Chapter 16
Institutional Water Resources Management and Livelihood Adaptation: A Case from Kilombero Rural Areas, Tanzania

Paul Vedeld, Edgar Liheluka and Gimbage E. Mbeyale

Abstract The impacts of irrigation schemes on poor people's livelihoods are studied in Kilombero, Tanzania. Total household income is 2 times higher for improved irrigation scheme farmers, and their farm income is 3 times higher than in traditional rainfed farmers. We further find that reported land productivity is 4–6 times higher in improved rice-irrigation fields. While the income of these farmers has gone up, so have their costs (3 times higher input costs). Looking at local people's dependence on water, households on average report to derive 43 % of their income from irrigation, and the dependence is even higher for poorer groups of households (57 %). Improved schemes come with formalized systems of rights and duties, monitoring, control, sanctions and water-user fee structures. This necessitates introducing new institutions on top of existing traditional systems for resource management. The new systems are bricolaged into existing systems, so in practice, traditional and modern irrigation schemes are not conducted very differently. Local people generally seem to manage these irrigation systems well within reasonable conflict levels. There is, however, concern that the new policy, advertised as the devolution of water rights to local communities, could lead to increased central control over rural water, especially when the hydropower sector's priorities (40 % of total water) sector's priorities constrain dry season irrigation. Within the agricultural sector large-scale commercial farmers may further access the majority of irrigation water at the expense of small-scale farmers.

P. Vedeld · E. Liheluka
Norwegian University of Life Sciences, As, Norway

G.E. Mbeyale (✉)
Sokoine University of Agriculture, Morogoro, Tanzania
e-mail: mbeyale@suanet.ac.tz

R. Lal et al. (eds.), *Climate Change and Multi-Dimensional Sustainability in African Agriculture*, DOI 10.1007/978-3-319-41238-2_16

16.1 Introduction

There is a 7-million-sq-km belt of arable land across the Great African Guinea Savannah. Presently, less than 10 % is permanently cultivated. The belt has a precipitation rate of 800–1500 mm and can support crops 150–220 days/year. According to the World Bank (Binswanger and Gautam 2010), this area is one of largest under-used agricultural land reserves in the world (Fig. 16.1).

Most of Tanzania's land falls into this category. Tanzania has been termed "an agricultural sleeping giant" with an estimated 44 million ha of arable land (Binswanger and Gautam 2010). Only 23 % of total land is presently under cultivation. Of the 29 million ha irrigable land, only 1 % of this land is presently under use. There is furthermore a substantial stock of livestock (20 million cattle) that is not much commercially exploited.

Tanzania's agricultural sector is the country's main productive sector, providing a livelihood for more than 70 % of the total population. Agricultural development thus indisputably remains key to the country's economic and social development, at least in the foreseeable future (Binswanger and Gautam 2010).

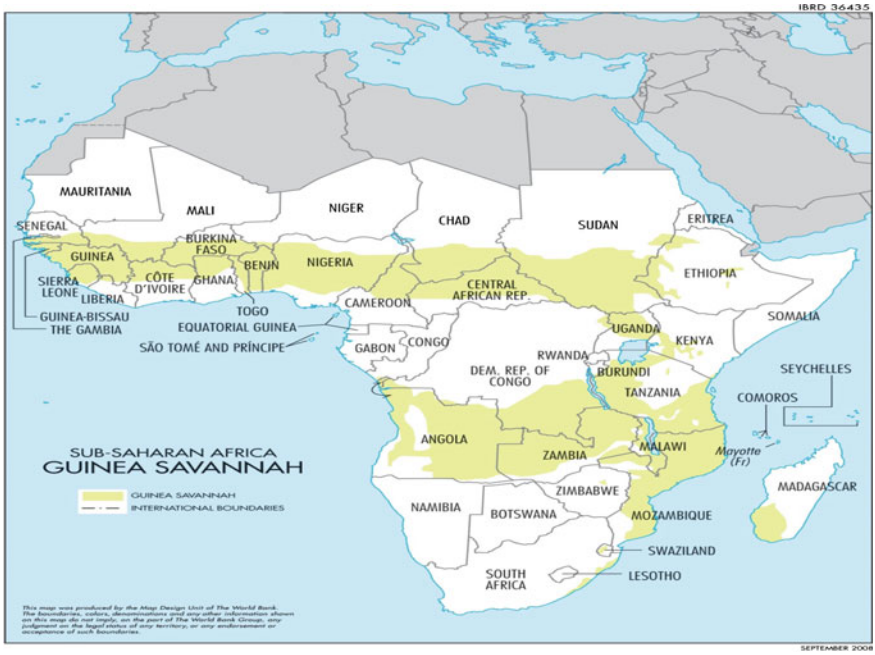

Fig. 16.1 Map of the Great African Guinea Savannah

Since Tanzania gained independence, there has been a striking lack of investment in agriculture. Tanzania annually invested some 5 % in agricultural infrastructure, whereas Asian countries spend 20–30 % of state investments In Tanzania, we further find that 80–90 % of the agricultural production increase has been achieved through the expansion into new agricultural land (land clearing)—not through increased productivity/ha (Binswanger and Gautam 2010). There are also other constraints, both economic and political, on productivity increases.

Irrigation is seen as an important measure to address several key challenges facing agricultural development. At the global level, irrigation is used on 20 % of all land, provides 40 % of all agricultural outputs, and consequently is crucial in agricultural intensification strategies (Food and Agriculture Organization 2007). The global movement of Integrated Water Resource management IWRM and the accompanying water policies have also been implemented in Tanzania. These water policies can be characterized as part of a neoliberal policy trend, rolling back the central state through devolution and decentralization, involving local communities in formalizing water and land rights, and introducing payments for environmental services, water fees, and other economic instruments. The World Bank and International Monetary Fund have been quite instrumental in national development of these policies, which have also found support among national elites and central state bureaucracies (Goldin and Kibassa 2009; ActionAid 2004).

Water use associations have been formed and linked to individual schemes and used to distribute sector-allocated water among members. The state still controls overall water-management planning and distribution of water rights among and within economic sectors. The government also controls the appropriation of funds through water fee allocations.

This paper investigates the substantial potential that decentralized, local water management and irrigation schemes offer for agricultural development and improved rural livelihoods in Tanzania. Poor people in rural areas in Tanzania depend on agriculture for survival and their livelihood. In areas where irrigation schemes are developed or improved, income levels and land productivity tend to increase. Household incomes often increase markedly relative to surrounding communities without this infrastructure. The scope for developing irrigation schemes throughout Tanzania is enormous, given that only 23 % of potential irrigation land is developed. There are several challenges related to the schemes introduced, including lower yield levels than expected and great input costs, debt, household vulnerability, local conflicts over water, and differences between rich and poor (Kissawike 2008).

This paper explores Tanzania's water policies in the context of rural livelihoods. How do people make a living? To what extent do they depend on water resources? How do they organize around the use of a common-pool resource, such as irrigation water? This paper uses the sustainable livelihood approach (SLA), economic indicators of irrigation-water dependence, and institutional theory on the challenges to introducing local-level, participatory, water-management organizational forms and institutions. We also offer policy recommendations.

