have arisen, the research project could also have reconsidered its approach. Additionally, information about possible tensions was sought on beforehand by consulting the district agricultural and livestock officer and village leaders. Nevertheless, suspicion vis-a-vis the research and reluctance to participate was initially encountered in one of the irrigation schemes. In fact, the main river feeding this particular irrigation scheme eventually flows into Ruaha River. Ruaha River is used by various sectors and efforts of integrated water resource management try to reconcile needs while sustaining the river flow. In this regard, plans had been made for a large-scale irrigation project for rice cultivation further downstream according to the people using the irrigation scheme and their leaders. The people using the irrigation scheme claimed to have been told to abandon small-scale irrigation in favour of the rice project. At first, there was suspicion that this research had something to do with these plans and the aims of this research project were distrusted. Eventually, after a lengthy discussion about the research team's affiliation and aims, trust was established and people were willing to participate.

Fourthly, the research team was carefully selected and trained. The research team included ten interviewers, two research assistants, the team leader/facilitator and the principal researcher. The ten interviewers conducted the surveys. They were selected via the principal researcher's network and via a notice posted at the Sokoine University of Agriculture in Morogoro. A preliminary selection was made on the basis of the curriculum vitae of the candidates. A final selection took place at the end of a four-day training workshop. The training workshop was meant to practice on how to conduct the

surveys. It included an exercise in the field. The selected interviewers held a bachelor degree in agricultural engineering, rural development or agricultural economics and had ample experience with collecting data in rural areas in Tanzania. Two of the interviewers used to reside in Mufindi district. This was useful to give prior notice to village leaders as they knew the way. One of them was able to interview the few respondents who did not speak Swahili in the local language (Kihehe). In the field, the interviewers were supervised by the team leader and the principal researcher.

Two research assistants were selected via the same canal as the interviewers. The research assistants had more experience, had conducted field research independently and had a higher degree. One of them held a master degree in agriculture. The other held a master degree in rural development and was acquainted with qualitative and quantitative data collection methods. The fact that the latter was a woman was important as some female respondents were more comfortable to address issues or concerns to her. Both research assistants assisted in the group discussions, mapping and ranking exercises and took notes. They also translated much of the data collection tools. The female research assistant also assisted in the semi-structured interviews in the second round of data collection.

The team leader/facilitator supervised the research team and facilitated during all data collection exercises, except the survey, during both rounds of data collection. He was a former colleague of the principal researcher at a local NGO in Mufindi district. He held a degree in agriculture and had yearlong experience in extension work and data collection in rural Mufindi district. Another asset was his network in the district council and in the villages of Mufindi district.

The principal researcher had work and research experience in Mufindi district as well as a fair knowledge of Swahili. Her experience in the district was appreciated by respondents as it proved she was not a "fly-in fly-out" researcher. Her knowledge of Swahili permitted to introduce herself and the research in Swahili. This reduced the distance with the research subjects. It also permitted her to actively follow the discussions and to understand and address issues that were raised during data collection.

Working with a Tanzanian research team and the principal researcher's own experience in Tanzania facilitated to establish credibility and trust among the research subjects. Yet, there is a danger that the team leader's experience in extension work and the principal researcher's foreignness made that people attempted to give a good impression by trying to give 'the right answer'. The only way to assess and control for such effects would have been to replace the team leader and the principal researcher. But the advantage of having the same persons asking exactly the same questions in the framed field experiment, the ranking and mapping exercises, semi-structured interviews and the focus group discussions probably outweighs this danger. Another danger is that people tried to show they were in need of assistance. At one point, there was a feeling one of the village chairmen tried to do so.

But in the group discussions, the team leader/facilitator was always attentive to domination of the discussion by specific individuals. Besides, much of the data was collected at the individual level, which reduced the chance people's answers were influenced by others.

Combining Quantitative and Qualitative Research Methods

The multidisciplinary nature of the research and the research questions called for an empirical strategy using a mixed method approach. Both qualitative and quantitative methods have been applied for data collection (Cresswell, 2003). Mixed methods research is sometimes criticised by scholars who believe qualitative and quantitative methods are incompatible or should at least be kept separate because of the different scientific paradigms they are based on (e.g. (post-) positivism versus constructivism). Sometimes scholars who adhere to one or another paradigm question the underlying assumptions of other research paradigms and their associated research methods. Some scholars argue that purity of paradigms should be safeguarded (Tashakkori & Teddlie, 2003).

Mixed methods research has several advantages though (Tashakkori & Teddlie, 2003). First, by mixing methods the complexity and multiple facets of social phenomena can be elucidated. A more convincing and robust explanation of observed social processes can be provided. Besides, some of the facets can be better captured using qualitative, others using quantitative methods. Secondly, mixed methods research can answer questions that other methods cannot. It offers the opportunity to simultaneously test predicted relationships and answer questions about how that predicted relationship actually comes about. Thirdly, a mixed methods approach can be a pragmatic solution to challenges posed by multidisciplinary research (Cresswell, 2003; Tashakkori & Teddlie, 2003).

Data Collection

Qualitative data was collected by means of focus group discussions, participatory mapping, participatory social status ranking and semi-structured interviews. Quantitative data was collected by means of a survey and a framed field experiment. All data on irrigators gathered via the different data collection methods can be linked through a unique individual identification code.

All data was gathered during the first round of data collection from June until August 2008, except for the semi-structured interviews. These were conducted during the second round of data collection in May 2009.

The data collection methods were designed and tested in consultation with two researchers from IDPM in Antwerp. Two researchers from the Soil Water Management Research Group at Sokoine University of Agriculture in Morogoro gave advice. Local experts on irrigated agriculture associated to the Mufindi District Council and to a local NGO, Incomet 2001, were also consulted. The survey

included an experiment measuring time preference whereby future payments had to be made to respondents. This was facilitated by the microfinance bank MuCoBa based in Mafinga. All data collection was done with consent from the Tanzania Commission for Science and Technology (COSTECH), the Mufindi District Council, the village chairmen and village executive officers.

a. The Level of Inquiry

Since the research adopts a micro level of analysis of resource appropriation and resource conflicts, in principle the level of inquiry has been the individual. Individual level data also permits to assess the effect of individual characteristics such as gender and social status on appropriation behaviour and conflictive behaviour.

In all data collection exercises, except in the focus group discussions, information has been collected about individual irrigators. The operational definition of an irrigator is the person in the household mainly responsible for cultivating the plot in the irrigation scheme and for making decisions regarding irrigated agriculture regardless of whether this person personally owns or rents the plot.

Some survey data, however, concerns the irrigators' households. This includes data on housing or assets, for instance, which individuals typically share with their households. The household has been defined as the group of people who normally occupy one or adjoined housing units and make joint provisions for food and other essentials for living. It includes people that are not residing in the house at the time of the interviews, such as students or people travelling.

b. Qualitative Methods of Data Collection: Participatory Mapping

Participatory mapping of the five irrigation schemes studied in this research had two purposes (Figure 6). One of the purposes was to obtain inventories of all irrigators cultivating a plot in each of the irrigation schemes from which random samples could be drawn. Such inventories of individuals using the irrigation schemes were absent even if most villages in Tanzania list all households and individuals living in the village.

The other purpose was to obtain maps of each of the irrigation schemes as the irrigators perceived them. Sometimes participatory maps are avoided because they remain spatially confined to the social, cultural and economic domain of those who draw the map (Alcorn, 2000). In this case, obtaining a map and inventory of the irrigators' community that reflects the perception of the irrigators was exactly the objective as it is the arena perceived by the CPR users that is relevant for CPR governance. A physical survey by an outsider risked to wrongly define this arena or to miss out on locally important features.

Figure 6: Participatory Mapping

One of the drawbacks of participatory mapping is that what is drawn on the maps and who is identified on the maps is sensitive to who is drafting the maps (Alcorn, 2000). To counter this, we invited a mixed group of 20 people who cultivate in the irrigation scheme to participate in the mapping exercise. The group was mixed with regard to gender, upstream and downstream location in the irrigation scheme, age, size of the irrigated plot and economic well-being. In each irrigation scheme, the participants were invited via the village chairman or village executive officer[6]. We assumed that the irrigators invited for mapping were well informed on the physical aspects of the irrigation scheme and were well acquainted with other irrigators in the same irrigation scheme. This seemed to be a realistic assumption since we observed little disagreement on the layout of the irrigation schemes and on who was cultivating which plot.

Another risk is that some (elite) members of the community may dominate the participatory mapping exercise (Alcorn, 2000). To avoid this, the facilitator made sure every participant had the opportunity to provide input to mapping. There was special attention to equally involve women and youth in mapping because we expected they could possibly highlight different aspects or identify irrigators who would otherwise be neglected. To avoid that those holding the pen would dominate the exercise, we provided ample marker pens for drawing and distributed them purposely to young men, elder men, elder women and young women (Pretty, Guijt, Thompson, & Scoones, 1995).

[6] In some irrigation schemes, the village chairman was an irrigator himself and participated as well.

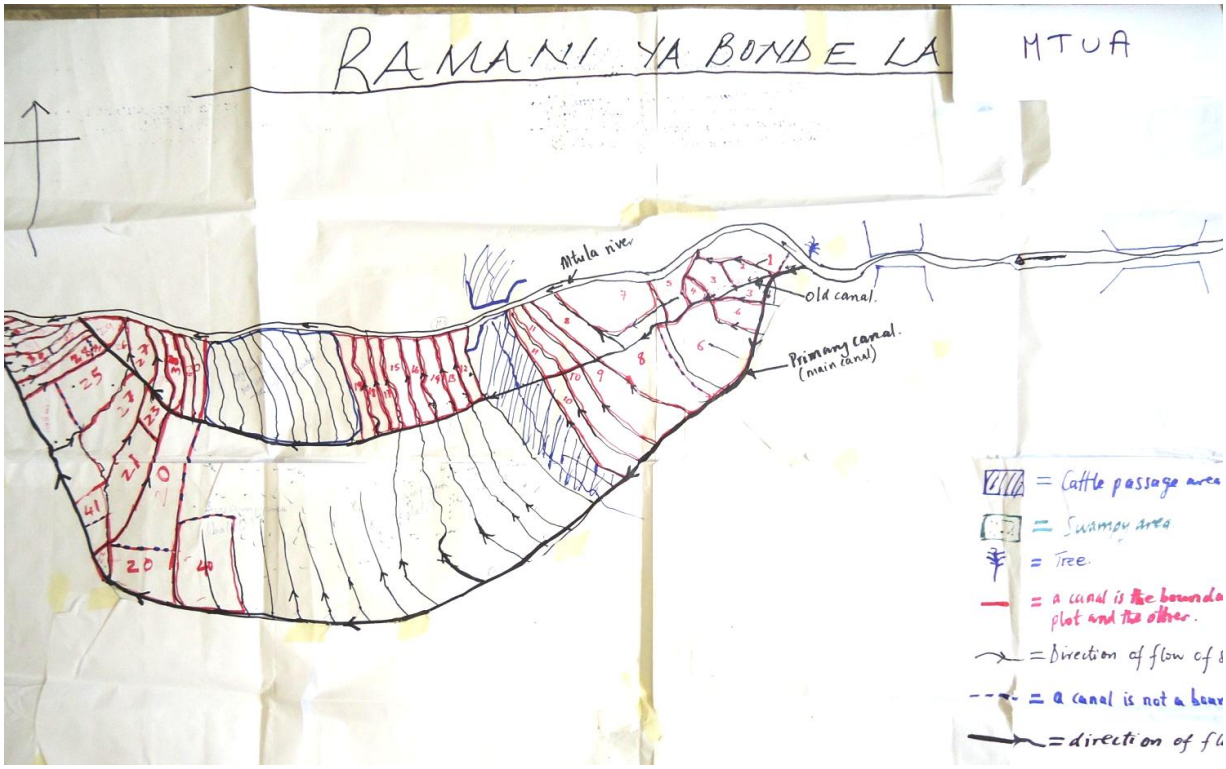


Figure 7: Participatory Map of Irrigation Scheme Mutua

Figure 8: Participatory Map of Irrigation Scheme Isanu

The mapping of the irrigation schemes required a delimitation of the boundaries. Three of the five irrigation schemes had real physical boundaries. Figure 7 shows a participatory map of one of these irrigation schemes. The other two irrigation schemes were located in a valley and stretched out upstream and downstream. Figure 8 shows a participatory map of one of the irrigation schemes located in a valley. Mapping had to be delimited to a part of the irrigation scheme that hosted about a hundred irrigators who cultivate on aligned plots and most of whom reside in the same village. The participants decided on the boundaries. This may have been somewhat arbitrary as they stopped when they reached a hundred irrigators on the list.

Practically, the exercise ran like this. Participants were asked to first draw the primary, secondary and tertiary canals on the map and to add any other marking features, such as bridges, intakes or swampy areas. Then, they indicated the direction of the water flow. After that, they drew the plots and identified the irrigator of each plot drawn on the map.

c. Qualitative Methods of Data Collection: Focus Group Discussions

In each of the irrigation schemes, the same participants took part in a focus group discussion after the mapping. The aim of the focus group discussion was to get a sense of the rules, norms and enforcement mechanisms for governing irrigation water in each of the irrigation schemes. Concretely, participants were asked what rule of thumb was applied to allocate and share water in the irrigation scheme at the time of data collection and during the previous dry season. They were asked where and when problems with water distribution such as disputes, stealing and so on, arose. Participants described what the problems entailed and who was involved. They were probed for their opinion on who was wrong and what was wrongful about their behaviour. Lastly, they explained how the problems were resolved, whether a compromise was reached, whether a mediator was involved and whether a fine or compensation was paid. Via these questions, an indication of the underlying norms and beliefs for water allocation and water sharing in the irrigation schemes was obtained.

At first the participants were reluctant to admit that problems or conflicts over water distribution had arisen in their irrigation schemes. They emphasised they lived peacefully together and shared water without friction. We assured that we believed that they managed and shared water in a peaceful way. We underlined that it is normal that disagreements arise occasionally. We explained that the aim of the research was to understand how they solved their problems. Only then, the participants were willing to give information on problems and disputes that had arisen in the irrigation schemes.

During the focus group discussions the role of the team leader/facilitator was crucial to ensure everyone participated in the discussion and no one could dominate the discussion. He actively

involved women in the discussion because they were more likely to keep quiet. This was effective and useful since women sometimes came up with other cases or other interpretations of the facts.

d. Qualitative Methods of Data Collection: Participatory Ranking

It has been argued that networks of personal relations and social power are important variables in processes of institutional evolution. Such relations and one's social position and power in the community's hierarchy greatly determine one's capability to shape institutions (Cleaver, 2002). Besides, distribution of resources and entitlement to resources are strongly connected to broader socio-political structures that underlie inequalities in the community, such as gender and social status (Leach et al., 1999). This is especially true in patriarchal, status-based societies in rural Africa (Platteau & Abraham, 2002; Silbersmidt, 2001).

Yet, institutional theory is often deficient in identifying indicators that unambiguously reflect the degree of social power of resource users. Resource users can have overlapping identities and social roles. Social status, which is a collective judgment of the relative position of an individual in society and which is an important source of (social) power, may depend on various other ascribed or achieved characteristics (Cleaver, 2002; Weiss & Fershtman, 1998). Evaluating actors' social status and power in their community on the basis of their productive identities such as 'farmers' or 'traders', or on their social roles such as 'leaders' or 'youth', is problematic. It is based on assumptions about the relation between status, power and these social positions that cannot be easily validated (Cleaver, 2002).

A contribution of this research consists of using a direct measure of actors' relative social status that is based on the perception of community members. This avoids relying on assumptions that are hard to validate. Besides, when it comes to distribution of irrigation water, the social hierarchy as it is perceived by the community of irrigators is more likely to be pertinent than any hierarchy drafted by an outsider based on whichever categorisation.

To obtain such measure of actors' relative social status we conducted a participatory ranking exercise in each irrigation scheme with the same 20 participants that were involved in mapping and in the focus group discussions (Figure 9). Divided into four subgroups, the participants ranked all irrigators identified on the maps by social status. They did so by putting cards with the irrigators' names on a ladder that represented the social hierarchy in the community (more details on the participatory ranking exercise can be found in Part II and Part III).

In order to rank irrigators according to their social status in the community, a common understanding of the concept 'community' and the concept 'social status' was essential. Community was defined as the group of irrigators using the specific irrigation scheme. This was likely to be the arena where people dealt with the governance of their common water flow.

Coming to common understanding and to an accurate translation of the concept social status was even more important but also more challenging. The original aim of the ranking exercise was to measure the relative power status of every irrigator in the irrigation scheme. But, as one's relative social status is highly positively correlated to one's relative power status in a society and more likely to be commonly understood, we opted to establish a ranking according to social status. 'Hadhi ya jamii' and 'uwezo' were used as the Swahili translations for social status. 'Hadhi ya jamii' literally means 'status in society' but this term is not widely used. 'Uwezo' means 'ability' and is generally interpreted as economic ability. The term also holds the notion of power (Kamusi Project). The participants were instructed to interpret ability broadly, including the ability to attain what one wants, the influence one can have on others, the ability to be respected and to be listened to. The concept of a social status hierarchy was represented by a ladder. If one is high on the ladder one is positioned high in the social status hierarchy, low on the ladder corresponds to a low position in the social status hierarchy (Singh-Manoux, Marmot, & Adler, 2005). A thorough description and a hypothetical example by the facilitator further aided to come to a commonly understood concept of social status and a social status hierarchy.

Figure 9: Participatory Ranking

Still, the internal validity of the social status measure could be called into question. One could think it measures (economic) well-being rather than social status. In Part II the social status indicator is checked for correlations with wealth indicators like asset holding, housing quality and sources of income outside agriculture. Social status and economic well-being were found to be positively correlated. But economic well-being is not the sole determinant for social status. Additionally, post-ranking group discussions about the advantages and disadvantages of having a relatively low or high

social status in the community confirmed the common understanding and internal validity of the concept. These discussions also highlighted the pertinence of social status as source of differentiation in the studied irrigation communities.

In order to improve the quality of the measure for irrigators' relative social status in the community and reduce subjectivity we let four subgroups rank the same irrigators. These rankings were then transformed into a mean score. The mean score is less sensitive to subgroups ranking irrigators in the 'wrong' way, for instance out of resentment or because they think some form of assistance could follow (Van Campenhout, 2007). It was also important that the participants were assured that the ranking remained secret. To prove so, the research team made sure the participants witnessed that the piles with ranked irrigators' name cards were put in a sealed envelope that remained with the principal researcher. To avoid embarrassment, overestimation or underestimation of one's own social status, the participants were not expected to rank themselves. Cards with names of subgroup participants were put aside. Another quality control measure consisted of close monitoring of the subgroups. This was done to ensure understanding of the ranking exercise and the concepts and to avoid that some individuals dominated the exercise.

Finally, the participants were compensated for the half day they spent successively in the mapping exercise, the focus group discussion and the ranking exercise. Each participant received 1,000 TSH[7].

e. Qualitative Methods of Data Collection: Semi-Structured Interviews

Institutions for conflict management are part and parcel of the institutional set-up for common resource governance (Ostrom, 1990). Initially, it was assumed that a clear-cut set of institutions for conflict management would be in place at the level of the irrigation schemes and that these would be easily identifiable. Yet, there was no fixed set of institutions for conflict management. At the irrigation scheme level, conflicts over water or land were observed to be solved in a pragmatic way and it was concluded that the institutions for conflict management were 'under construction' (See Part III).

Another initial assumption was that information on conflict management in the irrigation schemes could be obtained by scrutinising archives of local courts and other organisations involved in conflict resolution. But complaints over access to resources and disputes between irrigators were not treated in the formal bureaucratic set-up. One of the reasons is that all irrigators in the studied irrigation systems extract water without holding an official water right. As the preliminary assumptions proved wrong, the empirical strategy had to be adapted.

[7] With 1 US$ = 1,200 TSH

Instead, disputed resource claims and problems related to accessing water or land in the studied irrigation schemes became the starting point. These disputes formed the unit of analysis. The consecutive actions by various actors involved in the disputes were examined and the way the disputes were settled was investigated. As such the institutions for conflict management were uncovered. This proved to be a more useful strategy to study the flexible and pragmatic set of solutions for resource conflicts and to uncover actor-driven processes of institutional evolution.

This micro-level case based analytical approach to studying conflict resolution and actor-driven processes of institutional evolution also allowed to explicitly take social differentiation and power relations into account. Concretely, the way of dealing with resource conflicts and the outcome of the conflicts were systematically related to the indicator for the relative social status of both the one(s) that were affected and the offender(s). Additionally, the way of settling disputes and the outcome was related to the gender of those involved.

Irrigators who had been involved in resource conflicts in the recent past were identified via the participatory maps and via the survey data, which were collected during the first round of data collection (June until August 2008). These irrigators, the village chairmen (VC), the village executive officers (VEO) and, if present, irrigation scheme leaders took part in individual semi-structured interviews during the second round of data collection in May 2009. In total, ten men and six women reported on 25 different cases. Most cases occurred less than five years prior to data collection.

The individual semi-structured interviews included questions on the subject and severity of the conflict, on irrigators involved and the location of their irrigated plot, on timing and recurrence of the conflict, on who mediated the conflict or who enforced rules and on sanctions. Lastly, also the respondent's viewpoint was asked on what rules or norms were broken and who turned out to have won or lost the conflict.

Most respondents did not hesitate to talk about the cases. Some of them did. Some guarantees were needed to make them overcome their hesitation. Interviews were conducted in private, anonymity was assured and the respondents were guaranteed their account would remain secret and would appear with coded names in any research output. It also helped that it was the research team's second visit to their village.

f. Quantitative Methods of Data Collection: An Individual Survey

An individual survey with structured questions was conducted (Figure 10). The survey included standard questions on socio-economic characteristics, questions on irrigation and production on irrigated fields and questions on accessing irrigation water in the two latest dry seasons and problems related to that. It included questions on (financial) reciprocity networks. The General Social Survey questions that measure beliefs in trust, helpfulness and fairness were also included (Karlan, 2005, p. 20). The survey was further composed of a framed field experiment measuring risk aversion and a framed field experiment measuring time preference (for details see (D'Exelle, Van Campenhout, & Lecoutere, forthcoming)[8]. While most of the questions in the survey measure data at the individual level, some enquire about household level data such as housing quality or household assets.

The respondents were interviewed face-to-face. To the maximum possible extent interviewers sought out a private spot to conduct the interview. Before commencing the interview, the interviewers briefly informed the respondents about the research team and about the aims of the research. Anonymity was assured. The interviewers started after the respondent gave consent to be interviewed. The complete interview took on average 45 minutes. In some cases, it took longer, for instance when the interview had to be conducted in Kihehe instead of Swahili or when the respondent had many types of crops in her irrigated fields. Respondents were compensated for their time spent in the interview by means of the payoffs that were earned in the framed field experiments on risk aversion and time preference.

In total 228 irrigators participated in the survey. All irrigators who were identified during participatory mapping and who were available at the time of the survey were interviewed. It was seen to it that all irrigators who participated in the framed field experiment on sharing irrigation water were interviewed. The time lapse between the participatory mapping and the survey was approximately one month. About 35% of the irrigators identified on the maps could not be interviewed because they were not available at the time we conducted the survey. Some travelled, some moved, some fell ill and one of them died. As the average social status score and the proportion of women in the group of irrigators who were not available for the survey are not significantly different of those who indeed were available, we can reasonably believe that a (self-) selection bias remains limited.

[8] A range of questions, including the framed field experiments on risk aversion and time preference, that were taken up in the survey used for this research has been incorporated in a 1000-respondents survey on market integration and in a 600-respondents survey on microfinance conducted in the same district. The data on these variables from the three surveys can be pooled.

Figure 10: Individual Interviews

The irrigators to interview were invited via the village chairman whom was given notice two days in advance. If people did not show up on the appointment, the interviewers went to their homes or their fields to look for them. Per irrigation scheme, there were two days to conduct the interviews with a team of ten interviewers, except in one village where only one single day could be used.

There are indications of interviewer biases in the time preference experiment (D'Exelle et al., forthcoming). These need to be controlled for when using data from that experiment. Such biases may also exist in the data from the risk aversion experiment. Possibly, as instructions for these experiments were given by different interviewers, interviewer differences in demeanour or attitude may have influenced respondents' choices. Other questions in the survey did not need elaborate instructions and did not result in any payoff. Therefore, an interviewer's bias is less likely.

g. Quantitative Methods of Data Collection: A Framed Field Experiment

The Pros and Cons of Framed Field Experiments

Economic experiments are an appropriate tool to identify and qualify the role of institutions, social norms, social preferences on individuals' behaviour and the outcomes (Cardenas & Carpenter, 2008). They offer methods to test behavioural hypotheses in CPR environments and in environments where individual behaviour may be driven by other motives than pure self-interest. Economic experiments also make it possible to elicit a reaction to different circumstances by the same people. Observational data cannot provide the same information as people may not be able or not be willing to answer to (hypothetical) questions about their behaviour in various circumstances.

Laboratory experiments with university students playing abstract games, however, may not produce outcomes that are valid predictors of real world behaviour (Velez et al., 2009). Regular laboratory experiments focus on the importance of material payoff incentives and downplay the importance of other (non-material) incentives. Yet, it is widely recognised that the context of subjects' lives, their culture, beliefs, group identity, social context and personal identity can influence behaviour in experiments (Cardenas & Ostrom, 2004; Velez et al., 2009). The material payoff can be transformed into an internal subjective game under influence of the subject's identity, the group and the repeated nature of the interactions (Cardenas & Carpenter, 2008). Therefore, framed field experiments explicitly bring in context and other information on the group and the individual apart from material incentives. In addition, the research subject-pool for framed field experiments is drawn from actual CPR or public goods users (Cardenas & Ostrom, 2004; Harrison & List, 2004). By framing the research subjects are presented with a CPR dilemma that closely resembles the dilemma they face in their everyday lives (Velez et al., 2009). It assures that research subjects play the game the experimenter intended (Cardenas & Carpenter, 2008). This increases the external validity of the results as compared to abstract laboratory experiments conducted with university students (Velez et al., 2009).

Data gathered via the framed field experiment can be combined with survey data on demographic and socio-economic characteristics and beliefs in social values of each of the research subjects and their group. This helps to explain the variation in behaviour and cooperation levels across the same experimental design (Cardenas & Ostrom, 2004).

There are some limitations attached to framed field experiments however. First, despite the advantages of framing, some argue that framing may prompt norm-driven behaviour while the objective should be to look for non-situation-specific, robust behaviour (Cardenas & Carpenter, 2008).

Secondly, behaviour in experiments is sensitive to the framing. Therefore, when the framing is different, experiments with the same objective structures and incentives may produce different behaviour (Cardenas & Ostrom, 2004). To reduce the risk that variations in framing induce variations over different sessions, standard instructions, procedures and examples can be used. And, if feasible, the same experimenter should run the different sessions to reduce variations in framing and to avoid an experimenter bias.

Thirdly, sometimes the robustness of behaviour observed in framed field experiments is called into question. Proof that behaviour measured in such experiments is somewhat robust is provided by the fact that framed field experiments produced similar results when they were repeated with different people in the same communities (Henrich et al., 2006).

Fourthly, some question the external validity and question that the behavioural propensities captured in experiments correlate with real-life economic activity (Cardenas & Carpenter, 2008). To the extent possible, this can be crosschecked with real-life observations via other methods, for instance via surveys. A direct way of evaluating the external validity is via post experiment questions that assess to what extent participants recognise elements from real life in the experiment.

Fifthly, the methods used for sampling and the possibility of earning payoffs through the experiment sometimes raise scepticism about the validity of the findings (Cardenas & Carpenter, 2008). If sampling happens via voluntary participation, this may introduce a (self-) selection bias, especially if it is known that payoffs can be earned. A random sample drawn from a population is ideal but not always feasible. Payment of payoffs earned in experiments is sometimes questioned. The fact that payoffs introduce strategic behaviour is of course intentional. Others have ethical concerns about 'spoiling' participants and hampering free cooperation to research. Yet, participants' time is not free. Therefore it is appropriate to compensate the time they spent in the experiment. A rule of thumb is compensating a half day session with the equivalent of a one-day or two-day's wage.

Sixthly, limited literacy and numeracy, low levels of education and different ways of (abstract) reasoning can hamper understanding of the instructions and the protocol of the experiment. This can introduce a bias (Cardenas & Carpenter, 2008). Prior testing in the field helps to reveal many of the pitfalls and ambiguities. These challenges can be countered by using unsophisticated tables, production functions and decision cards that show both figures and symbols. Reading instructions aloud, providing posters of tables and decision cards and using examples aids as well. Although care should be taken while providing examples as they can favour certain strategies (J. C. Cardenas & Carpenter, 2008). Furthermore, an experimenter who is familiar with dealing with lowly educated participants can anticipate problems of understanding.

Seventhly, participants may doubt the credibility of the experimenter and her team if they spent little time in the community. This can bias results. Working with locally-known experimenters is a solution; teaming up with people who have credibility is close substitute (Cardenas & Carpenter, 2008). Likewise, the fact that a foreign team conducts an experiment in the village may raise false expectations among participants. It is important to be honest about the aims and the limitations of the experiment.

A last challenge of framed field experiments is crosstalk (Cardenas & Carpenter, 2008). Participants may share their experiences of the experiment with others who will participate later and this may introduce a bias. This can be avoided by organising sessions simultaneously or by allowing only a short time lapse between sessions. Crosstalk could also create selection problems if participants are sampled through voluntary participation because it can affect who will participate.

The Scope and the Limits of the Framed Field Experiment Used in this Research

The framed field experiment, on which a large part of the analysis in this dissertation is based, has been conducted with actual users of common water flows living in semi-arid conditions. More particularly they are users of smallholder irrigation schemes in which appropriation of water is largely self-governed by the user community. The experiment was framed as water appropriation from the common irrigation schemes and replicates dilemmas that irrigators experience in real life.

When spatially-fixed irrigators appropriate water from common irrigation water flows, irrigators located upstream can repeatedly determine how many of the available units of water they will extract. Their water extraction will affect the remaining units for the subsequent irrigator(s) located downstream. This can be mimicked in a framed field experiment by a repeated distribution game in which a participant, who is randomly assigned to be an upstream user, can propose a split of an available twelve hours to extract irrigation water. The number of hours corresponded to a certain payoff, representing the harvest from irrigated agricultural production, payable at the end of the experiment. The downstream user, permanently paired to the upstream user, receives the remainder of the hours available for water extraction. Yet, she is not a passive receiver in reality. Therefore, in each round of the game, she could react to her received share to the upstream user by opting to remain silent, to communicate appreciation or dissatisfaction or to punish the upstream user. The latter implied a minor cost for the downstream user and a small fine for the upstream user, deductible from the final payoff.

In reality, irrigators in semi-arid areas appropriate water in circumstances of water abundance and water scarcity. Therefore, the experiment started with five rounds in which water is abundant and total water availability was sufficient for both upstream and downstream user to reach a threshold – set at four hours – that represents a critical water input required for irrigated agricultural production. Above the threshold, payoffs rose with hours of water extracted; below the threshold, payoffs were minimal. Then followed ten rounds in which water is scarce. Water scarcity entails there is an insufficient supply of resource units to fulfil the users' needs (United Nations Development Programme, 2006, p. 133). It was mimicked by fixing the threshold at seven hours, which renders it impossible for both users to reach above threshold payoffs. In addition, payoffs per hour of water extraction were lower and increased only half as fast per extra hour[9].

[9]A more detailed description of the experimental design and protocols can be found in the text in Part **II** and Part IV. The actual protocol and instructions as they were used in the field can be found in the Appendix I.

The focus of this study is on sharing common resources. Therefore, unlike other CPR games and irrigation games, the framed field experiment used here did not include a stage that replicates the contribution to provisioning common resources. For instance, the design of our experiment and the irrigation game introduced by Cardenas, Johnson &Rodriguez (2009) differs in the following aspects. In the experiment used here, there is no first stage in which irrigators contribute to a public fund (provision) before making appropriation decisions. The decision of each upstream user in this experiment is similar to the decision of an upstream user in location D in the irrigation game in which she shares a given amount of resource units with one downstream user (in location E). The amount of resource units an upstream user in location D can share, depends on the contributions to the public fund and the appropriation decision by upstream users in location A, B and C. In our experiment, the amount of resource units to be shared remains exogenous and fixed over rounds.

In the experiment used here, scarcity is introduced in a different way than in other experiments. In many experiments that replicate the inherent social dilemma of CPR, like the one used by Rutte, Wilke, & Messick (1987) and Oses-Eraso & Viladrich-Grau (2007), the primary underlying concern is safeguarding resource provision. To safeguard resource provision, appropriation levels should be such that they sustain the resource stock and do not cause negative externalities on other users. In these experiments, resource scarcity makes the resource stock smaller, which affects appropriation behaviour because provision is more rapidly compromised. But this lower amount of available resource units under scarcity conditions does not necessarily imply that users' needs cannot be fulfilled. Yet, when it concerns a common water flow resource scarcity raises problems of water distribution rather than sustainability problems. Appropriation from a common water flow is sequential and entails vertical downstream externalities (Cardenas, Janssen, & Bousquet, 2008). By consequence, appropriation mainly affects the remaining resource units for subsequent users located downstream and does not necessarily affect the resource stock. Moreover, scarcity entails there is an insufficient supply of resource units to fulfil the users' needs. That is why, in the experiment used here, water scarcity is replicated by making the available resource units insufficient to fulfil the water needs of both the upstream and downstream user.

The framed field experiment used here allows assessing how participants who are upstream users in the experiment share available resources when water is abundantly available. It also allows examining how they share resources when water is scarce and the water needs of either upstream and downstream users cannot be satisfied. The repeated nature of the game corresponds to real-life repeated interactions between irrigators. The repetition could induce incentives for cooperation and could invoke reciprocity. Or it could prompt more sophisticated strategies like rotation that make it possible to obtain efficiency gains while guaranteeing equal sharing over time (D'Exelle, Lecoutere, & Van Campenhout, 2010). Furthermore, the effect of communication or punishment by the downstream

user on the upstream user's appropriation behaviour can be evaluated. The ability to communicate or to punish are attributes that are known to augment fairness in dictator games (Frey & Bohnet, 1995). The likelihood of punishment by the downstream users in response to their received share could be assessed as well. But this fell out of the scope of this research. Lastly, since individual survey data and social status ranking data of each experiment participant was available, variation in behaviour in the experiment can be linked to individual and group level layers of information.

The participants of each session were randomly and secretly assigned to be upstream or downstream users and paired up. Whether irrigators were assigned to be upstream or downstream users in the experiment was independent of their actual position in the irrigation schemes. It referred to the type of decision they had to take in the experiment, respectively a decision about the distribution of water or about the reaction to a received share of water. It was assumed that, in reality, each irrigator had a neighbour located upstream and downstream and that he was confronted with both types of decisions.

Participants did not have any information about the participant they were paired to. Apart from the influence of institutional factors, behaviour in the experiment and possible social distance effects are dependent on one's personal preferences and on internalised behavioural implications of one's position in the irrigator community (Cardenas, 2003; Cardenas & Ostrom, 2004). One could argue that social distance effects and relational aspects of social factors like gender, power and relative social status may have had stronger effects on behaviour if these characteristics of the paired participant were known. Yet, providing this information risked influencing behaviour in uncontrollable ways. It could also complicate understanding of the game as prior testing proved. It possibly jeopardised anonymity as well.

Validity and Robustness of the Experimental Findings

To maximise the external validity and robustness of the findings obtained via the framed field experiment, several issues were addressed. First, ex-ante, key informant interviews and focus group discussions were organised to gain information about the rules, norms and enforcement mechanisms that underlie governance of irrigation water in the studied irrigation schemes. This information aided to shape the experimental design such that it closely replicates dilemmas the irrigators experienced in real-life.

Secondly, the design of experiment was pilot-tested with irrigators that belonged to an irrigators' community in Mufindi district that is not part of this study. It could be reasonably assumed that the irrigators who participated in the pilot test had similar characteristics as the irrigators who took part in the experiment. The pilot-testing revealed several pitfalls that were addressed in the final design of the experiment. For instance, the protocol and instructions had to be simplified to ensure understanding

and to reduce the length of the session. The tools had to be adapted to enable all participants, also those with limited literacy or numeracy, to use them. Providing participants with information about specific characteristics of the paired participant had to be avoided because it produced on overload of information to process before making a decision. It also was a challenge to the experimenter team to look up the data on the participants' characteristics on the spot. The location needed two separate rooms where the two groups – the upstream and downstream participants – could sit comfortably.

Thirdly, all participants were irrigators who faced dilemmas similar to those in the experiment. They were not recruited via voluntary participation but via a random sample drawn from their irrigation community's population. More specifically, per irrigation scheme, participants were randomly selected from those identified on the participatory maps. They were invited via the village chairman. Sessions included irrigators from the same irrigation schemes. Per irrigation scheme, maximum four sessions of the experiment were conducted, each with maximum fourteen irrigators.

