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A half empty bucket: women's role in the governance of water resources in Zambia

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Introduction

Water use in Zambia's rural households is strongly determined by the work of women. Women are primarily responsible for water collection, domestic water use decisions, irrigation of orchards and fields, and other related practices. Seventy nine percent of Zambian women live in rural settings and are employed in the agricultural sector; in comparison to the 64 percent of men that live in a similar setting (GoZ, 2006). Agriculture, still considered an important engine of development and growth in the Zambian economy (GoZ, 2011a), contributes 21.6 percent of the national gross domestic product (World Bank, 2011). In 2009, 74 percent of the urban population and only 53 percent of the rural population in Zambia had access to a safe water supply (GoZ, 2011a). Rural areas have not benefited so far from the commercial utilities' development of a piped water network. Instead, most of the rural areas in Zambia are served by wells and boreholes. Between 2005 and 2010, the Government of Zambia (GoZ) constructed 3,800 new boreholes in rural areas and it plans on constructing 6,000 more boreholes by 2015.

The Zambian water governance system has recently undergone major transformations with both a new Water Policy and a Water Resources Management Act, ratified by Parliament in 2010 and 2011 respectively. These measures stipulate the decentralization of the water sector and the devolution of power to the lowest level of authorities. One consequence is the creation of new institutions[3], namely the Catchment Councils (CC) and Sub-catchment Councils (SCC), as well as the strengthening of the Water Users Associations (WUAs) under the overall coordination of the Water Resources Management Authority. Table 1 summarizes the main functions of the Zambian institutions in the water sector. In addition, the law fosters stronger participation of all water users, in particular smallholders, and among them, women (GoZ, 2010; GoZ, 2011(b2)). The National Water Policy adopts gender equity in accessing water resources as a guiding principle for water management[4]. This principle is reflected in several articles of the Water Resources Management Act that explicitly promote the role of local communities and the participation of women at all levels of the decision making process with regards to water use[5].

The central role of women in water management has been recognized by the international community (Wahaj and Hartl, 2007).Several studies describe rural water consumption patternsand the role of women in the collection and use of wter (Nyong and Kanaroglou, 2001; Arouna and Dabbert, 2010; Potter and Darmane, 2010). However, few of these studies quantitatively assess the role of women in the collection and use of water. Moreover, no available study attempts to explore how women perceive the water governance system, how knowledgeable they are of the institutional setting, and how they actively participate in these institutions.

Other studies that try to assess some of these questions concentrate more generally on the role of rural women in connection to the strategic water use decisions at the household and farm level (Hawkins and Seager, 2010; Bennett, 2004; Makoni et al., 2004; Farmar-Bowers, 2001). Upadhyay (2003) attempts to investigate the gender aspects of participating in the management and governance of water resources; however, the study makes exclusive reference to irrigated agriculture. A handful of studies describe the legal and policy environment related to gender and natural resources management in developing countries (e.g. Manase et al., 2003; van Wijk et al., 1996). Studies related specifically to gender and water governance in rural areas are rare (Harris, 2009) and they are neither based on specific survey data nor do they target developing countries.

Methods

This study was conducted in Zambia in the lower Kafue River Basin, the area lying between the Itezhi-Tezhi Dam and the Kafue Gorge Dam. With the choice of this geographical location, we aimed at capturing the views of water stakeholders (smallholders) in one of the economically most active areas of the country. Large and small-scale agriculture, fishing, tourism, and hydropower generation are major economic activities carried out in the lower Kafue region. A team of local enumerators conducted 428 interviews within the course of three weeks. Fifteen villages were sampled along the Kafue River

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[3] The definition of a water institution adopted in the present work is the broad definition proposed by Saleth and Dinar (2000, p. 176): a "water institution sets the rules and defines, thereby, the action sets for both individual and collective decision-making in the realm of water resource development, allocation, and utilization. Since these rules are often formalized in terms of three inter-related aspects, i.e., legal framework, policy environment, and administrative arrangement, water institution can be conceptualized as an entity defined interactively by its three main analytical components, i.e., water law, water policy, and water administration."