16.2 Agricultural and Water Policies in Tanzania

Irrigation is not a new intervention in Tanzania. There are records of pre-colonial gravity-fed irrigation activities in certain high-potential areas conducive for irrigation. These activities were managed and controlled under customary rule systems (Chiza 2005; Kikula 1997; Kissawike 2008). Good examples include old irrigation systems in the northern highlands, where the Chagga people irrigated fields through canals accelerated by gravity. Certain areas in the Usangu Plains in the southern highlands also had permanent water supply. Individual German missionaries already introduced irrigated cash-crop systems in pre-colonial times, while Arabs introduced irrigated rice production in the Iringa, Mbeya and Tabora areas during the slave-trade period (Kissawike 2008; Pipping and Chale 1976). During the colonial era (1884–1960), irrigation policies mostly focused on supplying water to commercial farmers and settlers. As seen in Table 16.1, increasing formalization and organizational and management capacity developed over time throughout the colonial period.

Table 16.1 Timeline on evolution of water management institutions in Tanzania, 1885–2009

Year	Events
Before 1885	Customary systems used to manage water resources and irrigation systems, particularly in Kilimanjaro, Arusha and Mbeya regions; not in Kilomebro (as far as we know)
1914	Formation of first water law in Tanganyika under German rule
1923	First water law approved under British rule
1948	Water Rights Ordinance introduced. Recognized rights of native Africans to water for customary use
1959	Water Rights Ordinance introduced ownership of and right to use of water
	Mandated establishing institutions for water supplies in urban and rural areas
1950ies	Flood control and storage dam measures implemented throughout country
1961	Independence
1965–1973	Ujamaa villagization policies supporting irrigation scheme development
1974	Water Utilization (Control and Regulation) Act No. 42, 1974 introduced. Replaced 1948 Water Ordinance. Regulated river, streams, and internal lakes resources. Established institutions and organizations through principal water office and Central Water Board. Established the Regional Basin Water Board system. The Principal Water Act
1981	Water Utilization Act No. 42, 1974 amended to integrate the concept of river basin management
1981	Designation of Tanzania water resources into nine river basins
1989	Water (Misc.) Act. No. 17 of 1989 and General (Regulations) Act provided regulatory and institutional framework for water resources management. All water vested with the state. Principal Water Office authorized to be responsible for setting policy and allocating water rights at the national level. Basin Water Office given responsibility for designating water drainage basins

(continued)

Table 16.1 (continued)

Year	Events
1980ies	National Village Irrigation Development Programme (NVIP) supports farmer-managed village irrigation programs (DANIDA, CIDA, JICA)
1991	Water Policy of 1991 emphasizing the free provision of clean and safe water to all Tanzanians
1991	Establishment of Pangani Basin Water Board and Office
1992	Dublin principles established water as a right, economic good, and finite resource needing participatory, engendered management. No explicit trade-offs made between the principles
1993	Establishment of Rufiji Basin Water Board and Office
1994	National Irrigation Development Plan (1994–2014) and the National Irrigation Policy aimed at expanding irrigation activities
2000	Revision of national water policy to include aspects of integrated water resource management
2002	Development of new National Water Policy (NAWAPO), forming institutional basis for new policy regulating rights to irrigation and management at the national, basin, community and individual levels. New Ministry of Water and Irrigation. New policies on economic incentives and efficiency in water use
2003	Amendment of water legislation to reflect the new policy
2009	New Water Resource Management Act No. 11 of 2009

Sources Maganga et al. (2002), Sokile (2003), Van Koppen et al. (2007), URT (2009), Kissawike (2008), Patel et al. (2014) and Mosha et al. (2016)

In the post-independence era (1961–), managerial interventions and institutional evolution have continued. The Water Utilization (Control and Regulation) Act, 1974 was enacted to regulate the use of rivers, internal lakes, and streams. In 1981, adopted the river basin management concept and established nine basins (Sokile and van Koppen 2004). The Water Utilization Act (1974) and its Amendment Acts (1981 and 1989) provided the regulatory and institutional framework for water resource management. All water was vested with the state. The Principal Water Office was responsible for policy formation and allocation of water rights at the national level, while the Basin Water Office had charge of designating and administrating water-drainage basins. The 2002 National Water Policy and 2013 National Irrigation Act are the present cornerstones for water-sector policies and are aimed at increasing efficiency in water use through economic and legal incentives (Liheluka 2014).

The Rufiji Basin Water Office (RBWO) is the responsible body for the study area. The functions of RBWO includes administration of water utilization law, collection of various water-user fees, allocation of water rights, legalization of water use, and modification and controlling of water abstractions. Other functions include providing grants, monitoring water use, resolving conflicts, holding stakeholders meetings, and researching issues (Maganga 2003; RBWO 2007).

16.3 Theory

This paper employs an economic version of the sustainable livelihood approach (Scones 1998; Ellis 2000; Patel et al. 2014) to assess the socioeconomic effects of irrigation. We apply an institutional approach drawing on Ostrom's (1990) design principles and a critical institutional interpretation of them (Cleaver 2012) to investigate challenges to managing an irrigation scheme as a "long-enduring," local social institution (Ostrom 1990) (Table 16.2).

Table 16.2 Comparing institutional perspectives

Themes	Mainstream, rational-choice institutionalism	Emerging, critical institutionalism
Livelihood and natural resources management	Clear links between single resources and use	Multiple users, complex and diverse livelihood systems
Human agency	Rational, clear, consistent, consequential logic	Socially constructed, diffuse, interpretive, negotiable, logic of appropriateness
Community	Local, specific-user-group, homogenous, bounded rationality	Multiple locations, diffuse, heterogeneous, diverse, multiple social identities and groups
Institutions	Static, rules, managerial, functionalist, formal organizations and institutions emphasized	Institutions as socially constructed and embedded in practice, struggles over meaning, formal–informal, interlinked with knowledge and power
Property regimes	CPR as a set of rules based on collective action, determined, strategic outcomes, and clear universal boundaries	Determined by practice and not by formal rules, overlapping rights and responsibilities,ambiguity, inconsistency, flexibility interpretation, negotiation
Resources	Material, economic, direct use-values, clear sets of interests	Symbols, resources are locally and historically embedded and socially constructed, carriers of meaning and identity
Power and control	Transaction cost focus, elites, community leaders, common interests and perspectives	Differentiated actors, gender, conflict, central bargaining, negotiation and power relations

Sources Ostrom (1990), Mehta et al. (2001), Cleaver (2012), Vedeld (2002) and Patel et al. (2014)

16.4 Methods and Study Area

16.4.1 Methods, Data and Models

In a mixed-methods approach (Bryman 2008), quantitative and qualitative data were collected at the regional, village/community, and individual levels between September and December 2012. We used focus group discussions, key informants, and structured household surveys with open-ended and closed questions to collect and generate material (Liheluka 2014).

We selected 2 of 81 villages in Kilombero District where both rainfed agriculture and traditional and improved irrigation schemes were present. We interviewed 103 households, of whom 31 were members of improved irrigation schemes, 12 members of traditional schemes, and 60 without irrigation scheme memberships. We also held meetings with irrigation groups and key informants in the villages. The data were analyzed using descriptive and analytical models and SAS/JMP software packages.

16.4.2 Study Area

Mkula and Msolwa A are the two case study villages in the Kilombero Valley beside the Udzungwa Mountains in the Kilombero District in Morogoro Region, Tanzania (Fig. 16.2). The district covers 14,918 sq km, including the Selous Game Reserve, Udzungwa National Park, and Kilombero wetlands.