Fourthly, the external validity of the findings can be evaluated in a direct way on the basis of the post-experiment question: "Did you recognise many, some, few or no elements from real life in the exercise?". Most upstream users in the experiment recognised many elements from real life in the experiment (59.2%; N=78). A minority of the upstream users did not recognise any elements (13.2%). The other upstream users recognised some elements. Most downstream users recognised many elements, few did not recognise any (resp. 54.5% and 9.1%; N=77). Other downstream users recognised some elements. The external validity of our findings can also be assessed in an indirect way by cross-checking with real life in the irrigation schemes. Real-life data is available via the individual survey, focus group discussions and the semi-structured interviews.

Fifthly, the robustness of the findings can be assessed by checking whether there are notable differences between irrigator communities. In general, the average proposed share in the abundance treatment of the experiment does not significantly differ between irrigation schemes. Only in one irrigation scheme (Kitangzi), it is significantly lower than in two of the other irrigation schemes (Mutua and Ika)[10]. Another way to evaluate the robustness of our findings would be to repeat the experiment with other irrigators from the same irrigation schemes. However this was beyond the scope of this study.

As a robustness check, the findings can also be compared with those from similar experiments. As the design of our experiment slightly differs from other framed CPR and irrigation games, findings however are not entirely comparable. The average proposed share by male upstream users when water is abundant in our framed field experiment is 0.50 (0.21); by female upstream users 0.57 (0.17). In the

[10] Average proposed share in the abundance treatment in Kitangzi is 0.44(0.24), in Mutua 0.58 (0.36), in Ika 0.55 (0.41).

baseline treatment of the irrigation game conducted by Cardenas et al. (2009), participants in location D, who have to make a similar decision as the upstream users in this research' experiment, on average keep three tokens and leave two for participants in location E. This corresponds to an average proposed share of 0.40. Female participants are more likely to extract in a fair way.

A one-to-one comparison between dictator games and the distribution game played in our experiment is impossible since we used framing and experiment participants face dilemmas they know from real life. Therefore, selfish behaviour is expected to be countered by social proximity and social norms, which are known to prevent excessive extraction in CPR settings (Velez et al., 2009). The repeated nature of the game and the opportunity for the downstream user to communicate or sanction the upstream user may also ease selfishness (Frey & Bohnet, 1995; Osborne & Rubinstein, 1994). Still, the decisions of upstream users in the experiment resemble the decisions taken by dictators in dictator games. A comparison may be informative. In dictator games conducted in western societies, the proposed share ranges between 0.31 and 0.5 (Colin F. Camerer, 2003). In Tanzania, a student population proposed an average share of 0.3 in a dictator game that follows a trust game (Holm & Danielson, 2005). Gender did not affect behaviour. Somewhat unexpectedly, the Hadza, a hunter gatherers population in Tanzania, were found to exhibit unfair behaviour in dictator games while they are considered to adhere strongly to egalitarian norms (Marlowe, 2004). The average share proposed was 0.10. Women were observed to offer less than men. The average proposed shares in our framed field experiment are higher than in the dictator games described above and there are gender differences[11]. The higher proposed shares are probably partly due to the different design of the game, the repeated nature and the framing and partly due to the social norms that the participants internalised and referred to in the game (Cardenas & Ostrom, 2004).

h. Quantitative Methods of Data Collection: The National Sample Census of Agriculture 2002/2003

In Part IV, we check whether inequalities observed at the irrigation scheme level also exist in the wider region. To do so, we use data on agricultural households in Iringa region, gathered via the National Sample Census of Agriculture 2002/2003 (National Bureau of Statistics, 2006)[12]. We obtained permission to use the data from the National Bureau of Statistics and received a copy of parts of the national dataset.

[11] In our experiment, the average proposed share by upstream users is equal to 0.52 (0.20) when water is abundant and is equal to 0.45 (0.22) when water is scarce (and giving is more expensive). Women offer more than men.

[12] An agricultural household is defined as a household where one or more persons have or operate at least 25 square meters of arable land for agricultural production and/or own or keep at least one head of cattle or five goats/sheep/pigs or 50 chicken/ducks/turkeys during the agricultural year 2002/03. Agricultural holdings larger than 20 hectares or with more than 50 cattle, 100 goats/sheep/pigs or 1000 chicken are excluded.

Water in the Tanzanian Context

In this section we will first discuss water resources in Tanzania. Thereafter, we will review the main ideas of the mainstream discourse on water and water governance and raise some points of critique. Lastly, we will shed a light on water governance policies in Tanzania and some of their shortcomings.

Water Resources in Tanzania

Tanzania's stock of annual renewable water resources amounts to 89 cubic kilometres (United Republic of Tanzania, 2002). The water resources include rivers, lakes, wetlands, springs, reservoirs and groundwater aquifers. Tanzania has several great freshwater lakes that cover approximately 60,000 square kilometres in total. Many are shared with neighbouring countries. The country is divided in nine river basins[13] (Figure 11).

Tanzania has a tropical climate and is divided into four main climatic zones. These include the hot humid coastal plain, the semi-arid zone of the central plateau, the high-moist lake regions and the temperate highland areas. In most of the country there are two rainy seasons: the Masika (long rains), that fall from mid-March to the end of May, and the Mvuli (short rains) that come intermittently throughout November and December. Some areas, such as the South-Western Highlands which include Mufindi district, get a prolonged rainy season that starts end November and continues to the end of April (Chang'a et al., 2010). The different types of climate and rainfall patterns cause regional and temporal variability in rainfall and variability in river flows. Also water reservoirs and groundwater aquifers are unevenly spread across the country.

[13] River basins are the geographic area contained within the watershed limits of a system of streams and rivers converging toward the same terminus, generally the sea or sometimes an inland water body (Molle et al., 2007, p. 587).

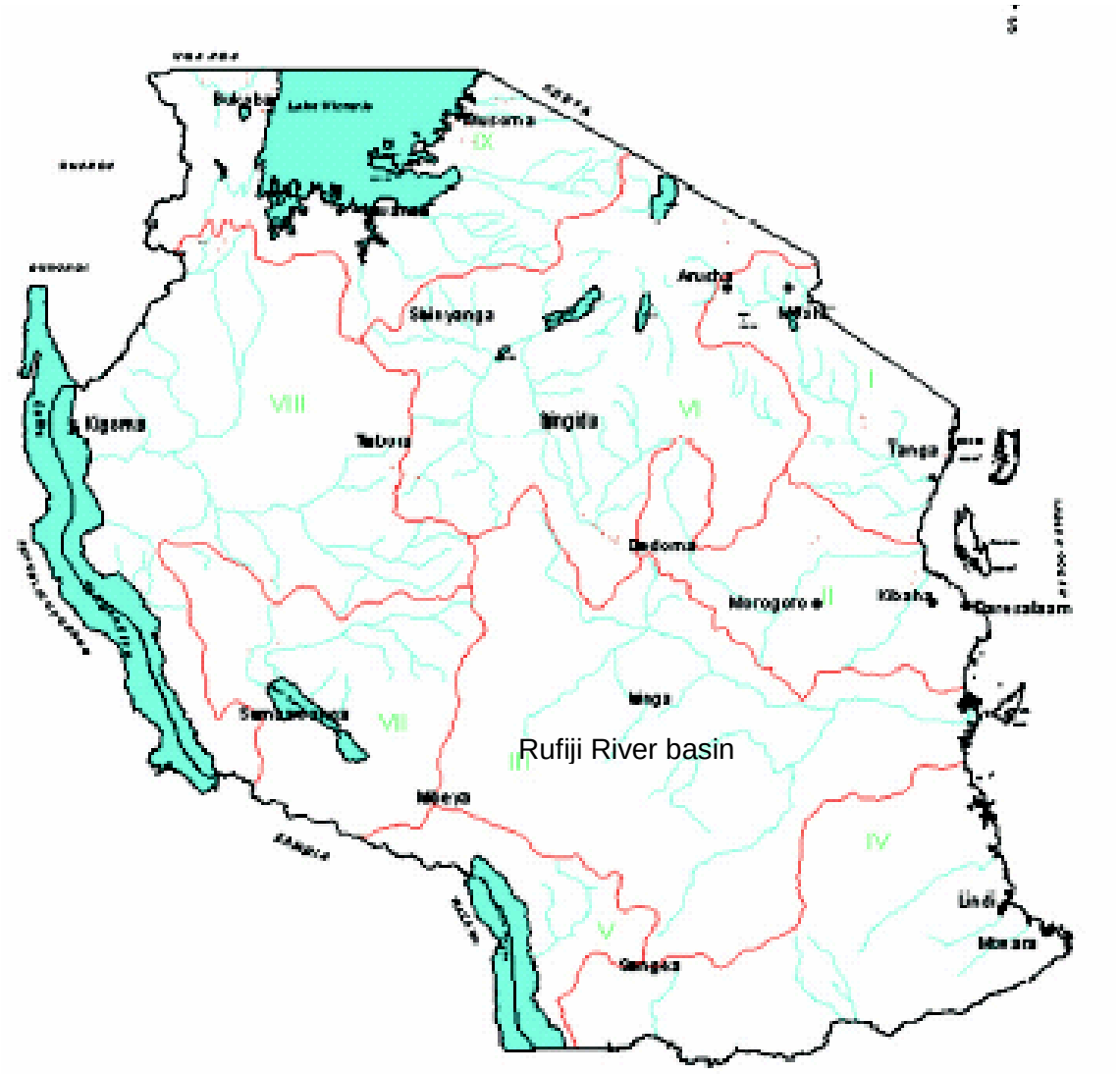


Figure 11: River Basins in Tanzania (United Republic of Tanzania, 2002, p. 49)

The total Tanzanian population is estimated to amount to 44,5 million in 2011 and expected to grow at about 3% per annum (National Bureau of Statistics, 2009). This comes down to an average water availability of approximately 2,000 cubic meters per person per year. The fast growing population makes that Tanzania is projected to fall below the water-stress threshold of 1,700 cubic meters per person by 2017 and below the 1,000 cubic meters per person water-scarcity threshold by 2036 (ceteris paribus)[14]. As water resources and replenishment are not equally spread over the country, the average water availability however varies considerably by area.

[14] Population projections based on 2002 census data (National Bureau of Statistics, 2009)

Climate change, increased climate variability and inter-annual climate variability, such as El-Niño effects, have made rainfall less predictable in many East African countries and particularly in Tanzania (Chang'a et al., 2010; Dixon, Smith, & Guill, 2003). The South-Western Highlands, which include Mufindi district, are largely vulnerable to climate variability and will become even more vulnerable under the projected climate change. Mean annual rainfall is expected to decrease by 6% due to the doubling of carbon-dioxide concentration in the atmosphere. Additionally, an increase in the frequency and severity of droughts and floods is expected (Chang'a et al., 2010). Although climate change is not addressed directly in the national water policy of 2002, it is recognised at the highest level (Ministry of Foreign Affairs and International Cooperation, 2010; Nkwame, 2010).

Furthermore, a rising demand for domestic and productive water is likely to diminish the stock of water resources (United Republic of Tanzania, 2002). For instance, the demand for water for traditional small-scale irrigation has increased over the last decades. While its potential for food insecurity prevention and income generation for smallholder farmers is recognised, there is also a concern that its water use is inefficient (Adams, Potkanski, & Sutton, 1994; United Republic of Tanzania, 2002).

Water Policies

a. The Global Discourse on Water Governance

The current mainstream development discourse on water shows a growing concern for water scarcity. When it comes to ways to deal with water scarcity, two schools can be distinguished in this discourse. One school argues that the economic valuation of water should provide the necessary incentives to use water more efficiently. Along the same line of thinking are those that argue that the productivity of water should be increased, for instance by raising the "crop per drop". (United Nations Development Programme, 2006). The other school is conscious about the heterogeneity of water users and the common pool resource characteristics of water. This school argues that the allocation of scarce water resources should be the outcome of a process of integrated decision making while weighing up the disadvantages and advantages of alternative options (Savenije, 2002). There are two approaches to weighing up the disadvantages and advantages. In one approach, water is regarded as a scarce resource that should be deployed where it generates the greatest wealth and increases the total productivity of water (United Nations Development Programme, 2006). Another approach to allocating water takes into account that the marginal product and the marginal value of water are different for different type of users. This approach, situated in the 'redistribution camp' appears to receive less attention though.

The marginal value of water is substantial for semi-subsistence farmers and smallholder irrigators in development countries because water is an essential production factor, critically needed to sustain in their livelihood. Approaches aiming to maximise the total productivity of water via the market or via integrated decision making hold the risk that semi-subsistence farmers and irrigators will be pushed out of the market. This issue however relates to the underlying development model and to the trade-off between efficiency and equity. The school that aims to maximise the total productivity of water appears to adhere to the idea that generally "growth is good for the poor". It seems to disregard concerns about equity and pro-poor growth endeavours to achieve growth without a trade-off with redistribution (Dercon, 2003).

Besides, the mainstream discourse on water tends to overlook the fact that power and powerlessness determine the distribution of access to key commodities, such as water, among and within different groups in society (Leach et al., 1999) (Collinson, 2003) (United Nations Development Programme, 2006). Political and social exclusion in the distribution of resources and in the redistribution of resources that may result from newly-introduced policies for water management do not always receive the necessary attention.

b. Water Governance Policies in Tanzania

Natural resource management and water management in Tanzania has a colonial legacy (Kabudi, 2005). The colonial state aimed to access and control the abundant natural resources in the country. Therefore, it vested all natural resources in the Governor on behalf of the colonial state. People were alienated from ownership, access rights and use rights with regard to natural resources. To access and use natural resources people were required to have permits or licenses. The application of "customary law" with regard to natural resource ownership, use and management was tolerated to the extent that it did not conflict with the interests of the colonial state.

In the post-colonial era, all natural resources remained vested in (the president of) the state (Kabudi, 2005). Access and use of natural resources is (officially) regulated by statutory law. Similarly to the colonial situation, in practice there is a large grey zone where both statutory and "customary" laws co-exist. Natural resource management still happens in a context of legal pluralism, especially at the more decentralised level (Maganga, 2002).

Initially, the postcolonial state adhered to socialism. The fact that natural resources and water resources remained vested in the state put public good characteristics on them. The central government provided funding for capital and maintenance costs of water distribution development (Huggins, 2000). Since the late 1980s, central government has become less involved in provision. Its role shifted to regulation, control and monitoring (Huggins, 2000). In the national water policy

adopted in 1991 water remained vested in the state. The payment for water rights was reintroduced as a means to recover some of the costs involved in provision of water.

In keeping with the current global discourse on water governance Tanzania renewed its policies for water resource management in 2002. In the current national water policy all water in Tanzania remains, "by constitution and law, vested in the United Republic of Tanzania". The addition that "every citizen has an equal right to access and use of the nation's natural water resources for his and the nations' benefit" should be in favour of an equitable distribution of water (United Republic of Tanzania, 2002, p. 17). Yet, official water rights are still a prerequisite to accessing it.

The renewed National Water Policy (NAWAPO) strives towards a harmonised framework for water resource allocation (United Republic of Tanzania, 2002). Its foundation is an integrated, multi-sectoral water resource management in order to attain economic, social and ecological sustainable use. This should at the same time ensure that all social and productive sectors and the environment receive their adequate share of the water resources. The modi operandi are decentralisation of allocation, participation and representation of water users in water user associations (United Republic of Tanzania, 2002) (United Republic of Tanzania, 2005). The NAWAPO however hesitates between treating water resources as common pool resources that can be managed by the users and as a private good that can be regulated via market transactions (United Republic of Tanzania, 2002). The NAWAPO leaves space for both communities and the private sector to be involved in provision (Huggins, 2000).

The NAWAPO has some shortcomings in our view. It includes competing objectives and statements that can legitimise non-equitable allocation of water and that can disadvantage small-scale users, reducing their water security instead. Human water needs are the first priority and the environment the second in the NAWAPO. The allocation of water to other uses is subject to (unspecified) social and economic criteria. But the main objective is to increase the productivity of water (United Republic of Tanzania, 2002). The emphasis on efficient use of water and the principle of treating water as an economic good in order to raise productivity can threaten the entitlement to water of small-scale users, like semi-subsistence farmers and irrigators or livestock keepers. Their use of water may be considered inefficient if measured for instance by the 'crop per drop' ratio. Moreover, semi-subsistence farmers, irrigators and livestock keepers, who are in general relatively poor, may have difficulty paying for water rights. The ecological sustainability argument can easily be misused as well.

Figure 12: Smallholder Irrigated Agricultural Production

The sector of semi-subsistence smallholder irrigation has a particularly low priority in Tanzania's water, agricultural and irrigation policies (Figure 12). Small-scale, extensive irrigation is blamed for inefficient water use and for water resource depletion at the expense of the environment and domestic users in the NAWAPO (United Republic of Tanzania, 2002). The agricultural sector development programme and the national irrigation policy mainly provide for investments in large-scale irrigation schemes (United Republic of Tanzania, 2006a, 2009). They plan to improve smaller-scale irrigation and to provide funds for investing in these at the district level. The two main criteria to compete for funds for development of smaller-scale irrigation schemes via the district are the economic rate of return and the farmers' contribution to the capital investment costs. These are two stringent criteria for semi-subsistence smallholder irrigators.

Lastly, the participatory approach to water resource management advocated by the NAWAPO remains a challenge. On the one hand, the government management style remains generally top-down and directive (Huggins, 2000). On the other hand, the NAWAPO is based on over-optimistic assumptions that all water users will have equal opportunity to participate in water resource management and that user representation and decentralisation of management will automatically result in unbiased and politically neutral responses to the users' needs. And thus lead to an equitable distribution of water. Various studies show that these assumptions are not always valid (Cleaver & Toner, 2006) (Ribot et al., 2010). In fact, in the process of negotiating for water rights, power relations are very important. Elites can negotiate better water rights for themselves than less powerful members of society because they control the decision-making processes that legitimise the rules for allocation and distribution of water ((Meinzen-Dick & Pradhan, 2002). The views and needs of the representatives of user sectors like the smallholder irrigation sector, who are often elite members, are not necessarily the same as other users' (Cleaver, 2002). Lastly, considering the mere fact that many small-scale users do not hold an official water right and are not regarded a legitimate water user, their participation in integrated water management is not straightforward.

The NAWAPO is not likely to do away with legal and institutional pluralism with regard to local water management (Maganga, 2003). NAWAPO has no specific guidelines on how water should be governed at the local level, for instance within the sector of smallholder irrigation. According to the NAWAPO, resource governance at the local level should be organised via Water User Associations within the confines of the NAWAPO, laws and water acts in force (United Republic of Tanzania, 2002). In reality, it is organised in more 'informal' ways. Yet, little is known about these informal ways and the extent to which they contribute to sustainable, efficient and equitable water management.

c. "Customary" Ways of Water Governance in Tanzania

While a formal legal framework has been imposed on natural resource management since colonial times, natural resources have long been managed under "traditional" governance systems (Orindi & Huggins, 2005). Many (elements) of these still prevail over formal governance systems at the local level (Sokile, Mwaruvanda, & van Koppen, 2005). Such traditional governance systems are often locally specific, adapted to the particular environment or livelihood systems (Maganga, 2002; Orindi & Huggins, 2005). There are some commonalities. Institutions governing water and land are often intertwined and may also have other social functions. In many cases, entitlement to water is inherently connected to land access (Orindi & Huggins, 2005). Often, traditional resource governance systems are embedded in and interwoven with the existing customs, traditions, norms, beliefs and folklores (Sokile et al., 2005). Generally, maintaining social harmony while sharing (common) natural resources is highly valued. In many cases, the community interests prevail over individual benefits (Orindi & Huggins, 2005). There tends to be a preference for reconciliatory ways of conflict resolution or conflict mitigation (Maganga, 2002). Yet, under such customary systems, entitlements to natural resources are often gender-biased and differentiated according to age and status (Adams, Watson, & Mutiso, 1997; Orindi & Huggins, 2005; Potkansky & Adams, 1998). Traditional resource governance systems however are not static. They evolve, become infused or blended with elements of formal governance systems (Cleaver, 2002). This research will provide insights into what "informal" water governance looks like at the local level.

d. The Role of the State in Natural Resource Governance

In principle, Tanzania evolved from a centralised governance model to a more decentralised governance model (Mollel, 2010). In keeping with the current developments, the local government reform programme (LGRP) aimed for democratic decentralisation. It devolved more power, responsibilities and resources to local government authorities (Chaligha, Henjewele, Kessy, & Mwambe, 2007). In practice, democratic decentralisation is not yet established for various reasons.

One of the reasons is that the power of local government authorities remains curtailed by central government (Ribot et al., 2010).

As argued before, statutory water management policies have a marginal role at the local level and higher level government authorities are not strongly present at the local level (Sokile et al., 2005). The role of local government authorities in local water resource governance remains dubious. On the one hand, the NAWAPO does not explicitly assign an active role for local government in water governance. On the other hand, the LGRP indirectly increased the potential of village government to intervene in water and land management. The role of (local) government authorities in local resource governance will be discussed in more detail in Part III.

The Effect of Gender and Social Status on Fairness in Common Water Flows: Evidence from a Field Experiment in Tanzania

Abstract

A framed field experiment is used to examine the effect of the gender and social status of users of self-governed common irrigation systems in rural sub-Sahara Africa on fairness in the distribution of water. When water is abundant in the experiment, women distribute water in an altruist way, men in a fair way. A higher social status has a negative effect on the share users propose to others but not so among women. When water is scarce in the experiment, all reduce the share they propose to others, although users with a higher social status reduce it less substantially. On the whole, men and women with a relatively low social status propose more than equal shares of water in abundance but they do not when water is scarce. Women with a relatively high social status distribute water in an altruist way when it is abundant. Even if they reduce their proposed share in scarcity, they remain fair. Men with a relatively high social status distribute water in a selfish way throughout abundance and scarcity. The gender- and status-related unfairness in the distribution of resources could challenge the sustainability of self-governed common water flows as it undermines trust, reciprocity, mutual commitment and provision. The differential water access that results from it could reinforce gender and status-based inequalities. Water scarcity likely exacerbates such drawbacks. Policies building on community governance of natural resources should acknowledge the underlying causes of inequity in the distribution of resources and actively address these, especially as climate change is expected to increase water scarcity.

Introduction

Equity in the distribution of common pool resources (CPR) has received little attention in the economic literature on CPR. Yet, a distribution of CPR that is considered fair by the users is essential to build and reinforce trust, reciprocity norms, and mutual commitment, which form the pillars of self-governance of CPR (McKean, 1986 in: Baland & Platteau, 1998; Ostrom, 1990). It is therefore one of the criteria for judging the performance of community institutions for natural resource governance (Agarwal, 2000). Moreover, when it concerns common water flows, a fair distribution is fundamental for a sustainable provision. If downstream users deem upstream users do not distribute resources in a fair way, downstream users may fail to contribute to provision activities, which are equally important for upstream users (Ostrom, 1990; Ostrom & Gardner, 1993). Besides, fairly sharing common water flows is especially challenging when water is (temporarily) scarce, which is common in semi-arid areas in sub-Sahara Africa. Under certain circumstances, the distribution of scarce resources can even be a security issue (Bogale & Korf, 2007; Turner, 2004). The distribution of resources also has important implications for livelihood opportunities, especially if it concerns an essential good like water. In this regard, the post-institutionalist literature has emphasised the need to address political and social exclusionary factors in the distribution of resources (Collinson, 2003; Leach et al., 1999).

Investigating fairness in the distribution of CPR is crucial to avoid an overly romantic and simplistic picture of self-governance of resources, blind to possible structural causes of inequality. Else, this may be a pitfall for policies that build on community self-governance of water resources and expect this to result in efficient, sustainable and equitable use of resources (Leach et al., 1999; Mehta et al., 2001). Moreover, as climate change is expected to increase water scarcity, the distribution of water may become a more pressing development and security concern (United Nations Development Programme, 2006).

While fairness norms are important features of CPR institutions, it is not evident that all CPR users comply with fairness norms and distribute water in a fair way under all circumstances (Agarwal, 2000; Baland & Platteau, 1998; Ostrom, Gardner, & Walker, 1994). Water scarcity and CPR users' gender and their relative social status are expected to affect the willingness and ability to distribute in a fair way. The incentive structure and behaviour of CPR users is likely to be influenced by gender and social status specific preferences, behavioural norms and reputation mechanisms. Such norms and reputation mechanisms may be especially important in patriarchal and status-based societies in rural Africa where gender and social status are linked to economic and socially embedded inequalities (Agarwal, 2007; Platteau & Abraham, 2002; Silbersmidt, 2001). While the implications of social factors on incentives and behaviour are admitted, they are rarely analysed in CPR environments using quantitative methods (Cleaver, 1998).

In this article, we use a framed field experiment to examine the resource distribution behaviour of users of a common irrigation system in rural sub-Sahara Africa in function of their gender and their relative social status in the community. We look at their distribution behaviour under conditions of water abundance and scarcity. More specifically, we address the following questions: do male and female irrigators share resources in a different way? Do they react differently when water becomes scarce? Does irrigators' social status affect the way they share resources when water is abundant and when it is scarce? Does this apply in the same way to male and female irrigators? And, to what extent do real life observations substantiate the experimental findings on irrigators' resource distribution behaviour?

The article is structured as follows: in the first section we review the CPR and experimental literature that deals with the relation between gender, social status and distribution behaviour. In the second and third section we describe the methods for data collection and the context. In the fourth section we present the results and relate these to the literature and to real life behaviour in the irrigation communities in the fifth section.

Literature

Common pool resources (CPR), like communal forest, fishing grounds or irrigation systems, are natural or man-made resource systems that are sufficiently large to make it difficult and costly to exclude potential beneficiaries (Ostrom, 1990, p. 30). The rival nature of the resources distinguishes CPR from public goods (Ostrom et al., 1994). Refuting Hardin's (1968) prediction that exploitation of the commons inevitably leads to a tragedy of overuse, Ostrom (1990) proved that self-governance by the community of CPR users can successfully avoid overexploitation and distributive conflicts. CPR self-governance is based on trust, reciprocity norms, and mutual commitment, which substitute for formal institutions and complete otherwise incomplete contracts (Cardenas & Carpenter, 2008; Ostrom, 1990).

Fairness norms are important features of institutions of self-governed CPR as they should ensure a distribution of CPR that is considered fair by the users (Agarwal, 2000; Baland & Platteau, 1998; Ostrom et al., 1994). To accomplish a fair distribution of CPR, high rates of conformity to fairness norms are needed (Ruttan, 2008). Conformity to shared norms is often ensured through community sanctioning mechanisms like social pressure or (social) sanctions that raise the cost of non-cooperative behaviour (Hayami, 2009; Velez et al., 2009). Norms may also be internalised in which case people face internal costs like guilt, shame or anxiety upon defying norms (Ostrom, 1990). Additional incentives to conform to fairness norms may derive from one's own benefit from equality (inequity aversion) or from community members that set the example (strong reciprocators) (C. F. Camerer & Fehr, 2006; Fehr & Schmidt, 1999).

Ensuring widespread adherence to fairness norms and maintaining a fair resource distribution is especially challenging when it concerns common water flows in semi-arid areas. The dilemma in the distribution of resources is bigger than in other CPR because appropriation from a common water flow is sequential and engenders vertical downstream externalities. This means appropriation by upstream users affects the remaining resource units (and the quality) for subsequent downstream users (Cardenas et al., 2008). When water is scarce, which is common in semi-arid areas, and the resource stock is insufficient to provide for all users, the dilemma in the distribution of resources becomes even more stringent (Cardenas et al., 2009).

Socio-economic heterogeneity in the community of CPR users is another challenge to compliance with shared norms. Heterogeneous CPR users may have different incentives to abide by rules that restrict extraction because they do not face symmetric benefits and costs from using the resource (Ruttan, 2008). Heterogeneous CPR users may also place different non-monetary values on the costs and benefits of abiding by fairness norms and distribution rules (Cardenas, 2003).

Issues of fairness and resource distribution are also strongly connected to broader socio-political structures that underlie inequalities in the community (Agarwal, 2007; Leach et al., 1999). Two sources of structural social differentiation are CPR users' gender and relative social status in the community. Gender refers to the "socially determined ideas and practices of what it is to be female or male" (Reeves & Baden, 2000). Social status is a collective judgment of the relative position of an individual in society based on her traits and assets and is an important source of power (Weiss & Fershtman, 1998). Inequalities that relate to gender and status do not only imply differences in economic endowments but are also socially embedded in specific social norms and perceptions. Specific behavioural norms, imposed or internalised, and reputation mechanisms associated to status and gender can thus shape people's incentive structure and behaviour (Agarwal, 2007; Brauer & Bourhis, 2006). This is especially true in patriarchal and status-based societies in rural Africa (Platteau & Abraham, 2002; Silbersmidt, 2001). Social status and gender do not only influence economic behaviour in real life, but also in the experimental laboratory where all participants play the same role and are given the same level of resources (Hong & Bohnet, 2007). In what follows, we will review what the experimental and CPR literature says about the effect of gender and social status on distribution behaviour.

First, gender differences in distribution behaviour can be due to differences in social preferences that are independent of what others do or are expected to do (Greig & Bohnet, 2009). Women have been found to be more generous than men in the dictator games conducted with student populations (Andreoni & Vesterlund, 2001; C. Eckel & Grossman, 1998). Andreoni and Vesterlund (2001) specified that women are more generous than men when it is relatively expensive to give. When the price of altruism is lower, however, men begin to give more than women. Women also have a

preference for sharing evenly whereas men are more likely to be either perfectly selfish or perfectly selfless (Andreoni & Vesterlund, 2001). In field experiments framed as water appropriation in irrigation systems conducted with actual irrigators, female users generally extract a fair share of resource units. They even reduce the share they extract if unfair behaviour is heavily fined (Cardenas et al., 2009).

Secondly, in CPR environments, gender is observed to influence compliance with fairness norms and resource appropriation. In many cases, women's capabilities to appropriate resources are restricted in an unfair way. Women also have stronger incentives to abide by appropriation rules such as prescriptions of fairness (Agarwal, 2007). Generally women, and especially poor women, are more inclined than men to avoid rule breaking, reprimand and conflict (Agarwal, 2007; Cleaver, 1998). They may do so because they rely more on informal reciprocal support systems and they have to preserve social ties more (Cleaver, 1998).

In contrast, women sometimes have weaker incentives than men to comply with rules that ensure sustainable or fair resource appropriation levels. This may be the case if the costs associated to use restrictions are higher for women than for men, while the benefits are lower (Agarwal, 2007). Costs may be higher for women because they are highly dependent on the resource and have few exit options (Agarwal, 2007; Pandolfelli, Meinzen-Dick, & Dohrn, 2007). For example, in Tanzania women infringed forest extraction rules more frequently than men because they rely heavily on the forest reserve for firewood (Chitiga & Nemarundwe, 2003). Benefits from use restrictions may be smaller for women because of gender inequalities. Due to intra-household inequalities, women may profit less from income from CPR or from redistributed benefits generated by use restrictions (Agarwal, 2007; Pandolfelli et al., 2007). In some cases, women are not deterred by rules they did not help design. Women may violate appropriation rules that men (unintentionally) made unfeasibly restrictive or may circumvent taboos preventing them from accessing resources (Adams et al., 1997; Pandolfelli et al., 2007). Sometimes, use restrictions are relaxed to allow poorer women to secure their minimum water needs (Cleaver, 1998).

Thirdly, there are various reasons why one's social status could affect fairness and resource distribution. Members of high-status groups may act more altruistically than members of low-status groups because they may be better off, or because they want to demonstrate their superiority and preserve their status (Hong & Bohnet, 2007; Liebe & Tutic, 2010). The social norm of 'noblesse oblige' can prescribe members of high status groups to donate more to others in less favourable positions than members of low-status groups (Liebe & Tutic, 2010). People of low-status groups may prefer equality because of fears not to receive what they deserve without equality (Hong & Bohnet, 2007).

Dictator games, conducted with pupils from different German high school systems, which are associated to different social status, showed that average donations per school increased with status. On a disaggregated level, however, the relation between social status and altruistic behaviour is not clear-cut (Liebe & Tutic, 2010). Hong and Bohnet (2007) conducted risky dictator games with university students with different characteristics associated to high or low status in Northern American society, such as gender, race, religion and age. They found that low-status groups have strong inequality risk aversion while high-status groups exhibited strong inequality risk proneness. In low-status groups, a concern for disadvantageous inequality appears to outweigh efficiency considerations and being other-regarding.

Social status and power are generally seen as strong positive correlates (Weiss & Fershtman, 1998). According to the literature on social power in psychology, power is an impediment to rule compliance and fairness (Keltner, Gruenfeld, & Anderson, 2003; Van Kleef, De Dreu, Pietroni, & Manstead, 2006). Powerful individuals are less motivated to pay attention to others because they have many resources and are less dependent on others (Fiske, 1993). Being more powerful gives people the capacity to resist the influence of others and to behave according to their internal states. This may explain why powerful individuals are more likely to transgress social norms (Keltner et al., 2003). Power can also enhance incentives for self-interested behaviour. For instance, individuals who gained power in an experiment think they deserve the more powerful position. They believe they have the right to exploit their power and think they deserve more (Ball & Eckel, 1998).

Fourthly, also in CPR situations, users' relative social status in the community and the power it allots to them influence their compliance to fairness norms and their resource distribution behaviour. There are indications that high status and powerful CPR users will be less fair. CPR users with a higher status may be wealthier and/or have larger interests in the resource. In that case, resources may be more valuable to them. This reduces their incentives to share equally (Ruttan, 2008). Possibly, their status makes they can get away with violations of rules. For example, in the Taita hills in Kenya, upstream users, who are more powerful as they accumulated wealth and prestige, extract more than their share. They count on downstream users leaving their infringements unchallenged (Fleuret, 1985). In Sonjo in Tanzania, priests, who play a leading political and social role, distribute irrigation water. Their restraint from selfishness is the moral obligation to strive for collective well-being. But when water is scarce, this does not stop priests from selfish appropriation, nor do possible social sanctions (Potkansky & Adams, 1998). Also in Indian irrigation systems, village elite and better-off, highly placed farmers break water allocation rules more often than non-elite, especially if they have not crafted the rules (P. Bardhan, 2000).

But there are also reasons why high status and powerful CPR users would be more compliant to fairness norms and other resource distribution rules. CPR users with a high status in the community

may also encourage compliance with norms that regulate water appropriation by taking a leadership role or by setting the right example (P. Bardhan & Dayton-Johnson, 2002). Or, if higher status CPR users have large interests in the resource, they may coerce others to comply with use restrictions as this serves their purpose (Ruttan, 2008; Vedeld, 2000). Else, if they are economically less dependent on the resource, they may more easily comply with use restriction than users with a lower status (P. Bardhan & Dayton-Johnson, 2002; Ruttan, 2008).

While there is ample evidence that social factors like gender and social status influence preferences and incentives for fairness and for compliance to fairness norms, their impact on fair water distribution behaviour in irrigation systems has rarely been analysed. We will now describe the methods we have used to assess that impact.

Methods

The data was collected from June until August 2008 in five smallholder irrigation schemes that are largely self-governed by the irrigators. The irrigation schemes are situated in the semi-arid lowland areas of Mufindi district in Tanzania, which are part of the Rufiji river basin. Mufindi district was chosen because of the importance of irrigated agriculture for food crops and crops for local markets. Rainfall is uni-modal and concentrated in one rainy season. The rest of the year it remains dry. This confronts irrigators with seasonal water scarcity (Mkavidanda & Kaswamila, 2001; United Republic of Tanzania, 2006b).

Initially, in each of the irrigation schemes, participatory mapping exercises were conducted with twenty randomly selected male and female irrigators. In total, the plots of 351 irrigators were indicated on five maps. An irrigator is defined as the person in the household responsible for decisions on and cultivation of the irrigated plot. Next, focus group discussions were organised to get a sense of the rules, norms and enforcement mechanisms for governing irrigation water in each of the irrigation schemes.

Thereafter, participatory ranking exercises were conducted to measure irrigators' relative social status in the irrigation community based on the perception of the community members (Laws, Harper, & Marcus, 2003)[15]. In each of the irrigation schemes, four randomly composed subgroups of the twenty irrigators who did the mapping ranked all irrigators identified on the maps by social status. They did so by putting cards with the irrigators' names on a ladder with four rungs[16]. High (low) rungs

[15] Social status was translated in Swahili as 'hadhi ya jamii', which literally means 'status in society', and as 'uwezo', which implies economic ability but also the ability to attain your goals, to influence others and to be respected. The notion of power is present in the term 'uwezo' (Kamusi Project).

[16] Participants were not expected to rank themselves nor users they were not well acquainted with. Rungs could be removed (added) if participants distinguished less (more) than four categories.

represented high (low) social status (Singh-Manoux et al., 2005). This resulted in (maximum) four rankings for each irrigator. Each ranking was transformed into a score, equal to the value assigned to the rung divided by the total number of rungs on the ladder. The mean of subgroup scores makes up a measure of irrigator's social status relative to other irrigators of the same scheme. This measure ranges from 0.24 to 1, with 1 corresponding to the highest social status. Then, we standardised the social status measure per irrigation community by subtracting the mean for the irrigation community from each individual's social status and by dividing this by standard deviation for the irrigation community. The standardised indicator of social status ranges from -1.91 to 1.98. Positive (negative) values represent a relative social status that is higher (lower) than the irrigation community's mean. After ranking, the advantages and disadvantages of having a high and low social status in society were listed during group discussions.

