

**EFFECTIVENESS OF GROUNDWATER GOVERNANCE IN MBARALI
DISTRICT, TANZANIA**

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**A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE
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EXTENDED ABSTRACT

Groundwater governance is increasingly becoming critical worldwide. In Tanzania like other countries in Sub Saharan Africa, water governance including groundwater has been top on the development agenda. Nevertheless, the extent of effectiveness of groundwater governance remains unclear. To that effect, the general objective of this study was to determine effectiveness of groundwater governance with particular focus on governance structures and institutions that guide water users' behaviour. The study employed exploratory sequential research design with two phases. In this design, qualitative data, using key informant interviews and Focus Group Discussions (FGDs), were first collected and analyzed and the results were used to refine questionnaire used in the second phase of data collection that adopted a household survey. A random sample of 90 water users including 50% females was involved in the survey. Qualitative data were analysed using content analysis. A Summated Index Scale was used to measure the extent of groundwater users' awareness of water institutions and effectiveness of governance structures and institutions. The results show that 66.7% of the respondents depended on the groundwater (deep wells) for domestic use. The groundwater user's perception about groundwater cleanness and the lack of other water sources were reported as the factors that influenced the use of groundwater in the study area. The mean distance from a household to a groundwater source was 249.50 metres. The results demonstrate that 50% of the respondents showed medium awareness of formal institutions; 70% and 48.9% showed high awareness of norms and values respectively. In addition, respondents showed high awareness of governance structures particularly Village Councils and Community Water Supply Organizations (COWSOs) relative to Village Water Committees. In respect to effectiveness of formal institutions in influencing groundwater governance, 56.6% of the respondents showed medium effectiveness of formal institutions compared to norms and

values that showed high effectiveness by 54.4% and 55.4% respectively. In addition, the results showed statistically significant difference about awareness of institutions ($P=0.0001$) such that respondents showed higher awareness of the informal institutions relative to formal institutions. Furthermore, the results showed statistically significant difference between male and female responses on the effectiveness of governance institutions ($P=0.0001$). Female respondents reported effectiveness of governance institutions than male respondents. Based on the results, the study concludes that respondents were aware about norms and values than formal water institutions. As reported by female respondents, norms and values were more effective than formal institutions. The study recommends that further sensitization about awareness of formal institutions at local level is needed. The study recommends further investigations on factors that influence limited awareness and effectiveness of formal institutions at a local level. This will be worth for water policy planning and implementation.

DECLARATION

I, **JOHNSON L. GUDAGA** do hereby declare to the Senate of Sokoine University of Agriculture, that this dissertation is my own original work done in the period of registration and that it has neither been submitted nor being concurrently submitted in any other institution.

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DEDICATION

I dedicate this work to my beloved wife Felista, our son Lusungu and our daughter Wende for the immense sacrifices and prayers throughout my studies period. Also, this work is dedicated to my mother Atuganile Kidindzi for providing morale support and prayers throughout my studies.

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LIST OF ABBREVIATIONS AND ACRONYMS

COWSO	Community Water Supply Organizations
FGDs	Focus Group Discussions
GRR	Great Ruaha River
ICWE	International Conference on Water and Environment
IWRM	Integrated Water Resource Management
NAWAPO	National Water Policy
RNP	Ruaha National Park
SSA	Sub Saharan Africa
UBAMPA	Ubaruku Mpakani
UN	United Nations
URT	United Republic of Tanzania
VSSC	Village Social Services Committee
WDC	Ward Development Committee
WRMA	Water Resource Management Act

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

Globally, groundwater governance is a serious agenda since the quantity and quality of the resource is being threatened by unsustainable water extractions and consumption (Sharma *et al.*, 2006; Wijnen *et al.*, 2012; Komakech *et al.*, 2013). In Sub Saharan Africa (SSA), groundwater is managed by Integrated Water Resource Management (IWRM) principles. According to Araral and Wang (2013), there are four principles of IWRM namely: management of water based on hydrological boundaries covering the catchment and sub-catchment areas; decentralization- transfer of water management to local water users; treatment of water as an economic good, and stakeholder's participation in water management decisions.

In many SSA countries, IWRM approach was adopted in early 1990s after the International Conferences on Water and Environment (ICWE) issues that was held 1992 in Dublin-Ireland and in Rio de Janeiro- Brazil (Mosha *et al.*, 2016). The approach provides principles of managing freshwater resources including groundwater sustainably (Calder, 2005). The aim of IWRM is to enhance water users' capacity to cordially develop, manage and share water resources efficiently. However, the implementation of IWRM is constrained by various impediments including serious lack of capacity at river basin and local level, lack of institutional development at local level; and limited resources for resource management (Wijnen *et al.*, 2012; Pavelic *et al.*, 2012).

In Tanzania, groundwater resource is managed by using both informal and formal institutions. Formal institutions include the National Water Policy (NAWAPO) of 2002,

Water Resource Management Act (WRMA) no 11 and 12 of 2009, Water Supply and Sanitation Act of 2009, and legal rules and regulations. The government acknowledges the contribution of informal institutions in managing water resource. Informal institutions are unwritten rules including norms, values and beliefs that are normally developed and shared by water users at their own context (Maganga, 2002; Sokile and Van Koppen, 2003). Besides, there are various formal and informal structural arrangements responsible for coordination, monitoring and controlling water allocation and distribution. The legal structures or organizations are: national water boards; basin water boards; catchment and sub catchment committees and water users associations (URT, 2009) and Community Water Supply Organizations (COWSOs). There are also informal organizations like social networks (water user groups) which also support water management actions (Mosha *et al.*, 2016).