The mean annual air temperature is 26–32 °C, with precipitation of 1200–1600 mm spread across two rainy seasons. Most areas in the Kilombero Valley experience flooding during the rainy seasons (Region Commissioner's Office Morogoro 2008).

The Kilombero district has two main vegetation types: wooden grassland and Miombo woodland. These areas also contain wildlife populations in both national parks, game reserves, and outside national park areas (Haule et al. 2002). The district has a water surface area of 1341 sq km, with 38 perennial and seasonal rivers. The Mkula River is sourced at the Udzungwa Mountains and drains through Mkula village and passes several villages downstream before discharging into the Kilombero River. The dominant ethnic tribes in Kilombero district are the Wambunga, Wandamba, Wabena, and Wahehe. The district's population is 407,880, with a growth rate of 2.5 % (National Bureau of Statistics 2013).

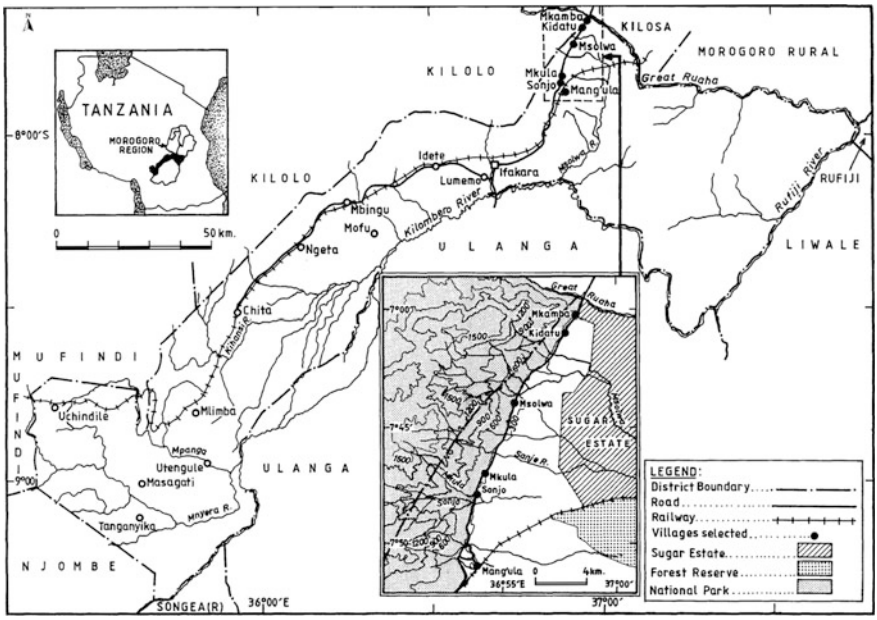

Fig. 16.2 Kilombero District and the case study area. *Source* Cartographic Unit, Geography Dept, UDSM

16.5 Results and Discussion

We present the results on people's reported livelihoods, dependence on water use, and capabilities to manage irrigation institutions, as well as the impacts from different irrigation-water-management institutions and water access on livelihoods.

16.5.1 Livelihood Adaptation and Irrigation Schemes

16.5.1.1 Wealth Groups, Location and Assets

The average household in the Kilombero district has 5.7 members and low education level (5 years of schooling) and owns very little land (2.1 ha). Of these households, 36 % have access to irrigation, only half have electricity, 68 % have bicycles, and 80 % have mobile phones (Table 16.3). They are hard-core poor, with an estimated per-capita income of USD 0.84 per day.

There are significant relationships among household assets, reported income, and various types of access. Looking at variation by income groups, we find substantial variations in land and capital access, labor, and education levels as the less poor groups generally have more capital from which to generate income. We also see

Table 16.3 Socio-economic assets by wealth groups, Kilombero district, Tanzania, 2012

Household assets	Very poor (N = 33)	Poor (N = 37)	Less poor (N = 39)	Sample (N = 109)
Sex (% male)	75 %	87 %	81 %	81 %
Household size (members)*	4.9[a]	5.3[a]	6.8[b]	5.7
Age (years)	50.4	52.5	52.25	51.7
Education level*	5[a]	6[ab]	7[b]	5.4
Land owned (ha)	1.7	1.7	3	2.2
Land used (ha)	1.7	1.8	3	2.2
Access to commons (%)*	86 %[a]	95 %[a]	67 %[b]	82.3 %
NGOs social network (%)	33 %	46 %	64 %	48 %
Hired labor (TZS)	86 %	97 %	92.3 %	91.7 %
Access to bicycles (%)	61 %	70 %	72 %	68 %
Electricity access (%)	33 %	43 %	52 %	43 %
Access to credit (yes)	9 (25 %)	7 (18 %)	18 (50 %)	11.3 (31.19 %)
Amount of credit	260,000	418,000	836,000	506,000
Location Msolwa Mkula	25 (35.7 %) 8 (20.5 %)	27 (38.6 %) 10 (25.6 %)	18 (25.7 %) 21 (53.9 %)	23.3 (100 %) 13 (100 %)
Main type of agriculture				
Improved irrigation	4 (12.5 %)	9 (28.1 %)	19 (59.4 %)	11 (100 %)
Traditional irrigation	4 (30.8 %)	4 (30.8 %)	5 (38.5 %)	4 (100 %)
Rain-fed agriculture	25 (38.5 %)	24 (36.9 %)	15 (23.4 %)	22 (100 %)
Total costs of production	497,915	1,229,757	2,842,349	1,585,172
Net income TZS (USD/cap and day)	498,165 (0.17)	2,485,410 (0.78)	5,851,736 (1.4)	2,893,732 (0.84)

USD 1 = TZS 1650 (2012). N = 109. *Significant differences in the absolute incomes from a source between income groups ($p < 0.05$); income groups with different superscript letters differ significantly in their level of dependence on a given source ($p < 0.05$) in a Tukey Kramer HSD test ($R^2 = 0.27$; DF24; Chi-square 63.74; Prob > ChiSq 0.0001)

that there is an overrepresentation of farmers with improved irrigation in the less poor groups, and there are more rainfed-dependent farmers in the very poor group. Land—and water during the dry season—are increasingly scarce in the area as the surrounding land has been incorporated into in Selous National Park and Udzungwa Mountain National Park on the western and northern side and in the Illovo Sugar Company plantation on the eastern side. This constrains agricultural land expansion and reduces access to various environmental resources.

In addition, the population growth rate of 2.5 % (doubling in less than 20 years) has precipitated a rapid, significant subdivision of land. The RBA has banned water access in the dry season, much to the dismay of farmers. Family labor access constrains production, and more than 90 % of study participants report hiring labor for certain tasks, such as land clearing, bunding, rice planting, land and soil

preparation, and harvesting. Rice and sugarcane production are both labor-intensive activities, and the costs involved in commercial rice production are quite high, up to 50 % of net incomes in many cases.

There is substantial loaning activity in the area: 31 % of participants report borrowing money, and most are from the less-poor group. In the whole sample, households have an average household debt of 506,000 TSH, or some 17.5 % of the total household income. Among those who have loans, the average is TSH 1.4 million. Loans are given on a 1–3-year basis, and the interest rate varies between 2 and 20 %. Most of the loans are informal (70 %), while 30 % are through credit and saving institutions, national marketing Boards, and similar institutions. Farmers with improved schemes utilize much more credit (TSH 766,000) than traditional-scheme farmers (TSH 499,000) and rainfed farmers (TSH 384,000).