[4] The National Water Policy (2010, p. 19) stresses that "women shall be empowered and fully participate in issues and decisions related to sustainable development of water resources and, specifically, in the use of water."

[5] Art. 20.1.q and Art. 25.e mention that the Catchment Council and the WUA shall "promote the participation of the community in water resources management and ensure gender mainstreaming in the decision-making process relating to the management, development and use of water." Art. 27.2.b mandates the Minister of Water with the "mainstreaming of gender into the policies, programmes and activities relating to water resource management, development and use." Art. 31.3.d mandates the Water Resources Management Authority to "provide mechanisms [...] for enabling the public and communities, in particular women, to participate in managing the water resources within each catchment."

Table 1. Functions of the Zambian institutions in the water sector (source: author´s elaboration of Uhlendahl et al. 2011)

	Water Resources Management Authority (WRMA)	Catchment Council (CC)	Sub-Catchment Council (SCC)	Water User Association (WUA)
Water Allocation	- Approve allocation plans and determine water allocation - Identify freshwater sources - Plan water development - Secure the provision of adequate safe water - Issue water permits - Carry out tasks of the CC, SCC or WUAs if none exist	- Regulate and supervise the use of water at the catchment level - Include sub-catchment allocation plans in the catchment management plan - Carry out the tasks of the sub-catchment Council if no SCC exists	- Regulate the use of water at the sub-catchment level - Investigations and recommendations on water permit or license applications in the sub -catchment - Prepare the allocation plan in a sub-catchment - Monitor permits, water works, water quantity in sub-catchment	- Facilitate and support inspections
Water Charging	- Develop and revise water charges - Revenue collection where no CC exists.	- Collect revenues		
Water Quality Monitoring	- Protect freshwater sources - Resource quality monitoring and evaluation - Conserve, preserve and protect the environment	- Resource quality monitoring and evaluation - Undertake catchment protection	- Monitor water quality and implement regulations and guidelines on catchment protection	- Monitor water quality and ensure water conservation - Undertake projects that would ensure catchment protection
Policy Function	- Advise and recommend policies for the management of water resources to the Minister			
Information Management	- Establish and maintain a water resources information system	-Hydrological and geological surveys - Consolidate data	- Collect hydrological, meteorological, water quality and quantity, socio-economic and environmental data for submission to the CC	- Collect hydrological, meteorological, water quality and quantity, socio-economic and environmental data for submission to the SCC
Participation	- Advocacy programs	- Public awareness campaigns	- Public awareness campaigns - Promote community participation	- Promote community participation
Planning and Reporting	- National water resources strategy - Recommend constitution of the CC - Technical support - Approve catchment and sub-catchment plans	- Develop catchment management plans - Harmonize sub-catchment management plans - Technical support	- Develop sub-catchment management plans - Harmonize local plans - Technical support to WUAs	- Local water management plans