Subsequently, we administered structured individual surveys to all available irrigators identified on the maps (N=228). The survey included questions on socio-economic characteristics of the individual and their household, on irrigated agricultural production, on access to irrigation water in the two latest dry seasons and on belief in trust, fairness and helpfulness[17].

Finally, irrigators' water distribution behaviour was observed via a framed field experiment that was designed to replicate dilemmas that irrigators experience in real life. This contributes to the external validity of the findings (Velez et al., 2009). The dilemma in appropriation from common water flows with spatially fixed irrigators consists of upstream users who can repeatedly determine a split of the available units of water, whereby their appropriation affects the remaining units for the subsequent user(s). This dilemma can be mimicked by a repeated distribution game in which the upstream user is the 'proposer' who can propose to split off twelve hours during which irrigation water can be extracted. The number of hours corresponds to a certain payoff, representing the harvest from irrigated agricultural production, paid out at the end of the experiment. The downstream user, permanently paired to the upstream user, is the 'receiver'. She is not a passive receiver in reality. Therefore, in each round of the game, she could react by opting to remain silent, to communicate appreciation or dissatisfaction or to punish the upstream user. The latter implied a minor cost for the downstream user and a small fine for the upstream user, deductible from the final payoff.

In practice, in each round, the upstream user indicated the proposed hours split on a card that was passed on to the paired downstream user. Then, the downstream user indicated one of the four possible reactions on the same card that went back to the upstream user. Thereafter, the subsequent round started and the upstream user proposed a split another time and a new card went to the downstream user for reaction, and so on. Participants were not informed about the number of rounds.

[17] Based on the General Social Survey (GSS) questions (Karlan, 2005, p. 20).

In reality, irrigators appropriate water in circumstances of water abundance and water scarcity. Therefore, the experiment started with five rounds in which water is abundant and total water availability was sufficient for both upstream and downstream users to reach a threshold – set at four hours – that represents a critical water input required for irrigated agricultural production. Above the threshold, payoffs rose with hours of water extracted; below the threshold, payoffs were minimal. Then followed ten rounds in which water is scarce. Water scarcity entails there is an insufficient supply of resource units to fulfil the users' needs (UNDP, 2006:133). It was mimicked by fixing the threshold at seven hours, which renders it impossible for both users to reach above threshold payoffs. In addition, payoffs per hour of water extraction were lower and increased only half as fast per extra hour. The payoff structure for water abundance presented in Table 1 was available to upstream and downstream users in the five rounds with abundance; that for water scarcity in the ten scarcity rounds[18].

Per irrigation scheme, maximum four sessions of the experiment were conducted, each with maximum fourteen irrigators from the same irrigation scheme randomly selected from those identified on the maps. In total, 13 sessions were conducted with 156 irrigators, of which 52 are female. At the end of the experiment, each participant received the sum of payoffs minus fines or punishment costs if any. On average participants received 2460 TSH.

	Water Abundance		**Water Scarcity**	
Hours Upstream User	Upstream User	Downstream User	Upstream User	Downstream User
0	50	500	50	350
1	50	500	50	325
2	50	475	50	300
3	50	450	50	250
4	175	425	50	200
5	250	375	50	125
6	325	325	50	50
7	375	250	125	50
8	425	175	200	50
9	450	50	250	50
10	475	50	300	50
11	500	50	325	50
12	500	50	350	50

Table 1: Payoff per Hour of Water Extraction

[18] Payoffs are measured in Tanzanian Shilling (TSH), with 1 US$ = 1200 TSH. The table and every other tool used both figures and symbols to ensure understanding by lowly educated people. Tools and instructions can be found in Appendix I and Appendix II.

The participants of each session were randomly assigned to be upstream or downstream user and paired up[19]. Upstream and downstream users were seated in separate rooms. Participants were not informed about the gender and social status of the participant they were paired to. Behaviour in the experiment and possible social distance effects, therefore, are dependent on internalised awareness and internalised behavioural implications of one's gender and one's relative social status in the irrigator community (Cardenas, 2003; Cardenas & Ostrom, 2004). One could argue that social distance effects and relational aspects of gender and social status may have had stronger effects on behaviour if gender and social status of the paired participant was known. Yet, providing this information risked influencing behaviour in uncontrollable ways and complicating understanding of the game, as proved by prior testing. It possibly jeopardised anonymity as well.

Context

Rural households living in the semi-arid lowlands of Mufindi district mainly depend on semi-subsistence smallholder farming to provide for their livelihood. Most households keep small livestock to supplement their diet or for trade. Some keep small herds of cattle as savings, for milk or for trade. Other activities include crop trade, petty trade, brick or charcoal production, seasonal labour and beer brewing.

Agricultural production is primordially based on rain-fed cultivation with the use of rudimentary technology and minimal inputs. Irrigated agriculture permits production of food crops out of the season for rain-fed agriculture. Irrigation is also used for the production of vegetables and cash crops for local and regional markets, like tomatoes and onions. In most cases, the right to use and take decisions on the plot of irrigated land is in the hands of either the husband or the wife in the household. The husband generally owns (or rents) the plot.

The irrigation schemes consist of networks of locally dug river diversions and canals. Occasionally locally made wooden gates, earthen dams or sandbags are used to manage the water flow. By exception, concrete intakes or technically more advanced gates are used. Flooding and capillary absorption make the soil of the plots in the irrigation schemes moist enough to farm. Alternatively, the proximity of water permits bucket irrigation. The irrigation schemes comprise a patchwork of plots most of which are relatively small (on average one acre) and cultivated by one irrigator. Less than one third of the irrigators use two or more plots and only a few own large plots (up to 13 acres).

The principal norms and rules for governing water appropriation in the irrigation systems are the following: competition and distributive conflicts are avoided to the extent possible in order to

[19] Being up- or downstream user in the experiment was independent of irrigators' their actual position in the irrigation schemes. We assumed that, in reality, each irrigator has a neighbour located upstream and downstream and is therefore familiar with decisions up-and downstream users have to make in the experiment.

maintain harmony in the community. Furthermore, there are strong beliefs that everybody has a right to water. A fair distribution of irrigation water is regarded essential.

Gender relations in rural Tanzanian communities, like the ones studied here, are characterised by patriarchal socio-cultural norms and values that constrain women's rights and privileges, their access to resources and decision-making power (Mzinga, 2002)[20]. Women are structurally subordinate to men and dependent on men for their access to means of production even if economic hardship caused women to take up a role as breadwinner, a role previously reserved for men (Silbersmidt, 2001).

An ILO report (2000) states that women in Mufindi district do most of the agricultural work but have limited access to and control over any income derived from it. Women's access to resources, such as land, generally passes via their husband or male relatives, although recent changes in land legislation should facilitate women's direct ownership of land. Additionally, women's decision-making powers are limited. They have little or no voice in local village government. Yet, since a policy directive issued in 1997, at least 25% of all village councillors elected should be women.

Our impression is that patriarchal structures and norms are still in place in the studied irrigation communities. Even if, de jure, women's decision-making powers may have increased, de facto, women are hesitant to give their opinion or to openly challenge a men's opinion in a mixed public. Also intra-household relations remain patriarchal.

As elsewhere in sub-Sahara Africa, rural Tanzanian communities are status-based societies rather than open societies with democratic decision-making and with socio-economic differentiation based on differences in preferences and skills. In such societies, people who occupy the upper rung of the social ladder provide an authority structure that imposes its rule. People of lower ranks have no choice but to comply. Most socio-economic interactions in these communities are embedded in the existing social hierarchy that is cautiously conserved (Platteau & Abraham, 2002).

A high status in these societies may be lineage- and age-based (Platteau & Abraham, 2002). For instance, among the Iraqw in Tanzania, the (descendants of the) founder of the community is on top of the social ladder and leads the elder council, which constitutes the highest rung of status and authority. Nowadays, the local government has taken over most of the functions of the elder councils, but still elders (are supposed to) guard the community's welfare and represent the population. Older men, but also older women, may derive their authority and respect from their role in the local community as well (Snyder, 2001). People of lower ranks include young age classes, women, recent

[20] Patriarchy is used to describe male superiority over women and the conditions that privilege men and put women in a subordinate position vis-à-vis men (Silbersmidt, 2001, p. 658).

immigrants, people with secondary rights to land, like herders, or poor and dependent farmers (Platteau & Abraham, 2002).

The pertinence of (social) status as a source of differentiation in the irrigation communities is evident from the (dis)advantages of having a high or low social status listed during the post-ranking group discussions. According to the irrigation community members, advantages of having a high social status include respect, decision power and being informed about village affairs. Other advantages are having better access to resources, credit and services and higher well-being. Disadvantages include time-consuming responsibilities and the obligation to keep up the status. The latter demands a particular consumption pattern and makes it impossible to seek (informal) assistance or reimbursement.

A low social status is associated to marginalisation, which reveals itself in "being like slaves", having no freedom to independently make decisions, being defenceless, being uninformed, being ill-appreciated for one's opinion, not receiving recognition and limited access to services. Not unexpected, such profound deprivation of capabilities results in ill-being, like poor living conditions, low income, poor nutrition, failing to send children to school and being unable "to fulfil one's dreams". Among the few advantages of a low social status are easy access to informal assistance and the ability to work as casual labourer.

Additionally, we have looked for correlations between individual and household characteristics and the standardised social status indicator in the survey sample (Table 2). Patriarchy is reflected in the fact that being female and being a female household head is negatively correlated to social status. As expected, being involved in the formal or traditional government or council positively correlates to social status. Also if one's father was involved in the formal or traditional government or council, this increases one's social status. Unexpectedly, age and time of residence do not correlate to social status in the studied communities. Economic well-being and social status are positively correlated. Larger asset holding in terms of (irrigated) land, livestock, bicycle, iron roofing on the house positively and significantly correlate with social status. Destitution, measured by having experienced food insecurity in the last two years, and having no off-farm income opportunities negatively correlate to social status. Having primary education positively correlates with social status, while having no education negatively correlates with it.

In this article, we examine if irrigators' gender and social status affects fairness in the distribution of irrigation water in water-abundant and in water-scarce conditions. Scarcity is expected to render the dilemma of fairly distributing resources more difficult. Gender and social status are expected to affect distribution behaviour because they relate to economic differences and to differences in social preferences, behavioural norms and reputation mechanisms.

Individual or Household Characteristic	Social Status
Female	-.295**
Female household head	-.260**
Age	-.060
Non-lifetime resident	.038
Food insecure (HH)	-.189**
No off-farm income	-.231**
Value of total livestock (HH)	.223**
Owning cows (HH)	.282**
Owning bicycle (HH)	.422**
Iron roof (HH)	.390**
No education	-.335**
Primary education	.252**
Acreage irrigated land (HH)	.168*
Acreage total land (HH)	.219**
Member of village government/council	.300**
Member of traditional government/council	.115°
Able to make important decisions in kinship group	.214**
Father was member of village government/council	.145*
Father was member of traditional government/council	.153*
Father was able to make important decisions in kinship group	.061

Significance levels two-sided: ° = 10%, * = 5%, ** = 1%; N=228
(HH): measured at the household instead of the individual level

Table 2: Correlations between Social Status and Individual and Household Characteristics

Results

More specifically, we will address the following questions by means of a framed field experiment that mimics the distribution of irrigation water: does gender affect distribution behaviour? Does gender make a difference for reactions to water scarcity? Does the relative social status of irrigators affect distribution behaviour in water abundance and in scarcity? And does this happen in the same way for male and female irrigators?

First, both experimental and case studies suggest that men and women will share available resources in a different way. To examine this, we estimated the share of hours, out of twelve hours available for irrigation water extraction that upstream users propose to the paired downstream users under conditions of both water abundance and scarcity in the framed field experiment. Upstream users' gender is used as an explanatory variable. It is a dummy variable that takes the value 1 if the upstream user is female. The treatment (scarcity) is also included as a fixed effect, which we interact with the female dummy. We used Ordinary Least Squares regression analysis whereby we controlled for clustering within individuals[21]. Table 3 presents the results. Table 4 shows whether differences in

[21] One could argue that this simple model is likely to suffer from omitted variable bias. The nature of our experiment is such that current appropriation behaviour is a function of the downstream user's reaction in the previous round. But including this as an explanatory variable is not straightforward. The downstream user's sanctioning behaviour is a direct function of the upstream user's appropriation behaviour. Hence, including the downstream user's reaction would make our model a dynamic panel data model. It is well known that, in such a model, the appropriation behaviour is likely to be correlated within individuals over time, which renders the

estimated proposed shares by men and women in water abundance and water scarcity are significant with a Wald F-test. The proposed shares are based on the estimated model and calculated by assigning the value 0 and 1 respectively, to the dummy variable female and by assigning the value 0 and 1 respectively, to the dummy variable scarcity.

The results demonstrate that, on average, male upstream users propose an equal split of the available hours (=.500). Female upstream users however propose a share of hours that is significantly larger than an equal split and significantly larger than that of male upstream users (respectively 0.500+0.072=0.0572 and 0.500; see Table 4 for F tests). The difference between proposed shares by female and male irrigators is equivalent to almost one additional hour.

Variable	β	S.E.[a]	t	P>|t|
Intercept	.500	.023	21.27	.000
Scarcity	-.057	.017	-3.35	.001
Female	.072	.038	1.91	.060
ScarcXFemale	-.043	.042	-1.03	.304
R^2	.034			
Root MSE	.215			
F(3,77)	8.21			
Prob>F	.000			
N	1170			
Strata	1			
Units	78			

Dependent variable = Proposed share
[a] Corrected for clustering within individuals

Table 3: Linear Regression Estimating Proposed Shares while Interacting Gender with Water Scarcity Treatment

When water scarcity is introduced, material incentives change. Do men and women react differently to this? We observe that both male and female irrigators significantly lower their proposed share (-0.057) (Table 3). Female irrigators however do not reduce their proposed share more than male irrigators (insignificant coefficient of the interaction effect of scarcity and female). But as women's proposed share was higher when water is abundant, the share they eventually propose when water is scarce is slightly, but insignificantly, higher than the share men propose (0.500+.072-.057-.043=0.472 versus 0.500-0.057=0.443; see Table 4 for F tests). When water is scarce, women's proposed share is not significantly different from an equal split, whereas men's is significantly lower.

downstream user's reaction in the previous period endogenous. The standard solution to estimate the model in first differences and use suitably lagged levels of the endogenous variable as instruments is uninteresting for us, as this deletes all time invariant variables from the model, which are key in this study. However, to get a sense of the magnitude of this omitted variable problem, we ran an additional set of regressions. The reasoning of this analysis, as well as the results, are presented in the Appendix III. Overall, we find that excluding the downstream user's reaction in the previous round has little effect on the other variables.

Compares Proposed Share	With Proposed Share	F(1,77)=	Prob>F=
By male in abundance	By female in abundance	3.65	0.0597
By male in abundance	Equal split	0	0.9894
By female in abundance	Equal split	5.90	0.0175
By male in scarcity	By female in scarcity	0.51	0.4794
By male in scarcity	Equal split	8.73	0.0042
By female in scarcity	Equal split	0.60	0.4426

Table 4: Wald F Test for Significant Differences between Estimated Proposed Shares

It seems that men and women respond in a similar way to a change in material incentives. When water is scarce, both men and women lower the share of water they propose. But, as women distribute water in an altruistic way when water is abundant and men distribute water evenly, the reduction due to scarcity results in selfish distribution behaviour among men and fair distribution behaviour among women.

Secondly, distribution behaviour is expected to be influenced not only by gender but also by one's relative social status. Figure 13 represents average shares proposed in each round of the experiment by male and female upstream users with a relatively high and low social status. We centred the standardised social status indicator on the mean for the sample of upstream users (=.0299). Low social status includes 40% of the upstream users with the lowest centred standardised social status, i.e. smaller than or equal to -0.47. High social status includes 40% of the upstream users with the highest centred standardised social status, i.e. greater than or equal to 0.25. Both low and high social status groups are split up by gender[22]. Round one to five in the experiment mimic water abundance, round six to 15 mimic water scarcity.

Figure 13 illustrates that male upstream users with a high social status tend to propose less than equal shares throughout the experiment[23]. Men with a low social status and women with a high social status however, propose on average more than an equal share when water is abundant. In rounds with water scarcity, low social status men tend to propose less than equal shares. Women with a high social status generally propose (more than) equal shares. Initially, women with a low social status propose more than an equal share in water abundance. The proposed share drops below an equal split in the fifth and last round with abundance. It remains lower than an equal share throughout the water scarcity treatment.

[22] The figure does not show proposed shares by the 20% upstream users with centred standardised social status larger than -.47 and smaller than 0.25 as this is less interesting for our analysis.

[23] As some groups by gender and social status are small, differences in distribution behaviour can be sensitive to decisions of one or a few individuals in the group. Therefore, we cannot draw any conclusion on the significance of differences on the basis of Figure 13.

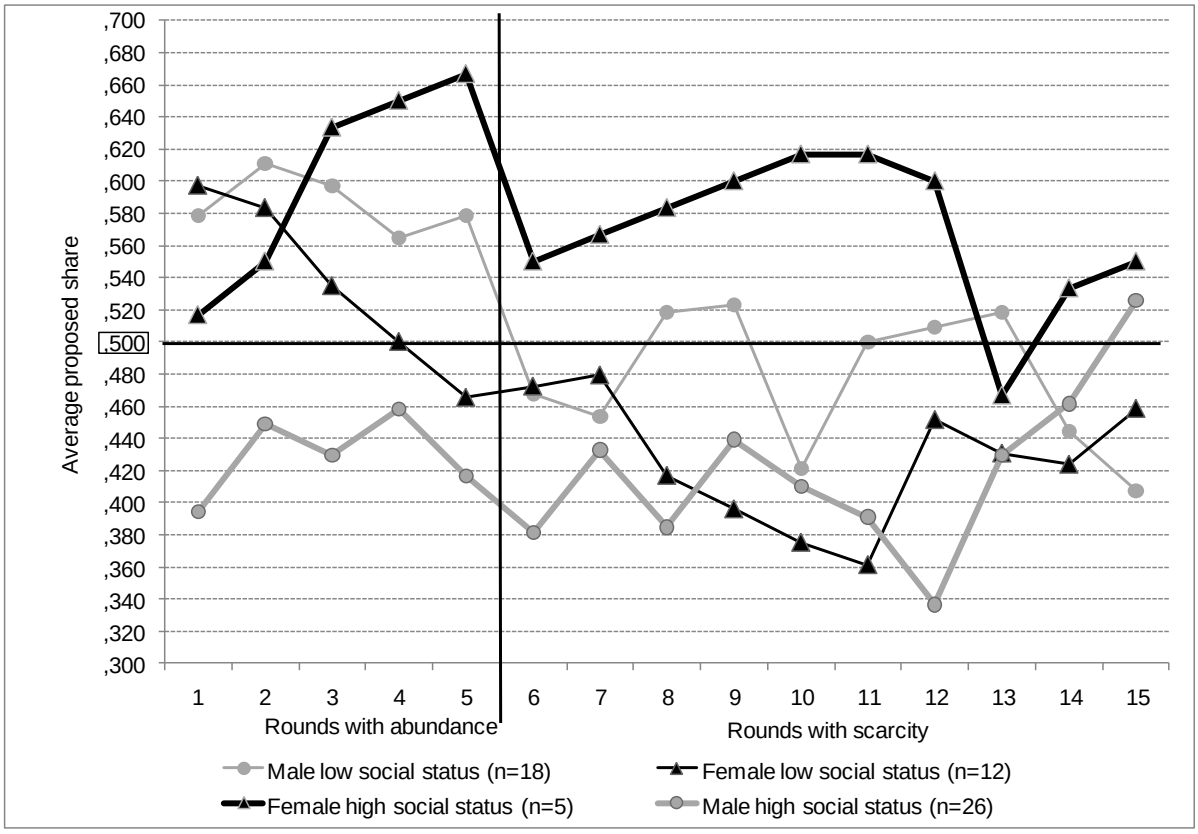


Figure 13: Upstream Users' Proposed Share of Hours of Water per Round by Gender and by Social Status

To examine the significance of the differences in distribution behaviour by gender and by social status, we have estimated the proposed share in the experiment as a function of participants' gender and social status and the interaction of these variables. We did so for water abundance and for scarcity by including interaction effects of the (scarcity) treatment with gender, with social status and with the interaction of those two characteristics. The standardised social status indicator has been centred on the mean for the sample of upstream users in the experiment (=.0299) to facilitate interpretation of the results. The variable scarcity takes the value 1 for rounds with water scarcity. We used Ordinary Least Squares regression analysis and controlled for clustering within individuals, the results of which are described in Table 5. Table 6 shows significance of differences in estimated proposed shares in water abundance and scarcity by reference types of upstream users using Wald F-tests. The reference types of users include men and women respectively, with a high (low) social status. Their proposed share is based on the estimated model. It is calculated by assigning the value 0 and 1 respectively, to the dummy variable female and assigning value 1 (-1) to the variable that represents the centred standardised social status[24].

[24] Standard deviation of the standardised social status for the sample of upstream users in the experiment=1.

In water abundance, the share irrigators propose decreases with higher social status as is shown by the significant, negative coefficient of the variable social status (-0.061). However, the interaction effect of being female and social status is significantly positive (0.083). It largely annuls the negative effect of social status on the proposed share among women.

Consequently, estimated proposed shares by women with a high social status and by women with a low social status do not significantly differ from each other, but they are significantly higher than an equal share (resp. 0.503+0.079-0.061+0.083=0.604 and 0.503+0.079+0.061-0.083=0.560; see Table 6 for F tests). Proposed shares by men with a high social status are significantly lower than those by men with low social status (resp. 0.503-0.061=0.442 and 0.503+0.061=0.564). Proposed shares by high status men are significantly lower than an equal share, those by low status men significantly higher. It also follows that proposed shares by men and women with a low social status do not significantly differ, whereas proposed shares by men and women with a high social status do.

Variable	**β**	**S.E.**[a]	**t**	**P>|t|**
Intercept	0.503	0.021	23.41	.000
Scarcity	-0.065	0.016	-3.96	.000
Social Status	-0.061	0.021	-2.90	.005
ScarcXSocStat	0.049	0.015	3.21	.002
Female	0.079	0.04	1.97	.052
ScarcXFemale	-0.026	0.041	-.63	.528
SocStatXFemale	0.083	0.038	2.17	.033
ScarcXSocStatXFemale	-0.041	0.033	-1.22	.227
R^2	.064			
Root MSE	.210			
F(7,75)	5.46			
Prob>F	.000			
N	1140			
Strata	1			
Units	76			

Dependent variable=Proposed share
[a] Corrected for clustering within individuals

Table 5: Linear Regression Estimating Proposed Shares while Interacting Gender with Social Status and with the Scarcity Treatment

We know that upstream users with higher social status propose lower shares when water is abundant in the experiment (-0.061). When water is scarce, however, all reduce their proposed share (-0.065) but upstream users with higher social status reduce it less (positive significant coefficient of the interaction effect of scarcity and social status =0.049).

When it concerns female upstream users, the negative effect of a higher social status on proposed shares in water abundance is cancelled out. Female upstream users reduce their proposed share as much as male upstream users when water is scarce (insignificant coefficient of the interaction effect of being female and scarcity). To the same extent as among male upstream users, a higher social status makes female upstream users reduce their proposed share less (insignificant coefficient of the interaction effect of being female, scarcity and social status).

Compares Proposed Share	With Proposed Share	F(1,75)=	Prob>F=
By low status male in abundance	By high status male in abundance	8.39	0.0050
By low status male in abundance	By low status female in abundance	0.01	0.9265
By low status male in abundance	Equal split	4.94	0.0293
By low status female in abundance	By high status female in abundance	0.48	0.4914
By low status female in abundance	Equal split	3.10	0.0825
By high status male in abundance	By high status female in abundance	6.37	0.0137
By high status male in abundance	Equal split	3.39	0.0696
By high status female in abundance	Equal split	3.47	0.0663
By low status male in scarcity	By high status male in scarcity	0.33	0.5686
By low status male in scarcity	By low status female in scarcity	0.04	0.8422
By low status male in scarcity	Equal split	2.47	0.1201
By low status female in scarcity	By high status female in scarcity	9.92	0.0023
By low status female in scarcity	Equal split	0.89	0.3477
By high status male in scarcity	By high status female in scarcity	3.67	0.0592
By high status male in scarcity	Equal split	10.08	0.0022
By high status female in scarcity	Equal split	0.26	0.6122
By low status male in abundance	By low status male in scarcity	19.31	0.0000
By high status male in abundance	By high status male in scarcity	0.70	0.4040
By low status female in abundance	By low status female in scarcity	4.06	0.0476
By high status female in abundance	By high status female in scarcity	3.23	0.0763

Table 6: Wald F Test for Significant Differences between Estimated Proposed Shares

The combination of these effects results in the following differences in proposed shares (Table 6). In water scarcity, the proposed shares by men with low social status, by women with a low social status and by men with a high social status do not significantly differ (respectively 0.503-0.065+0.061-0.049=0.450; 0.503-0.065+0.061-0.049+0.079-0.026-0.083+0.041=0.461; 0.503-0.065-0.061+0.049=0.426). The proposed share by men with a high social status is significantly smaller than an equal share. The proposed shares by low status men and women are smaller than an equal share but the difference is insignificant.

The proposed share by women with a high social status in water scarcity remains larger than an equal share, albeit insignificantly (0.503-0.065-0.061+0.049+0.079-0.026+0.083-0.041=0.521). It is significantly larger than the proposed share by low status women (and men) and by high status men.

All upstream users, except men with a high social status, significantly reduced their proposed share in water scarcity as compared to water abundance. High social status women reduced their share, yet it remained an altruist split. Low social status men and women reduced their share from an altruist split to a (less than) equal split. High social status men propose less than an equal split throughout the experiment.

Discussion

In this section we first compare our findings with the experimental and CPR literature. Then, we assess the extent to which real-life gender- and status-specific characteristics like resource valuation, subsistence needs and beliefs in fairness, trust and helpfulness can explain the distribution behaviour observed in the experiment. We continue by evaluating the external validity of our findings and, finally, we reflect on policy implications.

The distribution behaviour by male and female participants as observed under conditions of water abundance in our framed experiment confirms that women are more generous than men (Andreoni & Vesterlund, 2001; Catherine Eckel & Grossman, 2008). They care less about disadvantageous inequality in water distribution even while this is relatively costly in terms of payoffs. Possibly, women have different social preferences than men and are more other-regarding (Greig & Bohnet, 2009). It may also be that women are more reluctant than men to break the irrigation system's rules that prescribe a fair resource distribution, as Agarwal (2007) and Cleaver (1998) suggested.

When water is abundant, men and women with a low social status and women with a high social status distribute water in an altruistic way. Men with a high social status are less generous than others. They disrespect the irrigation schemes' fairness norms and behave selfishly. Their behaviour confirms social psychology findings that higher status and more powerful people are less other-regarding, more selfish and transgress norms more often (Ball & Eckel, 1998; Keltner et al., 2003).

Furthermore, our results show that both men and women react to water scarcity by lowering the share they propose. As a result, women, who distributed in an altruistic way in water abundance, distribute in a fair way in water scarcity. Men, who distributed in a fair way in abundance, distribute in a selfish way in water scarcity. In our experiment, women are more generous than men, whether water is relatively cheap to give (in abundance) or expensive (in scarcity). Andreoni and Vesterlund (2001), however, state that women are more generous when it is expensive to give, while men are more generous when it is cheap to give.

When water is scarce, especially women with a high social status remain generous. They propose more than an equal share irrespective of water being abundant or scarce. High status women appear to be more other-regarding or more willing to live by the rules. Possibly, they can afford to be generous. As shown in Table 7 A&B, they are economically better off since they are less likely to have experienced food insecurity, they more likely have off-farm income opportunities and they own more valuable livestock. Or it may be that they take up a leadership role as guardians of fairness norms,

since they strongly believe in fairness (Table 7 C&D)[25] (P. Bardhan & Dayton-Johnson, 2002). Status seeking behaviour or 'noblesse oblige' could be other explanations (Liebe & Tutic, 2010).

Low status women, however, are generous and propose more than equal shares when water is abundant but this fades when water is scarce. Water scarcity possibly made proposing (more than) equal shares prohibitively expensive in our experiment as it results in a negligible payoff. Possibly, under scarcity, being other-regarding or living up to fairness norms is prohibitively disadvantageous for low status women given their more deplorable economic status, their higher levels of subsistence distress and their higher dependence on irrigation water for food production (Hong & Bohnet, 2007). The same may apply to men with a low social status; they react in a similar way to water scarcity as low social status women.

In fact, in the irrigation communities, irrigators with a lower social status, and especially women with a lower social status, are more likely to have experienced food insecurity than irrigators with a higher social status (Table 7 A&B). They rely more on irrigated agriculture for subsistence as they allocate larger percentages of their irrigated plots to food crops, they have less income opportunities outside agriculture and they own less livestock (Table 7 A&B). In addition, low status women are more likely to belong to minority tribes, possibly because they married into the community (Table 7 B&C). This could make it easier for them to disregard rules to fairly distribute water despite their strong beliefs in fairness.

Even while men with a high social status propose larger shares in water scarcity than in water abundance, they disregard fairness throughout and propose less than equal shares. When water is scarce they decrease their proposed share less than others. Possibly, considerations of being other-regarding, taking leadership or 'noblesse oblige' only come into play under scarcity when they realise their counterpart is seriously deprived if they take the lion share. Still men with a high status remain selfish and deprive their counterpart of gaining any substantial payoff.

In fact, in the irrigation communities, irrigators with a higher social status allocate larger percentages of their irrigated plots to cash crops (Table 7 A&B). Irrigation water, thus, has a high (market) value for them, both when water is abundant and when it is scarce. This could explain why higher social status irrigators take large shares of water in the experiment. Yet, we observe such behaviour among high status men but not among high status women even while they grow similar percentages of cash crops. One of the factors explaining the different distribution behaviour of high status men and high status women may be that men less strongly believe in fairness than women (Table 7 C&D).

[25] Women generally have stronger beliefs in fairness than men. Yet beliefs of high status women are somewhat weaker than low status women's.

Group	By	Food Insecurity	% Food Crops	% Drought Crops	% Cash Crops	Live Stock Value	No Off-Farm Income	Belief in Fairness	Belief in Trust	Belief Helpfulness	% Same Tribe
A. Sample: Upstream users in experiment											
Men *(n=52)*	Social status	-.210	.199	-.043	.019	0.277°	-.179	-.027	-.133	-.088	-.048
Women *(n=24)*	Social status	-.230	-.264	-.176	.232	.333	-0.342°	-.482*	-.040	-.129	.312
All *(n=76)*	Social status	-0.221°	.058	-.069	.087	.307**	-.251*	-0.194°	-.107	-.129	.092
B. Sample: Irrigation communities											
Men *(n=140)*	Social status	-.126	-.092	-.057	.122	0.170°	-.186*	-.068	-.055	-.009	-.074
Women *(n=78)*	Social status	-.266*	-.155	-.166	.162	.249*	-0.221°	-.015	-.061	.080	0.198°
All *(n=218)*	Social status	-.189**	-0.123°	-0.114°	.156*	.223**	-.231**	-.105	-.069	.028	.058
C. Sample: Upstream users in experiment											
Low status[a] *(n=30)*	Male *(n=18)*	-.082	-.100	-.307°	.191	.183	-.085	-.703**	.092	-0.291	.394*
High status[b] *(n=31)*	Male *(n=26)*	.115	.196	/	.069	-.204	.175	-.244	.010	-.026	-.047
All *(n=78)*	Male (n=53)	-.042	-.037	.001	.159	.151	-.141	-.320**	.001	-.136	.241*
D. Sample: Irrigation communities											
Low status[a] *(n=87)*	Male *(n=44)*	-.152	-.061	-.137	.095	.176	-.075	-.266*	-.013	.016	.300**
High status[b] *(n=89)*	Male *(n=73)*	.018	.016	.063	.031	-.013	.071	-.219*	-.032	-.065	-.062
All *(n=227)*	Male *(n=142)*	-.081	-.040	-.060	.106	.168*	-.144*	-.165*	-.056	.026	.184**

Significance levels two-sided: ° = 10%, * = 5%, ** = 1%.
[a] Low social status if centred standardised social status <=-0.47
[b] High social status if centred standardised social status >=0.25

Table 7: Correlations between Social Status, among Men and Women, and Indicators of Resource Valuation, Subsistence Needs or Adherence to Norms[26]

A direct evaluation of the external validity of our findings can be made on the basis of the post-experiment question: "Did you recognise many, some, few or no elements from real life in the exercise?" Most upstream users in the experiment recognised many elements from real life in the experiment (59.2%; N=78). A minority did not recognise any element (13.2%). Fewer women with a low social status recognised many elements (26.7%) but still many some elements (53.3%). This could suggest low status women are confronted with slightly different dilemmas in water appropriation in real life.

[26] Food insecurity indicates that the respondent's household has experienced food insecurity in two years preceding the survey. Percentage of food/drought/cash crops is the percentage of the irrigated plot allocated to food crops, which include maize and beans, to drought resistance crops, which include yams, cassava and sweet potatoes, and to cash crops, which include tomatoes, carrots, cabbage and African eggplant. Livestock value is the total value of big and small livestock owned by the respondent's household calculated using market values at the time of the survey (www.lmistz.net and market prices recorded in Mufindi district, July 2008). No off-farm income indicates the respondent lacks income opportunities outside agriculture and livestock. Belief in fairness/trust/helpfulness was expressed by referring to a scale going from low over moderate to high levels. The last indicator is the percentage in the community of the same tribe as the respondent.

The external validity of our findings can be evaluated in an indirect way by looking at real life behaviour in the irrigation schemes. More particularly, we can look at the type of crops grown on irrigated plots. Growing drought resistant crops is a typical low-risk, low-return strategy to deal ex-ante with the risk of insufficient (irrigation) water (Dercon, 1996). We observe that high status men allocate smaller percentages of their irrigated plot to drought resistant crops (0.4%) than others in the irrigation communities and larger percentages to cash crops (14.7%) (N=228)[27]. They may do so because they are more confident in an adequate water flow. Or, they may be less risk averse or more market-oriented. Low status men and women, regardless of their status, grow more drought resistance crops (resp. 1.0% and 2.0%). Either, women and low status men anticipate on an inadequate supply of irrigation water as they are less assertive in claiming a share; or they are generally more risk averse.

Indirectly, the experimental results are backed by the findings of a related study on resource conflicts in the same irrigation schemes (Lecoutere, 2011). In that study, we found that offenders had a low social status in less than one quarter of the twenty five studied cases of resource conflicts. Offenders had a relatively high social status in more than half of the cases. Women were the offenders only in three cases. These observations correspond with the experimental findings that high status men respect a fair distribution of resources less than women and lower status men. Yet, low status women disregard fairness when water is scarce in the experiment but hardly any of such cases was reported. Either, in real life this rarely happens, or people turn a blind eye to it to allow women to foresee in their minimum needs (Cleaver, 1998).

Our findings imply that policy that naively builds on self-governance and expects this will guarantee equitable water use may be disappointing. There are four possible approaches for policy to advance equity in the distribution of resources. First, if feasible, the efficiency of water use or the water flow could be increased. But, this may be a stopgap measure as this could attract more users while the dilemma and inherent inequalities remain the same. Secondly, selfish water appropriation by men high on the social ladder may be warded off by more enforceable appropriation rules and by supporting women and users of low social status in negotiation processes over access to water. Appropriation rules could be more enforceable if they are recorded at the irrigation scheme or village level. Support in negotiation processes could be organised in the form of easily accessible 'legal' aid. Thirdly, users with lower social status could more easily afford to maintain a fair resource distribution if their dependence on (irrigated) agriculture for subsistence would be reduced through other income opportunities or micro-insurance. Finally, high status women should be actively involved in water governance as they are the true guardians of fairness in the distribution of resources.

[27] Differences however are insignificant as percentages are low and standard deviations are high.

Conclusion

Equity in the distribution of CPR is not evident. Embedded social differentiation linked to gender and social status plays a significant role for the willingness and ability to fairly distribute water in rural African irrigation systems. Water scarcity further intensifies differences in distribution behaviour. As men with a high social status often fulfil a leadership role in patriarchal and status-based societies and they are economically better-off, one would expect them to comply with fairness norms and distribute resources evenly. But they do not. They seem less other-regarding but more efficiency-minded. Low status women and low status men, however, appear unable to stick to a fair distribution when water is scarce. The economic loss that comes with fairness is insurmountable given their more deplorable economic situation and their dependence on irrigation water for subsistence. Only women with a high social status adhere and are able to adhere to fairness. Even if there are different reasons for it, the unfair distribution behaviour of high status men and people with a low social status could undermine trust, reciprocity, mutual commitment and CPR provision and render the system for self-governance of irrigation schemes unsustainable. Moreover, the way water is distributed results in differential access to irrigation water that mirrors structural inequalities and may reinforce economic inequalities linked to gender and social status. Such drawbacks are exacerbated when water is scarce. Policy that builds on self-governance but remains blind for structural impediments to fair distribution of water may fail to attain sustainable and equitable water governance, especially if climate change increases water scarcity.