We selected two villages in Kilombero district, one (Mkula) where inhabitants have access to both a modern and a traditional irrigation scheme and one village (Msolwa) without such access. Msolwa had access to sugarcane production, an important alternative market option within agriculture. The two villages are both old Tanzanian Ujamaa villages from the 1970s, when people were centralized into villages and provided with infrastructure, schools, water supply, and social services. These public policies still affect the land layout and distribution in Msolwa. The government allocates 50 % of land, and only 21.7 % is inherited. In contrast, Mkula has a longer history with a more traditional land acquisition pattern, so 64 % of the land is inherited, and 25.6 % is allocated through the government. Approximately 10–12 % of the land in the two villages is reported to have been purchased.

16.5.1.2 Wealth Groups, Location, Activities and Outcomes

Households diversify their assets through variations in on-farm and livestock production, migration and remittances, and various off- and non-farm activities. Looking at Table 16.4, we see that agriculture is by far the main income source

Table 16.4 Income source by wealth group in the studied villages, Kilombero district, Tanzania, 2012

Income sources	(N = 36) Very poor		(N = 37) Poor		(N = 36) Less poor		(N = 109) Total	
	Income (TZS)	% Total	Income (TZS)	% Total	Income (TZS)	% Total	Income (TZS)	%Total
On-farm*	297,915	60	2,059,062	83	4,548,431	78	2,299,575	77
Off-farm	73,028	15	67,973	3	86,361	1	75,716	3
Non-farm*	102,500	20	327,297	13	1,108,889	19	554,404	18
Remittances	24,722	5	31,081	1	108,056	2	54,403	2
Total income*	498,165	100	2,485,410	100	5,851,737	100	2,984,098	100

N = 109. *Significant differences among households' wealth groups ($p < 0.0001$; Rsq 0.91; Prob > Chi-sq 1). Standard deviation in brackets. USD 1 = 1650 TZS

Table 16.5 Annual income source by type of production system in the studied villages, Kilombero district, Tanzania, 2012

Household variables	Rain-fed agriculture farmers (N = 64)	(%)	Traditional irrigation farmers (N = 13)	(%)	Improved irrigation farmers (N = 32)	(%)	Sample average (N = 109)	(%)
On-farm*	1,474,575[a]	72	2,988,615[b]	88	3,669,653[c]	81	2,299,575	77
Off-farm	95,453	5	46,076	2	48,281	1	75,716	3
Non-farm	460,000	22	317,692	9	692,188	15	554,404	18
Remittances	26,250	1	26,923	1	121,875	3	54,403	2
Total	2,056,278	100	3,379,307	100	4,531,997	100	2,984,098	100

USD 1 = 1650 TZS. N = 109. *Significant differences among types of agriculture ($p = 0.0001$; RSq 0.16; Prob > Chi-sq 0.97). Standard deviation in brackets. *Significant differences in the absolute incomes from a source between income groups ($p < 0.05$). Income groups with different superscript letters differ significantly in the extent of dependence on a given source ($p < 0.05$) in a Tukey Kramer HSD test

(some 80 % of all incomes) in the two villages, followed by non-farm income (18 %). We observe that the poor-income group has the highest share of income from activities outside agriculture, particularly piecework, environmental incomes, and various non-farm activities. There are in general low environmental incomes in the area, most likely due to the lack of available commons created by the use of land for protected areas and plantations. Agriculture accounts for 76 % of total income in Msolwa and 81 % of total income in Mkula. Within agriculture, rice accounts for 58 % of total income in Mkula and sugarcane 62 % of total income in Msolwa. Sugarcane and rice are the second-largest income sources in the two villages. Remittances are not important to these villages.

How does the type of farming system affect the overall diversification patterns among different groups of households (Table 16.5)? First, improved irrigation scheme farmers have more than twice the income of rainfed farmers, along with higher overall non-farm and remittances incomes. Rainfed farmers have lower total incomes and adapt by procuring nearly 30 % of their income from non-farm and off-farm activities. This difference likely reflects their lower ability to depend on agriculture due to less access to water, land, credit, and labor.

If we further dissect on-farm income, we see that farmers depend on either rice or sugarcane as their main livelihood (Table 16.6). Improved irrigation scheme farmers depend heavily on rice production, while traditional-irrigation and rainfed farmers depend more on sugarcane. Most of the sugarcane is produced outside irrigation areas. The poor and the less-poor income groups depend on sugarcane and rice production. Rice provides higher income in Mkula than Msolwa, where there is little irrigation.

Table 16.6 On-farm income by type of farmer, Kilombero district, Tanzania, 2012

Crop production income	Rainfed agriculture farmers (N = 64)		Traditional irrigation farmers (N = 13)		Improved irrigation farmers (N = 32)		Sample average (N = 109)	
Rice*	358,075[a]	24.3	818,000[b]	27.3	2,306,716[c]	62.7	985,006	42.8
Sugarcane	836,953	56.9	1,586,385	52.99	1,231,656	33.5	1,042,211	45.3
Maize	104,750	7.1	148,077	5.0	76,563	2.1	101,642	4.4
Vegetables	94,532	6.5 %	289,231	9.7	43,124	1.2	935,27	4.1
Livestock	77,797	5.3 %	151,923	5.1 %	20,000	0.5 %	69,690	3 %
Total on-farm income*	1,472,107[a]	100	2,993,615[b]	100	3,678,059[c]	100	2,299,575	100

N = 109. *Significant differences among types of agriculture ($p < 0.05$). Income types with different superscript letters differ significantly in the extent of dependence on a given source ($p < 0.05$) in a Tukey Kramer HSD test (RSq 0.30; DF 200; Prob > Chi-sq 0.9996)

16.5.1.3 Vulnerability Contexts

Important vulnerability challenges in the area arise from government policy failures, natural vagaries, a lack of efficient, fair markets for both inputs and outputs, and, of course, the recurrent themes of land and water shortages that have intensified over the past 5–10 years, according to respondents.

Risk Management

Farmers report engaging in various household risk-management strategies as they seek to earn a livelihood and survival. These strategies are related to, among others, the diversification choices between agriculture and other activities. These choices are more pronounced among the very poor farmers who tend to take on more off-farm activities (working for others). Many farmers are also involved in some agricultural production that does not depend on irrigated water. Many farmers also report storing part of their grains to avoid or reduce price and income fluctuations and maintain a store for unforeseen events. Farmers also attempt to grown more than one crop a year to build up a reserve of savings, both in kind and cash. They might also opt to plant some crops that are flood and drought resistant as a back-up to avoid the effects of recurrent crop failures.

Coping Strategies

This repertoire provides responses to crises of various types, including floods, drought, price variations, wildlife raiding crops and livestock, the illness or death of productive family members, and the loss of remittances and other non-farm activities that can bring in cash but are often accompanied by substantial

uncertainties. Farmers respond to such crises by selling or renting assets such as bicycles, livestock, and land. They might migrate for periods of time (20 %). Poor people are more vulnerable to shocks than those who are less poor.