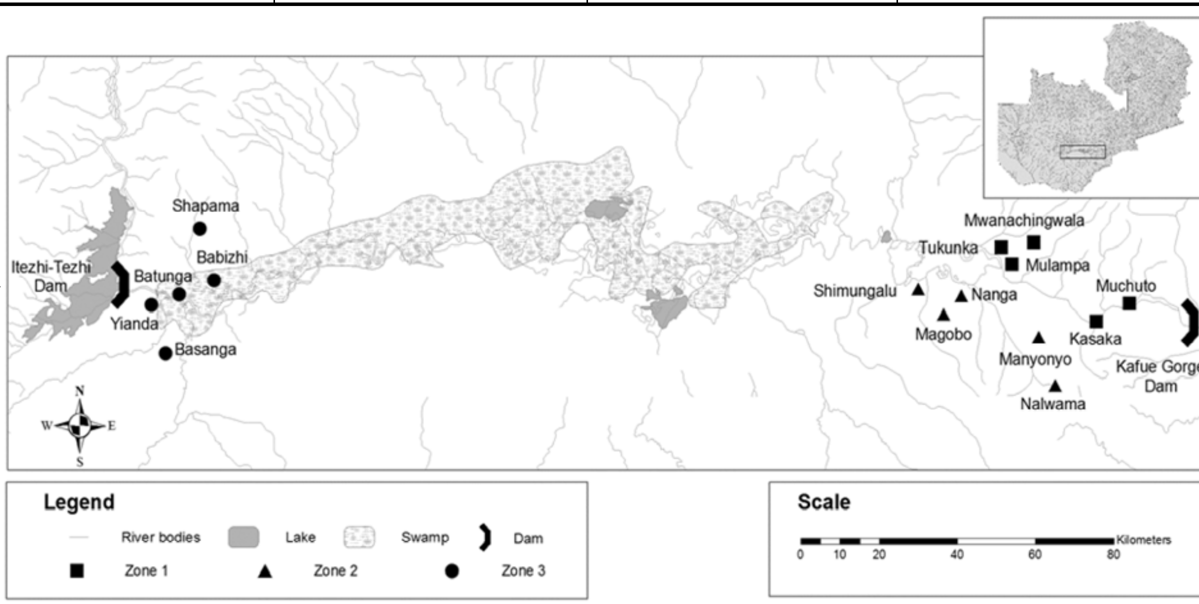

Fig. 1.
Sampled villages.

Source: Map constructed by authors with ArcMap, using data layers provided by the Zambian Ministry of Land

(Fig. 1), excluding the permanently flooded area (and protected national park) of the Kafue Flats where the population density is extremely low and economic activity is limited. The survey instrument was a formal questionnaire that comprised seven modules (identification, household information, domestic water use, agriculture, fisheries, income, and governance) for a total of 210 questions[6]. The survey was administered in the local languages. Zambia counts 72 languages (although many of them can be considered as dialects), but only four languages are currently spoken in the study area (namely Nyanja, Bemba, Tonga, and Ila) and these were used to administer the questionnaire.

The total number of 428 observations was reduced to 400 due to the elimination of two incomplete questionnaires and 26 outliers in the dependent variable. SPSS's procedure to identify outliers functions by identifying households that have an anomaly index value larger than or equal to 2. The anomaly index is the ratio of the group deviation index to its average over the cluster that the case belongs to (IBM, 2013, p.547-554). Before dropping observations, we controlled the original questionnaires and concluded that in each case either reporting errors by interviewees or data entry errors by interviewers had occurred. The two most extreme outliers reported either a zero in total water used or more than 100,000 liters per day.

Results

The fundamental role of women in water use for household consumption is assessed through the use of regression analyses. The dependent variable is the logarithm of the total household water use measured in liters per day. The regression models control for the size of the villages, the position of the villages with respect to a main watercourse, the location (district) of the villages, and the level of education and age of the household heads. These control variables are never statistically significant and are not reported in the subsequent tables. We use hierarchical Ordinary Least Squares (OLS) regressions, i.e. in the first stage the control variables were entered, then the regressors. Appendix 1 reports summary statistics for all variables included in the analysis.

First and foremost we hypothesize that water consumption is dependent upon the prosperity of households. We construct a wealth index based on assets owned by households. Observable assets are usually a more reliable indicator of prosperity than income or consumption data collected through household interviews. The wealth index is computed from weights obtained from a Principal Component Analysis, as suggested by Filmer and Pritchett (2001). Appendix 2 describes the method and data to construct the index.

Other explanatory variables comprise demographic and some occupational characteristics of households: the number of persons living in a household, the share of female household members (or, as an alternative, the ratio between female and male members), the gender and the main occupation of the household head, and whether the household members participate in a cooperative. Water source-specific explanatory variables include the water quality, the ownership of water sources, the level of water abstraction (surface or underground), the distance from the sources of water used, and the frequency of lacking water (due to mechanical problems, depletion of water resources by competing users, or drought). Expenditures for the use, operation, and maintenance of the water sources are also included, which cover both regular monetary contributions and irregular contributions in terms of labor or *una tantum* disbursements.