Institutions under Construction: Resolving Resource Conflicts in Tanzanian Irrigation Schemes

Abstract

Water governance in Tanzania's small-scale irrigation schemes has become ever more challenging because of increasing market penetration, declining predictability of water availability and widening institutional pluralism. Despite these trends, resource conflicts at the local level have generally been avoided. Instead, one observes processes in which actors involved in conflicts make and remake institutions. This renders these irrigation schemes interesting for studying water governance institutions under construction. By documenting how conflicts over water are solved in small-scale irrigation schemes in rural Tanzania, we show that resource conflicts do not necessarily lead to violence, but motivate actors to pragmatically search for solutions. Institutional pluralism is turned into an asset because it increases the potential for creativity. As such, pragmatic conflict resolution and institutional pluralism contribute to the development of more sophisticated and locally adapted resource governance institutions. However, despite its potential, actor-driven development of resource governance institutions can also reproduce deeply entrenched power imbalances and gender roles. As such, it can hinder inclusion of less powerful resource users because the latter do not always have the capability to engage in creative conflict resolution.

This essay was published in the Journal of Eastern African Studies, Volume 5 Issue 2, May 2011.
DOI: 10.1080/17531055.2011.571388

Introduction

The last decennia have been marked by neo-Malthusian predictions of water wars and ever increasing incidences of conflicts over scarcer water supplies (Homer-Dixon, 1994; Starr, 1991). While rising competition for natural resources can be a potential trigger for violence in concurrence with broader tensions, there is little evidence that substantiates a direct causal relation between water scarcity and violent conflict (Le Billon, 2001). If appropriate resource governance institutions are in place, competition for scarce resources does not necessarily lead to violence (Ostrom, 1990). What is more, competition may well be a driver for institutional evolution (Bogale & Korf, 2007; Singleton, 2007).

In Tanzania, different trends have boosted competition for water in small-scale irrigation schemes. More semi-subsistence farmers now supplement traditional rain-fed food production with irrigated agriculture (Kaswamila & Masuruli, 2004). Irrigated production of crops for local and regional markets, like tomatoes and onions, has become increasingly important over the last decade (Shao, Nyomora, Mlay, & Kasunga, 2002). In addition, climate change and inter-annual climate variability such as El Niño effects have made rainfall less predictable, rendering rain-fed agriculture more risky (Dixon et al., 2003; Sokoni & Shechambo, 2005). To date, there have been few incidences of violent conflicts over water for irrigation in Tanzania that are unrelated to other tensions. It appears that the increased competition has mainly generated a growing need for more sophisticated water governance.

Concurrently, the decentralisation process has added to legal and institutional pluralism with regard to water governance in Tanzania. Formerly, water had been principally governed by user communities relying on "traditional" institutions at the local level, but recent policy changes have made institutional pluralism more tangible (Maganga, 2002). The renewed national water policy (NAWAPO) has introduced a new institutional framework for water governance with more implications for the local level (United Republic of Tanzania, 2002, 2005). Additionally, the local government reform program (LGRP) has devolved more power, responsibilities and resources to local government authorities (Chaligha et al., 2007).

These recent developments have emphasised the dynamics of making and remaking institutions for governing water in small-scale irrigation schemes. We believe it is important to uncover these local dynamics to counter neo-Malthusian predictions of water wars, to counterbalance the idea that the sole challenge lies in "getting the institutions right" and to downscale romanticised views about harmonious and inclusive local self-governance of natural resources. A more unprejudiced view on local resource governance is essential to inform policy.

In this article, we address three persistent fallacies about local resource governance institutions and their evolution by making use of data on how resource conflicts are solved in Tanzanian small-scale

irrigation schemes[28]. First, conflicts that arise over natural resources like water or land are not necessarily disruptive. In fact, conflicts may prompt processes of pragmatic problem solving through which local resource governance institutions are reproduced. Secondly, institutional pluralism is not systematically exploited in opportunistic ways. Actually, institutional pluralism can be an asset for the making and remaking of local resource governance institutions because it can be used in a creative way to resolve resource conflicts. As such, it can contribute to the development of more sophisticated resource governance institutions. Thirdly, pragmatic and creative conflict-solving in institutional pluralist contexts is not an impartial process. Actors' positions in the local power structure play a decisive role in this process, which risks further entrenching existing power imbalances.

In the following sections we will first present a conceptual framework based on the post-institutionalist literature, which describes processes that shape institutional evolution in contexts of institutional pluralism and increased decentralisation. Secondly, we will discuss our empirical approach to study processes of institutional evolution prompted by resource conflicts. Thirdly, we will describe the spatial layout, livelihoods and water governance in Tanzanian smallholder irrigation schemes. Fourthly, we will present an empirical account of the way resource conflicts are solved while assessing the implications of the power status of all actors involved. This will enable us to uncover the dynamics of local resource governance institutions in this setting.

Institutions under Construction: A Conceptual Framework

Competition and conflicts over scarce resources like water do not necessarily bring about violence. They can be potential drivers of the further evolution of water governance institutions. To appreciate such evolution, a conceptualisation of institutions is required that allows understanding how events such as disputes, shocks or the introduction of new policies can ignite processes of institutional evolution. Therefore, the idea of institutional crafting has to be relaxed. It is more appropriate to approach institutions as regularised patterns of behaviour that are constantly made and remade through people's practices but emerge from underlying structures and sets of "rules in use" (Cleaver, 2002; Leach et al., 1999). In fact, when it comes to solving issues like disputes over water, the actors involved search for solutions, and preferably non-violent ones. Solutions arise in a pragmatic and creative way and may involve elements of formal policy, traditional law and common practice. This search for solutions leads to organically evolving resource governance institutions.

The diverse historical and geographical diversity of institutions for natural resource governance suggests that institutional evolution has not been unidirectional, but rather is a result of ad-hoc

[28] Recourse conflicts are defined here as conflicts between individuals or between groups resulting from competing claims on resources and disputes over access to and management of resources. These conflicts may imply violent encounters, but they are not instances of violent mass conflicts, defined as systematic breakdowns of the social contract which involve mass violence instigated through collective action (Justino, 2009).

processes. Moreover, it appears that contexts characterised by legal and institutional pluralism have created greater opportunity for divergence in institutional evolution. Such contexts have also given ample scope for human agency while concretising claims to resources and resolving emerging problems (Maganga, 2002; Meinzen-Dick & Pradhan, 2002).

The (post-)institutionalist literature provides insight into various practices and processes that shape institutional evolution in contexts of legal and institutional pluralism and increased decentralisation. We discuss processes of institutional bricolage and institutional syncretism. We also deal with forum shopping and legitimising practices which are part and parcel of such processes.

First, processes of "institutional bricolage" are defined as those in which socially embedded actors respond in an ad-hoc, creative, yet structurally constrained way to issues that arise regarding natural resource governance. In these processes, actors borrow or construct mechanisms for resource governance from existing institutions, styles of thinking and sanctioned social relationships (Cleaver, 2002, p. 16). Actors can blend elements of diverse institutions without paying attention to classifications like traditional and modern or formal and informal. Along the way, elements of more bureaucratic institutions like water policies can become more "socially embedded" as they are used as a reference, even when problems are solved outside the bureaucratic system. Conversely, a bureaucratisation of elements of socially embedded institutions can take place when these become integrated in more formal rules and regulations.

Institutional bricolage is a process that involves contestation and negotiation between actors embedded in a social structure. Therefore, actors' position in their community's power structure, their social relations, their interests and their capabilities will influence the outcome of such negotiations. Consequently, institutions evolving through bricolage may perpetuate and reinforce social divisions (Cleaver, 2002, p. 20). Yet, the social embeddedness of the actors involved may also imply that objectives like maintaining social consensus, solidarity, reciprocity, conflict avoidance and reconciliation are as important as maximising the economic utility of resources (Cleaver, 2002; Maganga, 2002).

Institutional syncretism can be seen as a subset of institutional bricolage. Whereas institutional bricolage encompasses all processes of creative blending, institutional syncretism only considers those that result in innovative institutions. The innovative construction that becomes the "commonly" accepted institution is supposed to be a more viable, durable and legitimate institution in the long run than an un-moulded, imposed institution (Galvan, 2007; Galvan & Sil, 2007).

More opportunistic processes can be at work when actors pragmatically blend and interpret components of different sets of institutions in response to emerging issues. First, forum shopping, a

phenomenon that is inherent in situations of legal or institutional pluralism, is a process whereby actors base their claims on the legal framework that suits them best. Or take their claim or dispute to the institution which they deem most likely to produce a satisfactory outcome (Lund, 2006, p. 676; von Benda-Beckmann, 1981). It is a negotiation process in which power relations matter a great deal. According to Aldashev et al. (2010), the mere threat of relying on a more suitable legal framework or institution may well be enough to enforce a claim. They infer that groups marginalised by the "traditional" legal framework may profit from legal pluralism, because they can threaten to refer to the formal law when it offers better protection.

Secondly, legitimising practices are processes whereby organisations representing certain institutions seek resource claims to authorise and disputes to solve in order to gain and sustain legitimacy in the eyes of their constituency and to turn their power into authority (Sikor & Lund, 2009). Legitimising practices occur in circumstances with a multiplicity of institutions and different legitimacies that compete for authority[29].

The notion of legitimising practices is especially interesting in light of recent endeavours in democratic decentralisation and decentralisation of natural resource management (NRM) in Tanzania and the rest of sub-Sahara Africa. Democratic decentralisation aims to devolve more discretionary powers to locally representative authorities so they can respond more effectively and efficiently to local priorities (Fjeldstad, Braathen, & Chaligha, 2006). Yet, in many cases, democratic decentralisation is not yet established (Ribot et al., 2010). There are several reasons for this. Firstly, local authorities are hardly responsive or accountable to local populations (Ribot et al., 2010). Secondly, their space for discretion remains narrow because they are still bound by priorities and budgets set at higher levels of government (Fjeldstad et al., 2006). Thirdly, the performance of village and district governments is problematic in many cases because of misuse and misallocation of funds, a lack of transparency, corruption and (violent) coercion (Afrobarometer, 2008; Brockington, 2008)[30].

The decentralisation of natural resource management is expected to improve sustainable management of natural resources and ameliorate the livelihoods of local beneficiaries. Yet the expected benefits are rarely realised because of the problems related to democratic decentralisation (Brockington, 2008; Ribot et al., 2010). Moreover, development agencies and government bodies dealing with NRM prefer community-based NRM approaches instead of engaging local authorities. In Tanzania, few forest management committees are vested in village government. If they are, there is little space for discretion for village government or responsibilities remain ambiguous (Persha & Blomley, 2009;

[29] Legitimising practices are closely related to ''shopping forums'' (von Benda-Beckmann, 1981)

[30] Brockington based his conclusion on data gathered before the LGRP. The Afrobarometer survey, conducted in Tanzania in 2008, however, does not give the impression that the LGRP led to a drastic improvement of local government's performance or their reputation.

Ribot et al., 2010). As we will discuss further, with regard to water management in Tanzania, the recently adopted institutional framework hardly offers a role for local authorities.

These opportunities and weaknesses that accompany decentralisation open a space for legitimising practices. Village governments and other politico-legal organisations try to gain legitimacy and authority and try to widen their space of discretion by (re)claiming their role in natural resource management(Ribot, 2009; Sikor & Lund, 2009). In Senegal, for instance, there is competition for authority between the elected rural council, which was recently granted the power to manage the forest, and the Forest Service, which formerly controlled the forests. The rural council pursues legitimacy in the eyes of the local population by being able to authorise their access to the forest. The Forest Service tries to authorise access to the forest to urban-based merchants. It coerces and bribes the president of the rural council to accomplish this (Ribot, 2009). Wardell and Lund (2006) describe how illegal efforts to access land in a forest reserve in Ghana inspired legitimising practices over rights of access and authority. When the local chief tried to accommodate (and extract fees from) new tobacco farmers, he challenged the traditional earth priest's authority to allocate land. When a serious dispute arose, the District Chief Executive intervened and negotiations followed. Eventually, the earth priest kept the authority to allocate land, but found space for the local chief's new tobacco farmers. The District Chief Executive was perceived as a wise and constructive man of office.

Yet the way that local institutions for natural resource governance are shaped through contestation and negotiation by actors embedded in a social structure holds the potential to entrench existing social divisions and power imbalances. On the one hand, past injustices and inequalities can undermine the participation of certain groups in actor-driven processes of institutional evolution (Vihemäki, 2005). Ribot et al. (2010) refer to different case studies which show that decentralised NRM can sustain existing gender inequalities, social hierarchies or ethnic division. While analysing the management of forests in the East Usambara Mountains in Tanzania, Vihemäki (2005) observed that village members with a higher social position are generally better informed about forest control rules than women and poorer village members. This encumbers the latter's participation in forest management. In Uchira, Tanzania, the water user association responsible for domestic water management is mainly composed of elites. The water user association demands considerable amounts of communal labour on top of financial contributions which are especially demanding for poorer community members (Cleaver & Toner, 2006). In India, agencies involved in water governance generally talk to highly placed men who are more influential than women and poorer community members. As a result, the needs of the latter are forgotten(Mehta, 1997).

On the other hand, actor-driven processes of institutional evolution can shift or maintain the ways that local elites benefit from resources and exercise power over them. Ribot et al. (2010) cite case studies in which better-positioned actors with extensive social relations were able to maintain access through

the manipulation of authorities or reciprocal relations and payments. In the East Usambara Mountains, efforts to increase participation through joint forest management led to the exclusion of village members who were not connected to village government from development initiatives like bee-keeping (Vihemäki, 2005). In Uchira, Tanzania, community-based water management resulted in the installation of more private water taps, which mainly benefits wealthier people and makes poorer people increasingly dependent on them for their water supply (Cleaver & Toner, 2006).

Methods to Study Institutions under Construction

Actor-driven processes that reproduce institutions are often empirically substantiated through ex-post observation of institutions and the interpretations of stakeholders[31] . However, processes that shape institutions through resource conflict management can be disentangled if resource conflicts are taken as the unit of analysis and the way they are settled is investigated. A similar approach is used by Ribot (2009) to examine legitimising practices, by Galvan (2007) to examine syncretism and by Juma and Maganga (2005) to examine bricolage.

For data on resource conflicts in smallholder irrigation schemes in Tanzania, we could not rely on evidence from court cases because these only represent a fraction of the conflict management that occurs in this institutional pluralist context (Maganga, 2002). Moreover, the court is avoided by most smallholder irrigators since they lack legal water rights. Therefore, we collected original data on recent resource conflicts and how they were solved in five small-scale irrigation schemes.

The data were collected in five small-scale irrigation schemes situated in the semi-arid lowland areas of Mufindi district in Tanzania, which are part of the Rufiji river basin (Figure 14). They were selected in consultation with local experts on irrigated agriculture. Mufindi district was chosen because of the importance of irrigated agriculture for food and cash crops and because of the seasonal scarcity of water (Mkavidanda & Kaswamila, 2001). The average annual rainfall in these areas ranges between 600 and 700 mm. Rainfall is concentrated in one rainy season that lasts from December until April (United Republic of Tanzania, 2006b).

Initially, in a first round of data collection from June until August 2008, focus group discussions were organised to get a sense of the types of institutions for irrigation water appropriation and conflict management. Participatory mapping exercises, conducted in each of the irrigation schemes, resulted in detailed maps that localise the plots of each irrigator. In total, 351 irrigators are identified on five maps. The maps also indicate water flows and other features. Some include information on resource conflicts. Subsequently, all available irrigators identified on the maps answered a structured

[31] Examples of institutional bricolage include Cleaver (2002) and Sehring (2009). Examples of legitimising practices include Nuijten and Lorenzo (2009) and Roth (2009).

individual survey, which included questions on socio-economic characteristics, on irrigated production and on involvement in resource conflicts. A total of 228 respondents took part in the survey. Both the maps and survey data enabled the identification of irrigators who had been involved in resource conflicts in the recent past. Most conflicts occurred less than five years prior to data collection.

In a second round of data collection in May 2009, individual semi-structured interviews were conducted with irrigators involved in resource conflicts and with village chairmen (VC), village executive officers (VEO) and, if present, irrigation scheme leaders. In total, 10 men and six women reported on 25 different cases. The interviews included questions on the subject and severity of the conflict, on irrigators involved and the location of their irrigated plot, on timing and recurrence of the conflict, on who mediated the conflict or who enforced rules and on sanctions. Respondents generally did not hesitate to talk about the cases because the interviews were conducted in private, anonymity was assured and respondents were familiar with the research team.

Furthermore, institutions and their reproduction are approached as actor-driven negotiation processes in this study. Gender and gender roles are important in such negotiation processes because there are socially determined ideas and practices associated with being female and being male (Reeves & Baden, 2000). The actors' position in the local power structure is another important variable in such negotiation processes because it influences their ability to control their environment and others' behaviour (Eyben et al., 2006; Leach et al., 1999)[32]. Empirically, this called for an assessment of the implications of gender and for an unambiguous measurement of actors' position in the local power hierarchy.

We organised a participatory ranking exercise to measure irrigators' relative power status in the irrigation community's power hierarchy based on the perception of the community members (Laws et al., 2003). As such, we avoided making assumptions about relations between power status and social positions or socio-economic characteristics that cannot be easily validated (Cleaver, 2002). During the exercise, social status was used as a proxy of power status because it is a more commonly understood and unambiguous concept that was positively correlated[33].

[32] The focus here is on the enabling nature of power, which relates to Sen's concept of capabilities, or Lukes' (2005) concept of ''power to'' (Stewart & Deneulin, 2002).

[33] Social status is a collective judgment of the relative position of an individual in society based on her traits and assets and is an important source of power (Weiss & Fershtman, 1998). Social status was translated in Swahili as ''hadhi ya jamii,'' which literally means ''status in society,'' and as ''uwezo,'' which implies economic ability but also the ability to attain your goals, to influence others and to be respected. The notion of power is present in the term ''uwezo.''

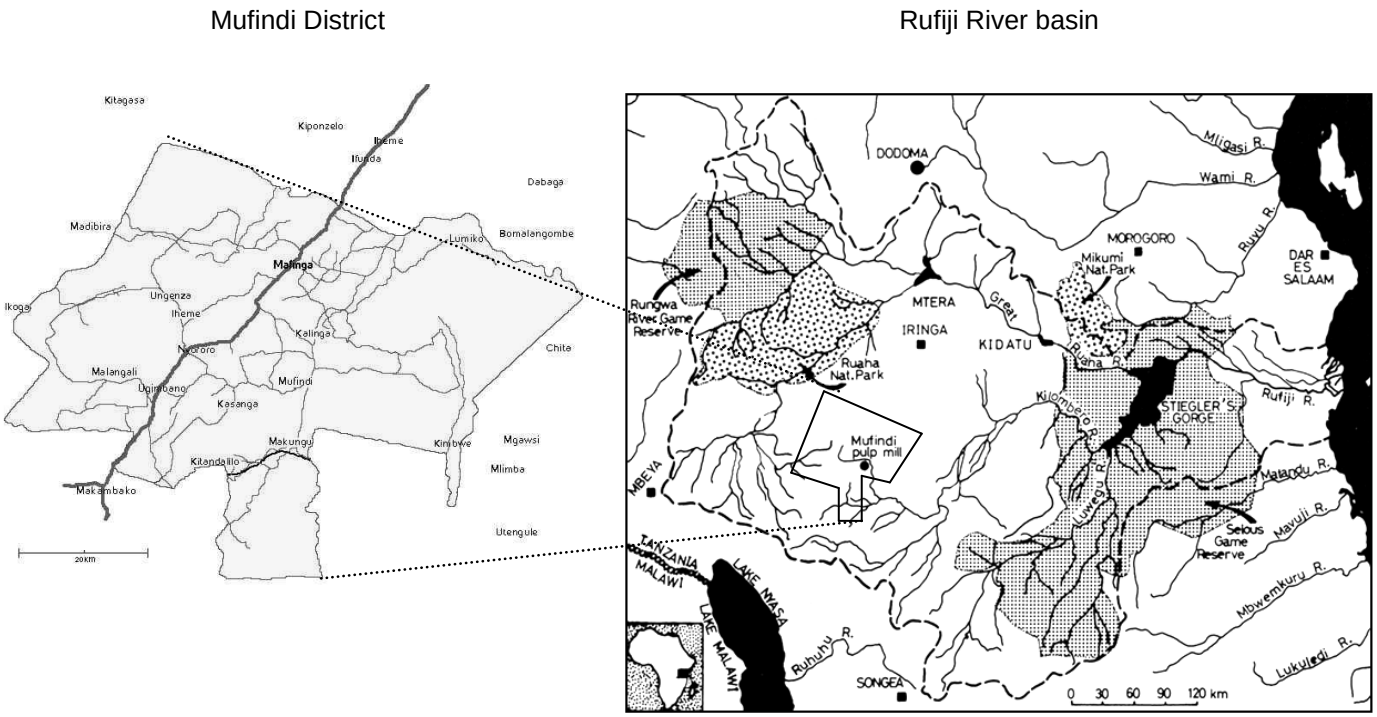


Figure 14: Mufindi District in the Rufiji River Basin (Bernacset (1981))

The participatory ranking exercises were conducted in each of the five irrigation schemes during the first round of data collection. They followed after the participatory mapping exercises. Four randomly composed subgroups of the 20 irrigators who did the mapping ranked all irrigators identified on the maps by social status. They did so by putting cards with the irrigators' names on a ladder with four rungs[34]. High (low) rungs represented high (low) social status (Singh-Manoux et al., 2005). This resulted in up to four rankings for each irrigator. Each ranking was transformed into a score, equal to the value assigned to the rung divided by the total number of rungs on the ladder. The mean of subgroup scores makes up our measure of irrigator's social status relative to other irrigators of the same scheme. This forms our indicator for irrigators' relative power status. The indicator ranges from 0.24 to 1 and the average is 0.59 (0.20). Higher values represent higher relative power status. On average, women were ranked lower than men. In group discussions that were held after the participatory ranking exercises, a high power status was related to more decision power whereas a low power status was linked to marginalisation, defencelessness and voicelessness.

Context: Livelihoods, Spatial Layout and Water Governance

Rural households living in the semi-arid lowlands of Mufindi district mainly depend on semi-subsistence smallholder farming to provide for their livelihood. Most households keep small livestock to supplement their diet or for trade. Some keep small herds of cattle as savings, for milk or for trade. Other activities to supplement the household's income include crop trade, petty trade, brick or charcoal production, seasonal labour and beer brewing.

Agricultural production historically has been based on rain-fed cultivation with the use of rudimentary technology and minimal inputs. Irrigated agriculture permits production of food crops outside of the season for rain-fed agriculture. An extra harvest of food crops in irrigated fields can prevent seasonal food insecurity. Selling surplus food crops from irrigated agriculture - often at a better price in the lean season - can provide an income (Mkavidanda & Kaswamila, 2001). Irrigation is also used for the production of vegetables and cash crops for local and regional markets. Such crops supplement the households' diet and income. Of the 228 irrigators surveyed in this case study, almost all grow food crops for own consumption on their irrigated plots. These include maize, sweet potato and beans. About half of them grow food crops which they partly sell, such as Irish potato, peas and spinach. About 40% grow crops for local and regional markets like tomatoes, onions and cabbage.

The smallholder irrigation schemes dealt with here consist of networks of locally dug river diversions and canals. Occasionally, locally made wooden gates, earthen dams or sandbags are used to manage the water flow. In exceptional cases, concrete intakes or technically more advanced gates are used.

[34] Participants were not expected to rank themselves nor users they were not well acquainted with. Rungs could be removed (added) if participants distinguished less (more) than four categories.

Flooding and capillary absorption make the soil of the plots in the irrigation schemes moist enough to farm. Alternatively, the proximity of water permits bucket irrigation. The irrigation schemes comprise a patchwork of plots most of which are relatively small (on average, one acre) and cultivated by one farmer and her household. Less than one-third of the farmers use two or more plots and only a few farmers own large plots (of up to 13 acres).

More particularly, irrigation scheme Mutua (Mt) is composed of two main canals diverted from a river, with plots along secondary and tertiary canals, and is used by about 40 farmers[35]. It was developed by local residents about 40 years ago. Irrigation scheme Kitungulu (KitU), consists of a primary irrigation canal which is sourced by a river higher uphill. The primary canal was constructed by colonial farmers and was renovated about 10 to 20 years ago. Secondary canals diverted from the primary canal irrigate the sloped farming plots of approximately 50 farmers. Irrigation schemes Isanu (Is) and Ika (Ik) can be described as locally improved riverbed irrigation schemes. They consist of a network of diversions from the main river at the bottom of the river valley. At the slopes of the valley, they comprise diversions from tributaries of the main river and one or more recently dug canals. These irrigation schemes have been used as long as people can remember. They continue up and downstream, but we limited our analysis to a strip of a maximum of 100 adjacent plots used by farmers from the same village. Irrigation scheme Kitangzi is located in a broad valley and is sourced by four rivers. It consists of diversions from the rivers and some recently dug canals and is used by approximately 70 people from the same village.

Water governance and management of resource conflicts in the studied irrigation schemes happen in a context of institutional pluralism. Broadly, the "bureaucratic" set of water governance institutions includes NAWAPO, based on integrated water resources management (IWRM) principles, and the National Water Sector Development Strategy, which sets out the formal rules and an institutional framework (United Republic of Tanzania, 2002, 2005). NAWAPO has not been fully incorporated into legislation yet. Older legal acts stipulate that all water abstraction requires possession of a water right (Juma & Maganga, 2005). The organisational structure that comes with NAWAPO is largely in place. On the basin level, Basin Water Boards and the executive Basin Water Offices coordinate IWRM, issue and enforce water rights and resolve conflicts. Our case study sites fall under the Rufiji Basin Water Office (RBWO). In principle, irrigation water users should be organised in water user associations (WUAs), the lowest level of water resource management. WUAs should hold a legal water right. Their responsibilities include mediation in local water conflicts. In reality, few smallholder irrigators are organised in WUAs or have a legal water right.

[35] Codenames are used to assure anonymity.

The renewed institutional framework on water governance does not explicitly assign a role for government on a district, ward or village level apart from representation in Basin Water Boards. Still, district agricultural and livestock officers deal with irrigated agriculture and extension services. Stipulations issued by the district planning office - for instance, on land use in riverbeds - can have repercussions for irrigation schemes. But generally, water appropriation within irrigation schemes or local water conflicts are not dealt with at the district level[36]. Whether the village government level is involved in water governance depends on whether bylaws have been adopted. The VC, VEO and village council sometimes make decisions that deal with water provision and appropriation. They are regularly called to intervene in conflicts over water or land.

Concurrently, the LGRP intended devolution of power, responsibilities and resources to local government. Although the objectives of democratic decentralisation by devolution have not been fully realised, the village government's space for discretion has widened somewhat (Fjeldstad et al., 2006). As a result, the LGRP indirectly increased the potential for village government to intervene in water and land management. Nonetheless, NAWAPO seems to take over local government's role in local water management. These developments increased dubiousness towards discretionary powers over natural resource management.

Water governance institutions in the studied irrigation schemes are in flux and have a high degree of local specificity. It is nevertheless possible to identify some common principles of "informal" water governance institutions[37]. Canals and river diversions are dug collectively or on the initiative of a few individuals. Usually, irrigators are expected to contribute to canal maintenance. Fixed rules regarding water appropriation are largely absent. Often, irrigators individually decide on water appropriation. Sometimes, they informally agree on water sharing or make up a rotation scheme. Generally, competition and distributive conflicts are avoided in order to maintain harmony. Irrigators also strongly believe that everybody has a right to water. With regard to conflict management, there is a clear preference for reconciliation over confrontation. Other than that, conflict management, rather than being based on well-defined institutions, relies on pragmatic problem solving when disputes arise.

[36] Interview with Mufindi District Agriculture Extension Officer, Mr. Nko, Mafinga, June 20, 2008.

[37] Based on information gathered through group discussions in 2008.

An Empirical Account: Solving Resource Conflicts

Recently, in Isanu, an additional irrigation canal was dug on the initiative of a young, ambitious, market-oriented and powerful farmer with a large plot in the irrigation scheme. Since it was dug, competition for water between river irrigators and canal irrigators has caused grave disputes. A first incident was called "a dangerous situation because a war could have started"[38]. In fact, the canal initiator blocked the river intake to make water flow to the canal, thereby depriving river irrigators of water. Three of the most affected river irrigators complained to the canal initiator. The dispute almost turned violent. Other river irrigators observing the commotion reported to the VC. The VC stated that he suspected the canal initiator "think[s] the water is his and others have no right to use it"[39]. To settle the dispute, the VC used the NAWAPO guideline saying that: "Every citizen has an equal right to access and use the nation's natural water resources for his benefit" (United Republic of Tanzania, 2002, p. 17). He reprimanded the canal initiator and forbade him to close the river intake. Additionally, mediation by the VC and VEO resulted in an agreement on rotating water use, allocating water to the canal initiator on Sundays and to other irrigators on weekdays.

Later, another dispute arose as one of the river irrigators obstructed the canal intake[40]. The canal initiator declared: "We could have fought and killed each other"[41]. Eventually, the village extension officer mediated between the river irrigator and the canal initiator. He decided the river irrigator did not comply with the rotation agreement nor with the prohibition to close water intakes. The river irrigator had to pay a substantial fine. In addition, the village extension officer instructed irrigators to stick to the rotation agreement. The sanctioned river irrigator was also made "canal guard", a newly created function with the responsibility to make sure the rotation scheme is respected.

The conflict was still lingering at the time of research, and the water intake of the river and the canal are routinely obstructed. The canal initiator admitted that he did not report the latest incident to the village government[42]. Instead, he reported it to the RBWO while being aware that water appropriation by both river and canal irrigators is illegal as they lack legal water rights. According to the canal initiator, the RBWO told him to apply for a water right and promised to improve the canal intake. Indirectly, the RBWO granted permission to canal irrigators to appropriate water, which is also how the canal initiator interpreted it. It is probable that the canal initiator secretly attempted to circumvent some levels of regulation as another strategy to end his problems with river irrigators.

[38] Interview with village chairman, Isanu, May 9, 2009. Case Is2.

[39] Interview with village chairman, Isanu, May 9, 2009.

[40] Case Is4.

[41] Interview with canal initiator, Isanu, May 9, 2009.

[42] Case Is7.

Clearly, the series of disputes described here could have turned out badly and could have instigated violence but they did not. In fact, this series of disputes form an excellent example of how disputes over water between competing users have motivated the actors involved to search for non-violent solutions. It also shows how institutions for governing water in this irrigation scheme have become more sophisticated along the way.

Solving the disputes between the river and canal irrigators in non-violent ways demanded creativity and pragmatism. When instruments of traditional water governance like informal talks failed, the village government was called in. Nonetheless, the village government's toolbox needed the backing of rules made at higher levels of bureaucracy like NAWAPO. As a result, elements of these bureaucratic institutions became more socially embedded. Along the way, a rotation agreement and a canal guard were introduced as innovative water governance institutions. Later, the rotation agreement became more formal and more "bureaucratised" when the village extension officer instructed irrigators to comply with it. The canal guard function may have been created to ensure the river irrigator's cooperation by co-opting him, or may have been a form of a compensation for his fine. As such, resentments may have been avoided in a reconciliatory form of conflict resolution. Finally, one of the actors decided to skip some levels of regulation and bring his claim directly to RBWO in the hope that forum shopping would benefit him. Evidently, actors involved in these disputes engaged extensively in processes of institutional bricolage, institutional syncretism and forum shopping. Solving the emerging problems in this way contributed to the development of more refined resource governance institutions. Ultimately, institutional pluralism definitely was not an obstacle here; it was quite useful.

a. Solving Resource Conflicts with the Aid of Institutional Pluralism

The above example is not unique. To the contrary, in each of the studied irrigation schemes, many disputes over water or land have instigated processes that contribute to institutional evolution. In the following cases, actors respectively engage in institutional bricolage, forum shopping and legitimising practices. Throughout the descriptions of the cases, we consistently refer to the relative power status of the actors involved because this is expected to play a significant role in such processes. At a later stage, this role will be analysed.

In irrigation scheme Kitangzi, a conflict arose between a downstream and an upstream irrigator because the latter neglected to unblock the canal after irrigating. The affected downstream user, who claimed to be the initiator of that canal, solved the problem through an informal talk. To make his case, he invoked the common practice of unblocking canals after irrigating. In addition, he referred to

the NAWAPO guideline stipulating that everyone has an equal right to water[43]. It seemed that the affected user had attended an RBWO training and readily applied his knowledge. He might also have needed the backing of more "bureaucratic" rules in his dispute with the upstream user, who had a slightly higher power status (respectively equal to 0.69 and 0.73).

In irrigation system Ika, a dispute arose because somebody with a relatively high power status (equal to 0.81) dug a new canal in order to drain water from his plot, which was too moist to farm[44]. A group of downstream users, both irrigators and domestic water users, feared this would cause water shortages and soil erosion. The group complained to the VEO. A written request from the VEO to stop digging the canal had little effect. Subsequently, as the village had no appropriate by-laws, the village council referred to the RBWO prohibition on digging additional canals in the river valley. The village council summoned the farmer to fill the canal and imposed a fine. The above example of institutional bricolage on the part of the village government is reminiscent of the dispute over the closure of the river intake in Isanu[45]. In that case, the village government referred to a NAWAPO guideline to overrule the relatively powerful canal initiator (power status equal to 1).

Again, the emerging resource problems described above have not caused grave or violent disputes, but have instead brought about processes of institutional bricolage. The emerging problems made actors blend elements of diverse institutions in their search for ad-hoc solutions. As such, NAWAPO policy guidelines or district regulations became more "socially embedded" when irrigators referred to them to make their claims. Village governments also contributed to "social embedding" of rules established at hierarchically higher levels of bureaucracy when they absorbed them in their set of working rules. It is notable here that the offenders had a high power status, which suggests that relying on rules established at higher levels may have served to gain leverage.

Oppositely, the "bureaucratisation" of "informal" and "socially embedded" elements can also result from pragmatic solving of resource conflicts. In Mutua, for instance, an irrigator used a woman's failure to participate in canal cleaning as an argument to deprive her of water despite a rotation agreement[46]. One of the sources reporting on this case, an IUC member, agreed with this argument. This could have been an (not necessarily deliberate) attempt to "formalise" canal cleaning as a condition for water access. Likewise, the disputes in Isanu discussed before prompted the

[43] Case KitZ1.

[44] Case Ik3.

[45] Case Is2.

[46] Cases Mt3 and Mt6.

development of a rotation scheme that was later invoked by the village extension officer and made official along the way[47].

While institutional pluralism can be used in a creative and constructive way, it can also be employed in somewhat opportunistic ways. In the following case, institutional pluralism offered the opportunity of forum shopping. This case occurred in irrigation scheme Kitungulu. An irrigator sold a plot of land he used but did not legally own to a semi-commercial farmer from a neighbouring town[48]. After the former legal owner died, an inheritor contested the sale and the land ownership of the semi-commercial farmer. The inheritor argued with the one who sold the plot and complained to the VC. The village council decided that the plot belonged to the inheritor. The semi-commercial farmer, however, appealed to the ward tribunal. The tribunal stated that the property right, including the alienation right, to land goes to the person using the land if this had been fallow for more than 12 years. Thus, the tribunal decided the sale was legal and the semi-commercial farmer rightfully acquired landownership. Strikingly, the inheritor was instructed to pay compensation to the semi-commercial farmer.

Forum shopping is said to be mainly a strategy of the more powerful, which is indeed the case here. The semi-commercial farmer was ranked relatively high in power status (power status equal to 0.75). Since he did not belong to the community, he also may have been more immune to social pressure to opt for less confrontational ways to resolve the land conflict (Hayami, 2009). Indeed, there is still a general feeling in the community that the land was not acquired in a rightful way. The case clearly stuck in people's minds as three different sources reported on it. This suggests that the semi-commercial farmer's strategy was exceptional or was socially unacceptable. Similarly, the canal initiator in Isanu, who was forum shopping to get permission for water abstraction, was secretive about his strategy[49]. He likely suspected his strategy would face social disapproval, but it is possible that his high power status rendered him more inconsiderate.

Nevertheless, actual forum shopping apparently is not always necessary; threatening to do so may be an effective deterrent as well. For instance, in irrigation site Ika, an elderly woman and another irrigator quarrelled because the latter opened the irrigation canal for too long and caused the woman's plot to flood. This destroyed the beans in her field[50]. A (female) neighbour, who was called to mediate emphasised that the rotation scheme should be respected, also threatened to report the incident to the sub-village chairman (sub-VC). Eventually, the offender agreed to close the canal. The fact that the

[47] Case Is4.

[48] Case KitU5.

[49] Case Is7.

[50] Case Ik4.

affected elderly woman's power status is slightly higher than the offender's may have contributed to winning her case (respectively equal to 0.54 and 0.43).