Irrigation introduces a new type of risk: a more capital-intensive form of production. Farmers report borrowing some 20 % of their total income every year for purchased inputs and heavily depend on secure outcomes. Irrigation farmers use more credit and capital than rainfed farmers. Although these practices are reflected in higher incomes and yields in good years, there certainly are also increased risks in years when irrigation water is scarce or crops fail for other reasons. Interest rates averaging 11.2 % add to the risk of irrigation farmers forfeiting loans and encountering problems, as is reported by other studies from Tanzania (Kissawike 2008).

16.5.2 Irrigation Water Dependence and Sustainable Livelihoods

In this livelihood assessment, we explore the level and type of household dependence on irrigation-water income in relation to livelihood outcomes and vulnerability. The share of total household income from rice irrigation was used to calculate an index for water household-livelihood dependence. It was found that 47 % of overall income from *households with irrigation* is derived from irrigation-dependent production. Traditional-irrigation farmers (24 %) but especially improved-scheme farmers (50 %) exhibit high income dependence on irrigation water.

If we look at the wealth groups of those involved in irrigation (Table 16.7), we find that the less poor have much higher total incomes from water but are also less dependent on water (43 %). The very poor have 8 times lower income from irrigation but still derive 50 % of their income from irrigation.

Table 16.7 Water income dependence of irrigators by household wealth group, Kilombero district, Tanzania, 2012

Irrigation and non-irrigation incomes for irrigation farmers	Very poor (N = 8)		Poor (N = 11)		Less poor (N = 20)		Total irrigation (Sample N = 39)	
	Average	%	Average	%	Average	%	Average	%
Irrigation income*	384,375[a]	50	1621,127[b]	62	2,656,125[c]	43	1,898,203	47
Non-irrigation income*	384,125[a]	50	997,000[b]	38	3,461,750[c]	57	2,135,256	53
Total household income*	768,500[a]	100	2618,127[b]	100	6,117,875[c]	100	4,033,459	100

N = 39. *Significant differences among wealth groups ($p < 0.05$). Income groups with different superscript letters are statistically significantly different ($p < 0.05$) in a Tukey Kramer HSD test (RSq 0.8321; DF 4; Prob > Chi-sq 0.0001)

Table 16.8 Water income dependence of Irrigators and None Irrigators by household wealth group, Kilombero district, Tanzania, 2012

Irrigation and non-irrigation incomes for all farmers	Very poor (N = 36)		Poor (N = 37)		Less poor (N = 36)		Total farmer sample (N = 109)	
	Average	%	Average	%	Average	%	Average	%
Irrigation income*	85,417[a]	17	481,956[b]	19	1,475,625[c]	25	679,173	23
Non-Irrigation income*	412,748[a]	83	2,003,457[b]	81	4,376,112[c]	75	2,304,925	77
Total household income*	498,165[a]	100	2,485,413[b]	100	5,851,737[c]	100	2,984,098	100

N = 109. *Significant differences among wealth groups ($p < 0.05$). Income groups with different superscript letters are statistically significantly different ($p < 0.05$) in a Tukey Kramer HSD test (RSq 0.8959; DF 4; Prob > Chi-sq 0.000)

It seems then that the very poor invest whatever land and labor they have into irrigation agriculture, whereas the less poor can diversify and expand their income into other agricultural and non-farm activities. Looking at averages for the total sample including those without irrigation income, we see that the average dependence is 23 %, somewhat higher among less-poor households. The average total income for the whole sample is more than 11 times higher than that of less-poor households, reflecting the limited access to both irrigated land and capital among the poorest households (Table 16.8).

16.5.3 Institutional Arrangements Around Water Use in Kilombero

We address to what extent people can manage water resources locally in the context of official policies, organizational structures, and institutions that frame local water management.

16.5.3.1 Brief Description of the Schemes

There are 14 schemes in the Kilombero district, covering 17,600 ha of irrigated land (Ngasonwa 2007). The Mkula village has two different irrigation systems: the Mkula improved irrigation scheme and the MAKI traditional-irrigation scheme. There were no irrigation schemes in the other village studied (Msolwa A).

The population in Kilombero has gradually increased after the founding of a sugar company in 1962, the construction of the Tazara railway, and the designation of Mkula as an Ujamaa village. There were no irrigation schemes before 1979, when Mkula was established with a traditional system and later upgraded to an improved scheme. Land was generally abundant before 1979, and the wetlands

were not cultivated. The irrigation scheme launched in 1979 opened the wetlands to agricultural use. It was later transformed into an improved scheme, and MAKI, a traditional scheme, was established in 1994.

The Mkula scheme has 254 ha and 91 members, and the MAKI system 320 ha and 120 farmers. The two schemes are partly fed from the same river (Mkula River), while MAKI also draws water from the Msufini River. Both rivers have annual flows. Both schemes have written constitutions approved by the responsible authorities and the same administrative arrangements with an elected chairman, vice chairman, secretary bursar, board members, and various committees (maintenance, disciplinary, administration, and planning). The Rufiji Basin Office issues water permits, collects water fees, and provides planning and advisory services for the schemes.

The two types of schemes are still somewhat different. The traditional scheme has a poor physical infrastructure with limited water conveyance and hydraulic water-distribution mechanisms. Much work is spent repairing annual flood damage to the canal systems. The improved scheme has better water control, which reduces both water-management problems and workloads. The concrete intake and main canals facilitate control of the required water levels and reduce flooding costs and labor use. There is a general problem of leveling in both schemes because water flow is gravity fed, and even within a single field, amounts of water might differ around the plot.

16.5.3.2 Water Management Institutions

We investigated whether farmers perceive the institutions in place to manage water resources as water effective, cost efficient, and legitimate through the use of Likert-type statements (Table 16.9). We asked respondents to what extent they (strongly) agreed or disagreed to the statements and used a modified version of Ostrom's (1990) design principles to organize a discussion of the institutional arrangements. We discuss the findings related to Cleaver's (2012) more critical institutionalism.

(1) Clear Boundaries on Water Access and Rights

The clear boundaries principle posits that delimitations on physical resources, amount of water accessed, and land boundaries improves management and reduces conflicts. The scheme administrators at the local level identify users and allocates their water access from the main, secondary, and tertiary canals at given times and days. Water flows also vary over the year, causing seasonal shortages and excesses of water. Overall water access is regulated by RBWO through issuing water-user permits.