The two regression models presented in Table 2 differ in the way the gender composition of the household is represented. Model 1 uses the percentage of female persons as the indicator of gender composition, Model 2 the ratio of women to men. In addition, three specifications of each model are being tested in order to assess the functional relation between household water uses on the one hand and the wealth and household size on the other hand. The first specification assumes a log-linear relationship between household water use and wealth and a non-linear relationship between water use and household size (using a linear and a quadratic term). The second specification assumes a log-linear relationship between water use and wealth and a non-linear (log-log) relationship between water use and household size. Finally, the third specification, assumes a non-linear (log-log) relationship between water use and wealth as well as water use and household size.

The results suggest a positive and highly significant effect of wealth on domestic water use. The slightly higher R^2 of specification 3 compared to specifications 2 and 1 (of both models 1 and 2) indicates that the log-log relationships between water consumption and wealth and household size should be preferred.

The total amount of water consumed at household level increases, as expected, with the number of people in the household. Also, the level of users' payments allocated to the operation and maintenance of the water sources significantly contributes to an increase in water consumption. This result, if confirmed by more detailed studies, could suggest that user payments for the maintenance and operation of water sources contribute to improving the reliability of water supplies and consequently to an increase in the use of water.

A positive and significant relationship between gender and water consumption is found in all specifications of the two

[6] The complete questionnaire is available from the authors upon request.

[7] The dependent variable is the logarithm of the total household daily water use; therefore, some of the regression coefficients cannot be directly interpreted as the expected change in the value of the dependent variable subject to one unit change in the independent variable, *ceteris paribus*.

Table 2: Coefficients of the regression analysis[7].

	Model 1			Model 2		
	Specific. 1	Specific. 2	Specific. 3	Specific. 1	Specific. 2	Specific. 3
Constant	3.340*** *.212*	3.190*** *.209*	3.015*** *.206*	3.427*** *.206*	3.260*** *.230*	3.097*** *.200*
Wealth Index	0.011*** *.003*	0.011*** *.003*		0.011*** *.003*	0.011*** *.003*	
Wealth Index (Log)			0.205*** *.037*			0.201*** *.037*
Total contribution to water source	0.002** *.001*	0.002** *.001*	0.002** *.001*	0.002** *.001*	0.002** *.001*	0.002** *.001*
Gender of household head (male=0, female=1)	-0.102 *.073*	-0.099 *.072*	-0.068 *.071*	-0.101 *.073*	-0.098 *.072*	-0.067 *.071*
Occupation of the household head (other=0, agri=1)	0.152* *.087*	0.138 *.086*	0.115 *.084*	0.142 *.087*	0.130 *.086*	0.107 *.084*
Member of a cooperative (no=0, yes=1)	0.236** *.067*	0.237** *.066*	0.211** *.065*	0.243** *.068*	0.243** *.066*	0.218** *.065*
Frequency of lack of water	0.004 *.005*	0.004 *.005*	0.004 *0.004*	0.004 *.005*	0.004 *.005*	0.005 *.004*
Water quality (bad=0, good=1)	0.100* *.059*	0.108* *.058*	0.113** *.057*	0.107* *.059*	0.115** *.058*	0.119** *.057*
Distance from main water source	0.029 *.0.23*	0.027 *.022*	0.031 *.022*	0.031 *.023*	0.028 *.022*	0.032 *.022*
Type of source (Ground=0, Surface=1)	0.068 *.060*	0.064 *.060*	0.054 *.059*	0.069 *.061*	0.066 *.060*	0.056 *.059*
Ownership of source (Public=0 Private=1)	-0.099 *.070*	-0.100 *.069*	-0.096 *.068*	-0.099 *.070*	-0.100 *.069*	-0.096 *.068*
Number of people in the household	0.098*** *.020*			0.100*** *.020*		
Square number of people in the house-hold	-0.002*** *.001*			-0.002*** *.001*		
Number of people in the household (Log)		0.388*** *.056*	0.365*** *.055*		0.394*** *.055*	0.372*** *.054*
Percentage of women in the household	0.362** *.142*	0.303** *.141*	0.320** *.138*			
Ratio women to men				0.066** *.030*	0.056** *.030*	0.055** *.029*
R square	0.288	0.303	0.328	0.285	0.3	0.325
Observations	400	400	400	400	400	400