In irrigation scheme Kitangzi, a potentially violent conflict arose when two men competed for a vacant plot of land[51]. Elders were called to mediate. Later, the village government was asked to intervene, but it decided that the conflicting parties should settle the issue themselves. According to our source, one claimant finally renounced his claim to the plot because the other claimant's reputation made him fear an escalation. Our source called the other claimant "a 'characterman', meaning he is intractable, is known to like conflicts, does not fear fighting and does not hesitate to go to court or call in the police"[52]. It appears that the fear of violence and of bureaucratic measures discouraged the one claimant from pursuing his case despite his relatively higher power status.

Furthermore, socio-political organisations like the village government also take advantage of conflicts in a context characterised by institutional pluralism and dubiousness about discretionary powers over natural resources. For instance, resolving a conflict over a new canal in irrigation scheme Ika boosted the village government's authority in water governance[53]. The VEO praised the village government's success in water governance: "people now come to ask how to manage water and which rules to follow. The affected users thanked the village government for intervening"[54].

In irrigation site Kitungulu, there were recurrent disputes between a semi-commercial farmer and the irrigation user committee (IUC)[55]. First, the semi-commercial farmer did not participate in canal cleaning and broke an IUC regulation that makes water access conditional on canal cleaning. The IUC chairman and secretary talked to the farmer to solve the problem. Despite his apologies, the farmer still did not clean canals. The second dispute arose when the semi-commercial farmer refused to pay contributions to the IUC for the water right, for which they applied to the RBWO. The IUC chairman reported this to the RBWO, but the RBWO advised him to go to the village government first. The village government, however, did not want to intervene as long as the farmer was not officially included in the list of irrigators as submitted to the RBWO. In addition, they demanded that the IUC "formalises" its rules on canal management and water use and present these to the village government. The village government also refused to endorse the IUC water right application. According to the VEO, the village government feared the IUC would "monopolise" the irrigation canal while the village government legally owns it.

[51] Case KitZ9.

[52] Interview with female member of water committee, Kitangzi, May 11, 2009.

[53] Case Ik3.

[54] Interview with village executive officer, Ika, May 10, 2009.

[55] The semi-commercial farmer is the one involved in the alleged illegal land sale; see case KitU5. See also cases KitU4, KitU6 and KitU8.

Another interpretation of these actions would be that the village government's refusal to endorse the water right application and their precondition of "formalising" rules before they intervene in conflicts constitute an attempt to "reclaim" authority in governing resources. Governing resources in the village seems to have passed to the IUC and RWBO. With the means at their disposal, the village government may have tried to (re)position themselves as legitimate decision makers and as legitimate judges over claims regarding natural resources. Such strategies fit into what Sikor and Lund call legitimising practices(Sikor & Lund, 2009). The feeling of being sidelined with regard to natural resource governance and the (aspirations for) larger space for discretion in the wake of the LGRP may have nourished the village government's motivation for legitimising practices.

It is noteworthy that none of the irrigation schemes in our case study operates with a legal water right, which implies all water appropriation is illegal according to national water laws. Still the village government intervenes in governance of "illegally" appropriated water.

Yet not all opportunities for legitimising practices are necessarily seized. For instance, when called upon to intervene because an irrigator refused to contribute to water right fees, the RBWO advised the complainant to go to the village government first, rather than taking the issue on board[56]. In another case, the RBWO removed sandbags that obstructed a river intake during a routine visit but did not take any other measure[57]. It is possible that the recently established RBWO does not feel the same need for legitimising practices as village governments.

b. Solving Resource Conflicts the "Traditional" Way

Although various disputes over resources in the studied irrigation sites have instigated processes of institutional bricolage, institutional syncretism, forum shopping and legitimising practices, other disputes have not. They have been solved according to "traditional" rules of the game which include "informal" talks, settlements between families and the intervention of mediators.

In irrigation scheme Mutua, for instance, a dispute started because one user did not respect the rotation scheme which had been informally agreed upon. As a result, another user - his sister - was deprived of water[58]. She complained to her brother in person and they settled the dispute within the family. In the same irrigation scheme, another quarrel started because a woman with a relatively low

[56] Case KitU4.

[57] Case Ik2.

[58] Case Mt2.

power status (equal to 0.25) did not participate in canal cleaning, which caused a reduced water flow for others[59]. She was not sanctioned but was "instructed" to participate in the future.

Two other incidents in irrigation scheme Mutua were apparently solved by the users themselves. The incidents cropped up because upstream users did not comply with the rotation scheme[60]. Both issues were resolved after one of the affected downstream users personally complained to upstream users. Although this downstream user claimed he "informally" talked to the upstream users as a fellow irrigator; he is also the VC, irrigation site leader and canal initiator and has a high power status (equal to 0.83). Regardless of the role in which he approached the upstream users, his multiple functions most probably granted him authority: "As I am the chairman and the canal initiator, the man listened. If I would have been someone else, he might not have listened"[61].

Sometimes mediators were called to settle conflicts. In irrigation scheme Isanu, a woman - the wife of a man with a high power status - obstructed the water flow in a canal[62]. She put downstream irrigators' tomatoes and other crops at risk. A mediator was called. The woman promised not to close the canal again but did not keep her promise.

At the time of digging the canal in irrigation site Isanu, which caused the recurrent disputes between canal and river irrigators previously discussed, a conflict cropped up between the canal initiator and a farmer whose plot the canal was supposed to pass through[63]. Two fellow irrigators, one of whom is the sub-VC, were called upon to mediate. After informal talks, the canal initiator and the farmer agreed that the canal could pass through the farmer's plot if he could use the water as well. Later, the same parties had another dispute. When the canal initiator asked all irrigators to clean the canal, the farmer refused and blocked the water flow[64]. Another irrigator mediated between the conflicting parties. The issue was settled with a handshake and the mediator decided rules on canal cleaning would be necessary.

In irrigation site Ika, a dispute arose between river users and two irrigators who closed the river intake with sandbags to divert water to their irrigation canal. Although there were no fixed rules on water distribution at the time of the conflict, blocking each other's water intake was considered unacceptable. One of our sources - a respected elder - recounted how he was called upon by the affected users to mediate. He said he convinced the offenders that others also needed water, after

[59] Case Mt6.

[60] Cases Mt7 and Mt8.

[61] Interview with village chairman, Mutua, May 8, 2009.

[62] Case Is3.

[63] Case Is5.

[64] Case Is6.

which they removed the obstruction[65]. The mediator claimed this was the only intervention, but according to the VC, the affected users reported the issue to the village government. The VC declared that a village government delegation removed the sandbags and forbade the offenders to block the river intake[66]. The "true" story about who solved the problem could not be uncovered. But regardless of who intervened in the dispute, it seems that affected users called someone with considerable authority to deal with the offenders, who had relatively high power statuses (equal to 0.6 and 0.71).

A woman was called upon to mediate a dispute in only two cases. In one case, an elderly woman was called upon to mediate when a fight broke out between two male irrigators after one of them encroached upon the other's land to dig an additional irrigation canal[67]. This woman concluded that: "Women cannot mediate between men"[68]. Hence, she referred them to the sub-VC. In another case, which has been described above, a female neighbour was asked to mediate in a dispute about a flooded plot[69]. The issue was resolved after the female neighbour threatened to call the sub-VC.

From the above cases, it appears that mediators generally stick to "informal talks". Another commonality is that nearly all mediators are powerful men (their power statuses range from 0.63 to 0.94). They often have multiple identities; they are fellow irrigators but also sub-VC. Apparently, women cannot mediate between men, and in an exceptional case in which a woman was called to mediate, she threatened to call upon bureaucratic measures. In two of the three cases mediated by men, the offenders had a high power status and the mediators' "weight" was probably necessary to deal with them.

Yet the "traditional" way of solving disputes through an intervention of a mediator does not seem to be very effective. Offenders did not change their behaviour, the conflicting parties were involved in other disputes later or the village government ultimately also had to intervene. This may suggest that the "traditional" way to resolve disputes using a mediator has reached its limits.

c. The Role of Power in Solving Resource Conflicts

Whereas all previously described conflicts were solved in one way or another and with more or less lasting success, in four cases conflicts were not solved. In the first case, the crops of a group of downstream irrigators were imperilled when two upstream irrigators disrespected water sharing

[65] Case Ik1.

[66] Case Ik2.

[67] Case Ik5.

[68] Interview with female irrigator, Ika, May 10, 2009.

[69] Case Ik4.

agreements and excessively extracted water from the canal[70]. As one of those upstream irrigators was also the VC, irrigation leader and canal initiator and considered powerful - his power status equals 0.83 - the downstream users "kept quiet whether their harvest is high or low"[71].

Secondly, in irrigation site Kitangzi, there was a dispute because an upstream user neglected to reopen the canal after irrigating her plot. There was no settlement but the two affected downstream users stopped farming. One of the affected users formulated her reason for inaction like this: "She is the wife of the extension officer; so that is why I left it like that"[72]. Another dispute involved a male relative who encroached on a woman's plot of land in irrigation site Mutua[73]. The man had a high power status, equal to one, whereas the woman had a low power status, equal to 0.33. Our source said the affected woman "decided to keep quiet and stop the argument because the offender was a man and because they are relatives"[74]. In the end, she just abandoned her plot.

A different, quite vigorous and potentially violent conflict cropped up in irrigation site Mutua. A male farmer denied a female farmer access to irrigation water despite an "informal" agreement to take water in turns[75]. According to a male IUC member, their families reconciled and reached an agreement on water sharing. Commenting on the same dispute, another female source explained that the female farmer did not complain to the offender nor did she call a mediator because: "Nobody would have been able to stop him from irrigating his field because he has the power of being a man"[76]. The female farmer is said to have stopped farming despite the need to provide for her family. In this case as well, the affected farmer, a woman with a low power status, faced a problem with a man considered among the most powerful on the irrigation site (power statuses respectively equal to 0.25 and 1).

The disputes described here were not really solved, but they ended because the affected parties simply rested their case. There is one particular commonality in all four disputes: The affected ones are the least powerful of the conflicting parties and many of them are women. Apparently, creative problem solving is out of their reach.

Browsing through the cases described above, we analyse the role of the actors' relative power status in the occurrence of conflicts, in the resolution of conflicts and in the processes through which the

[70] Case Mt4.

[71] Interview with irrigation user committee member, Mutua, May 8, 2009.

[72] Interview with female irrigator, Kitangzi, May 11, 2009. See case KitZ10.

[73] Case Mt1.

[74] Interview with female irrigator, Mutua, May 8, 2009.

[75] Case Mt3.

[76] Interview with female irrigator, Mutua, May 8, 2009.

"rules of the game" are reproduced. A first observation is that actors' power status plays a role in compliance with rules and agreements about water and land use. In less than one-quarter of the cases the offender has a low power status, whereas in more than half of the cases the offender has a relatively high power status. There are also two "serial offenders" who both have a high power status. One of them is the semi-commercial farmer who resides in a neighbouring town and who is involved in disputes over land and water in Kitungulu. The other is a young, ambitious, market-oriented farmer who initiated irrigation via a canal in Isanu. They could be flagrant offenders not deterred by social sanctions - or, they could be obvious scapegoats because they generate jealousy and because they are not fully integrated in the community.

Another observation is that actors' power status is also an important determinant for processes that are prompted by resource conflicts. First, irrigators with a high power status are more inclined to engage in forum shopping and to threaten to do so. Secondly, "traditional" or purely socially embedded instruments to enforce rules or resolve conflicts are mainly used when the conflict involves offenders with a low power status, many of whom are female. If the conflict involves powerful offenders, many of whom are male, there is a higher likelihood of relying on more authoritative and often more bureaucratic forms of conflict management. These seem to be needed as leverage to deal with powerful offenders. Mediators are also more likely to be deployed in cases with powerful offenders. These mediators are generally powerful men, often with an administrative function underpinning their authority. Again, this suggests the need for leverage in these instances.

Conclusion

Examining how conflicts over water and land are solved in small-scale irrigation schemes in rural Tanzania provided several insights into local resource governance institutions and their dynamics. A first insight is that conflicts over scarce resources can arise when competition is increasing, but that these conflicts are not necessarily disruptive or violent. Actually, the resource conflicts that crop up challenge existing local resource governance institutions, especially in a context of intensified institutional pluralism. They instigate processes in which the actors involved in resource conflicts search for solutions, and preferably non-violent ones. Such actor-driven processes can contribute to the further evolution of local resource governance institutions.

A second insight is that institutional pluralism is an asset for pragmatic problem solving and for the processes through which resource governance institutions are reproduced because it provides opportunities for creativity and human agency. As such, institutional pluralism can contribute to the gradual development of more sophisticated resource governance institutions. Through this process, these institutions may be more adapted and meaningful at the local level because their development is shaped by the particular social and ecological context (Cleaver, 2002; Galvan, 2007).

A third insight is that pragmatic problem solving and the processes of institutional evolution are not necessarily impartial, fair nor universally accessible. Problem solving and the processes of institutional evolution happen in a socially embedded way. This means that responses to emerging conflicts depend on who is involved, on who is intervening, on actors' gender and on actors' involvement in other incidents. The type of response also highly depends on the relative power status of the actors involved in the conflict. Stronger, more authoritative and often more bureaucratic instruments for conflict management are used to deal with powerful offenders. But the most striking observation is that women and actors with a low power status do not always have the capability (or forsake their capability) to engage in creative conflict resolution and uphold their interests. It shows that inherent power imbalances seriously limit the scope of creative and pragmatic problem solving for the least powerful in the community. As a result, there is a risk of existing power imbalances becoming further entrenched in local resource governance institutions.

Our case study shows that building on the pragmatic and socially embedded processes through which institutions evolve at the local level can enrich a policy aiming for meaningful, useful and locally adapted resource governance institutions. To realise this potential, however, the dynamics of innovation, creative problem solving, flexible interpretation of policy principles and legitimation should be appreciated by policy makers (Galvan, 2007; Meinzen-Dick & Pradhan, 2002; Roth, 2009).

In addition, policies should reflect that the outcome of institutional design cannot be predicted since institutions are products of ongoing social processes in which numerous actors play their roles in environments characterised by uncertainties. Therefore, any (formal) institutional design that aims for social equity should assess how it concurs or collides with informal institutions, how elites could find ways to enhance their power over resources and what the potential pitfalls or opportunities might be for women and marginalised groups (Leach et al., 1999). This requires an acknowledgement of the heterogeneity of communities and existing social differences and power imbalances (Mehta, 1997).

Policy should also actively address deep-rooted power imbalances which hamper the capability of women and the least powerful members of society to engage in constructive problem solving. Less articulate members of communities should be consulted and actively engaged in natural resource governance. Women and the less powerful should be supported in the negotiation processes that arise over claims to natural resources through easily accessible legal aid. Additionally, their claim-making capacity should be enhanced through targeted information on natural resource policies, adult literacy programs or leadership training.

Who Would Engage in Water Scarcity Conflicts? A Field Experiment with Irrigators in Semi-Arid Africa

Abstract

Does water scarcity induce conflict? And who would engage in water scarcity conflicts? In this paper we look for evidence of the relation between water scarcity and conflictive behaviour. A framed field experiment, conducted with smallholder irrigators from semi-arid Tanzania, replicates appropriation from an occasionally scarce common water flow. Water scarcity is observed to induce selfishness despite the strong non-competition norms that regulate water appropriation in these irrigator communities and despite the fact that this is considered conflictive behaviour. But not all react to water scarcity in the same way. By combining experimental evidence and survey data we found out that mainly the poor the ones with little extensive social networks and the ones for whom irrigation water is critical for agricultural production - are more inclined to react in a conflictive way to scarcity by being selfish. Viewed from a wider perspective we conclude that circumstances in Tanzania could be conducive to resource scarcity conflicts. The ones who are more likely to react in a conflictive way to water scarcity in the experiment suffer from real economic and political inequalities which could form a basis for mobilisation for more violent ways of competing for scarce resources. At the same time, water governance institutions entail exclusionary elements that are likely to disfavour the same people. These factors concur with climate change and other socio-economic developments that increase competition for increasingly scarce water.

Introduction

Conflicts over water have been the centre of attention for some time. Not only has a future of interstate water wars been forecasted, also the internal, civil conflicts that mark the last decennia have been linked to an increasing scarcity of natural resources like water or cropland (Homer-Dixon, 1994; Kaplan, 1994; Le Billon, 2001; Starr, 1991; United Nations Development Programme, 2006; Welsch, 2008). Besides, climate change threatens to exacerbate water scarcity which puts the concern about resource scarcity conflicts high on the development and security agenda (United Nations Development Programme, 2006).

While the literature provides bits and pieces of the answer on how resource scarcity and conflict relate, there is no evidence of the relation between resource scarcity and the individual predisposition towards conflictive behaviour. This study will provide such evidence by making use of a framed field experiment, conducted with irrigators from semi-arid Tanzania, which replicates water appropriation dilemmas in common water flows under circumstances of water abundance and water scarcity.

Combining experimental evidence of water appropriation behaviour with data on socio-economic characteristics of the irrigators participating in the experiment will enable to determine which type of irrigators is more to react in a conflictive way to water scarcity. An experiment enables to elicit a reaction to different circumstances by the same people. Observational data cannot provide the same information as people may not be able or not be willing to answer to (hypothetical) questions about their behaviour in water-abundant and water-scarce circumstances.

It is particularly relevant to look for experimental evidence of who reacts in a conflictive way to water scarcity because these may be the types of water users who are more likely to break social norms and exhibit conflictive behaviour when water is scarce in reality. Evaluating these findings in a broader perspective by assessing the presence of other drivers of resource conflicts in Tanzania will allow hypothesising about the potential of water scarcity conflicts in this setting.

The article is structured as follows: In the first section we review the literature on the relation between resource scarcity and conflict. In the second section we describe the methods for data collection. In the third section we present the experimental results. In the last section we discuss the potential of water scarcity conflicts in the Tanzanian context.

Literature on the Relation between Resource Scarcity and Conflict

The relation between resource scarcity and conflict has been amply debated in the literature. We give an overview. The environmental security literature states that there is a causal relation between scarcity of natural resources and violent conflict and predicts that resource scarcity conflicts are on the rise[77]. Increasing scarcity of resources is expected not only to provoke internal or interstate conflicts, but also to induce large population movements that will feed group identity conflicts. It may deepen economic deprivation and disrupt social institutions and contribute to deprivation conflicts (Homer-Dixon, 1994). Besides, resource scarcity is more likely to lead to violent conflict if an inability to solve complex problems aggravates grievances and erodes the moral and coercive authority of government (Homer-Dixon, 1999). The environmental security literature has been criticised, however, for being too deterministic and a-political and for generalising too much. Another critique is that it is founded on anecdotal evidence that suffers from a selection bias as it is mainly based on cases where resource scarcity and conflicts coincided (Gleditsch, 2001; Le Billon, 2001).

The common pool resource (CPR) literature also deals with the relation between resource scarcity and conflict. Actually, it has proven that institutions hold the potential to overcome overuse and distributive conflicts (Ostrom, 1990). The CPR literature, however, is criticised for oversimplification as it sees scarcity as a likely cause of competitive struggles if unconstrained by proper institutions. But it does not suffer from selection bias because of its focus on cooperation (Turner, 2004). For instance, in the politically instable Somali Region in Ethiopia where drought causes environmental scarcity, many elements conducive to resource scarcity conflicts are present. Yet farmers and pastoralists have a non-violent relationship because they have adopted different institutions for sharing scarce resources (Bogale & Korf, 2007). Another example involves the sharing of increasingly scarce salmon stocks in the Coastal Salish Fisheries in the US. This happens in a relatively peaceful way with the aid of an adapted and flexible set of institutions for governing fish appropriation (Singleton, 2007).

Apart from case studies on cooperation and conflict in circumstances where CPR are scarce, this literature also includes analyses of CPR users' behaviour based on laboratory or field experiments (e.g. Cardenas, 2003; Cardenas & Carpenter, 2008). Some experimental studies look at the effect of resource scarcity on resource appropriation behaviour. Examples include Rutte et al. (1987) who conducted an experiment with students using a one shot game simulating sequential CPR appropriation. They found that subjects harvested less from the resource in scarcity than in abundance conditions, especially when scarcity was nature-induced. Osés-Eraso and Viladrich-Grau (2007) use

[77] Natural resources like water, cropland, forests and fish are diffuse, not lootable and renewable resources with a low marginal value but a high total value because they are essential for humans and the biosphere. Scarcity makes such resources valuable and raises competition (Le Billon, 2001).

an experiment with students in which subjects first choose between extracting or not from a CPR stock after which the remaining resource units are shared. Resource scarcity is replicated by reducing the initial resource stock. They show that appropriation levels diminish with increasing CPR scarcity that they attribute to subjects' concern for resource scarcity.

Political ecology scholars argue that causes of resource conflicts may be much more complex than competitive struggles over scarce resources[78]. While physical scarcity is often seen as the main cause of such conflicts, this is only one aspect (Turner, 2004). They state that resource-related conflicts develop as social phenomena. The relative scarcity of resources is partly socially constructed since it depends on livelihoods, markets and commodity chains (Le Billon, 2001). While at first sight conflicts may seem to relate to resource scarcity, a closer look may reveal that they are rooted in history, in broader social tensions or in disagreements over ethical issues like proper resource use (Le Billon, 2001; Peluso & Watts, 2001; Turner, 2004). Such conflicts can sometimes be traced to attempts to protect of moral issues, to different views on resource commoditisation or to longer-term strategic motives (Turner, 2004). Resource-related conflicts can have roots in feelings of marginalisation and frustration about corruption and injustice as well (Benjaminsen et al., 2009). The Kilosa killings in Tanzania, for instance, cannot be solely explained by a competitive struggle over scarce resources between farmers and pastoralists. Underlying is an historical and ongoing spatial and political marginalisation of pastoralists in favour of farmers. Additionally, a culture of clientelism and corruption have eroded trust in the local government and have reduced the willingness of local judiciary and police to prevent conflicts (Benjaminsen et al., 2009). The political ecology literature urges to take other factors into account when studying the relation between resource scarcity and violent conflict.

The literature on civil conflict theorises on the contextual factors, group effects and individual incentives that potentially contribute to (violent) conflict. A first line of thinking in this literature maintains that marginalisation contributes to a higher incidence of civil conflict and a higher likelihood that individuals or groups will participate in violence (Stewart, 2000). Groups may be mobilised to join in violence on grounds of real or constructed group inequalities. This is most effective if differences in economic opportunities or political marginalisation coincide with cultural, ethnic or religious differences. If groups suffer from exclusion from access and control over natural resources, this can contribute to resource-related conflicts (Benjaminsen et al., 2009; Turner, 2004).

A second line of thinking asserts that people decide to join in conflict or not based on cost-benefit considerations. While participating in acts of violence or supporting armed groups may imply high

[78] Resource conflicts or resource related conflicts are social conflicts (violent or non-violent) associated with both struggles to gain access to natural resources and struggles resulting from the use of natural resources (Turner, 2004, p. 864).

individual costs (death, injury, imprisonment and so on), people may still choose to participate because of the potential gains such as improved socio-economic opportunities, access to valuable assets or loot (P. Collier & Hoeffler, 1998; Keen, 1998). The gains may consist of protection or the fulfilment of basic economic needs. High levels of poverty may drive individuals into conflict especially when productive activities are scarce, unemployment is high and returns from agriculture work are low (Justino, 2009). The ones with poorer economic opportunities – the poor, the uneducated, the jobless, the landless, the dissocialised, the youth – are more likely to join criminal groups or rebel activity because they have nothing to lose but all to gain (P. Collier & Hoeffler, 1998). Gaining access to resources of which they are otherwise (relatively) deprived may provide a strong incentive. Besides, for people who live at the margin of society the (social) cost of breaking social norms may be relatively low (Hayami, 2009). Not participating in conflict may also be particularly costly because it raises suspicion or because it excludes one from protection by armed groups and access to resources they control. Such costs may render it impossible to stay out (Kalyvas & Kocher, 2007). Furthermore, participating in conflict is generally thought to be restricted to men. Women are assumed to be more peaceful and less violent than men. Women, however, are observed to actively participate in conflicts but often they have more supporting roles and not combat roles (Bouta, Frerks, & Bannon, 2004).

A political economy approach to analyse conflict forms a third line of thinking (Collinson, 2003). This approach highlights that power determines the distribution of access to key resources and the potential to safeguard basic political, economic and social rights. Vulnerability and powerlessness often result from a political and economic process of neglect, exclusion or exploitation (Le Billon, Macrae, Leader, & East, 2000). Hence, resource-related conflicts and their underlying causes often relate to power relations and power struggles. Therefore, these should receive the necessary attention when studying such conflicts.

While the literature tries to explain how incidences of conflict relate to resource scarcity, there is little evidence of the relation between the individual predisposition towards conflictive behaviour and resource scarcity. Yet at a fundamental level, conflict originates from individuals' behaviour and their interactions with their immediate surroundings (Verwimp et al., 2009). Individuals' decisions to behave in a conflictive way are likely to be influenced not only by material incentives but also by non-material incentives, such as norms or grievances. Economic experiments are a way forward to better understand individual decisions to behave in conflictive ways and the role of both types of incentives (Blattman & Miguel, 2010).

This study will provide evidence on the relation between resource scarcity and the individual predisposition towards conflictive behaviour by making use of a framed field experiment. The experiment replicates water appropriation dilemmas in common water flows under circumstances of

water abundance and water scarcity. It is conducted with smallholder irrigators from semi-arid Tanzania of whom we have data on their socio-economic characteristics. Three subsequent questions will guide our analysis of the experimental findings. First, we want to make out whether water scarcity induces a reduction of extraction as the CPR thesis predicts; or whether it introduces competition as the resource scarcity conflict thesis predicts. Secondly, we want to find out what types of users of the common water flow are more inclined to react in a conflictive way to water scarcity. Thirdly, by putting our findings in a broader perspective, we want to evaluate to what extent real life circumstances are such that resource scarcity could engender conflict in Tanzania.

Research design

Data was collected in five irrigation schemes that are located in the Rufiji river basin in the semi-arid lowland areas of Mufindi district, Iringa region, Tanzania. Mufindi district was selected because irrigated agriculture is relatively important for food and cash crops (Majule & Mwalyosi, 2005; Mkavidanda & Kaswamila, 2001). The study was conducted in the lowlands of Mufindi district because these are characterised by a semi-arid climate and a single rainy season (Chang'a et al., 2010; United Republic of Tanzania, 1999, 2006b). Hence, people are confronted with a recurrent seasonal scarcity of water. The five irrigation schemes were selected with the help of local experts on smallholder irrigation and the district authorities. The irrigation schemes are similar to other irrigation schemes in the semi-arid lowlands of Mufindi district and in the wider region.

Participatory mapping exercises were conducted in each of the five irrigation schemes with mixed groups of 20 people who cultivate in the specific irrigation scheme. Via the participatory mapping exercises, inventories of all irrigators cultivating a plot in each of the irrigation schemes were obtained[79]. Random samples of irrigators were drawn from these inventories to participate in the framed field experiment and the survey.

Focus group discussions were conducted in each of the irrigation schemes with the same groups involved in participatory mapping. We inquired about the prevailing norms and rules for water extraction and water distribution. Additionally, we probed what people thought was a violation of these norms and what they considered to be conflictive behaviour.

A framed field experiment was used to study irrigators' water appropriation behaviour and their reaction to water scarcity. The framed field experiment was designed to replicate real life dilemmas irrigators face when they appropriate water from a common water flow in circumstances of water abundance and scarcity. These dilemmas imply two particularities. Appropriation from a common

[79] An irrigator is defined as the person in the household mainly responsible for cultivating the plot in the irrigation scheme and for making decisions regarding irrigated agriculture regardless of whether this person personally owns/rents the plot or not.

water flow is sequential and entails vertical downstream externalities (Cardenas et al., 2008). Consequently, appropriation does not necessarily affect the resource stock but mainly affects the remaining resource units for subsequent user(s). Furthermore, scarcity is not just a reduction of resource units per head but essentially entails there is an insufficient supply of resource units to fulfil the users' needs (United Nations Development Programme, 2006, p. 133). Our design takes these particularities into account. Therefore, it differs from experiments that replicate CPR dilemmas where appropriation is not sequential. It also differs from experiments in which resource provision is the underlying concern and in which resource scarcity reduces resource stocks but does not make them insufficiently large to satisfy the CPR users' needs (e.g. Oses-Eraso & Viladrich-Grau, 2007).

When spatially fixed irrigators appropriate water from common irrigation water flows, irrigators located upstream can repeatedly determine how many of the available units of water they will extract. Their water extraction will affect the remaining units for the subsequent irrigator(s). This can be mimicked in a framed field experiment by a repeated distribution game in which a participant, who is randomly assigned to be an upstream user, can propose a split of an available twelve hours to extract irrigation water[80]. The number of hours corresponds to a certain payoff, representing the harvest from irrigated agricultural production, payable at the end of the experiment. Another participant, randomly assigned a downstream user and permanently paired to the upstream user, receives the remainder of the hours available for water extraction. In practise, the upstream user indicated his decision on a card that was passed to the downstream user. The downstream user, however, is not a passive receiver in reality. Therefore, in each round of the game, she could react to her received share by opting to remain silent, to communicate appreciation or dissatisfaction to the upstream user or to punish the upstream user. The latter implied a minor cost for the downstream user and a small fine for the upstream user, deductible from the final payoff. In practise, the downstream user indicated her reaction on the same card that went back to the upstream user. Thereafter, the subsequent round started. The upstream user decided on water extraction another time and a new card went to the downstream user for reaction, and so on. Participants were not informed about the number of rounds.

To assess the effect of water scarcity on appropriation behaviour, the experiment included five rounds in which water is abundant and ten rounds in which water is scarce. Under water abundance, total water availability was sufficient for both upstream and downstream user to reach a threshold – set at four hours – that represents a critical water input required for irrigated agricultural production. Above the threshold payoffs rose with hours of water extracted; below the threshold payoffs were minimal.

[80] Whether participants were assigned to be upstream or downstream users in the experiment was independent of their actual position in the irrigation scheme. It referred to the type of decision they had to take in the experiment, respectively a decision about the distribution of water units or about the reaction to a received share of water units. It was assumed that, in reality, each participant has a neighbour located upstream and downstream in the irrigation scheme and is confronted with both types of decisions.

Water scarcity was mimicked by fixing the threshold at seven hours, which rendered it impossible for both upstream and downstream users to reach above threshold payoffs. In addition, payoffs per hour of water extraction were lower and increased only half as fast per extra hour. The payoff structure for water abundance presented in Table 8 was available to upstream and downstream users in the five rounds with abundance; that for water scarcity in the ten scarcity rounds [81].

	Water Abundance		**Water Scarcity**	
Hours Upstream User	Upstream User	Downstream User	Upstream User	Downstream User
0	50	500	50	350
1	50	500	50	325
2	50	475	50	300
3	50	450	50	250
4	175	425	50	200
5	250	375	50	125
6	325	325	50	50
7	375	250	125	50
8	425	175	200	50
9	450	50	250	50
10	475	50	300	50
11	500	50	325	50
12	500	50	350	50

Table 8: Payoff per Hour of Water Extraction

In total, 13 sessions were conducted with 156 irrigators, of which 52 are female. A maximum of four sessions of the experiment were conducted in each of the irrigation schemes. Each session included maximum fourteen irrigators from the same irrigation scheme randomly selected from those identified via the participatory maps. At the end of the experiment, each participant received the sum of payoffs minus fines or punishment costs if any. On average participants received 2,460 TSH.

An individual survey was conducted with all irrigators identified during participatory mapping who were available at the time of the survey, including all who participated in the experiment. In total 228 irrigators were interviewed. The survey included questions on socio-economic characteristics, on networks, on irrigated agricultural production and on conflicts over irrigation water.

A participatory ranking exercise was organised to get a measure of irrigators' relative social status in the irrigation community based on the community members' perception (Laws et al., 2003). Social status was used as a proxy for power status because it is a strong positive correlate and it is a more commonly understood and unambiguous concept[82]. In each of the five irrigation schemes, four

[81] Payoffs are measured in Tanzanian Shilling (TSH), with 1 US$ = 1,200 TSH. The table and every other tool used both figures and symbols to ensure understanding by lowly educated people. Tools and instructions are available in Appendix I and Appendix II.

[82] Social status is a collective judgment of the relative position of an individual in society based on her traits and assets and is an important source of power (Weiss & Fershtman, 1998).

randomly composed mixed subgroups of the groups involved in mapping ranked the irrigators who were identified on the participatory maps. They did so by putting irrigators' name cards on a ladder with four rungs[83]. High (low) rungs represented high (low) social status (Singh-Manoux et al., 2005). Each of the four rankings per irrigator was transformed into a score, equal to the value assigned to the rung – one to the lowest rung, four to the highest – divided by the number of rungs on the ladder. The mean of scores makes up a measure of irrigator's relative social status relative to other irrigators of the same scheme. This measure was standardised per irrigation scheme by subtracting the mean for the irrigation scheme from each individual's social status and by dividing this by standard deviation for the irrigation scheme. The standardised indicator of relative social status ranges from -1.91 to 1.98. Positive (negative) values represent a relative social status that is higher (lower) than the irrigation community's mean.

Finally, we reflect on our findings and the specific Tanzanian context to hypothesise on the potential of resource conflicts. We discuss trends that drive up competition for water in Tanzania and potential exclusionary features of water governance institutions on the basis of secondary sources. Additionally, we assess inequalities in wealth, income opportunities, power, water and land access at the irrigation scheme level with our own survey data; and at the regional level by using National Sample Census of Agriculture 2002/2003 data (National Bureau of Statistics, 2006).

Results

In this section we will first examine appropriation behaviour of upstream users in the framed field experiment when water is abundant and the change in appropriation behaviour when water becomes scarce. This will permit to answer the first research question whether water scarcity induces a reduction of resource extraction (the CPR thesis) or whether it introduces competition (the resource scarcity conflict thesis). Thereafter, we will sketch a profile of those who react in a conflictive way to water scarcity by linking different responses to water scarcity to individual characteristics of the irrigators who participated as upstream users in the experiment. This will provide an answer to the second research question.

During the focus group discussions conducted in each of the irrigation schemes, we learned that strong non-competition and reciprocity norms form essential tools for regulating the distribution of the common water flows. Irrigators sometimes defy these norms and enter into appropriative competition with others, even though violent encounters remain exceptional (Lecoutere, 2011).

'Hadhi ya jamii' (status in society) and 'uwezo' (ability: economic ability but also ability to attain one's goals, to influence others) were used as Swahili translations for social status (Kamusi Project).

[83] Participants were not expected to rank themselves nor users whom they were not well acquainted with. Rungs could be removed (added) if participants distinguished less (more) than four categories.

Nonetheless, competition for water is badly looked upon in these irrigator communities. Disregarding the needs of others and extracting water in a selfish way is considered to be conflictive behaviour.

In principle, the only pure strategy equilibrium of the game played in the framed field experiment would consist of the upstream user appropriating all of the available hours for water extraction, if (common knowledge of) narrow material self-interest is assumed. This would maximise her payoff. Empirically, such equilibria are seldom observed in distribution, dictator or ultimatum games. In dictator games, the average proposed shares range between 0.31 and 0.5 and are generally larger in small-scale communities where strong egalitarian norms prevail (Colin F. Camerer, 2003; Joseph Henrich et al., 2004). A one-to-one comparison between dictator games and the distribution game played here however, is impossible since we used framing and experiment participants face dilemmas they know from real life. Hence, selfish behaviour is expected to be countered by social proximity and social norms, both of which are known to prevent excessive extraction in CPR settings (Velez et al., 2009). The repeated nature of the game and the opportunity for the downstream users to react to their share may also ease selfishness (Frey & Bohnet, 1995; Osborne & Rubinstein, 1994).

In fact, we observe that the 78 upstream users in our experiment appropriate on average less than half of the available hours for water extraction over the five rounds in which water is abundant. More specifically, they appropriate 5.73 hours (SD 2.01), which corresponds to an average proposed share of 0.52. Their 'more than fair' appropriation behaviour probably is partly motivated by the strong norms of non-competition that regulate water distribution in the irrigation schemes.

Introducing water scarcity could induce competition. That is what the thesis of resource scarcity conflicts predicts. In contrast, the CPR thesis states that communities can overcome distributive conflicts over scarce resources with a suitable set of institutions. According to this thesis, resource scarcity may well induce a reduction in resource extraction. In line with this thesis, Osés-Eraso and Viladrich-Grau (2007) and Rutte et al. (1987) observed experiment participants to reduce their resource extraction in response to increasing resource scarcity.

In our experiment, however, upstream users do not reduce their water extraction in response to water scarcity. Over the ten rounds of water scarcity, upstream users appropriate on average more than half of the available hours, i.e. 6.57 hours (SD 1.87). This is significantly more than under water abundance. It corresponds to an average proposed share of 0.45. Our experiment shows that water scarcity induces selfish appropriation behaviour despite the strong non-competition norms regulating CPR use in the participants' communities. Given the irrigation schemes non-competition norms, we take that upstream users behave in a conflictive way in the framed field experiment if they appropriate water in a selfish way and claim more than an equal share of the available twelve hours for water extraction. Our findings thus confirm the resource scarcity conflict thesis.