The formal boundaries might be clear as to how much water one can expect to get and who is eligible to get water, but practice conflicts with these principles, creating a sense of unclear boundaries. Examples given include farmers having to watch their fields at night to prevent others from diverting water to their own fields

Table 16.9 Farmers' statements on robust institutions, Kilombero, Tanzania, 2012

Institution and management	Improved	Traditional	All	Comparing schemes
Are boundaries clearly assigned? –Should others be restricted?	39 54	46 61	44 68	There are boundary issues in both schemes. There are somewhat clearer boundaries and a will to exclude in the traditional scheme. Rights also imply exclusions. An improved system would most likely be better for downstream users
Are memberships and rights clear and fairly distributed? –Do some have more water rights?	52 27	53 48	53 32	About half find the issues to be clear. The improved plan is clearer but has more exclusion (pastoral, in-migrants? Who plans? Who owns?) The scheme was clan–based before and is now more focused on individual rights. There is a more skewed rights distribution in the traditional system
Does everyone carry out their duties? –Are water charges paid regularly?	53 48	34 0	39 23	Many do not carry out duties. More work is done by poor farmers, and some avoid communal labor and get more water access in both schemes. More effective water use and higher outcomes in improved scheme
Is there a fair say in decision making?	84	64	70	Most report being involved. Village elders lead in the traditional scheme; in the improved scheme, the WUA and VC do. The improved scheme requires paying fees, but this has met with strong resistance. There are more meetings in the improved scheme
Is the monitoring system effective? –Is the water maintenance system satisfactory? –Do people take more water than allowed? –Do rich people have more water access?	41 34 83 66	30 53 76 62	35 42 84 65	Monitoring and control are generally low There seems to be overuse of water under both systems, especially by less poor people There is more control of water use in the improved scheme, but the control is less legitimate A majority seems to agree that less poor people have better water access
Does the sanction system work well?	56	61	56	There are many conflicts (between users, pastoral, in-migrants) in both systems, but somewhat more in the traditional schemes. Sanctions by village elders function somewhat better than in the improved WUA, where more formal (court) systems are involved

(continued)

Table 16.9 (continued)

Institution and management	Improved	Traditional	All	Comparing schemes
Are internal conflicts managed and resolved fairly? –Are conflicts over water use common? –Are conflicts are resolved quickly? –Has water competition increased? –Do you get the right amount of water?	60 83 72 91 50	53 76 76 76 50	57 81 74 88 50	Conflicts were seen as common by 80 % of the sample, a bit more in improved schemes. There is more competition over water, and 50 % complain about too little water
				The traditional scheme is cheaper and results in less water scarcity and fewer conflicts
Do external authorities interfere in local water arrangements? –Do local authorities have power over water? –Does the traditional water management system function?	17 76 51	41 88 83	23 81 79	There is a perception of local control of water and not much external interference in local water use. There is more formal and state control under the improved system
				The appropriation of fees, plus possible taxation basis and sector division or ban in dry season under the improved produce conflicts with the state

outside the schedule in the dry season or diverting water away onto other farmers' fields during the wet season. The major reported conflicts occur in the dry season. Interestingly, members of the improved irrigation scheme complain about blurred boundaries (61 %) more than traditional-scheme members (54 %). The very poor group (62 %) complains more than less poor groups (47 %) about blurred boundaries, limited water access, and weakened water rights. Clarifying boundaries is interpreted, negotiated, and molded into local institutions for resource management (Cleaver and Franks 2005). The physical boundaries of the resource typically are not clear because water is shared among people from different villages upstream and downstream, and these individual actors might be involved in various schemes. Additionally, people may develop or have kinship relations in other villages and engage in informal land exchange to secure water from within different social boundaries. Seasonality is an additional issue blurring boundaries because the dry season migration of pastoralists can generate blurred boundaries of both land and social memberships. As Cleaver and Franks (2005:9) claim one should expect boundaries to be "permeable and often fluctuating" and that boundaries are entrenched in the existing social institutions and networks where people access resources and make a living. Establishing formal rules and regulations concerning resource management boundaries on top of these existing social institutions can easily create more problem than they solve.

(2) Fair Distribution of Rights and Memberships

While some new schemes are established in pristine areas, the studied schemes have a land-use history, and those who have acquired water rights often have prior land-access rights. In the case of the traditional system, much of the land had already been distributed by 1994, when the scheme was developed. When water was made available, access rights were allocated to those who had land adjacent to the canals. The improved scheme was an upgrade of the existing traditional scheme, so to some extent, there already was an infrastructure for the physical layout and distribution system. In both cases, however, the placement of canals was decisive in distribution of water rights.

The prevailing rights system seems to be somewhat contested within both schemes, even if a slight majority of participants (53 %) states that the rights are reasonably fairly distributed. Complaints state that rights are not fulfilled (due to insufficient water supply or others taking water) and that they have to pay for rights, not access, while others get away with theft and force. There are no major, systematic differences among different scheme members' and wealth groups' views on rights and memberships. People renting irrigation land enjoy the same rights as others in the schemes. There were no reported tensions in the local community between people renting and owning irrigated land. Whereas rational-choice institutionalists emphasize rights as formally established, rational, consistent, and consequence-oriented devices, critical institutionalists interpret rights as more informal, social, negotiable, and interpretive and apply the logic of social appropriateness in their interpretation and management practices. Even if there is an ambition in the improved scheme to adhere to the rational-choice view of rights, it seems difficult to do so in practice. Coupled with Cleaver's (2012) institutional bricolage, it seems that the two types of schemes are more similar than expected in the management of rights.

(3) Duties, Rights, and Congruence

Ostrom's (1990:91) principles assume that a "congruence between appropriation and provision" is necessary for a robust institution to endure. In our case, there is a division of labor between the government and local people. The government is responsible for distributing water among sectors. Within agriculture, the government divide rights and duties between and within schemes. The government is also responsible for the establishment and major maintenance of intakes, main canals, and like infrastructure. For this service, the government charges an establishment fee and an annual user fee collected by the scheme administration. Members of the improved scheme arrange regular cleaning of the canals, report canal breakages, and carry out minor repairs. The traditional scheme does not have provisions for user fees or any formalized maintenance duties.

Neither local communities nor the government tend to carry out these duties and responsibilities. The government is rarely physically present at local level, so farmers are reluctant to pay fees and participate in maintenance work, even more so in the traditional scheme. The lack of joint action is a serious challenge.

Even if the government is not physically present, it still controls and restrains water access and rights, and there is a clear challenge to distributing water among small-scale farmers and commercial farmers within the watershed. While a rights-based clarification seems formally reasonable, what is seen as congruence in a local context is in practice an object for interpretation, negotiation, and social assessment. For example, upon deliberation, it might seem proper to relieve widows, the disabled, and the sick of communal duties.

(4) Collective Choice Arrangements

Scheme leaders have a substantial role in distributing water through main, secondary, and tertiary canals, but also members take part in these discussions. There are membership meetings at which issues concerning management and maintenance are raised. The level of participation in duties and responsibilities is reportedly low in both groups. In both improved (47 %) and traditional irrigation (66 %) schemes, farmers claim that there is little participation in carrying out duties and responsibilities. Scheme officials report regular confrontations with farmers who avoid participating in maintenance.

Tanzania has a dual-rights system to land and water, and clans still operate alongside formal rights systems in a number of resource-use issues in rural Tanzania. In many ways, clan leaders are still accepted as important authority persons, and clan elders can facilitate collaboration, involvement, and help in times of conflict. The clan system, however, is under pressure from the imposed official, legal, formal management system but also from within. Approximately 30 % of residents in Mkula and 70 % in Msolwa are (now) outsiders, which reduces social consistency and cohesion and might lead to more conflicts. However, the clans and traditional system still operate in most of the design principles discussed.

(5) Monitoring at the Local Level

Water use should be monitored at the basin level down to watersheds and individual rivers and locally down to the initial intake and through main, secondary, and tertiary canals and then farmers' fields until the remaining water drains back into the river. Daily water allocation and distribution falls under the responsibility of the Infrastructure Committee in improved schemes and the Canal Committee in traditional irrigation. These committees under the supervision of the scheme secretary are responsible for monitoring water schedules and distribution.