*** Significant at the 0.01 level ** Significant at the 0.05 level * Significant at the 0.1 level

models. Thus, it is possible to conclude that an increase in the number of women in the household leads to higher water use. This result corroborates findings of descriptive analyses by Nyong and Kanaroglou (2001) and Makoni at al. (2004), where the authors find that women have a predominant role in household water management and hygiene. In fact, the presence of more women in the household implies that a larger amount of water is collected, since it is mainly the women's role to collect water. Additionally, water consumption increases with the number of women in the household due to a series of women-dominated activities, such as household cleaning, child and personal hygiene, and watering of small gardens.Results for the three versions of model 1 indicate that, in an average household with a daily consumption of 124 litres of water, a swap from a male member to a female member increases the total water consumption by amounts between 5.7 and 6.8 litres. For the three versions of model 2 the respective values

[8] We calculate these changes by first multiplying the regression coefficients given in Table 2 with the mean values of the sample variables reported in Appendix 1. This gives us our "baseline" water consumption for the "average" household, described with the mean values of the sample observations. We then substitute one male household member by an additional female person, which changes the gender composition variable (from 0.47 to 0.61 for the share of female persons, from 1.1 to 2.05 for the ratio women to men). In the next step we calculate the water consumption after the swap and the relative difference to the baseline. Finally we multiply this relative change with the average water consumption of 124 liters.

vary between 6.6 and 8 liters[8]. Finally, water consumption appears not to be related to the gender of the household head.

Contrary to what could be expected, the distance from the water as well as the frequency of lacking water have no significant effect on water consumption. This might be due to the fact that the lower Kafue region, which, endowed with a sub-tropical climate, does not suffer from physical water scarcity. In fact, 50.3 percent of the households withdraw water from sources located not farther than 15 minutes away on foot, and 85 percent use sources located within 30 minutes. This result is in line with the findings of a survey conducted in 25 sub-Saharan countries that reports a mean time to collect water of approximately 30 minutes (UNICEF and WHO, 2012).Moreover, levels of water use for domestic purposes are still extremely low: in 8out of the 15 villages sampled, the average per capita daily use of water does not exceed the threshold of 20 liters[9]. With such low levels of consumption, mechanical breakdowns, competition for water, or temporary water scarcity at one source might not affect the total water used at the household level. In fact, in order to maintain a minimum level of per capita water consumption, the collectors could travel longer distances and use secondary, often not clean, sources of water or queue longer at the primary source.

As expected, the quality of the water withdrawn has a positive and significant effect on water use, clearly underlining the importance of improved water sources to maintain sufficient levels of water use. While the main occupation of the household head is generally not significant to explain household water use, the participation of one or more of the household members in a cooperative is positively and significantly related to higher household water use. Usually the cooperatives (fishing or agricultural) are coordinated by government officials and include the participation of several households located in the same neighborhood. Therefore, this result could possibly indicate the importance of coordination at the household level to improve water use.

The results of our regression analyses corroborate the hypothesis that women have a key role in water management and consumption and that they markedly influence the total amount of water used at the household level. This finding supports the emphasis given by Zambia's Water Policy and Water Act to women's empowerment and participation in issues and decisions related to water resource use. In fact, one of the govern

[9] The World Health Organization (WHO) classifies the requirement for water service level to promote health into:
- No access: quantity collected often below 5 litres per capita per day (l/c/d) and more than 30 minutes total collection time;
- Basic access: average quantity unlikely to exceed 20 l/c/d and between 5 to 30 minutes collection time;
- Intermediate access: quantity about 50 l/c/d and water delivered through tap or within 5 minutes collection time;
- Optimal access: average quantity 100 l/c/d and Water supplied through multiple taps continuously.

ance principles listed under paragraph 6 of the Water Act reads that "there shall be equity between both gender in accessing water resources and, in particular, women shall be empowered and fully participate in issues and decisions relating to the sustainable development of water resources and, specifically, the use of water" (GoZ 2011b).