But, not all upstream users react to water scarcity in the same way. We distinguish four ways in which upstream users can react to scarcity. First, upstream users can react in a conflictive way to water scarcity if they move from non-selfish water extraction in water abundance to selfish water extraction in water scarcity. Secondly, upstream users can react in a persistently conflictive way if they selfishly extract water in abundance and keep extracting selfishly in scarcity. Thirdly, upstream users can react by reducing the hours of water extraction if they change from being selfish in abundance to being non-selfish in scarcity. Fourthly, upstream users can react in a persistently non-competitive way if they are non-selfish when appropriating water in abundance and remain non-selfish in scarcity.

We now evaluate to what extent upstream users opted for any of the four reactions to water scarcity in the experiment. To do so we compare each upstream user's average number of hours of water extraction over the five rounds that mimic water abundance with the average number of hours of water extraction over the ten rounds that mimic water scarcity (AVG in Table 9). Alternatively, we compare each upstream user's number of hours of water extraction in the last abundance round (round 5) with that in the first scarcity round (round 6) (R5R6 in Table 9). As such, we appraise the shock effect of water scarcity. Table 9 presents the percentages of upstream users in the experiment who react in a conflictive, persistently conflictive, reducing or persistently non-competitive way to water scarcity.

Out of the 78 upstream users, 28.21% react in a conflictive way to water scarcity if average water extraction under water abundance and water scarcity are compared (Table 9: AVG). If water extraction in the last abundance round (round 5) and the first scarcity round are compared (round 6), we find that 37.18% react in a conflictive way to water scarcity (Table 9: R5R6). Quite high percentages of upstream users appropriate water in a persistently conflictive way (AVG: 33.33%; R5R6: 17.95%). Only limited percentages of upstream users react to water scarcity with a reduction of water appropriation (AVG: 3.85%; R5R6: 7.69%). Relatively high percentages of upstream users appropriate in a persistently non-competitive – non-selfish – way throughout abundance and scarcity (AVG: 34.62%; R5R6: 37.18%).

Reaction to Water Scarcity:	Conflictive	Persistently Conflictive	Reducing	Persistently Non-competitive
AVG: Comparing averages	28.21%	33.33%	3.85%	34.62%
R5R6: Comparing last abundance round (R5) with first scarcity round (R6)	37.18%	17.95%	7.69%	37.18%

Table 9: Comparing Hours Appropriated in Water Abundance and Water Scarcity: Percentage of Upstream Users per Type of Reaction to Water Scarcity (N=78)

These findings show that water scarcity induces different reactions among upstream users in the experiment. Since our second research objective is to discern who would engage in water scarcity conflicts, we want to find out what is the profile of those who react to water scarcity in a conflictive way.

To find this out, we relate upstream users' individual characteristics to the likelihood of reacting to water scarcity in each of the four possible ways (conflictive reaction, persistence in conflictive appropriation, reduction of appropriation and persistence in non-competitive appropriation). To do so, we need to look at appropriation behaviour in water abundance and the change appropriation behaviour when water becomes scarce in the experiment. That is why we estimate the (log) odds of making selfish appropriation decisions when water is abundant and when it is scarce in the experiment using a binary logistic regression in function of the upstream users' characteristics.

A dummy variable 'Scarcity' is included as an explanatory variable to assess the effect of water scarcity on the likelihood of selfish appropriation decisions. It takes the value one in the ten rounds in the experiment that mimic water scarcity. Interaction effects of the variable 'Scarcity' and each of the explanatory variables are included to evaluate the effect of water scarcity on upstream users with different characteristics[84].

The (log) odds of making selfish appropriation decisions are estimated with individual (and household) characteristics of the upstream users as the explanatory variables. Descriptive statistics of

[84] One could argue that this model is likely to suffer from omitted variable bias. The nature of our experiment is such that the current reaction is a function of the downstream user's reaction in the previous round. But including this as an explanatory variable is not straightforward. The downstream user's sanctioning behaviour is a direct function of the upstream user's appropriation behaviour. Hence, including the downstream user's reaction would make our model a dynamic panel data model. It is well known that in such a model, the appropriation behaviour is likely to be correlated within individuals over time, which renders the downstream user's reaction in the previous period endogenous. The standard solution to estimate the model in first differences and use suitably lagged levels of the endogenous variable as instruments is uninteresting for us, as this deletes all time-invariant variables from the model, which are key in this study. However, to get a sense of the magnitude of this omitted variable problem, we ran an additional set of regressions. The reasoning of this analysis as well as the results, are presented in the Appendix IV. Overall, we find that excluding the downstream user's reaction in the previous round has little effect on the other variables.

these variables are presented in **Error! Reference source not found.**. Hereafter we will explain why these characteristics are expected to influence the likelihood of conflictive appropriation behaviour in response to water scarcity.

First, gender is expected to influence the reaction to water scarcity because water values and community mechanisms to induce non-competitive appropriation behaviour are different for men and women ((Agarwal, 2007); see Part II). Moreover, men are assumed to more likely than women to engage in conflictive behaviour (Bouta et al., 2004). Therefore, we included the dummy variable 'Female'.

Variable	Proportion		N
Female	32.1%		78
Foodinsec (HH)	41.0%		78
Thatchroof (HH)	47.4%		78
Ironroof (HH)	52.6%		78
No_edu	19.7%		76
Cows (HH)	15.8%		76
Bicycle (HH)	66.2%		77
Watershort	26.9%		78
Farmincome	23.4%		77
Min_reli	30.8%		78
Min_tribe	24.4%		78
Immigrant	24.7%		77
Young	29.5%		78
Villgvt	42.3%		78
	Mean	**SD**	**N**
Livestock (HH)	0	1	74
" " unstandardised (TSH)	*522672*	*968421*	*74*
PctCash (HH) (%)	9.64%	18.27%	78
Irriland (HH) (acres)	1.37	1.05	77
SocStat	0	1	76
" " unstandardised	*0.0299*	*1*	*76*

Table 10: Descriptive Statistics of Independent Variables in the Sample of Upstream Users in the Experiment

Secondly, the literature suggests the poor and uneducated are more likely to exhibit conflictive behaviour (P. Collier & Hoeffler, 1998; Justino, 2009). As an indicator of (acute) poverty we included the dummy variable 'Foodinsec', which indicates that the participant's household has experienced food insecurity in the two years preceding the survey. Another indicator of poverty which is often used in the development literature relates to housing quality (Van Campenhout, 2007). The dummy variable 'Thatchroof' indicates the participant is relatively poor as her household lives in a house with a thatch roof (as opposed to an iron or tile roof). A lack of education is represented by the dummy variable 'No_edu' [85].

[85] Lack of education and poverty concur in this society. A lack of education is positively correlated with food insecurity and thatch roofing in the complete survey sample and in the subsample of upstream users in the experiment. It is negatively correlated with wealth indicators like livestock value, cow ownership, bicycle ownership and iron/tile roofing.

Thirdly, wealth is expected to have a negative influence on conflictive behaviour. Assets owned by the participants' household are an indication of wealth. In a rural Tanzanian setting, livestock often makes up a household's savings (Dercon, 1996; Lazaro, 2003). The value of the livestock owned by the participant's household is used as a wealth indicator ('Livestock')[86]. Alternatively, the dummy variable 'Cows' can be used. This variable takes the value one if the participant's household own cows. The dummy variable 'Ironroof' indicates the participant's household lives in a house with an iron or tile roof, which is associated to higher wealth. The dummy variable 'Bicycle' is another wealth indicator since mainly the wealthier own a bicycle in a rural Tanzanian setting (Van Campenhout, 2007).

Fourthly, water scarcity is expected to be more likely to induce conflictive behaviour if water is highly valued. In that case, the benefits of behaving in a conflictive way may be higher than the (social) costs. The (relative) importance and value of irrigation water is presumed to be higher to participants who experienced irrigation water shortage in any one of the two dry seasons preceding the survey. This is measured by the dummy variable 'Watershort'. Irrigation water is likely to be higher valued if agriculture is the only source of income. The dummy variable 'Farmincome' indicates the participant only gains an income out of agriculture and does not own (big) livestock either. A higher percentage of the irrigated plots allocated to cash crops, such as tomatoes, carrots, cabbage and African eggplant, is assumed to raise the value of irrigation water as well. This is measured by 'PctCash'. The size of the irrigated land of the participant's household ('Irriland') is used here as another indication of the participants' valuation of water[87]. We expect that the marginal value of water will be higher for irrigators with smaller plots, especially when water becomes scarce.

Fifthly, people who are marginalised, who have less extensive social networks or who immigrated into the community may be more likely to behave in a conflictive manner because (non-competition) norms and social pressure may not have evenly strong deterrence effects on these people (Hayami, 2009). As an indicator of being immigrated, the dummy variable 'Immigrant' that takes the value one if the participant is not a lifetime resident in the community. Not only ethnicity, but also religion is a basis of social (and economic) networks in Africa, even more so since the proliferation of new religious movements that has started in the late 70s (Meagher, 2009). As indicators of less extensive social network in the community, we constructed dummy variables that take the value one if the upstream user is a member of a religious group or a tribe that includes less than one third of the

[86] Livestock value is the total value of big and small livestock (in TSH) calculated using market values at the time of the survey (www.lmistz.net and market prices recorded in Mufindi district, July 2008). The variable has been standardised to facilitate interpretation by subtracting the mean for the sample of upstream users in the experiment (=522672) and by dividing by the standard deviation (= 968421)

[87] The size of the irrigated land is not a good indicator of wealth as land is generally not acquired via market transactions but rather via inheritance or via allocation by the village or traditional leaders (Dercon, 1996).

population living in the same community as the upstream user ('Min_reli'; 'Min_tribe'). Besides, if religious, ethnic or cultural differences concur with exclusion from economic or political opportunities, this may frustrate people and may create incentives for conflictive behaviour (Stewart, 2000).

Sixthly, on the one hand, youngsters are assumed to be more inclined to conflictive behaviour (P. Collier & Hoeffler, 1998). On the other hand, young people may be more compliant with norms and more susceptible to social pressure in rural African societies where the elite, mainly composed of elders, provide an authority structure to which younger people and other lower status people have to obey (Platteau & Abraham, 2002). The dummy variable 'Young' indicates the participant is (more than) seven years younger than the mean in her irrigation scheme[88].

Lastly, a political ecology perspective on resource conflicts requires taking into account patterns of power and dependency that may influence irrigators' appropriation behaviour (Le Billon, 2001; Turner, 2004). The literature suggests that the more powerful members of society may take advantage of their position, defy non-competition norms and compete for scarce resources (Keltner et al., 2003; Potkansky & Adams, 1998). The less powerful may be more careful in breaching norms and in competing with others. If powerlessness coincides with poverty or results from processes of exclusion, however, it may increase the likelihood of conflictive appropriation over scarce but vital resources such as water (Ruttan, 2008). We use a direct measure of decision-making power in the irrigation community and include a dummy variable that takes the value one if the participant is member of the village government or village council ('Villgvt'). Another indicator of the relative power status of the participant is based on the standardised indicator of social status ('SocStat'), which was measured via participatory ranking[89].

As a first step, we will evaluate the effect of upstream user's individual or household characteristics on the likelihood to make selfish appropriation decisions on the basis of the results of the binary

[88] Note that being young correlates with the indicator of decision-making power and with most of the poverty and wealth indicators. Therefore, it was included in a separate model to avoid multicollinearity.

[89] The standardised social status indicator has been centred on the mean for the sample of upstream users in the experiment (=.0299) to facilitate interpretation of the results. As social status correlates with other independent variables, it has included in a separate model to avoid multicollinearity.

Comparison of one's social status with that of the participant one was paired to in the experiment was impossible. This information was not provided to avoid a bias, to ensure understanding and to safeguard anonymity. Behaviour in the experiment and possible social distance effects are dependent on internalised awareness and internalised behavioural implications of one's relative social status in the irrigator community (Cardenas, 2003; Cardenas & Ostrom, 2004).

logistic regressions presented in Table 11[90]. This will be done for water-abundant conditions in the experiment and for water-scarce conditions.

As a second step, we will calculate the probability to react to water scarcity in a conflictive way, in a persistently conflictive way, in a persistently non-competitive way or by reducing appropriation based on the regression estimates. The probability to react to water scarcity in a conflictive way is calculated by multiplying the probability of non-selfish appropriation in water abundance with the probability of selfish behaviour in water scarcity, or $(1-p_{AB})xp_{SC}$[91]. The probability to react in a persistently conflictive way is calculated by multiplying the probability of selfish water extraction in abundance with the probability of selfish water extraction in scarcity, or $p_{AB}xp_{SC}$. To obtain the probability to react in a persistently non-competitive way we multiply the probability of non-selfish appropriation in abundance with the probability of non-selfish appropriation in scarcity, or $(1-p_{AB})x(1-p_{SC})$. The probability to react to water scarcity with a reduction of appropriation is obtained by multiplying the probability of selfish appropriation in abundance with the probability of non-selfish appropriation in scarcity, or $p_{AB}x(1-p_{SC})$.

The probabilities of each of the four reactions are calculated for a 'reference upstream user' on the basis of the regression estimates presented in the first column of Table 11. With a χ^2-test we verified that the probabilities of each of the four reactions to water scarcity by the reference upstream user are significantly different from each other. As a 'reference upstream user' we use a participant who is male, who does not belong to a minority tribe, who is not a member of the village government or village council and whose household did not experience food insecurity. The value of the livestock of this participant's household is equal to the mean of the sample of upstream users in the experiment. The percentage of this participant's irrigated plot allocated to cash crops is also equal to the mean.

To assess the effect of a particular individual (or household) characteristic on the probabilities of each of the four reactions to water scarcity, these probabilities are then calculated for upstream users who differ from the 'reference upstream user' with regard to that particular characteristic[92]. With a χ^2-test we verified that the probabilities of each of the four reactions to water scarcity significantly differ from those for the reference upstream user. The probabilities of each of the four reactions for different types of irrigators and the χ^2-tests are presented in Table 12.

[90] We estimated five different regressions, each of which includes different poverty and wealth indicators. These indicators are included separately to avoid multicollinearity. The five regressions also serve as a robustness check of the effect of poverty and wealth on the probability of selfish appropriation decisions.

[91] With $p_{AB}=\exp(\sum(\beta_i X_i)/(1+\exp(\sum\beta_i X_i)$ and $p_{SC}=\exp(\sum(\beta_i X_i+\gamma_i(X_i x Sc))/(1+\exp(\sum(\beta_i X_i+\gamma_i(X_i x Sc))))$.

[92] We add (subtract) one time the standard deviation when calculating the effect of higher (lower) livestock value and percentage of cash crops.

Variable	β	t[a]	Sig	β	t[a]	Sig	β	t[a]	Sig	β	t[a]	Sig	β	t[a]	Sig
Constant	-1.83	-4.29	**	-1.68	-3.81	**	-1.42	-3.55	**	-1.80	-3.68	**	-0.87	-3.95	**
Scarcity	1.50	3.10	**	1.49	2.91	**	1.45	3.05	**	1.46	2.77	**	0.87	4.18	**
Irriland	0.29	2.04	*	0.25	1.94	°	0.24	1.89	°	0.33	2.15	*			
ScarcXIrriland	-0.32	-1.88	°	-0.29	-1.73	°	-0.26	-1.58		-0.38	-2.29	*			
Min_reli	1.13	2.75	**	1.09	2.69	**	1.05	2.57	**	1.03	2.28	*			
ScarcXMin_reli	-0.64	-1.67	°	-0.59	-1.62		-0.48	-1.19		-0.49	-1.17				
Villgvt	0.71	1.75	°	0.72	1.84	°	0.76	1.96	*	0.56	1.39				
ScarcXVillgvt	-0.72	-1.85	°	-0.79	-2.10	*	-0.82	-2.09	*	-0.48	-1.23				
Female	-0.72	-1.51		-0.65	-1.45		-0.57	-1.32		-0.76	-1.57		-0.75	-1.60	
ScarcXFemale	0.60	1.24		0.50	1.08		0.36	0.81		0.65	1.34		0.39	0.79	
PctCash	0.01	1.67	°	0.01	1.80	°	0.02	2.74	**	0.01	1.38				
ScarcXPctCash	-0.01	-1.08		-0.01	-1.13		-0.01	-0.99		-0.01	-0.88				
Livestock	-0.37	-2.18	*							-0.40	-2.26	*			
ScarcXLivestock	0.03	0.13								0.07	0.30				
Cows				-0.66	-1.81	°									
ScarcXCows				-0.21	-0.41										
Bicycle							-0.67	-1.57							
ScarcXBicycle							-0.05	-0.11							
Foodinsec	-0.52	-1.25		-0.50	-1.25		-0.57	-1.49							
ScarcXFoodinsec	0.85	1.94	°	0.89	2.09	*	1.03	2.44	*						
Thatchroof										-0.37	-0.77				
ScarcXThatchroof										0.62	1.39				
SocStat													0.21	1.13	
ScarcXSocStat													-0.41	-2.28	*
% Correctly Predicted															
Obs/Pred=0	76.2%			75.1%			78.3%			75.2%			80.7%		
Obs/Pred=1	47.4%			47.0%			50.8%			42.4%			28.0%		
Pseudo R^2															
Cox and Snell	0.112			0.107			0.11			0.109			0.062		
Nagelkerke	0.151			0.145			0.148			0.147			0.084		
McFadden	0.088			0.084			0.086			0.085			0.048		
Sample Design Information															
Total N	1170			1170			1170			1170			1170		
Missing	75			45			30			75			30		
Strata	1			1			1			1			1		
Units	73			75			76			73			76		

Dependent variable= log odds of selfish water appropriation by upstream participants
Significance **99%;*95%;°90%
[a] Corrected for clustering within individuals

Table 11: Binary Logistic Regressions Estimating the Likelihood that Upstream Users Make Selfish Appropriation Decisions when Water Is Abundant and when It Is Scarce in a Framed Field Experiment

The results of the binary logistic regressions show that the variable 'Scarcity' has a positive significant effect on the probability of making selfish appropriation decisions. This confirms that upstream users are more likely to make selfish appropriation decisions when water is scarce in the experiment (Table 11). For instance, the probability that the 'reference upstream user' makes selfish appropriation decisions when water is abundant is calculated by $p_{AB}=\exp(\sum(\beta_i X_i)/(1+\exp(\sum\beta_i X_i)$ and is equal to 20.8%. When water is scarce, the probability that the 'reference upstream user' makes selfish appropriation decisions is calculated by $p_{SC}=\exp(\sum(\beta_i X_i+\gamma_i(X_i x Sc))/(1+\exp(\sum(\beta_i X_i+\gamma_i(X_i x Sc))))$ and is equal to 41.2% (based on regression results presented in the first column of Table 11)[93].

As a next step, we calculated the probabilities of each of the four reactions to water scarcity by the 'reference upstream user' (Table 12). The reference upstream user is most likely to be persistently non-competitive (46.54%). The probability he reacts in a conflictive way to water scarcity is about one in three (32.64%). The chance that he reduces the hours of water extraction in response to water scarcity is relatively low (12.24%). He is least likely to appropriate water in a persistently conflictive way (8.58%).

Although men are expected to be more likely to behave in a conflictive way, we do not observe differences between men and women in the experiment. The likelihood of selfish water extraction is not significantly different for women than for men either when water is abundant or when it is scarce. As a result, the probabilities that female upstream users react in any of the four possible ways to water scarcity are largely the same as the reference (male) upstream user's. However female upstream users are significantly less likely to react by reducing the hours of water extraction in response to scarcity. This is probably due to the fact that they are (insignificantly) less likely to start off with selfish water extraction in water abundance.

[93] $p_{AB}=\exp((-1.83)+0.29x1.37+0.01x9.64+(-0.37)x0)/(1+\exp((-1.83)+0.29x1.37+0.01x9.64+(-0.37)x0))$ and $p_{SC}=\exp((-1.83)+0.29x1.37+0.01x9.64+(-0.37)x0+1.50+(-0.32)x1.37+(-0.01)x9.64+0.03x0)/(1+\exp((-1.83)+0.29x1.37+0.01x9.64+(-0.37)x0+1.50+(-0.32)x1.37+(-0.01)x9.64+0.03x0))$

	Conflictive	Persistently Conflictive	Reducing	Persistently Non-Competitive
Reference[a]	32.64%	8.58%	12.24%	46.54%
Female	34.01%	4.34%	6.97%	54.68%
χ^2-stat	1.86	1.58	5.17*	0.64
Irriland: large (1.37+1.05)	29.81%	10.64%	15.67%	43.89%
χ^2-stat	10.89*	3.44°	5.96*	1.4
Irriland: small (1.37-1.05)	35.18%	6.82%	9.42%	48.58%
χ^2-stat	5.98*	3.08°	5.47*	0.84
Min_reli	29.41%	23.96%	20.93%	25.69%
χ^2-stat	13.05**	11.95**	3.13°	3.98*
Villgvt	26.74%	14.35%	20.58%	38.33%
χ^2-stat	4.61*	2.3	4.51*	1.43
PctCash: high (9.64+18.27)	31.80%	10.03%	13.94%	44.23%
χ^2-stat	3.36°	2.02	6.59*	0.97
Livestock: high value (0+1)	28.20%	5.14%	10.28%	56.38%
χ^2-stat	3.30°	5.32*	7.01**	2.34
Livestock: low value (0-1)	35.94%	13.64%	13.87%	36.55%
χ^2-stat	5.05*	7.25**	4.76**	3.27°
Foodinsec	42.65%	6.67%	6.86%	43.82%
χ^2-stat	1.43	0.7	3.16°	0.03
Reference: Conflictive				
χ^2-stat	/	70.73**	11.05**	44.93**
Reference: Persistently conflictive				
χ^2-stat	70.73**	/	7.43**	187.52**
Reference: Reducing				
χ^2-stat	11.05**	7.43**	/	7.43**
Reference: Persistently non-competitive				
χ^2-stat	44.93**	187.52**	7.43**	/

a: Reference: Female=0; Irriland=1.37; Min_reli=0; Villgvt=0; PctCash=9.64; Livestock=0; Foodinsec=0
Significance **99%;*95%;°90%

Table 12: Probabilities of Different Types of Users Reacting to Scarcity in a Conflictive, Persistently Conflictive, Reducing or Persistently Non-Competitive Way

Wealth has an effect on the likelihood of selfish appropriation decisions, but only when water is abundant. In times of abundance the likelihood of extracting water in a selfish way decreases when the upstream user is wealthier because the value of his household's livestock is higher. When there is water scarcity, the likelihood of selfish water extracting increases independently of the upstream user's wealth. Possibly, as livestock is a form of productive capital, it makes people less dependent on (irrigated) agriculture. This could explain why people with higher values of livestock demand less water (in abundance). The same relation between wealth and the likelihood of selfish water extraction is observed when cow ownership is used as a wealth indicator. Similarly, when the upstream user's household owns a bicycle, he is less likely to make a selfish appropriation decision in water abundance. This effect, however, is only significant at 88% (P>|-1.57|=88%). Wealth measured by having an iron or tile roof does not have a significant effect on the likelihood of being selfish, either in abundance or scarcity.

Consequently, relatively wealthy upstream users (measured by higher livestock values) are less likely to react to water scarcity in a conflictive way as compared to the reference upstream user. This

corresponds to what the literature suggested. They are less likely to appropriate in a persistently conflictive way as well. They are (insignificantly) more likely to be persistently non-competitive but also less likely to reduce water extraction when water becomes scarce.

In contrast, if the value of the livestock is lower and the upstream user is relatively poor, the likelihood of extracting water in a selfish way in abundance is higher than for others. As a result, upstream users whose livestock has a lower value are more likely to react in a conflictive way and in permanently conflictive way to water scarcity than the reference upstream user. They are less likely to appropriate water in a persistently non-competitive way. These observations confirm the presumption that the poor are more likely to exhibit conflictive behaviour.

Further proof for this presumption is the fact that upstream users who are poorer are more likely to make selfish appropriation decisions when water is scarce in the experiment, than others would. This relation is observed both when acute poverty is measured (food insecurity) and more chronic poverty is measured (thatched roof). The effect of chronic poverty however, is less outspoken. The effect is smaller and only significant at 83% (P>|1.39|=83%). But when water is abundant, poorer upstream users' are not more likely to extract water in a selfish way than others. Possibly, if resources are abundant the poor abide with non-competition norms because of their vulnerable and dependent position. But if vital resources such as water are scarce, their relative poverty may make them to defy such norms.

Consequently, if the upstream user's household has experienced food insecurity, the upstream user is less likely to reduce water extraction and (insignificantly) more likely to behave in a conflictive way as a reaction to water scarcity than the reference upstream user. These observations form a (weak) confirmation of the presumption that the poor are more likely to exhibit conflictive behaviour.

Being uneducated (No_edu) has been included in a model without other poverty indicators to avoid multicollinearity. Being uneducated, however, did not have any significant effect on the likelihood of selfish appropriation decisions in abundance, nor in scarcity.

If upstream users allocate larger proportions of their irrigated fields to cash crops (PctCash), they are more likely to appropriate water in a selfish way when water is abundant in the experiment. When water is scarce, their likelihood to appropriate in a selfish way increases independently of the proportion allocated to cash crops. Probably, as they grow cash crops irrigators need sufficient water for their cash crops under all circumstances.

Consequently, upstream users with higher proportions of their irrigated fields allocated to cash crops are more likely than the reference upstream user to reduce water extraction in response to water scarcity. This is because they are more likely to start off with selfish appropriation in times of water

abundance. They are also more likely to appropriate water in a persistently conflictive way. This difference however, is only significant at 85% (P>|2.02|=85%). This is a (weak) confirmation of the hypothesis that a higher valuation of irrigation water increases the likelihood of conflictive appropriation behaviour. But in this case, the higher demand and higher likelihood of competing for water does not necessarily come as a reaction to water scarcity.

Upstream users with larger plots of irrigated land (Irriland) are more likely to appropriate water in a selfish way when water is abundant. When water is scarce, they are less likely than others to appropriate water in a selfish way. It may be that people with larger irrigated plots take large shares of water when there is enough water. If water is scarce, however, they may be able to reduce their demand as they can more easily afford to give up some of their (more diversified) produce. Or, if water is scarce they may refrain from extracting as much water as they would need for their bigger plot because (they feel) they could offend others. In contrast, if people have small irrigated plots it may not be so important to take large shares of water when it is abundant. But when water is scarce, it may be all or nothing. If they do not get a sufficient share of water, their sole irrigated produce may perish. Therefore, when water becomes scarce the marginal value of irrigation water may increase much more for irrigators with relatively small irrigated plots than for others.

Consequently, upstream users with larger plots of irrigated land are more likely than the reference upstream user to appropriate water in a persistently conflictive way. They are also more likely to reduce water extraction in response to scarcity. Upstream users with smaller plots of irrigated land, however, are more likely to react in a conflictive way than the reference upstream user and they are less likely to reduce their water extraction. As they probably allot a higher marginal value to irrigation water, it was to be expected that they would be more likely to react in a conflictive way to water scarcity.

The other indicators for a higher valuation of irrigation water, 'Watershort' and 'Farmincome', have not been included in the final model because these variables did not have any significant effect on the likelihood of making selfish appropriation decision in times of abundance nor in scarcity. Somewhat unexpectedly, upstream users' experience with water shortages did not affect their behaviour in the experiment. Possibly their experience has not raised the value they allot to water or they have 'learned' not to react with more selfish appropriation behaviour.

Upstream users who belong to minority religious groups are more likely to make selfish appropriation decisions when water is abundant. When water is scarce their likelihood of making selfish appropriation decisions increases less than for others. The latter however, may not be a very robust relation as it is not confirmed in the regressions where alternative indicators for poverty and wealth

are included. Belonging to a minority tribe or having immigrated into the village, however, did not have any significant effects[94].

As there is an (unconfirmed) lower increase in the likelihood of selfishness in water scarcity for members of minority religious groups, they are more likely to reduce water extraction in response to scarcity than the reference upstream user. As upstream users who belong to minority religious groups behave more selfishly than others in water abundance, they are more likely to appropriate water in a persistently conflictive way than the reference upstream user. The latter is in line with expectations that people who are marginalised or have little extensive social networks adhere less to (non-competition) norms and appropriate water in a more conflictive manner. Yet, it may be that they refrain from breaking norms to some extent when there is water scarcity.

Being relatively young ('Young') has not been retained in any model as it had no significant effect on the probability of selfish appropriation decisions in abundance or in scarcity. Probably, young people in these rural Tanzanian communities are quite susceptible to social pressure and therefore avoid competition.

Upstream users who are a member of the village government or village council are more likely than others to extract water in a selfish way when it is abundant, but less likely than others to do so when water is scarce. People with decision-making power may take advantage of their position and behave more selfishly if water is abundant. But when water is scarce, they transgress norms less than others. Possibly they realise that selfish behaviour deprives others and hence they correct their behaviour to some extent. They may do so because they take up a leadership role or want to set the example.

As a result, we observe that upstream users who are a member of the village government or village council are more likely to reduce water extraction as a reaction to scarcity than the reference upstream user. They are also slightly but insignificantly more likely to appropriate in a persistently conflictive way. Hence, there is no confirmation of higher probabilities of conflictive behaviour of irrigators with more (decision-making) power.

The relative social status of the upstream user, used as a proxy for their power, does not affect the likelihood of selfish water extraction in abundance. In scarcity, the likelihood of selfish water extraction of upstream users with a higher social status increases less than for others. Either, upstream users with a higher social status transgress non-competition norms less as they want to set an example. Or, as social status negatively correlates with poverty, people with a lower social status may be poorer. Therefore, they may be more likely than others to extract water in a selfish way when there is

[94] Possibly being a member of a minority tribe makes less of a difference because at present religion in rural Tanzania seems to bind people more than tribe (Toner, 2008).

scarcity of vital resources such as water. We observed such a relation with food insecurity as a poverty indicator.

The answer to our second research question is that the ones who are relatively poor, who have less extensive social networks and the ones for whom access to irrigation water makes a critical difference for their agricultural production are more likely than others to react in a conflictive way to water scarcity in the experiment. This is largely in line with the literature's presumptions that the poor, the marginalised and dissocialised and the ones who value resources highly are more likely to come into conflict over scarce resources. Our findings did not support presumptions that men, youth and uneducated people would be more inclined to struggle for scarce resources.

Discussion

In the previous section, we presented experimental evidence that some types of irrigators are more likely than others to enter into appropriative competition when water is scarce despite the existence of non-competition norms and despite the fact that such behaviour is considered conflictive in their communities. When water is scarce in reality, they may also be the ones who are more likely to break social norms and to react in conflictive ways to scarcity. There is a chance that these types of irrigators would also more easily engage in more violent ways of competing for scarce resources.

The relation between resource scarcity and conflict, however, is complex and multi-layered. Resource scarcity can bring about (violent) conflict but this is most often as a result of a concurrence of circumstances (Turner, 2004). Via the framed field experiment we observed that some people have a higher predisposition towards conflictive behaviour in response to resource scarcity. We will now evaluate if this coincides with the presence of horizontal inequalities, with marginalisation or with exclusionary features in policy. We will also assess to what extent other factors that could be conducive to resource scarcity conflicts, such as rising competition for water, are present in Tanzania. Looking at our findings from this wider perspective will enable to hypothesise to what extent circumstances in Tanzania are such that resource scarcity could engender conflict.

First, horizontal inequalities, marginalisation of certain groups and their exclusion from access to resources are factors that are known to be conducive to resource scarcity conflicts (Benjaminsen et al., 2009; Stewart, 2000). Inequalities in wealth, power and resource access could aid mobilisation for (resource scarcity) conflicts, especially when a higher predisposition for conflictive reactions to water scarcity concurs with such inequalities. We checked whether the types of people that were more inclined to react in a conflictive way to water scarcity in the experiment are confronted with real inequalities in each of the five irrigation schemes by using the complete survey sample. We checked this for the wider region as well by using data on Iringa region gathered in the National Sample

Census of Agriculture 2002/2003 (National Bureau of Statistics, 2006) (See Table 17 in the Appendix V).

The experiment showed that relatively wealthy irrigators are less likely than others to react in a conflictive way to water scarcity, while relatively poor irrigators are more likely to do so. We investigated whether these differences concur with inequalities in water and land access and (decision-making) power. We found that there is a positive (negative) correlation between wealth (poverty) and the size of (irrigated) agricultural land in each of the irrigation schemes and in the wider region. Wealth is also positively correlated with social status in every irrigation scheme and positively correlated with membership of village government or village council in some irrigation schemes[95]. At the regional level, there is a negative (positive) correlation between water shortage problems and wealth (poverty). Similar relations are observed in two of the irrigation schemes. These observations show that in reality, the poor are marginalised with regard to water and land access and (decision-making) power.

Next, the experiment gave indications that members of minority religious groups are less inclined to adhere to non-competition norms and more inclined to extract water in a persistently conflictive way than others. According to the literature, mobilisation to join in (resource scarcity) conflicts is most effective if inequalities in economic opportunities, resource access or political participation coincide with cultural, ethnic or religious differences (Stewart, 2000). We checked whether such inequalities are present in the studied irrigation schemes[96]. In fact, in three out of five irrigation schemes, members of minority religious group are more likely to be relatively poor or to possess less land. In the other two irrigation schemes, they are more likely to be relatively wealthy. In one irrigation scheme, members of minority religious group report more water shortage problems.

While we did not observe differences in reactions to water scarcity in the experiment between youth and older irrigators, inequalities in wealth, water and land access and (decision-making) power exist along these lines. In each of the irrigation schemes, the ones who are relatively young have less (irrigated) agricultural land at their disposal, they are less likely to be involved in the village

[95] Note that the indicators of wealth (poverty), irrigated land size, village government membership and social status did not significantly correlate with each other in the subsample of upstream participants in the experiment that was used in the binary logistic regression estimation.

Some variables are defined in a different way in our survey and in the National Sample Census of Agriculture. The exact definitions are included in the Appendix V together with Table 17. Correlations with membership of village government and with social status could not be checked at the regional level since this data is not available in the National Sample Census of Agriculture.

[96] This could not be checked at the regional level as data on religion is not available in the National Sample Census of Agriculture.

government or council and their social status is lower[97]. In the wider region, relatively young people have less land and fewer cattle and they report more water shortage problems.

Lifetime residents and the ones who immigrated to the village did not react differently to water scarcity in the experiment. Furthermore we did not observe any consistent inequalities in the irrigation schemes with regard to water and land access and (decision-)making power between these groups. In contrast to what is often assumed lifetime residents are not privileged in this setting.

Secondly, water governance institutions in Tanzania include potentially marginalising and exclusionary features that could contribute to conflicts over (increasingly) scarce resources. Despite the National Water Policy's good intentions, its arguments to use water in the most efficient and sustainable way and the principle of treating water as an economic good can endanger the entitlement to water of small scale users (United Republic of Tanzania, 2002)[98]. Participation of small-scale users at basin level water resource management should ensure their interests are defended. But it remains questionable that they can effectively influence resource management through their participation – if it takes place (Ribot et al., 2010). Moreover, representatives of small-scale users are often elite and do not always represent the interests of the different types of small-scale users (Cleaver, 2002). Besides, small-scale users are likely to pull the shortest string if competition for water arises since mostly they do not hold an official water right.

Processes of marginalisation and exclusion are at work at the level of the smallholder irrigation schemes as well. At this level, water use is largely regulated by a mix of informal and formal institutions. The flexible and pragmatic nature of these (blends of) institutions allows accommodating for different challenges posed by water appropriation. But, less powerful irrigators and female irrigators do not always have the capability to pragmatically search for a suitable solution. Sometimes they forsake their capability to do so. Often they cannot or do not uphold their interests, which consolidates deep-rooted inequalities (Lecoutere, 2011).

Thirdly, rainfall is becoming more erratic and less predictable due to climate change and increasing climate variability. This may well exacerbate competition for water resources (Chang'a et al., 2010; Paavola, 2008). Economic development and population pressure increase demand for water. Hence, conflicting pressures between different users of Tanzania's water resources such as domestic users, farmers, livestock keepers, industry and hydropower plants, are present and on the rise (Maganga, Butterworth, & Moriarty, 2002). Also within the small-scale irrigation sector competition for water is

[97] Probably a persistent cultural fact that reserves leadership for men of certain age deprives the young (and women) of the capability to participate in decision making. Plot division at heritage is probably one of the causes of problematic land access for youth involved in agriculture.

[98] NAWAPO serves as the reference even while it has not been fully incorporated into legislation yet.

ever increasing. Irrigated agriculture has become more attractive because rain-fed agriculture has become riskier due to climate change, and it has gained importance for production of locally marketable crops, like tomatoes and onions (Kaswamila & Masuruli, 2004; Sokoni & Shechambo, 2005).

Conclusion

Conclusively we can confirm that resource scarcity induces conflictive behaviour even if strong non-competition norms are present. Some people, however, are more inclined than others to respond to water scarcity in a conflictive way. Via the framed field experiment we observed that water users who are relatively poor, who have less extensive social networks and for whom irrigation water makes a critical difference for their agricultural production, are more likely to enter into appropriative competition when water is scarce, despite the existence of non-competition norms and despite the fact that such behaviour is considered conflictive in their communities. There is a chance that these types of water users would more easily break social norms, react in conflictive ways or even engage in more violent ways of competing for resources if water is scarce in reality, especially if circumstances are conducive to resource scarcity conflicts.