Monitoring water distribution is a source of numerous conflicts in irrigation schemes, especially in tertiary canals. Around 84 % of farmers report water overuse by others. The situation is reported to be severe during water shortage periods. As well, 59 % in the improved irrigation scheme and 70 % in the traditional system claim that monitoring is inefficient. More people in lower-wealth groups complain about a lack of monitoring.

Water use for domestic purposes, irrigation, and livestock occur at different times and in different places, making monitoring complex and challenging. Even in the irrigation canals themselves, little monitoring takes place; the central water authorities themselves often fail to do monitoring.

There are also conflicts between villages, and the Mkula and Magombela village leaders report holding meetings over joint monitoring because both villages depend on the Mkula River. The complexity of monitoring creates a need for legitimate, competent local institutions that are both efficient at monitoring and accepted by a broad range of local people.

(6) Legitimate Systems for Graduated Sanctions and Conflict Resolution

Farmers who violate operational rules face graduated sanctions. RBWO has the ultimate authority over issuing water rights and is formally obliged to impose graduated sanctions. The Disciplinary Committee is responsible for dealing with sanctions up to a certain level. Complex cases can be referred to higher-level authorities. Both formal and informal arrangements are used to resolve water-related conflicts, and many observed conflicts were resolved through informal arrangements. Elders and scheme officials are often called to resolve conflicts together. Farmers clearly prefer low-cost informal arrangements and less formal rule-based and more interpretive, negotiable solutions kept within the community. There were no reported court cases over water in the villages.

Guilty parties are to be penalized according to locally approved by-laws but are not so in practice. Most farmers choose to yield formal rights or duties and settle matters informally. Most sanctions need reshaping to work effectively, even if 56 % of farmers reported that the system works reasonably well (Table 16.9). There are no major differences in these views by type of scheme or wealth group. It seems as if there is a fine balance between farmers' desire to avoid conflict and maintain peace and harmony but also to make these systems water efficient and, not the least, fair.

Concerning conflict resolution, many farmers (57 %) report that, while conflicts over water use are common, so is conflict resolution. Conflict resolution mechanisms are claimed to be in place by farmers in both improved irrigation (60 %) and traditional irrigation schemes (53 %). At the nexus between formal and customary institutions which handle conflicts, we see, as Cleaver and Franks (2005:11) describe in the neighboring Usangu area, "a deeply held preference for conflict avoidance … and the desire for reconciliatory rather than adversarial solutions (fines and punishments)." This situation presents the dilemma of "public confrontation versus negotiated reconciliation" (Franks and Cleaver 2005:14). Traditional and modern systems of authority to issue sanctions co-exist. An important point is that social identity and individual context matter when sanctions are considered. Traditional systems might, of course, reproduce existing social structures but at the same time maintain social capital and cooperative relations.

(7) Right to Organize

Farmers are the ultimate owners and implementers of irrigation schemes and the direct beneficiaries of local irrigation policy. Internally, farmers manage the schemes and their rules and regulations through representatives, and practices molded in local institutions and agencies emerge as reasonably well functioning at the local level. The Zone Irrigation Officer and District Irrigation Engineer are

external authorities who directly collaborate with small-scale irrigation farmers and their organizations. Approximately 77 % of respondents claim that local authorities control the local scheme and that there is little interference from external authorities once water is allocated. More people in the improved scheme (87 %) than the traditional scheme (59 %) claim no external interference in decisions made locally.

Cleaver and Franks (2005) stress the challenge of local actors' tendency to not see aggregated or nested issues, and indeed, many researchers also focus on local-level issues, conducting case studies at the expense of the larger picture. Looking at scale of vertical power, there are at least two concerns that constrain local institutions of water management. The first relates to the allocation of water among users. Agriculture competes with other water uses, and the hydropower producer TANESCO (40 %) and the wildlife sector takes much water, leaving less for irrigation at large. The RBA, for instance, does not allow water use by local people during the dry season. Moreover, local people have little say in these important water-distribution fora.

The second concern arises from the distribution of irrigation water between agricultural schemes and users of very different sizes. Research in the Wami/Ruvu basin reveals that 89 % of the water is consumed by 3 % of users, leaving 11 % to the remaining 97 % who are small-scale farmers. This situation might be similar in Kilombero, where large landowners, such as the Kilomebero sugar company, Kilombero plantation, Rubada, and Chilimo Cha Yesu, hold as much as 40,000–50,000 ha, of which some is and more might be irrigated. In contrast, the two small-scale farmer schemes we studied in Kilombero involve approximately 600 ha and 200 farmers.

Upstream and downstream water-use concerns are also relevant here. The Mkula River is sourced at Udzungwa Mountains (within the Mkula boundary). It drains across the Mkula village, discharging downstream in the Mkula River, and is used for both irrigation and domestic purposes in the villages. The RBWO has ruled that water used in the irrigation schemes should be channeled back to the river for the benefit of downstream users. During PRA sessions, most small-holder farmers in the village seemed to have little concern for downstream water users. Water shortages are mostly experienced during the dry season (June–November), and smallholders expend much effort and time to maintain water access to their farms during this period. This is also the peak period for water-use conflicts.

16.6 Conclusions and Recommendations

The Kilombero district has experienced significant changes over the past 30–40 years, with increasing infrastructure development and high population growth and rural–rural in-migration from other parts of the country. Migrants include not only farmers looking for land but also business owners, merchants, and pastoralists displaced from pastoral land in other places. Land and water scarcity have increased, and conflicts

have emerged over competing uses, both within agriculture and between agriculture and other sectors.

Within agriculture, land use has increasingly shifted to irrigation agriculture and rice production over the past 10–20 years. Despite increasing production through irrigation, farmers in area remain poor. They have income levels below the poverty line (per-capita average USD 0.84/day). Even the least-poor group has an average daily income of only USD 1.4, while the poorest group reports a daily income average of USD 0.17. Households that access irrigation water have more than twice the income of rainfed farmers.

Households depend heavily on agriculture (77 % of total income). There are some differences: the poorest group and the rainfed farmer groups depend less on agriculture and more on off-farm (working for others) and non-farm activities. Within agriculture, irrigation farmers produce rice, while rainfed farmers grow more sugarcane.

Farmers close to the poverty line approach risks and uncertainties through risk management strategies and through coping strategies when crises occur. We see that farmers in this area diversify in agriculture and other activities but less than is common in other rural areas in Tanzania. Asset-poor farmers diversify more into off- and non-farm activities, especially working for others. Many farmers also diversify into rainfed production and flood- and drought-resistant cropping in case irrigation fails. Farmers also store crops over the year to avoid food-price fluctuations.

Irrigation introduces a new type of risk: capital-intensive production. Farmers report borrowing some 20 % of their total income on average and depending on high income to serve these loans. Interest rates of 10–20 % increase the consequences of crop failure from irrigation water failure or pests. In these circumstances, farmers could default on their loans and lose assets, such as land.

Among households with irrigation, we find that 47 % of the income is water dependent. The poorest households derive higher shares of their income from irrigation water, while less-poor households diversify into non-farm activities.

The two types of schemes are not very different as assessed by local people. They face similar issues of a lack of clear boundaries, membership, and access rights and neglect of performing duties, carrying out monitoring, paying water fees, and executing sanctions. People, though, do feel that, to some extent, they are participating in the water management system and that conflicts are reasonably well handled.