In this context, we analyzed the current level of awareness and participation of smallholders and women in water institutions, the understanding of the roles and functions of these institutions, and the perception of their performance. Respondents were asked questions concerning nine institutions, which also include the Sub-Catchment Councils, the Catchment Councils and the WUAs that were newly introduced with the Water Act. Out of the 428 respondents, 279 were male, 148 female, and only one of the respondents refused to complete the interview.
A first striking result concerns the low level of declared awareness of each of the institutions. Not only was the share of respondents that declared to be aware of the 2011 Water Act institutions very low (only 5.9 percent of the whole sample knew about the Sub-Catchment Council and 5.4 percent were familiar with the Catchment Council), but female respondents in general showed a more limited awareness of all water institutions (Table 3). This finding is unexpected considering that since 2008, the Government of Zambia set up decentralized water resources management structures in the Kafue and Lunsemfwa Catchments as pilot projects to test the application of the National Water Policy and Water Act. At the same time, the drafting process of the Water Policy and Water Act involved an extensive series of consultations, also in the Kafue Basin. In part-

Table 3. Percentage of total women and men respondents aware of each institution. The significance levels relate to the whole sample and provide an indication of the statistical significance of the difference between the two groups (men and women) of respondents.

	Men	Women
Water Users Association	6.1%	6.1%
	17	*9*
Ministry of Energy and Water Development	12.5%	8.1%
	35	*12*
Ministry of Agriculture and Cooperatives**	52.0%	40.5%
	145	*60*
Ministry of Livestock and Fisheries **	48.0%	37.8%
	134	*56*
Sub-Catchment Council	5.7%	6.1%
	16	*9*
Catchment Council	5.0%	6.1%
	14	*9*
Zambia Wildlife Authority **	42.3%	31.1%
	118	*46*
Environmental Council of Zambia *	13.6%	8.1%
	38	*12*
Water Utilities	10.4%	8.1%
	29	*12*

** Significant at the 0.05 level
* Significant at the 0.1 level

cular, women are significantly less aware of the work that is conducted by the Ministry of Agriculture (MACO), Ministry of Livestock and Fisheries (MLF), Environmental Council (ECZ), and Zambia Wildlife Authority (ZAWA).

The respondents' knowledge of the exact functions of the various institutions tends to corroborate this gender bias, indicating that women, even if they are aware of an institution, are less capable to precisely recognize its functions. In fact, only 25 percent of the women (compared to 89 percent of the men) who declared to be aware of the Ministry of Energy and Water Development (MEWD) exactly know the functions of the institution. Also, among the respondents aware of MACO and MLF, about 80 percent of women and over 90 percent of men are knowledgeable of the duties of the two institutions. Moreover, both men and women who declare to be aware of the New Water Act institutions fail to identify the functions of the Catchment Council, and only 25 percent of men can describe the functions of the Sub-Catchment Council.

Table 4. Participation by gender (percentage of respondents aware of the institution).

	Men	Women
Water Users Association*	35.3	0
Ministry of Energy and Water Development	5.9	16.7
Ministry of Agriculture and Cooperatives	35.9	26.7
Ministry of Livestock and Fisheries **	32.4	14.3
Zambia Wildlife Authority **	23.9	8.9
Environmental Council of Zambia	5.7	18.2
Water Utilities	10.7	9.1

** Significant at the 0.05 level
* Significant at the 0.1 level

To some extent, this result is also reflected in the lower degree of participation[10] of women in the water sector institutions compared to men. Although the majority of both men and women explain that they do not have any direct contact with the institutions, it is – at least for three of these institutions – evident that women's participation is significantly lower (Table 4).