In fact, circumstances in Tanzania are such that they could be conducive to resource scarcity conflicts. The ones who showed a higher predisposition to react in a conflictive way to water scarcity suffer from real economic and political inequalities. Besides, (formal and informal) water governance institutions hold exclusionary elements that possibly affect the same people. Inequalities and exclusion could form a basis for mobilisation for more violent ways of competing for scarce resources, especially in combination with rising values of water. The value of water can be reasonably expected to further increase as rainfall is becoming more unpredictable and erratic and water scarcity is increasing due to climate change. At the same time, economic developments, such as the growing commercialisation of irrigated agriculture, are raising the value of water.

Still, we do not want to raise suspicion that the poor and the marginalised will soon engage in resource scarcity conflicts in Tanzania. To date there have been few incidences of disruptive or violent resource scarcity conflicts in Tanzania. While water governance institutions suffer from limitations, they still function relatively well and are based on good intentions. Additionally, the strong egalitarian norms and the central national value of peacefulness reduce the threat of resource scarcity conflicts in Tanzania (Kessler, 2006). Our message is rather that care should be taken and policy should take measure to ease these factors that are conducive to water scarcity conflicts.

Measures should be taken to reduce the poor's dependency on natural resources, for instance through the creation of other income opportunities or safety-nets. At the same time, the concurrence of poverty

and unequal access to resources should be adjusted. Culturally, ethnically or religiously skewed resource access should be further prevented. What could be helpful are easily accessible initiatives that support poorer, less powerful and less networked people in land claims and disputes over water access. In addition, locally-specific (informal) resource appropriation rules could be made more enforceable and less ambiguous if they are recorded at the local level. The interests of small-scale users and less powerful users may be better protected in basin level water resource management when democratisation of resource management is further established. To achieve this, responsiveness to local needs and downward accountability to all users should be ensured. More decentralisation of discretionary powers and inclusion of mechanisms of accountability, like sanctions and elections, may be necessary (Ribot et al., 2010). While increasing commercialisation of agriculture is not a bad economic evolution, equal participation in this evolution should not be hindered. For instance, water may rise in value but pricing it could exclude less wealthy water users, which should be avoided. Countering the effect of climate change may prove difficult but the detrimental effect of increased rainfall variability could be partly absorbed by weather insurances (Skees, Varangis, & Larson, 2004)

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General Conclusion

Projections of a global water crisis, of rampant violent conflicts over increasingly scarce water resources and of a widening gap in entitlements to water between the powerless poor and others have inspired this research. Such projections find their roots in expected supply-demand problems, which will primarily hit development countries. Such problems may be caused by population growth and economic developments which increase the demand for water and by climate change which will make water increasingly scarce. These evolutions are expected to drive up competition, possibly to the extent that violence will be used to secure access and control over a scarce but essential natural resource. It is expected that equity in entitlement to resources will be harder to maintain under these conditions. When competition for resources is more intense, negotiations over access and control over resources are likely to be played higher. Power relations are likely to play a more decisive role. Hence, the poor and the least powerful may miss out on water entitlements.

Both from a security and a development perspective, an informed understanding of water governance and of the impediments to equity in the distribution of water are essential to counterbalance the gloomy projections of the current discourse on water. In fact, evolutions like climate change, population growth and economic development could contribute to violent competition for increasingly scarce resources, especially in combination with disparities in access to resources. Hence, from a security point of view, it is important to comprehend the origin of inequalities with regard to resource access, to know to what extent decentralised water governance can counter resource conflicts and to understand individuals' motives to react in conflictive ways to resource scarcity. Insights into the distribution of essential common resources like water are also important from a development perspective. The livelihoods of semi-subsistence farmers are particularly vulnerable to inadequate and insecure water access. Uncertainty about adequate water supplies also forms an additional risk in their production process. Often such risks are avoided through opting for less water dependent agricultural production at the expense of larger returns.

The literature presents diverging views on the relation between resource scarcity and conflict. The environmental security literature purports there is a causal relation between resource scarcity and violent conflict. The political ecology literature however claims that resource scarcity is neither a sufficient nor a necessary factor explaining conflict. It asserts that conflicts which seem related to resources are generally socially, culturally and historically embedded. The common pool resource literature states that distributive conflicts over common resources like water can be overcome with a suitable set of institutions.

Different strands of literature deal with decentralised governance of natural resources and the distribution of resources. The common pool resource literature inspired the introduction of more

decentralised natural resource governance which is expected to contribute to efficient, sustainable and equitable use of resources. The common pool literature, however, spent little attention to equity even if this is essential to ensure resource provision and maintain trust and reciprocity, which are key elements for self-governance. Hence, the extent to which decentralised governance of common resources assures equity in the distribution of resources is uncertain. The post-institutionalist literature concentrates on equity. It highlights that local institutions for governing natural resources are socially embedded and embedded in the prevailing power structures. As a result, entitlements to resources and the distribution thereof are likely to be shaped by social inequities and power imbalances.

The aim of this research is to provide a realistic account of local water governance and how common water flows are shared in semi-arid areas in sub-Sahara Africa. It addresses different gaps in the knowledge about how common water flows are locally governed and how water is shared in a setting where water is regularly in scarce supply. This setting is further characterised by increased competition for water due to climate change, population growth and economic developments and by widened institutional pluralism due to decentralisation and new water governance policies.

A first contribution of this research consists of striking a balance between romanticised views of harmonious, inclusive local governance of natural resources producing efficient sustainable and equitable resource use and gloomy, neo-Malthusian ideas of resource users fiercely and violently competing for scarce resources. It presents a more unprejudiced view on local resource governance while uncovering structural causes of inequality.

A second contribution is its rigorous analysis of the socially embedded nature of institutions and resource entitlements. In this research, resource governance institutions are not approached as fixed structures with an observable set of 'rules of the game'. Instead, institutions are viewed as sets of rules in use that are moulded by the resource users' practices. Such a view permits recognising and studying the socially embedded nature of institutions by uncovering how agency by socially and economically heterogeneous actors shapes institutions.

Thirdly, in contrast to much of the literature on common pool resources this research specifically addresses fairness of resource entitlements. While doing so it acknowledges that issues of fairness and equitable resource distribution are strongly connected to broader socio-political structures that underlie inequalities in the communities. It implies that the norms, rules and reputation mechanisms, which are inherent parts of local resource governance institutions, may have different effects on socially and economically heterogeneous common pool resource users confronted with water abundance and water scarcity. More specifically, this research analyses to what extent social factors like gender and social status influence resource distribution because institutions and resource values

may provide gender and status specific incentives to comply with resource appropriation rules under water abundant and water scarce conditions.

A fourth contribution of this research consists of providing rigorous empirical evidence of the role of power in engendering disparities in resource entitlements and in shaping institutions. The economic literature often avoids taking up such measures due to statistical problems, while the sociologically inspired literature does not always provide convincing evidence of the role of power. This research uses a measure of the resource users' relative power status in their community's power structure which is based on the perception of community members.

Fifthly, this research provides additional insights into the relation between resource scarcity and conflict. It uses a framed field experiment which enables to elicit a reaction to water abundance and water scarcity by the same people, which is impossible with observational data. By combining experimental evidence of water appropriation behaviour with data on socio-economic characteristics of the irrigators participating in the experiment it produces evidence on the relation between the individual predisposition towards conflictive behaviour and resource scarcity.

There are three main parts in this work which each address specific issues related to local water governance and competition for water from common water flows. Part II deals with resource distribution behaviour by socially heterogeneous irrigators under conditions of water abundance and water scarcity. It is based on an analysis of experimental data. Part II examines whether male and female irrigators share resources in a different way and whether they react differently to water scarcity. It determines whether irrigators' social status affects the way they share resources when water is abundant and when it is scarce and whether this effect is similar for male and female irrigators. Furthermore, it includes an assessment of the extent to which real life observations substantiate the experimental findings on irrigators' resource distribution behaviour.

Part III investigates how conflicts over land and water are dealt with in smallholder irrigation communities in semi-arid Tanzania which largely self-govern their water flows. While analysing how conflicts are solved in these irrigation schemes it is observed that conflicts may prompt processes of pragmatic problem solving through which local resource governance institutions are reproduced. The role of institutional pluralism in such processes is assessed. Throughout the analysis of how conflicts are solved, the role of actors' positions in the local power structure and their gender is looked at and the effectiveness of their resource claims is assessed.

Part IV provides experimental evidence of individual predisposition of conflictive behaviour in response water scarcity. It investigates whether water scarcity induces a reduction of extraction as the CPR thesis predicts; or whether it introduces competition as the resource scarcity conflict thesis

predicts. It determines what types of users of the common water flow are more inclined to react in a conflictive way to water scarcity. And by putting the findings in a broader perspective, it hypothesises about the extent to which real life circumstances are such that resource scarcity could engender conflict in Tanzania.

This research is defined to studying access to and conflict over productive water that is derived from common water flows in semi-arid sub-Sahara Africa. More particularly, five smallholder irrigation schemes in the semi-arid lowlands of Mufindi district, Tanzania, are studied. Tanzania is a representative example of the changes that take place in sub-Sahara Africa, such as climate change, economic development, population growth and increasing decentralisation of natural resource management. The smallholder irrigation schemes dealt with in this research consist of networks of locally dug river diversions and canals and are similar to schemes in the wider region. Irrigation is an important contribution to agricultural livelihoods in these settings and governance of irrigation water can be allotted to a well-defined community. Irrigators in these areas are confronted with recurrent water scarcity in the yearly dry season.

Since the research adopts a micro level of analysis of resource appropriation and resource conflicts, in principle, the level of inquiry has been the individual. The multidisciplinary nature of the research and the research questions called for an empirical strategy using a mixed method approach. Both qualitative and quantitative methods have been applied for data collection. Participatory data collection methods have been used for mapping the irrigation schemes and for identifying irrigators. Participatory methods have been used to obtain a ranking of irrigators according to their relative social status in their community which is based on the perception of community members. The measure of the relative social status served as a proxy for the relative power status of irrigators in their community. Other qualitative methods included focus group discussions and semi-structured interviews. Quantitative data collection methods included an individual survey which inquired about socio-economic characteristics of the irrigators and about accessing irrigation water. A framed field experiment is another quantitative method that was used. The experiment was conducted with users of the smallholder irrigation schemes. It was framed as water appropriation from the common irrigation schemes in water abundant and water scarce circumstances. It replicated the dilemmas that irrigators experience in real life.

Combining these different types of data permitted an analysis of resource distribution behaviour while taking into account the effect of social factors like users' gender, power and social status in the community. It also allowed explaining the variation in individual behaviour in the experiment. By taking resource conflicts as the unit of analysis and by investigating the way they are settled, an analysis of actor-driven processes that reproduce institutions was possible. Relating this to an

unambiguous measurement of the actors' positions in the local power hierarchy enabled uncovering the socially embedded nature of such processes and the role of power imbalances in these.

This research not only provided insights of how water is governed and shared in the irrigation schemes in semi-arid Tanzania. It also enabled drawing more general conclusions on local resource governance institutions, on agency by people embedded in a social structure, on access to scarce common resources and on decentralised natural resource management.

First, local resource governance institutions are not fixed structures with a clear and unambiguous set of norms and rules. Actually, the 'rules of the game' to govern irrigation water in the studied irrigation schemes are in flux and are socially embedded. They are a mix of elements borrowed from "formal" bureaucratic rules and more "informal", "traditional" ways to deal with water governance. Nevertheless, local water governance institutions involve some basic, common standards even if they are in flux and are locally specific. Competition and distributive conflicts are avoided in order to maintain harmony in the community. Irrigators also strongly believe that everybody has a right to water and water should be distributed in a fair way. With regard to conflict management, there is a clear preference for reconciliation over confrontation.

New challenges have brought about more disputes over water and land at the local level. But such disputes are not necessarily disruptive. They sometimes prompt further development of local water governance institutions. This happens in a pragmatic way when the people involved in disputes search for solutions, preferably non-violent, non-confrontational ones. While they do so, they engage in institutional bricolage and blend elements of formal and informal institutions. Sometimes they search somewhat opportunistically for the solution that best accommodates their needs. Besides, there are indications that the purely "traditional" ways to resolve disputes have reached their limits. Furthermore, while trying to solve disputes, the local government, which gained more discretionary power through efforts of democratic decentralisation, tries to establish its role in local resource governance and avoids being sidelined by newly introduced water governance policies.

Local water governance institutions are also socially embedded rules in use. The underlying norms and the monitoring and reputation mechanisms do not mean the same for all irrigators. People with different social positions in the community may value resources differently but they also face specific behavioural norms and reputation mechanisms. The experiment showed that gender and status specific behavioural norms and reputation mechanisms shape people's incentive structure and their resource distribution behaviour. Behaviour that is influenced by such internalised constraints may also consolidate inequalities related to the social structure in the community.

Secondly, the processes through which institutions take shape are subject to agency by people embedded in a social structure. While unravelling the ad-hoc development and the reshaping of institutions for solving resource related disputes in the irrigation schemes, it was shown that the social structure and the power relations in the irrigator communities play a decisive role. Irrigators' social position and power position in the community determine the extent to which they comply with the rules and norms that regulate water access and distribution. They are also significant for the way disputes are solved and for the type of processes of institutional (re)shaping that are initiated. Powerful irrigators, for instance, are more inclined to opportunistically search for the institutional framework and the rule that best serve their cases. Or, if disputes involve powerful offenders, many of whom are male, often more authoritative and more bureaucratic forms of conflict management are called in. Possibly these are needed as leverage to deal with powerful offenders. If conflicts involve less powerful offenders, in many cases more informal instruments are used to enforce rules or to resolve conflicts. It is also observed that less powerful irrigators, many of whom are female, do not always have the capability or forsake their capability to engage in creative conflict resolution and to uphold their interests. It shows that inherent power imbalances seriously limit the scope of the least powerful in the community to engage in creative and pragmatic problem solving and to contribute to the (re)shaping of institutions.

Thirdly, access to common pool resources under decentralised governance is not necessarily equitable. While some norms and rules are in place to ensure a fair distribution of water and to avoid competition in the studied irrigation schemes, not everybody complies with these norms to the same extent. Moreover, water scarcity makes it harder to comply with such norms. More specifically, one would expect that men with a high social status, who are often economically better-off and fulfil a leadership role in these patriarchal and status-based societies, would comply with norms prescribing a fair resource distribution. But they do not. Men and women with a low social status comply with norms of fairness, but only when water is abundant. When water is scarce they do not, possibly due to their dependence on irrigation water for subsistence and due to the economic loss that comes with fairly distributing resources. Only women with a high social status adhere and are able to adhere to fairness in water abundant and water scarce circumstances. Hence, the way water is distributed results in differential access to irrigation water that mirrors structural inequalities and may reinforce economic inequalities linked to gender and status.

Furthermore, water scarcity induces some irrigators to break the strong non-competition norms that regulate the use of the common water flows. Such behaviour is regarded conflictive in these irrigator communities. When water is scarce, the social norm to avoid competition is more easily broken by the ones who are relatively poor, the ones who have less extensive social networks and the ones for who access to irrigation water makes a critical difference for agricultural production. When water is scarce

in reality, they may also be the ones who are more likely to break social norms or to react in conflictive ways. Besides, the people with higher predispositions to react in a conflictive way to water scarcity suffer from real economic and political inequalities and are likely to be affected by exclusionary elements of formal and informal water governance institutions. These sources of inequalities and exclusion could form a basis for mobilisation for more violent ways of competing for scarce resources, especially in combination with rising water values and in the absence of other effective means of contestation.

Fourthly, policies aiming at increased democratic decentralisation and more decentralised natural resource management do not always produce the expected results. The analysis of local governance of common water flows in a setting where such policies have been introduced provides insights into what really happens. Even if efforts of democratic decentralisation indirectly increased the potential of the village government to intervene in water and land management, the renewed national framework for water management did not leave much room for village government to engage in local water governance. This inspired the village government to actively (re)claim their role in local resource governance. Interestingly, the village government intervened in issues of water appropriation that is illegal according to formal policy since it happens without official water rights. Hence, the ambiguity about whom governs natural resources at the local level and which rules apply remains.

Nevertheless, as we discussed before, the actual users of the natural resources give their own interpretation to the whole set of formal and informal institutional frameworks, rules and norms. They creatively make use of the institutional pluralism to which natural resource governance is subject. As such, institutional pluralism forms an asset for the gradual development of more sophisticated resource governance institutions.

Still, building on local water governance institutions can enrich a policy aiming for meaningful, useful and locally adapted resource governance. But to realise this potential, the dynamics of innovation, creative problem solving, flexible interpretation of policy principles and legitimation should be appreciated by policy makers. Policy makers should also be aware that the outcome of any institutional design cannot be predicted, since institutions are products of ongoing social processes in which numerous heterogeneous actors play a role in environments characterised by uncertainties. If policy aims to amend social inequities and to reduce the potential for resource conflicts, it should assess how institutional design concurs or collides with informal institutions, how elites could find ways to enhance their power over resources and what the potential pitfalls or opportunities might be for women and marginalised groups. It should address potential sources of marginalisation and exclusion. This requires an acknowledgement of the heterogeneity of resource users, of the existing social differences and power imbalances and of the contextual factors that could be conducive to resource conflicts.

Appendix I: A Framed Field Experiment on Irrigation - Instructions and Procedures

Introduction

[When people enter the meeting room, they are asked for their name. We have a list of invited candidates, a sample chosen from previously identified households by the irrigation mapping exercise. Their name is marked and they are given a sticker with an identity letter, which we ask them to stick on their shirt. It is explained that this identity letter is unique and allows us to identify them during the exercise while guaranteeing complete confidentiality. This is important, as they are able to earn real money in the exercise. They are asked to take a seat in the meeting room. Further instructions will be given once sufficient people have shown up.]

"Good morning/after noon. First of all, thanks for your interest. We are from the universities of Gent and Antwerp (Belgium) and we are making a study on local economic development and poverty. This study is important as it might help policymakers who are interested in combating poverty and stimulate economic development. We have been here in this village before to do an irrigation mapping exercise and a survey, in which many of you probably participated".

> [Swahili] "Habari za asubuhi/mchana. Kabla ya yote, asanteni kwa kufika. Sisi tumetokea Chuo Kikuu cha Gent na Antwerp (Belgium) na tunafanya utafiti wa maendeleo ya kiuchumi na umaskini.Utafiti huu ni muhimu kwani utasaidia watunga sera ambao wana nia ya kupunguza umaskini na kuhimiza maendeleo ya kiuchumi.Tulikuwepo katika kijiji hiki kabla na tulifanya zoezi la kutengeneza ramani ya umwagiliaji na utafiti, ambayo wengi wenu labda mlishiriki."
>
> ***(Keep the introduction as short as possible and acceptable)***

"You are now invited to participate in a new exercise, which allows you to earn real money. How much you earn depends on the decisions you will be asked to make, as well as the decisions of other people in the village. Like in real life, the harvest you can get from irrigated farming depends on your decisions but also on decisions of other users of water. Participation is voluntary. Your decisions will be dealt with in a confidential way, i.e. nobody in the village will ever know your individual decisions, or the money you will have earned. The money you earn will be paid out to you privately and confidentially after the exercise. During the whole exercise, you are not allowed to communicate with the other participants."

> [Swahili] "Kwa sasa mnakaribishwa kushiriki katika zoezi jipya, ambalo litakupatia fedha taslimu. Kiasi utakachopata kitatokana na maamuzi ambayo utaombwa kufanya, na pia na maamuzi ya watu wengine wa kijiji hiki. Katika maisha ya kawaida, mavuno unayoweza

kupata kutoka katika kilimo cha umwagiliaji kinategemeana na maamuzi yako na pia maamuzi ya watumiaji wengine wa maji. Kushiriki ni muhimu. Maamuzi yako yatafanyika kwa usiri mkubwa, kwamba hamna mtu katika kijiji hiki atafahamu maamuzi yako au fedha ulizopata. Fedha utakayopata utalipwa ukiwa peke yako na kwa usiri baada ya zoezi. Wakati wa zoezi zima, huruhusiwi kuwasiliana na washiriki wengine."

Part 1: Water Abundance (5 rounds)

"In part 1 of the exercise, you are matched with one other person. Imagine that you and the other person are both connected to the same irrigation channel. One person is located immediately 'upstream' of the other person. We call the first person the 'upstream person', whereas we refer to the second person as the 'downstream person'. Later we will inform you whether you are an upstream or a downstream person. It is important that you realise that you will never get to know the identity of this other person you are matched with. Nor will the other person ever get to know your identity."

[Swahili] "Katika sehemu ya kwanza ya zoezi, unaambatana na mtu mmoja, Fikiria kwamba wewe na huyo mtu mwingine mko pamoja katika mfereji wa umwagiliaji. Mtu mmoja yupo juu ya mtu mwingine. Tunamwita mtu wa kwanza 'mtu wa juu' ambapo tunamwita pia mtu wa pili 'mtu wa chini'.Baadaye tutakutaarifu kama u mtu wa juu au wa chini. Ni muhimu utambue kwamba hutamtambua huyu mtu mwingine unayeambatana naye. Hata mtu huyo mwingine hatakutambua"

"As the water flow passes first by the upstream person, this person has the possibility to distribute the water flow between him/herself and the downstream person. He/she does this in the following way. We assume there is a constant flow of water and the upstream person has to decide how many hours he/she will extract water from the irrigation channel, from a total of 12 hours per day for each day of the month. It is important to realise that the downstream user cannot make use of the irrigation channel while the upstream user makes us of it. This means that the downstream user can only make use of the irrigation channel during the hours the upstream user does not make use of it. For instance, if the upstream user decides to use the water channel during 10 hours every day of the month, the downstream user will only be able to make use of the water channel during the remaining 2 hours each day of the month."

[Swahili] "Maji yanapopita kwanza kwa mtu wa juu, huyu mtu anauwezekano wa kuyagawa maji kati yake na mtu wa chini. Mtu huyu anayagawa katika mpangilio huu. Tunadhania kwamba mtiririko wa maji uko kwa kiwango na mtu wa juu anatakiwa kuamua masaa mangapi atatoa maji katika mfereji, kutoka katika masaa 12 kwa siku kwa kila siku ya mwezi. Ni muhimu kutambua kwamba mtu wa chini hawezi kutumia mfereji wa maji wakati mtu wa juu anatumia. Hii inamaanisha kwamba mtu wa chini anaweza tu kutumia mfereji wa maji

kipindi ambacho wa mtu wa juu hatumii. Kwa mfano, kama mtu wa juu ataamua kutumia mfereji wa maji kwa masaa 10 kila siku ya mwezi, mtu wa chini atatumia tu kwa masaa 2 yaliyobaki kila siku ya mwezi"

(Distribute decision cards for first exercise together) (Stick flipchart with decision card on the wall)

"To make decisions in the exercise you will make use of decision cards. On the decision card you received we will do a first exercise together. We pretend you all are an upstream user now. And you have to decide of how many hours you will use the water in the irrigation channel per day for a whole month. On the decision card, you observe 12 dots, representing the maximum number of hours one can make use of the irrigation channel. This means this user will use this amount of hours per day for a whole month. To make a decision he/she colors the number of dots equal to the number of hours he/she makes use of the irrigation channel."

[Swahili] "Ili kufanya maamuzi katika zoezi hili utatumia kadi ya maamuzi. Katika kadi ya maamuzi mlizopata tutafanya zoezi la kwanza pamoja. Tunajifanya sasa wote ni watumiaji wa juu. Na itatakiwa muamue masaa mtakayotumia maji katika mfereji kwa siku na kwa mwezi mzima. Katika kadi ya maamuzi, utaona doti 12, zinawakilisha kiwango cha juu mtu anachoweza kutumia katika mfereji wa maji. Hii inamaanisha mtumiaji huyu atatumia masaa haya kwa siku na kwa mwezi mzima. Kufanya maamuuzi anapaka rangi idadi za doti sawa na namba za masaa anazotumia mfereji wa maji."

(Participants keep decision card of first exercise – Now distribute production table abundance for second exercise together) (Stick flipchart with production table on the wall)

"The hours of water and thus the amount of water one is able to extract from the irrigation channel to irrigate his/her plot determines his/her income. The more water one uses on his/her plot, the more s/he can harvest and earn. How much one can earn is indicated in the production table. You observe three columns. In the first column, you observe the entire range of decision options for the upstream user. He can choose between 0 and 12 (included) number of hours (number of black dots) making use of the irrigation channel. The second column indicates the harvest and profit of the upstream user for a chosen number of hours. E.g. if the upstream user decides to make use of the irrigation channel during 8 hours, he will obtain an income of **425 TSH** from the harvest of the irrigated field. This means the downstream user can only make use of it during the remaining 4 hours and will obtain an earning of **175 TSH**... Another example: if the upstream user takes water for 6 hours every day, the downstream user will remain with 6 hours per day in that month. The upstream user will then earn **325 TSH**, the downstream user **325 TSH**. It is important that you realise that you can earn real money. The total you earn will be paid out to you after the end of the exercise."

[Swahili] "Masaa ya maji na pia kiasi cha maji ambacho mtu anatakiwa kuchukua toka mfereji wa maji ili kumwagilia inaonyesha kiasi cha mapato yake. Jinsi mtu anavyotumia

maji mengi ndivyo anavyopata mavuno mengi na mapato mengi. Kiasi ambacho mtu anaweza kupata imeonyeshwa kwenye jedwali la uzalishaji. Utaona safu tatu. Katika safu ya kwanza, utaona chaguzi mbalimbali ya maamuzi ya mtu wa juu. Anaweza kuchagua kati ya 0 na 12 (zikiwemo) idadi za masaa (idadi za doti nyeusi) atakayotumia katika mfereji wa maji. Katika safu ya pili inaonyesha mavuno na faida ya mtu wa juu katika masaa yaliyochaguliwa. Kwa mfano, kama mtu wa juu ataamua kutumia mfereji wa maji kwa masaa manane, atapata mapato ya **425 TSH** kutoka kwenye mavuno ya shamba lililomwagiliwa. Hii inamaanisha kwamba mtumiaji wa chini anaweza kutumia katika masaa 4 yaliyobaki na atapata mapato ya **175 TSH**. Mfano mwingine, kama mtumiaji wa juu atatumia maji kwa masaa 6 kila siku, mtumiaji wa chini atabakiwa na masaa 6 kwa siku kwa mwezi huo.Mtumiaji wa juu atapa tena kiasi cha **shilingi**.**325**., na mtumiaji wa chini kiasi cha **shilingi** .**325** Ni muhimu kutambua kwamba utapata fedha taslimu. Jumla ya ulichopata utalipwa baada ya mwisho wa zoezi."

"In the production table, you also observe that there is a minimum required amount of water, equal to a flow of 4 hours per day, below which harvest is extremely low. In other words, if any of both users uses less than the minimum required water quantity, his/her production will be very low; he will only get **50 tsh**. Above this threshold, harvest drastically increases, and the more water one uses, the higher his income."

[Swahili] "Katika jedwali la uzalishaji utaona pia kuna kiwango cha chini cha maji kinachohitajika, sawa na mtiririko wa masaa manne kwa siku , chini ya hapo uzalishaji ni mdogo sana. Kwa maneno mengine, mtumiaji yoyote atatumia maji kidogo zaidi ya kiwango kinachohitajika, mavuno yake yatakuwa kidogo, mapato iko **shilingi 50 tu**. Zaidi ya kiwango hiki, uzalishaji unaongezeka, na mtu anavyotumia maji mengi ndivyo mapato yake yanavyokuwa makubwa."

(Participants now write on the decision card from the first exercise (on which they coloured dots to choose hours of water)) (They need production tables to find income of up and downstream user)

"Now look at the decision card: chose a number of hours of water you want to use and colour the number of dots. Look on the production table how much the upstream user can earn if s/he gets that number of hours of water. And write this on the decision card."

[Swahili] "Sasa angalia katika kadi ya maamuzi: chagua idadi ya masaa ya maji unayoyahitaji kutumia na upake rangi idadi za doti. Angalia katika jedwali la uzalishaji kiasi anachoweza kupata mtumiaji wa juu kama akitumia idadi ya hiyo ya masaa ya maji. Na kisha andika katika kadi ya maamuzi."

"Now look at the third column of the production table which indicates the harvest and profit the downstream user will obtain. Write down the earnings of the downstream user on the decision card now."

[Swahili] "Sasa angalia katika safu ya tatu ya jedwali la uzalishaji ambayo inaonyesha mavuno na faida mtu wa chini atakavyopata. Sasa andika mapato ya mtumiaji wa chini katika kadi ya maamuzi."

[Show the second part of the decision card on flip chart].

"After the upstream user made the decision on the hours of water he will use and wrote down his earnings and the earnings for the downstream user, the decision card will be given to the downstream user He will then know the decision made by the upstream user. The downstream user knows that next month the upstream user will distribute water again. So the downstream user may find it important to give his reaction regarding the decision made by the upstream user. The 'downstream person' can take four different actions.

- First, he/she may decide to communicate to the upstream water user that he is satisfied with the amount of water and with the harvest he can get,
- Second, he/she may decide to do nothing.
- Third, he may decide to communicate to the upstream water user that he is not happy, dissatisfied with the amount of water and with the harvest he can get
- Fourth the downstream user may decide to go to a mediator who punishes the upstream water user. The mediator punishes the 'upstream person' by giving him a fine, which reduces his/her earnings by **100 tsh**. The downstream user, however, has to pay a cost for resorting to the mediator (such as transport costs, 'judicial' cost, time…), of **30 tsh**."

[Swahili] "Baada ya mtumiaji wa juu akishafanya maamuzi ya masaa ya maji atakayotumia na kuandika mapato yake na ya mtumiaji wa chini, kadi ya maamuzi itapelekwa kwa mtumiaji wa chini. Ambapo atajua maamuzi yaliyofanywa na mtumiaji wa juu. Mtumiaji wa chini anajua kwamba mwezi ujao mtumiaji wa juu atayagawa maji tena. Hivyo mtumiaji wa chini ataona umuhimu wa kutoa tamko lake kuhusiana na maamuzi yaliyofanywa na mtumiaji wa juu. Mtumiaji wa chini anaweza kufanya maamuzi manne tofauti:

- Kwanza, anaweza kuamua kuwasiliana na mtumiaji wa juu kwamba karidhika na kiwango cha maji na mavuno atakayopata
- Pili, anaweza kuamua asifanye lolote
- Tatu, anaweza kuamua kuwasiliana na mtumiaji wa juu kwamba hajafurahi, hajaridhika na kiasi cha maji na mavuno atakayopata.

- Nne, anaweza kuamua kumtumia msuluhishaji ambaye atamwazibu mtumiaji wa juu. Msuluhishaji atamwazibu ‘mtu wa juu’ kwa kumtoza faini ambayo itapunguza mapato yake kwa **shilingi 100** Ingawa mtu wa chini atatakiwa kulipa gharama za kumwita msuluhishi (kama vile gharama za usafiri, mahakama, muda…..) ya **shilingi 30.”**

“After the downstream user decides on his reaction to the upstream user: the decision card is returned to the upstream user. This person will look at it and then make a decision on the water distribution for the next month.”

> [Swahili] “Baada ya mtumiaji wa chini kuamua tamko lake kwa mtumiaji wa juu, kadi ya maamuzi inarudishwa kwa mtumiaji wa juu. Mtu huyu ataiangalia na kuamua kufanya maamuzi tena ya mgawanyo wa maji kwa mwezi unaofuata.”

(Distribute example decision cards with 8 dots coloured)

“Now look at the decision card you got for this exercise: imagine that you are a downstream user and, this month, the upstream user left a certain number of hours of water per day for you, the downstream user. You are also left with a certain income. You know that the upstream user will distribute water again next month. Now decide on your reaction to the distribution made by the upstream user. Mark an X under the action you want to take.”

> [Swahili] “Sasa angalia kadi ya maamuzi uliyopata katika zoezi hili: fikiria kwamba wewe ni mtumiaji wa chini na, mwezi huu, mtumiaji wa juu amekuachia wewe mtumiaji wa chini idadi kadhaa ya masaa ya maji kwa siku. Umeachiwa pia mapato kadhaa.Unajua kwamba mtumiaji wa juu atagawa maji tena mwezi ujao. Sasa amua kuhusu mgawanyo uliofanywa na mtumiaji wa juu. Weka alama ya X chini ya amuzi unalotaka kulifanya.”

(Distribute example decision card with 12 dots for the upstream user and where a downstream decided to punish the upstream user via the mediator)

“We now distributed an example of a decision card where an upstream user used 12 hours of water. The downstream user was not happy with this.. He called in a mediator for which he paid **30 tsh** which he has to pay from his earnings. Calculate now how much remains for this downstream user.”

“And the upstream user was given a fine of **100 tsh** which will be deduced from his earnings. Calculate now how much remains for the upstream user.”

> [Swahili] “Sasa tunagawa mfano wa kadi ya maamuzi ambapo mtumiaji wa juu alitumia masaa 12 ya maji. Mtumiaji wa chini hakufurahia. Alimwita msuluhishaji ambapo alilipa kiasi ca **shilingi 30** ambayo atalipa toka kwenye mapato yake. Sasa piga hesabu kiasi kilichobaki kwa mtumiaji huyu wa chini.”

"Na mtumiaji wa juu alipewa faini ya **shilingi 100** ambayo itapunguzwa toka kwenye mapato yake. Sasa piga hesabu kiasi kilichobaki kwa mtumiaji wa juu."

[Before the start of the experiment: Distribute ID cards, which shows ID letter, upstream/downstream role]

"It is important that you don't show to anyone what is written on your ID card. And it is important to keep it because you will need it to be paid in the end. On the ID card you received you see your ID letter, the same as on your sticker. And you see if you are an upstream or downstream user. Upstream user is a triangle, downstream user is a square."

[Swahili] "Ni muhimu usimuonyeshe mtu yoyote kilichoandikwa kwenye kitambulisho chako. Ni muhimu pia kukitunza kwasababu utakihitaji ili kulipwa mwishoni. Katika kitambulisho ulichopata utaona herufi ya kitambulisho, sawa na ya kwenye stika yako. Na utaona kama wewe ni mtumiaji wa juu au wa chini. Mtumiaji wa juu ni pembetatu, mtumiaji wa chini ni mraba."

"Before starting with the exercise, we emphasise once again that it is important that you realise that you will never get to know the identity of the other person you are matched with, nor during nor after the exercise. Nor will the other person ever get to know your identity. We also ask you to give each other sufficient privacy, when taking decisions. Make sure that other people do not see the decision you write on your decision card. Communication is not allowed during the exercise. If you have a question, please raise your hand, so that one of us can come to you to answer your question in private."

[Swahili] "Kabla ya kuanza zoezi, tunawakumbusha tena ni muhimu kutambua kwamba hutamtambua mtu huyo mwingine unayeambatana naye, hata pia wakati wa zoezi au baada ya zoezi. Hali kadhalika mtu huyo mwingine hatakutambua. Tunaomba mpeane nafasi ya kutosha mnapofanya maamuzi. Mawasiliano hayaruhusiwi wakati wa zoezi. Hakikisha kwamba watu wengine hawaoni maamuzi uliyoandika katika kadi yako ya maamuzi. Mawasiliano hayaruhusiwi wakati wa zoezi. Kama una swali, tafadhali nyoosha mkono wako, ili kwamba mmoja wetu aje kujibu swali lako kwa usiri."

"You will now do the same exercise as we did together: some of you are upstream users, others are downstream users. You will be so for the rest of the exercise. Each upstream user is matched with one downstream user. You will be matched with the same person during the rest of the exercise. The upstream users will decide several times on the number of hours they will use water from the irrigation channel. The upstream users will write down their earnings and the earnings for the downstream user. After that, the downstream users receive the decision card and will then decide on how to react to the decision made by the upstream user After that the decision card will go back to the

upstream user, so that they will get to know the reaction of the downstream user. Thereafter, the upstream user will decide again on water distribution for the next month. This exercise will be repeated several times."

> [Swahili] "Sasa utafanya tena zoezi sawa na tulilofanya pamoja: baadhi yenu ni watumiaji wa juu, wengine ni watumiaji wa chini. Mtakuwa hivyo kwa zoezi lililobaki. Kila mtumiaji wa juu anaambatana na mtumiaji mmoja wa chini. Utaambatana na mtu yuleyule kwa zoezi lililobaki. Watumiaji wa juu wataamua mara kadhaa idadi ya masaa watakayotumia maji katika mfereji. Watumiaji wa juu wataandika mapato yao na mapato ya watumiaji wa chini. Baada ya hapo, watumiaji wa chini watapokea kadi ya maamuzi na wataamua jinsi ya kutoa tamko kutokana na maamuzi yaliyofanywa na watumiaji wa juu.Baada ya hapo kadi ya maamuzi itarudishwa tena kwa watumiaji wa juu, ili kwamba wafahamu tamko la watumiaji wa chini. Baada ta hapo, mtumiaji wa juu ataamua tena mgawanyo wa maji kwa mwezi ujao. Zoezi hili litarudiwa mara nyingi."