We have applied Ostrom's (1990) design principles, which clearly have a distinct neo-institutional flavor. She leads us to think that the irrigation schemes we have studied will function better the more they are intentional, formalized, and functional and that they will be effective when purposes, rights, duties, and rules are clear and transparent, and the operation legitimate and open.

Cleaver and Franks (2005:16) offer the contrasting critical institutionalist and ethnographic approach which focuses not only narrowly on purpose and outcomes but also more broadly on the complex relations between the "natural and social worlds." Rather than an instrumental view of institutions, Cleaver and Franks

(2005:16) view institutions as "formally and socially embedded, often multipurpose, intermittent and semi-opaque in operation." An institution should not be seen as a constraint or as a thing but as constitutive of humans as social beings. Practice is not formal and rule determined; instead, there are overlapping rights and responsibilities. There is ambiguity, inconsistency, flexibility, interpretation, negotiations, and appropriateness in contrast to rule-based clarity, intentionality, consistency, and consequentiality. In practice, we see that local people resort to elders and clan members in times of conflict and seek to legitimatize monitoring and sanctions based on traditional systems and clan institutions.

What does this study contribute to water policy formulation in Tanzania? There is at present some devolution of water rights and duties to village and scheme levels in Tanzania. These rights and duties, however, are contingent because priority is given first to hydropower (40 %), protected areas, and domestic and industrial water needs. Within agriculture, there is further division between commercial and local farmers, with some 70–80 % of water going to large-scale commercial users. This situation is documented for the Wami/Ruvu basin, but the figures are most likely similar for Kilombero (IDS 2014). A scenario is drawn in which improved schemes enable increased control of local water and imposition fees for water on small-scale farmers. Water is transformed from a common-pool resource accessed by local people into an increasingly state-controlled and -influenced resource regime. Taxation and user fees alienate people from water resources, and few services are offered in return for the user fees, leading to substantial levels of mistrust and perceived illegitimacy of the state by citizens. The TANESCO fees paid are not allocated to the basin or local governments but to the central state authorities. The priority of external actors increases. There has also been an attempt to establish new, parallel catchment councils and WUA outside the existing district councils and local governments. There is need for a revised water use policy, which allows local people more access to and control of resources and which returns fees to local use. At the same time, there is also a need for better control over the development of small- and large-scale commercial schemes. At present, it seems as if new and mostly commercial schemes are entered into without consultation with local- and district-level authorities.

References

ActionAid (2004) Turning off the taps; donor conditionality and water privatization in Dar es Salaam. Report Action Aid International, Dar es Salaam

Binswanger H, Gautam M (2010) Towards an internationally competitive Tanzanian agriculture. Draft report. World Bank, Washington

Bryman A (2008) Social research methods, 3rd edn. Oxford University Press, Oxford

Chiza CK (2005) The role of irrigation in agriculture, food security and poverty reduction. Presented to the 3rd annual engineer's day, 2005—learned discourse, 14-15-3-2005. Dar es Salaam, Tanzania

Cleaver F (2012) Development through bricolage: rethinking institutions for natural resource management. Routledge, London
Cleaver F, Franks T (2005) How institutions elude design: river basin management and sustainable livelihoods. BCID research paper No. 12. University of Bradford, Bradford, UK
Ellis F (2000) Rural livelihoods and diversity in developing countries. Oxford University Press, Oxford
Food and Agriculture Organization (2007) Irrigation management transfer: worldwide efforts and results. Food and Agriculture Organization of the United Nations, Rome
Goldin J, Kibassa D (2009) Past, present and future landscapes of water policy in Tanzania. In: Huitema BD, Meijerink S (eds) Water policy entrepreneurs—a research companion to water transitions around the globe. Edward Elgar, Massachusetts, pp 215–232
Haule KS, Johnsen FM & Maganga SLS (2002) Striving for sustainable wildlife management: the case of Kilombero Game Controlled Area, Tanzania. J Environ Manag 66(1):31–42
IDS (2014) Ensuring integrated water resource management benefits all. Policy briefing issue 76. IDS, Brighton, UK, October 2014
Kikula IS (1997) Policy implications on environment: the case of villagisation in Tanzania. The Nordic Africa Institute, Uppsala
Kissawike K (2008) Irrigation-based livelihood challenges and opportunities: a gendered technography of irrigation development intervention in the Lower Moshi irrigation scheme in Tanzania. PhD thesis, Wageningen University, Wageningen, Holland
Liheluka EA (2014) Institutional water resources management and livelihood adaptation in Kilombero rural areas Tanzania. Norwegian University of Life Sciences, Ås
Maganga FP (2003) Incorporating customary laws in implementation of IWRM: some insights from Rufiji River Basin, Tanzania. Phys Chem Earth 28(20–27):995–1000
Maganga FP, Butterworth JA & Moriarty P (2002) Domestic water supply, competition for water resources and IWRM in Tanzania: a review and discussion paper. Phys Chem Earth Parts A/B/C 27(11–22):919–926
Mosha D, Vedeld P, Kajembe GC, Tarimo AKPR, Katani JZ (2016) Reflections on evolving water management institutions and institutional bricolage: a case of irrigation schemes in Iringa Rural and Kilombero districts, Tanzania. Water Policy 18(2016):143–160
Mehta L, Leach M & Scoones I (2001) Environmental governance in an uncertain world. IDS Bull 32(4). IDS, Brighton, UK
National Bureau of Statistics (2013) Morogoro region population: 2012 Tanzania population and housing census. National Bureau of Statistics, Dar es Salaam
Ostrom E (1990) Governing the commons: the evolution of institutions for collective action. Cambridge University Press, Cambridge
Patel SP, Vedeld P & Tarimo A (2014) Irrigation management, institutions and local livelihood adaptation on Usangu Plains, Tanzania. Noragric working paper 49(26). Department of International Environment and Development Studies, Noragric Norwegian University of Life Sciences (NMBU) ISSN: 0809-4934
Pipping K, Chale HF (1976) Land holding in the Usangu plain: a survey of two villages in the southern highlands of Tanzania. Scandinavian Institute of African Studies, Uppsala, Sweden
Region Commissioner's Office Morogoro (2008) Morogoro region. TAMISEMI: Region Commissioner's Office, Morogoro
Rufiji Basin Water Office (2007) About RBWO. Rufiji Basin Water Office, Iringa
Scones I (1998) Sustainable rural livelihoods: a framework for analysis, vol 72. IDS Publications Office, Brighton
Sokile CS (2003) Towards an integrated water resource management in Tanzania: the role of appropriate institutional framework in Rufiji Basin. Phys Chem Earth 28(20–27):1015–1023
Sokile CS, van Koppen B (2004) Local water rights and local water user entities: the unsung heroines of water resource management in Tanzania. Phys Chem Earth 29(15–18):1349–1356

URT (2009) The water resources management act, 2009. Tanzania No. 20:90. Government Printers, Dar es Salaam

Van Koppen B, Sokile CS, Lankford BA, Hatibu N, Mahoo H & Yanda YZ (2007) Water rights and water fees in rural Tanzania. In: Molle F, Berkoff J (eds) Irrigation water pricing. CAB International, London, pp 143–163

Vedeld P (2002) The process of institutional building to facilitate local biodiversity management. Noragric working paper. Norwegian University of Life Sciences. Ås, Norway