A similar result is obtained when inquiring if the participation of smallholders could influence the decisions taken by the institutions. Respondents exhibit a generally pessimistic perception of the efficacy of participation in influencing decisions. In fact, only 45 percent of the respondents who are aware of the institutions believe in the effectiveness of smallholders' participation in the Ministry of Livestock and Fisheries, and about 50 percent in MACO, ECZ and ZAWA. Moreover, women express a markedly negative judgment regarding MLF and ZAWA: only 33 and 44 percent of women believe in the possibility to influence the decisions of MLF and ZAWA, while men are more optimistic with 56 and 69 percent answering in the affirmative.

This is all in contrast to there being no significant difference between men and women in the perception of the usefulness of the institutions to solve water related problems. Stakeholders are pessimistic regarding the problem-solving capacity of the Environmental Council and the Water Act (2011) institutions; more than 70 percent of the respondents aware of such institutions consider them to be unhelpful to the end users. This result is linked to the low awareness of these institutions, the uncertainty about their roles and mandates, and their scarce presence in the field. Surprisingly, though, MLF, MACO and ZAWA also did not pass the smallholder's test and received a rather negative judgment. 52 percent of the respondents consider MLF and MACO as not useful in solving water related problems at the grass-root level, and 50 percent of the interviewees reported the same opinion with regards to ZAWA.

Interestingly, 44 percent of the men and 31 percent of the women explain that they have been helped by one or more institution in solving water related problems. For this purpose, the respondents were asked an open question that allowed them to also mention institutions other than the water sector institutions. However, the national water institutions are rarely named (Table 5), while 43.9 percent of the men and 45.7 per

Table 5. Intervention for water related problems by institution (percentage of total respondents).

	Men	Women
Water Users Association	2.4	0
Ministry Energy and Water Development	0.8	2.2
Ministry of Agriculture and Cooperatives	3.3	2.2
Ministry of Livestock and Fisheries	0	0
Sub-Catchment Council	0.8	0
Catchment Council	0	0
Zambia Wildlife Authority	1.6	2.2
Environmental Council of Zambia	1.6	0
Water Utility	0	0
Donors and NGOs	43.9	45.7
District Council	7.3	6.5
Other Ministries	15.4	19.6
Zambia Sugar	4.1	2.2
Church	2.4	2.2
Other	5.7	4.3
Do not know	10.6	13.0

10. A set of questions were asked to understand the type and frequency of participation within each of the analyzed institutions. The respondents were first asked a generic question about their participation in the decision taken by each institution. Then they were asked to explain how and how often participation within each institution takes place. Finally the respondents were asked to express an opinion concerning how often their participation could influence the decisions taken by each institution (and in case this was "rarely" or "never" a follow-up questions addressed the possible reasons).

cent of the women reported that donor agencies and non-governmental organizations (NGOs) are the main actors that intervene in the case of water-related problems at the village level.

Moreover, in 77 percent of the cases, respondents are satisfied with the interventions of donors and NGOs. Taken together, these findings suggest that the awareness and the impact of the national water institutions at the grass-root level is still very limited, and that international donor agencies and NGOs are the main source of direct support in the water sector.

Conclusions

The study at hand presents one of the few examples of water governance analysis linked to water use and gender considerations. The statistical analysis of the data from a formal household survey confirms the important role of women concerning household water use, and supports the conclusion that rural smallholders in general, and women in particular, are not sufficiently aware of the water institutions and their functioning. The water sector reform process in Zambia is unknown to rural women, and their participation is correspondingly scarce. With the caveat that the survey covers only one region of the country, these results ring alarm bells. If the objectives stated in the current Water Act and Water Policy are to be achieved, the ministries and water institutions should invest in deeper and broader awareness campaigns and strive to involve women at all levels of the decision making process. In the rural areas of Zambia, women are key actors in water collection and domestic water use, and specific education and sensitization campaigns targeted towards women might increase their participation in the water sector. This would improve the capacity of women to act politically in the management of water resources at the grass-root level, and would strengthen the declared aim of more decentralization and participation. The women's involvement would improve their relation with the water sector institutions as well as their knowledge and perception of the institutions' functions. It would also foster participatory decisions that would benefit rural communities overall. Rural women are key to Zambian development, and without their strong involvement, the implementation of the water sector reform process can only be a half empty bucket.