"The upstream persons (those with triangle on the ID card) are now asked to take a seat in the other room. After everyone is seated again we will give you further instructions."

> [Swahili] "Watumiaji wa juu (wale wenye pembetatu katika kitambulisho) wanaombwa sasa kukaa katika chumba mwingine. Baada ya kila mtu kukaa, tutawapa tena maelekezo."

[Upstream and downstream users are seated in different rooms. We assure that there is sufficient space between each participant to guarantee privacy when taking decisions. Once everybody is seated again, further instructions are given]

1. ***DECISION CARDS are prepared on the basis of the LIST: pair number, also round number***
2. ***DECISION CARDS to upstream users (match via LIST and ID CODES)***
3. ***Upstream users decide***
4. ***DECISION CARDS to downstream users (match via LIST and ID CODES)***
5. ***Downstream users react***
6. ***DECISION CARDS back to upstream users (match via LIST and ID CODES)***
7. ***Next round….. (5 rounds)***
8. ***After each round earnings of up and downstream user are written in the printed Excel table***

Part 2: Water Scarcity (10 rounds)

[Distribute new production table with water scarcity and collect the old ones where there was abundance of water].

"We now inform you that rainfall has dropped drastically, which results in water scarcity. This means that from now on the water flow has drastically decreased. Consequently, people will need more time

for the same amount of water to come through to their plot. And thus you need more hours per day to get a good harvest and high earnings. It also means that you need at least 7 hours to get good harvest and high earnings. All these differences when there is water scarcity are taken up in the new production table."

[Swahili] "Tunakutaarifu kwamba mvua zimepungua sana, iliyopelekea kuwepo na ukame wa maji. Hii inamaanisha kwamba kuanzia sasa mtiririko wa maji umepungua sana. Kwa matokeo hayo, watu watahitaji muda zaidi kwa kiwango kile kile cha maji katika maeneo yao. Na kwamba unahitaji masaa zaidi kwa siku ili kupata mavuno mazuri na mapato mengi. Inamaanisha kwamba unahitaji angalau masaa 7 ili kupata mavuno mazuri na mapato mengi. Tofauti zote hizi ambapo kunakuwa na ukame wa maji zinachukuliwa katika jedwali jipya la uzalishaji."

(Play exercise again with new production table)(10 rounds)

1. ***DECISION CARDS to upstream users (match via LIST and ID CODES)***
2. ***Upstream users decide***
3. ***DECISION CARDS to downstream users (match via LIST and ID CODES)***
4. ***Downstream users react***
5. ***DECISION CARDS back to upstream users (match via LIST and ID CODES)***
6. ***Next round….. (10 rounds)***
7. ***After each round earnings of up and downstream user are written in the printed Excel table***

(At the end: put everything in Excel table on computer: calculate final earnings)

Part 3: Individual Post-Experiment Questions: (Confidential)

"In general, where you satisfied with the decisions made by the other user you were matched with? Very satisfied- satisfied -not so satisfied- dissatisfied"

[Swahili] "Kwa ujumla, je uliridhika na maamuzi wa mtu mwingine uliyeambatana naye?

Niliridhika sana – niliridhika - niliridhika/sikuridhika – sikuridhika"

"In the exercise: did you recognise many, some, few, no elements from real life?"

[Swahili] "Katika zoezi, je uligundua mambo mengi, mambo machache au hamna ambayo yanafanana na maisha ya kawaida?"

Part 4: Post-Experiment Group Discussion:

"What did you recognise from real life?"

[Swahili] je, nini ulichogundua kutoka maisha ya kawaida?

Appendix II: A Framed Field Experiment on Irrigation – Tools

WATER ABUNDANCE Hours of water per day for one month	PAYOFF UPSTREAM USER ▲	PAYOFF DOWNSTREAM USER ■
○○○○○○○○○○○○	50 TSH	500 TSH
●○○○○○○○○○○○	50 TSH	500 TSH
●●○○○○○○○○○○	50 TSH	475 TSH
●●●○○○○○○○○○	50 TSH	450 TSH
●●●●○○○○○○○○	175 TSH	425 TSH
●●●●●○○○○○○○	250 TSH	375 TSH
●●●●●●○○○○○○	325 TSH	325 TSH
●●●●●●●○○○○○	375 TSH	250 TSH
●●●●●●●●○○○○	425 TSH	175 TSH
●●●●●●●●●○○○	450 TSH	50 TSH
●●●●●●●●●●○○	475 TSH	50 TSH
●●●●●●●●●●●○	500 TSH	50 TSH
●●●●●●●●●●●●	500 TSH	50 TSH

WATER SCARCITY Hours of water per day for one month	PAYOFF UPSTREAM USER ▲	PAYOFF DOWNSTREAM USER ■
○○○○○○○○○○○○	50 TSH	350 TSH
●○○○○○○○○○○○	50 TSH	325 TSH
●●○○○○○○○○○○	50 TSH	300 TSH
●●●○○○○○○○○○	50 TSH	250 TSH
●●●●○○○○○○○○	50 TSH	200 TSH
●●●●●○○○○○○○	50 TSH	125 TSH
●●●●●●○○○○○○	50 TSH	50 TSH
●●●●●●●○○○○○	125 TSH	50 TSH
●●●●●●●●○○○○	200 TSH	50 TSH
●●●●●●●●●○○○	250 TSH	50 TSH
●●●●●●●●●●○○	300 TSH	50 TSH
●●●●●●●●●●●○	325 TSH	50 TSH
●●●●●●●●●●●●	350 TSH	50 TSH

ROUND:___
PAIR NUMBER:_____

DECISION CARD

UPSTREAM USER ▲

Hours water use per day (during one month):

○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○

UPSTREAM USER ▲ : YOUR PAYOFF:

…….. TSH

DOWNSTREAM USER ■ : HIS/HER PAYOFF

…….. TSH

DOWNSTREAM USER ■

Your reaction as downstream user:

Communicate your satisfaction to upstream user 	Do nothing	communicate your dissatisfaction to upstream user 	Call mediator to intervene ■Downstream: pay 30 TSH ▲Upstream: fine 100 TSH 
☐	☐	☐	☐

Appendix III: Assessment of Omitted Variable Bias in Part II

With reference to the footnote on page 75 in Part II: One could indeed argue that an important explanatory variable is missing from our models. The design of the experiment is such that the downstream user can influence the behaviour of the upstream user through communicating dissatisfaction or punishment. Table 13 presents the percentages of upstream users' decisions in round r to which downstream users reacted with communicating dissatisfaction or punishment in round r-1.

% of decisions	punished in r-1	punished or dissatisfaction in r-1	N decisions
abundance	12.5	30.9	312
scarcity	16.0	41.8	780

Table 13**:** Percentages of Upstream Users' Decisions to which Downstream Users Reacted with Dissatisfaction or Punishment in r-1

The fact that appropriation decisions are correlated within individuals and that sanctioning behaviour of the downstream user is a direct function of appropriation behaviour of the upstream user could generate endogeneity problems similar to those encountered in dynamic panel data models. To see this, we start form the following model:

$$y_{i,r} = X_{i,r}\beta + \rho s_{i,r} + \varepsilon_{i,r}$$

Where $y_{i,r}$ is the number of hours of water appropriated by upstream user *i* in round *r*, *X* is a matrix of explanatory variables, possibly including a constant and effects that do not change over the rounds, $s_{i,r}$ is a dummy indicating if individual *i* received a punishment and/or expression of dissatisfaction by the downstream user in the previous round. $\varepsilon_{i,r}$ is a residual which is assumed to be uncorrelated between individuals and over the different rounds. Note that for $s_{i,r}$, we use *r* as a subscript and not *r-1*, as the fact that the upstream user was sanctioned determines current appropriation behaviour. Since $s_{i,r}$ is a reaction on the number of hours of water the downstream user received from the upstream user in the previous round, we can also write:

$$y_{i,r} = X_{i,r}\beta + \rho f(y_{i,r-1}) + \varepsilon_{i,r}$$

The nature of our data, however, does not permit us to assume that $\varepsilon_{i,r}$ is uncorrelated over the different rounds. Indeed, since we observe the same individuals over time, it may be that, say individual *a* always gives more water than individual *b*. We could make this explicit by splitting the original error term $\varepsilon_{i,r}$ into two components, one that does not change over rounds for the individual,

and a remainder that is assumed to be uncorrelated between individuals (η_i) and over the different rounds ($\omega_{i,r}$):

$$y_{i,r} = X_{i,r}\beta + \rho f(y_{i,r-1}) + \eta_i + \omega_{i,r}$$

Clearly, here $y_{i,r-1}$ is positively correlated with the first part of our composed error term (η_i) and so estimation of the above equation by Ordinary Least Squares is inconsistent. We note here, for further consideration, that the OLS estimator is biased upward.

As the problem is caused by the individual specific effect in the error term, we might want to get rid of it. This can be done by estimating the same regression but on a transformation of original variables. We could, for example, use a within transformation, that expresses the variables as deviations from individual means over the rounds. However, it is known that, at least in short panels, such a fixed effects model leads to another correlation problem between the transformed error term and the transformed endogenous variable. In particular, the transformed endogenous variable is $f(y_{i,r-1}) - \frac{1}{R-1}(f(y_{i,1}) + ... + f(y_{i,r}) + ... + f(y_{i,R-1}))$, while the transformed error term is $\omega_{i,r} - \frac{1}{R-1}(\omega_{i,2} + ... + \omega_{i,r-1} + ... + \omega_{i,R})$. We can see that $\frac{-f(y_{i,r})}{R-1}$ is correlated with $\omega_{i,r}$, but also that $f(y_{i,r-1})$ is correlated with $\frac{-\omega_{i,r-1}}{R-1}$ (Bond, 2002). Furthermore, for our case, such a solution would also remove all time invariant explanatory variables (such as gender and social status) from the regression. These variables are the ones we are most interested in. This within groups (or fixed effects) estimator can be shown to be biased downward (Nickell, 1981)[99].

To get an idea of the bias of omitting the downstream user's sanctioning behaviour, we can use the fact that the pooled OLS regression generates estimators that are biased upward and the fixed effects regression generates estimators that are biased downward. The true magnitude of the effect will be somewhere between these estimators'. In addition, the correlation between the error term and the endogenous variable in the fixed effects regression disappears if the number of time observations increases. Since our panel is relatively long, we expect it to be close to the value obtained by the fixed effects regression.

[99] The proper way to handle this problem is to apply a first difference transformation to the data and then estimate the model using lagged levels of the endogenous variables as instruments, possibly in a GMM framework, as in Arellano and Bond (1991). However, just as the first difference transformation, this would eliminate the time invariant effects from our model, which are of interest to us.

Our estimation strategy is as follows. First, we perform a pooled OLS regression with inclusion of the sanctioning behaviour of the downstream user. This overestimates its effect. Next, we estimate a fixed effects regression with inclusion of the sanctioning behaviour of the downstream user. This underestimates the effect of the endogenous variable. Then we compare these results to the results of the OLS regression (corrected for clustering within individuals) without inclusion of the sanctioning behaviour of the downstream user. If the coefficients stay more or less the same as the coefficients from the fixed effects and pooled OLS regressions with inclusion of the sanctioning behaviour, we can be confident that there is no real problem of omitting sanctioning behaviour from our models.

Table 14 presents the results of such an analysis. In the first column, we copy the results of the OLS regression corrected for clustering within individuals without inclusion of the sanctioning behaviour of the downstream user as presented in the body of the text. The second column presents the pooled OLS regression with inclusion of the endogenous variable, in this case having received a punishment by the downstream user in the previous round. This provides us with an estimate of the coefficient of the endogenous regressor, albeit an overestimation of its effect. In the third column we present the results of a fixed effects regression with inclusion of the endogenous variable. As can be seen, all time invariant variables are removed from the model due to the within transformation. The effect of our endogenous variable is likely to be understated. The fourth and fifth column present the results respectively of the pooled OLS regression and the fixed effects regression, both with inclusion of the endogenous variable, in this case having received a punishment or expression of dissatisfaction by the downstream user in the previous round. The parameter estimate of the endogenous regressor in the fourth column is over-estimation of the effect, the one in the fifth column an underestimation.

However, we are not really interested in the effect of the endogenous regressor. It was only included to check if our reported estimates are robust to the inclusion of a variable that was expected to be important given the design of our experiment. We find that the regression coefficients of the exogenous variables are very stable over the different specifications. As such, we are confident that our results are not driven by specification error and the omitted variable bias remains limited.

	Corrected for clustering		Pooled OLS		Fixed effects		Pooled OLS		Fixed effects	
Variable	**Est.**	**S.E.[a]**	**Est.**	**S.E.**	**Est.**	**S.E.**	**Est.**	**S.E.**	**Est.**	**S.E.**
Intercept	0.503	0.021**	0.523	0.015**	.525	.010**	.533	.015**	.528	.010**
Scarcity	-0.065	0.016**	-.064	.018**	-.067	.014**	-.046	.018*	-.067	.015**
Social Status	-0.061	0.021**	-.052	.014**			-.055	.012**		
ScarcXSocStat	0.049	0.015**	.040	.017*	.045	.013**	.048	.015**	.048	.012**
Female	0.079	0.04°	.070	.026**			.064	.024**		
ScarcXFemale	-0.026	0.041	-.019	.031	-.022	.025	-.028	.29	-.024	.024
SocStatXFemale	0.083	0.038*	.078	.028**			.077	.025**		
ScarcXSocStatXFemale	-0.041	0.033	-.050	.033	-.051	.026°	-.058	.030°	-.042	.025°
PunishR_1			-0.123	-0.036**	-.025	.032				
ScarcXPunishR_1			-.001	.042	-.001	.034				
DissatorPunishR_1							-.107	.025**	-.028	.022
ScarcXDissatorPunishR_1							-.004	.029	.015	.025
R^2		.064		.100				.119		
Root MSE		.210		.205				.204		
Wald F	F(7,75)	5.46	F(9,1051)	12.91	F(6,979)	9.20	F(9,1130)	16.95	F(6,1058)	10.82
Prob>F		.000		.000		.000		.000		.000
N		1140		1061		1061		1140		1140
Strata		1								
Units		76								

Dependent variable=Proposed share

Significance levels two-sided: ° = 10%, * = 5%, ** = 1%.

[a] Corrected for clustering within individuals

Table 14: Estimations using Different Models to Assess the Bias by Omitting Sanctioning Behaviour by the Downstream User

Appendix IV: Assessment of Omitted Variable Bias in Part IV

With reference to the footnote on page 126 in Part IV: One could indeed argue that an important explanatory variable is missing from our models. The design of the experiment is such that the downstream user can influence the behaviour of the upstream user through communicating dissatisfaction or punishment. Table 15 presents the percentages of upstream users' decisions in round r to which downstream users reacted with communicating dissatisfaction or punishment in round r-1.

% of decisions	punished in r-1	punished or dissatisfaction in r-1	N decisions
abundance	12.5	30.9	312
scarcity	16.0	41.8	780

Table 15: Percentages of Upstream Users' Decisions to which Downstream Users Reacted with Dissatisfaction or Punishment in r-1

The fact that appropriation decisions are correlated within individuals and that sanctioning behaviour of the downstream user is a direct function of appropriation behaviour of the upstream user could generate endogeneity problems similar to those encountered in dynamic panel data models. To see this, we start form the following model:

$$\ln(p_{i,r}/(1-p_{i,r})) = X_{i,r}\beta + \rho s_{i,r} + \varepsilon_{i,r}$$

Where $p_{i,r}$ is the probability that upstream user *i* is selfish when appropriating water in round *r*, *X* is a matrix of explanatory variables, possibly including a constant and effects that do not change over the rounds, $s_{i,r}$ is a dummy indicating if individual *i* received a punishment and/or expression of dissatisfaction by the downstream user in the previous round. $\varepsilon_{i,r}$ is a residual which is assumed to be uncorrelated between individuals and over the different rounds. Note that for $s_{i,r}$, we use *r* as a subscript and not *r-1*, as the fact that the upstream user was sanctioned determines current appropriation behaviour. Since $s_{i,r}$ is a reaction by the downstream user on the appropriation by the upstream user in the previous round, we can also write:

$$\ln(p_{i,r}/(1-p_{i,r})) = X_{i,r}\beta + \rho f(\ln(p_{i,r-1}/(1-p_{i,r-1}))) + \varepsilon_{i,r}$$

The nature of our data, however, does not permit us to assume that $\varepsilon_{i,r}$ is uncorrelated over the different rounds. Indeed, since we observe the same individuals over time, it may be that, say individual *a* always gives more water than individual *b*. We could make this explicit by splitting the original error term $\varepsilon_{i,r}$ into two components, one that does not change over rounds for the individual,

and a remainder that is assumed to be uncorrelated between individuals (η_i) and over the different rounds ($\omega_{i,r}$):

$$\ln(p_{i,r}/(1-p_{i,r})) = X_{i,r}\beta + \rho f(\ln(p_{i,r-1}/(1-p_{i,r-1}))) + \eta_i + \omega_{i,r}$$

Clearly, here $\ln(p_{i,r-1}/(1-p_{i,r-1}))$ is positively correlated with the first part of our composed error term (η_i) and so estimation of the above equation by binary logistic regression is inconsistent. We note here, for further consideration, that the logistic regression estimator is biased upward.

As the problem is caused by the individual specific effect in the error term, we might want to get rid of it. This can be done by estimating the same regression but on a transformation of original variables. We could, for example, use a within transformation, that expresses the variables as deviations from individual means over the rounds. However, it is known that, at least in short panels, such a fixed effects model leads to another correlation problem between the transformed error term and the transformed endogenous variable. In particular, the transformed endogenous variable is

$$f(\ln(p_{i,r-1}/(1-p_{i,r-1}))) - \frac{1}{R-1}(f(\ln(p_{i,1}/(1-p_{i,1}))) + ... + f(\ln(p_{i,r}/(1-p_{i,r}))) + ... + f(\ln(p_{i,R-1}/(1-p_{i,R-1}))))$$

while the transformed error term is $\omega_{i,r} - \frac{1}{R-1}(\omega_{i,2} + ... + \omega_{i,r-1} + ... + \omega_{i,R})$. We can see that $\frac{-f(\ln(p_{i,r}/(1-p_{i,r})))}{R-1}$ is correlated with $\omega_{i,r}$, but also that $f(\ln(p_{i,r-1}/(1-p_{i,r-1})))$ is correlated with $\frac{-\omega_{i,r-1}}{R-1}$ (Bond, 2002). Furthermore, for our case, such a solution would also remove all time invariant explanatory variables (such as upstream users' individual characteristics) from the regression. These variables are the ones we are most interested in. This within groups (or fixed effects) estimator can be shown to be biased downward (Nickell, 1981)[100].

To get an idea of the bias of omitting the downstream user's sanctioning behaviour, we can use the fact that the binary logistic regression, which does not take into account clustering within individuals, generates estimators that are biased upward and the fixed effects regression generates estimators that are biased downward. The true magnitude of the effect will be somewhere between these estimators'. In addition, the correlation between the error term and the endogenous variable in the fixed effects

[100] The proper way to handle this problem is to apply a first difference transformation to the data and then estimate the model using lagged levels of the endogenous variables as instruments, possibly in a GMM framework, as in Arellano and Bond (1991). However, just as the first difference transformation, this would eliminate the time invariant effects from our model, which are of interest to us.

regression disappears if the number of time observations increases. Since our panel is relatively long, we expect it to be close to the value obtained by the fixed effects regression.

Our estimation strategy is as follows. First, we perform a binary logistic regression with inclusion of the sanctioning behaviour of the downstream user and without taking into account clustering within individuals. This overestimates its effect. Next, we estimate a fixed effects regression with inclusion of the sanctioning behaviour of the downstream user. This underestimates the effect of the endogenous variable. Then we compare these results to the results of the binary logistic regression corrected for clustering within individuals and without inclusion of the sanctioning behaviour of the downstream user. If the coefficients stay more or less the same as the coefficients from the fixed effects binary logistic regression and binary logistic regression without clustering with inclusion of the sanctioning behaviour, we can be confident that there is no real problem of omitting sanctioning behaviour from our models.

Table 16 presents the results of such an analysis. In the first column, we copy the results of the binary logistic regression corrected for clustering within individuals without inclusion of the sanctioning behaviour of the downstream user as presented in the body of the text. The second column presents the binary logistic regression, which does not take clustering within individuals into account, with inclusion of the endogenous variable, in this case having received a punishment by the downstream user in the previous round. This provides us with an estimate of the coefficient of the endogenous regressor, albeit an overestimation of its effect. In the third column we present the results of a fixed effects regression with inclusion of the endogenous variable. As can be seen, all time invariant variables are removed from the model due to the within transformation. The effect of our endogenous variable is likely to be understated. The fourth and fifth column present the results respectively of the binary logistic regression without clustering and the fixed effects logistic regression, both with inclusion of the endogenous variable, in this case having received a punishment or expression of dissatisfaction by the downstream user in the previous round. The parameter estimate of the endogenous regressor in the fourth column is over-estimation of the effect, the one in the fifth column an underestimation.

However, we are not really interested in the effect of the endogenous regressor. It was only included to check if our reported estimates are robust to the inclusion of a variable that was expected to be important given the design of our experiment. We find that the regression coefficients of the exogenous variables are very stable over the different specifications. As such, we are confident that our results are not driven by specification error and the omitted variable bias remains limited.

	Corrected for clustering			Without Clustering			Fixed effects			Without Clustering			Fixed effects		
Variable	**β**	**t[a]**	**Sig**	**β**	**t**	**Sig**	**β**	**t**	**Sig**	**β**	**t**	**Sig**	**β**	**t**	**Sig**
Constant	-1.83	-4.29	**	-2.17	-5.59	**				-2.00	-6.10	**			
Scarcity	1.50	3.10	**	1.62	3.75	**	2.01	4.09	**	1.01	2.63	**	1.89	4.12	**
Irriland	0.29	2.04	*	0.31	2.18	*				0.28	2.25	*			
ScarcXIrriland	-0.32	-1.88	°	-0.32	-1.98	*	-0.31	-1.54		-0.33	-2.24	*	-0.35	-1.95	°
Min_reli	1.13	2.75	**	1.06	3.43	**				1.08	3.98	**			
ScarcXMin_reli	-0.64	-1.67	°	-0.51	-1.43		-0.84	-1.82	°	-0.53	-1.62		-1.08	-2.57	**
Villgvt	0.71	1.75	°	0.56	1.83	°				0.65	2.42	*			
ScarcXVillgvt	-0.72	-1.85	°	-0.72	-2.06	*	-1.29	-2.85	**	-0.71	-2.24	*	-1.26	-3.15	**
Female	-0.72	-1.51		-0.48	-1.39					-0.62	-2.01	*			
ScarcXFemale	0.60	1.24		0.35	0.91		1.31	2.31	*	0.57	1.60		1.44	2.82	**
PctCash	0.01	1.67	°	0.01	1.58					0.01	1.33				
ScarcXPctCash	-0.01	-1.08		-0.01	-0.94		-0.01	-1.02		-0.01	-1.31		-0.01	-1.11	
Livestock	-0.37	-2.18	*	-0.54	-2.53	*				-0.34	-2.12	*			
ScarcXLivestock	0.03	0.13		0.21	0.92		0.10	0.38		0.06	0.31		-0.06	-0.31	
Foodinsec	-0.52	-1.25		-0.42	-1.30					-0.46	-1.62				
ScarcXFoodinsec	0.85	1.94	°	0.79	2.19	*	1.49	3.04	**	0.92	2.79	**	1.33	3.09	**
PunishR_1				1.21	3.07	**	-0.16	-0.29							
ScarcXPunishR_1				0.09	0.19		0.12	0.20							
DissatorPunishR_1										0.67	2.36	*	-0.42	-1.16	
ScarcXDissatorPunishR_1										0.88	2.69	**	0.38	0.92	
Pseudo R^2	0.112			0.115						0.154					
N	1095			1020			741			1095			840		

Significance levels two-sided: ° = 10%, * = 5%, ** = 1%.
[a] Corrected for clustering within individuals

Table 16: Logistic Regression Estimations Using Different Models to Assess the Bias by Omitting Sanctioning Behaviour by the Downstream User

Appendix V: Real Inequalities in the Irrigation Schemes and the Wider Region

Irrigation scheme[c]		Livestock	Cows	Bicycle	Ironroof	Foodinsec	Min_reli	Min_tribe	Young	Immigrant	Watershort[b]	Totalland	Irriland	Villgvt	SocStat
Is	Livestock	1	.884**	.223	.022	-.012	-.097	.152	-.020	0.231°	.046	.354**	.528**	.057	.309*
Ik	Livestock	1	.868**	.172	.100	-.135	.018	.194	-.205	-.082	.001	0.200°	.166	.028	-.031
KitU	Livestock	1	.826**	.233	.242	-.205	-.132	.141	-.171	-.027	.034	0.331°	-.062	0.268°	.496**
KitZ	Livestock	1	.850**	.107	.218	.160	.180	.162	.106	.033	.112	.029	.106	-.117	0.286°
Mt	Livestock	1	.857**	.154	0.277°	-0.296°	.025	-0.306°	.054	-.109	-0.328°	.163	.201	-.060	.452*
Iringa region	/														
Is	Cows	.884**	1	.246	.192	.000	-.135	.208	.084	.399**	.233	.418**	.314*	.301*	.311*
Ik	Cows	.868**	1	.222	.097	-.093	.036	.311**	-.151	-.045	-.035	0.226°	0.199°	.049	.094
KitU	Cows	.826**	1	.238	.167	-.177	.000	.218	.138	-.224	.100	.207	-.039	.067	.599**
KitZ	Cows	.850**	1	.109	0.334°	.023	.107	.128	.080	.134	.102	.140	.053	.004	0.324°
Mt	Cows	.857**	1	0.312°	0.353°	-0.338°	.000	-0.307°	.000	.000	-0.330°	.248	0.274°	-.092	.451*
Iringa region	Cows			.246**	.188**	-.114**			-.132**		-.040**	.275**			
Is	Bicycle	.223	.246	1	.267*	.054	.181	-.072	.410**	.016	-.019	.202	.300*	.099	.484**
Ik	Bicycle	.172	.222	1	.490**	-.302**	.389**	.092	.089	-.191	.016	.022	.053	.112	.496**
KitU	Bicycle	.233	.238	1	.354	-.053	-.053	.256	.004	.165	-.158	.185	.245	.192	0.278°
KitZ	Bicycle	.107	.109	1	.344*	-.008	.221	-.023	.015	.206	.105	0.306°	.149	-.023	0.258°
Mt	Bicycle	.154	0.312°	1	0.383°	-.182	.120	.054	-.037	.054	.089	.272	0.333°	.232	.462*
Iringa region	Bicycle		.246**		.314**	-.125**			.110**		-.041**	.154**			
Is	Ironroof	.022	.192	.267*	1	-.228	-.266*	-.090	-.013	.141	-.056	.072	-.079	.153	.410**
Ik	Ironroof	.100	.097	.490**	1	-.238*	.444**	.153	.105	-.040	-0.245°	.135	0.202°	.183	.425**
KitU	Ironroof	.242	.167	.354	1	-.226	0.313°	-.092	-.158	.136	-.262	.223	.231	0.300°	.334
KitZ	Ironroof	.218	0.334°	.344*	1	-.198	0.298°	-.077	-.040	0.332°	.105	.089	.114	.061	0.298°
Mt	Ironroof	0.277°	0.353°	0.383°	1	.239	.000	-0.290°	-.204	-.158	.204	-.039	.205	.259	.506*
Iringa region	Ironroof[a]		.188**	.314**		-.172**			.028**		-.034**	.109**			
Is	Foodinsec	-.012	.000	.054	-.228	1	0.229°	-.123	.129	-.185	-.021	.073	.176	.005	-.131
Ik	Foodinsec	-.135	-.093	-.302**	-.238*	1	-.307**	.087	-.168	.181	.038	-.122	.020	.085	-.270*
KitU	Foodinsec	-.205	-.177	-.053	-.226	1	-.127	-.177	.103	.226	-.079	-.114	.062	.053	-0.271°
KitZ	Foodinsec	.160	.023	-.008	-.198	1	0.296°	.156	-.277°	0.250°	.218	-.150	.033	-.109	-0.312°
Mt	Foodinsec	-0.296°	-.338°	-.182	.239	1	-.098	-.434*	0.292°	-.151	.222	-0.280°	.071	.015	.163
Iringa region	Foodinsec[a]		-.114**	-.125**	-.172**				-.055**		.137**	-.096**			

Irrigation scheme[c]		Livestock	Cows	Bicycle	Ironroof	Foodinsec	Min_reli	Min_tribe	Young	Immigrant	Watershort[b]	Totalland	Irriland	Villgvt	SocStat
Is	Min_reli	-.097	-.135	.181	-.266*	0.229°	1	-.164	.196	-.050	-.255	-.017	-.051	-.079	.027
Ik	Min_reli	.018	.036	.389**	.444**	-.307**	1	.202	.137	-.078	.051	-.056	.015	-.005	.259*
KitU	Min_reli	-.132	.000	-.053	0.313°	-.127	1	-.029	.103	-.144	.158	.128	0.253°	-.220	-.004
KitZ	Min_reli	.180	.107	.221	0.298°	0.296°	1	.350*	.049	.172	.250	.145	.265	.107	-.137
Mt	Min_reli	.025	.000	.120	.000	-.098	1	-.059	-.111	-.258	0.304°	-0.301°	-0.303°	-.370°	.046
Iringa region	/														
Is	Min_tribe	.152	.208	-.072	-.090	-.123	-.164	1	.274*	.097	.012	-0.188°	-0.173°	.005	.044
Ik	Min_tribe	.194	.311**	.092	.153	.087	.202	1	-.006	.210	-.132	-.143	-.052	-.015	-.059
KitU	Min_tribe	.141	.218	.256	-.092	-.177	-.029	1	-.071	-.386*	-.287	.059	.230	.033	.077
KitZ	Min_tribe	.162	.128	-.023	-.077	.156	.350*	1	0.325°	.134	.250	-.172	.027	.128	-.093
Mt	Min_tribe	-0.306°	-.307°	.054	-0.290°	-.434*	-.059	1	-.059	.321	-.032	.144	-.057	0.347°	-0.363°
Iringa region	/														
Is	Young	-.020	.084	.410**	-.013	.129	.196	.274*	1	-.117	.154	-.083	.037	-.112	.140
Ik	Young	-.205	-.151	.089	.105	-.168	.137	-.006	1	-.100	-0.186°	-0.189°	-.234*	-.192°	-.051
KitU	Young	-.171	.138	.004	-.158	.103	.103	-.071	1	-.056	-.115	-0.285°	-.206	-.407*	.139
KitZ	Young	.106	.080	.015	-.040	-0.277°	.049	0.325°	1	-.182	.102	-.189	.094	-.289°	-.034
Mt	Young	.054	.000	-.037	-.204	0.292°	-.111	-.059	1	-.258	.091	-.028	.141	-.159	.018
Iringa region	Young		-.132**	.110**	.028**	-.055**					.004*	-.126**			
Is	Immigrant	0.231°	.399**	.016	.141	-.185	-.050	.097	-.117	1	.012	.194	.019	.174	.097
Ik	Immigrant	-.082	-.045	-.191	-.040	.181	-.078	.210	-.100	1	-.149	-.021	.013	.078	-0.188°
KitU	Immigrant	-.027	-.224	.165	.136	.226	-.144	-.386*	-.056	1	.250	.372*	.334	-.027	.295
KitZ	Immigrant	.033	.134	.206	0.332°	0.250°	.172	.134	-.182	1	.140	0.297°	.133	.134	.192
Mt	Immigrant	-.109	.000	.054	-.158	-.151	-.258	.321	-.258	1	-0.420°	.234	.010	.205	-.145
Iringa region	/														
Is	Watershort[b]	.046	.233	-.019	-.056	-.021	-.255	.012	.154	.012	1	.267	.140	.120	.135
Ik	Watershort[b]	.001	-.035	.016	-0.245°	.038	.051	-.132	-.186°	-.149	1	-.127	.021	-.188°	-.064
KitU	Watershort[b]	.034	.100	-.158	-.262	-.079	.158	-.287	-.115	.250	1	.042	.061	-.187	-.010
KitZ	Watershort[b]	.112	.102	.105	.105	.218	.250	.250	.102	.140	1	-.200	-.242	-.050	.086
Mt	Watershort[b]	-0.328°	-.330°	.089	.204	.222	0.304°	-.032	.091	-0.420°	1	-.183	0.317°	.204	-.028
Iringa region	Watershort[a]		-.040**	-.041**	-.034**	.137**			.004*			-.021**			
Is	Total land	.354**	.418**	.202	.072	.073	-.017	-0.188°	-.083	.194	.267	1	.702**	.381**	.380**
Ik	Total land	0.200°	0.226°	.022	.135	-.122	-.056	-.143	-.189°	-.021	-.127	1	.787**	0.162°	.072
KitU	Total land	0.331°	.207	.185	.223	-.114	.128	.059	-.285°	.372*	.042	1	.687**	0.317°	0.342°
KitZ	Total land	.029	.140	0.306°	.089	-.150	.145	-.172	-.189	0.297°	-.200	1	.650**	0.242°	.309
Mt	Total land	.163	.248	.272	-.039	-0.280°	-0.301°	.144	-.028	.234	-.183	1	.416*	.156	.031
Iringa region	Total land		.275**	.154**	.109**	-.096**			-.126**		-.021**				

Irrigation scheme[c]		Livestock	Cows	Bicycle	Ironroof	Foodinsec	Min_reli	Min_tribe	Young	Immigrant	Watershort[b]	Totalland	Irriland	Villgvt	SocStat
Is	Irriland	.528**	.314*	.300*	-.079	.176	-.051	-0.173°	.037	.019	.140	.702**	1	0.223°	.349**
Ik	Irriland	.166	0.199°	.053	0.202°	.020	.015	-.052	-.234*	.013	.021	.787**	1	.292*	.119
KitU	Irriland	-.062	-.039	.245	.231	.062	0.253°	.230	-.206	.334	.061	.687**	1	.139	0.324°
KitZ	Irriland	.106	.053	.149	.114	.033	.265	.027	.094	.133	-.242	.650**	1	-.117	-.001
Mt	Irriland	.201	0.274°	0.333°	.205	.071	-0.303°	-.057	.141	.010	0.317°	.416*	1	0.303°	.175
Iringa region	/														
Is	Villgvt	.057	.301*	.099	.153	.005	-.079	.005	-.112	.174	.120	.381**	0.223°	1	.361**
Ik	Villgvt	.028	.049	.112	.183	.085	-.005	-.015	-.192°	.078	-0.188°	0.162°	.292*	1	.360**
KitU	Villgvt	0.268°	.067	.192	0.300°	.053	-.220	.033	-.407*	-.027	-.187	0.317°	.139	1	.021
KitZ	Villgvt	-.117	.004	-.023	.061	-.109	.107	.128	-.289°	.134	-.050	0.242°	-.117	1	.537**
Mt	Villgvt	-.060	-.092	.232	.259	.015	-0.370°	0.347°	-.159	.205	.204	.156	0.303°	1	-.006
Iringa region	/														
Is	SocStat	.309*	.311*	.484**	.410**	-.131	.027	.044	.140	.097	.135	.380**	.349**	.361**	1
Ik	SocStat	-.031	.094	.496**	.425**	-.270*	.259*	-.059	-.051	-0.188°	-.064	.072	.119	.360**	1
KitU	SocStat	.496**	.599**	.278	.334	-0.271°	-.004	.077	.139	.295	-.010	0.342°	0.324°	.021	1
KitZ	SocStat	0.286°	0.324°	0.258°	0.298°	-0.312°	-.137	-.093	-.034	.192	.086	0.308°	-.001	.537**	1
Mt	SocStat	.452*	.451*	.462*	.506*	.163	.046	-0.363°	.018	-.145	-.028	.031	.175	-.006	1
Iringa region	/														
Is	N	65													
Ik	N	73													
KitU	N	31													
KitZ	N	34													
Mt	N	24													
Iringa region	N	278717													

Significance **99%;*95%;°90%

a: Variables are defined differently in the survey and the National Sample Census of Agriculture 2002/2003.

In the survey, water shortage problems are defined as having had too little water for farming in the irrigation scheme in any of the two dry seasons preceding the survey. In the census, water shortage problems mean that drought was the main reason for a difference between the total area planted and harvested (irrigated or not).

In the survey 'Ironroof' indicates the respondent's household lives in a house with an iron or tile roof. In the census, it can also include a roof of asbestos.

In the survey, 'foodinsecure' indicates that the respondent's household has experienced food insecurity in the two years preceding the survey. In the census, it means the respondent's household always, often or sometimes had problems in satisfying the food needs of the household in year preceding the census.

b: Not all irrigators answered to the question on problems of water shortage in the survey

c: Codenames are used for the irrigations schemes

Table 17: Pearson Correlations to Check for Real Inequalities in the Irrigation Schemes (Based on Own Survey) and in the Wider Region (Based on the National Sample Census of Agriculture 2002/2003)

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