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Appendix 1: Descriptive statistics

	Minimum	Maximum	Mean	Median	Std. Deviation
Dummy variable for Kafue (district 1)	0.00	1.00	0.33	0.00	0.47
Dummy variable for Mazabuka (district 2)	0.00	1.00	0.33	0.00	0.47
Size of village (small=0, large=1)	0.00	1.00	0.50	1.00	0.50
Location (close to river=0, far from river=1)	0.00	1.00	0.16	0.00	0.37
Age of the HH head	18.00	98.00	45.49	41.00	18.19
Level of education of the HH head	1.00	4.00	2.27	2.00	0.63
Wealth Index	1.00	100.00	9.72	6.96	9.30
Total contribution to water source	0.00	360.00	14.39	0.00	35.81
Gender of household head (male=0, female=1)	0.00	1.00	0.18	0.00	0.39
Occupation of the HH head (other=0, agri=1)	0.00	1.00	0.88	1.00	0.33
Member of a cooperative (no=0, yes=1)	0.00	1.00	0.30	0.00	0.46
Distance from water source	1.00	5.00	2.66	2.50	1.19
Type of source (Ground=0, Surface=1)	0.00	1.00	0.63	1.00	0.46
Ownership of source (Public=0 Private=1)	0.00	1.00	0.22	0.00	0.41
Frequency of lack of water	0.00	365.00	21.56	0.50	75.34
Water quality (bad=0, good=1)	0.00	1.00	0.33	0.00	0.47
Number of people in the HH	1.00	30.00	6.80	6.00	3.76
Square number of people in the HH	1.00	900.00	60.37	36.00	89.31
Percentage of women in the HH	0.00	1.00	0.47	0.50	0.19
Ratio women to men	0.00	6.00	1.10	1.00	0.90

Appendix 2: Wealth Index

The estimation of the wealth index using Principal Component Analysis is based on the first principal component. By definition the first principal component variable across households or individuals has a mean of zero and a variance of λ, which corresponds to the largest eigenvalue of the correlation matrix of the j^{th}asset variable x. The first principal component yields a wealth index that assigns a larger weight to assets that vary the most across households so that an asset found in all households is given a weight of zero (McKenzie 2005).

Formally, the wealth index y for household i is $y_i = \sum_{j=1}^{n} \alpha_j \left(\frac{x_j - \bar{x}_j}{s_j} \right)$

where $\bar{x}_j$ and s_j are the mean and standard deviation of asset x_j, and α_j represents the weight for each variable x_j for the first principal component

The variables x_j included in the analysis and the respective α_j weights are:

	Maximum	Mean	Standard Deviation	α
Heads of cattle	400	6.83	26.102	0.234
Heads of goats	55	1.68	5.111	0.48
Heads of sheep	17	0.04	0.850	0.16
Heads of poultry	99	9.04	12.613	0.357
Heads of pigs	12	0.22	1.177	0.134
Number of beds	11	1.63	1.427	0.558
Number of tables	5	1.08	1.018	0.573
Radio/stereo/tape/CD-player	4	0.76	0.762	0.562
Television	4	0.26	0.533	0.657
Mobile phone	7	1.02	1.116	0.654
Land phone	2	0.02	0.172	0.568
Watch/clock	4	0.25	0.497	0.599
Charcoal stove	10	0.73	0.874	0.382
Gas/electric stove	2	0.03	0.216	0.53
Refrigerator	2	0.03	0.204	0.509
Generator	2	0.04	0.215	0.467
Bicycle	10	0.81	1.025	0.463
Motorbike	2	0.05	0.283	0.408
Car/pick-up	2	0.02	0.186	0.525
Private toilet (yes=1, no=0)	2	0.66	0.485	0.370