The use of groundwater has been growing rapidly in recent years because of advanced science and technology in exploration and well drilling techniques in Tanzania (Comte *et al.*, 2016). However, governing groundwater is simultaneously a growing challenge while dependence on this resource is increasing (Kashaigili, 2010). The intensive groundwater abstraction and groundwater pollution are part of the challenges facing groundwater resource governance almost all over the countries in the world including Tanzania (Llimas and Custodio, 2003).

The concept of water governance is defined differently by different authors. For instance, the UNDP defines it as political, social, economic and administrative systems that are in place and which directly or indirectly affect water resource at different levels in a society (Rogers and Hall, 2003). Other scholarly literature (Iza and Stein, 2009) found that water governance is a means to an end, which is good water management characterized with

efficiency, equitability, and sustainability among others. In this study, groundwater governance is taken as the process of practicing water institutions through the established governance structures to meet effective groundwater management. These institutions include rules, regulations, norms, values and beliefs. The governance structures include water basins, sub basins, village councils, water committees, and water users associations among others that are legally established to govern water resources. In addition, effectiveness concept is taken in this study as the degree to which water governance structures through using water governance institutions achieve their intended objectives of mediating individual behaviours to water governance.

The aridity condition in Mbarali District has steered the use of groundwater for various purposes including domestic uses (Villholth, 2013). Being an invisible resource, groundwater is hard to control and manage. Regulating it through laws and subsequently enforcing adopted rules inevitably comes with some unexpected outcomes (UNDP, 2013; Vigna *et al.*, 2014). As millions of revenue is invested in water supply systems in Mbarali District to meet water demand; and since competition among water users grows, groundwater governance remains important (URT, 2014).

1.2 Problem Statement

In Tanzania, for many decades Mbarali District continues to be an essential area of paddy production (Ngailo *et al.*, 2016) and source of water to the Great Ruaha River (GRR). The GRR is important because it provides water to Mtera, Kihansi and Kidatu hydropower plants (Mwakalila, 2011), which produces about 50% of the national electricity (Rajabu and Mahoo, 2008). Furthermore, the GRR is an important river in Tanzania for Ruaha National Park (RNP) ecology as it is the main source of water for wildlife especially

during the dry season (Kangalawe *et al.*, 2011; Stommel *et al.*, 2016). The sustainability of the above mentioned activities depends on surface water.

Notably, surface water is globally dwindling. Climate change, rapid population increase and economic development among others are mentioned to contribute to water diminishing (Kashaigili, 2010; URT, 2012). The Usangu plain in Mbarali District is one of the areas that have been experiencing water crisis. For instance, in 2012 and 2013 during dry season, large part of the GRR dried out, leaving discrete water pools separated by stretches of dry river bed (Stommel *et al.*, 2016). The continuing decline of surface water has a serious impact on downstream flows in hydropower generation plants such as Kidatu, Mtera and Kihansi, environmental conservation including biodiversity at Ruaha National Park (Rajabu and Mahoo, 2008; Stommel *et al.*, 2016; Sirima, 2016) as well as on paddy production. Declining of surface water motivates dependency on groundwater resource to enhance peoples' livelihoods.

To overcome this overwhelming water situation; the Government of Tanzania is promoting conjunctive use of surface and groundwater as an alternative to address water crisis (Kashaigili, 2010; Pavelic, 2012). In Mbarali District, there are responsible water governance structures such as Village Water Committees and Village governments (Franks *et al.*, 2013) and water governance institutions both written and unwritten rules at a village level (Sokile and Van Koppen, 2003). In Tanzania, Water governance structures and institutions govern both surface and groundwater resource. Several academic studies (URT, 2002; 2014; Franks *et al.*, 2013; Mosha *et al.*, 2016) indicate the performance of water governance particularly on surface water. However, the effectiveness of the current water governance for governing groundwater resource remains empirically unclear. This

raises a need to examine the effectiveness of groundwater governance with particular reference to Mbarali District, Tanzania.

1.3 Justification

The study generates empirical information about groundwater existing situation in Mbarali District. Furthermore, the findings provide information on the effectiveness of water governance structures and institutions particularly in governing groundwater resource in Mbarali District. The study highlights some areas of which water governance particularly groundwater should be further improved by the respective water authorities. In addition, the study reflects the extent of awareness of groundwater users about the water institutions and their perceptions on the effectiveness of groundwater governance structures and institutions.

1.4 Objectives

1.4.1 Overall objective

The overall objective of this study was to examine effectiveness of groundwater governance in Mbarali District.

1.4.2 Specific objectives

The specific objectives were to:

- (i) Assess groundwater situation in terms of its sources, distance, access to and use and challenges associated with the resource.
- (ii) Measure the extent of groundwater users' awareness on water institutions.
- (iii) Examine the degree of success of various management structures and institutions governing groundwater resource.

1.5 Research Questions

The study was guided by the following research questions:

- (i) What is the existing situation of groundwater in the district?
- (ii) To what extent are the groundwater users aware of water institutions?
- (iii) To what extent do water institutional structures, norms, values, rules, and regulations are effective in addressing groundwater related problems?

1.6 Conceptual Framework

The concept of water governance comprises both institutions like rules, regulations, norms, values, beliefs among others, and governance structures include Village Water Committees, Village Councils, and Community Water Supply Organisations (COWSOs). Ostrom (1990) views the institutions and structures in metaphorical perspective. In this, institutions are viewed as the rules of the game that guide structures as game players in influencing individuals' behaviour for resource management. The rules of the game and game players are interdependent between one another. For instance, the game players are the ones who establish the rules of the game while the rules of the game limit the game players in the resource governance process. The established water governance provides and implements decisions of whom, how and by what conditions the resource is exploited (Miranda *et al.*, 2011).

Effectiveness of groundwater governance is determined by performance of the established groundwater governance in terms of structures and institutions. Figure 1 shows three components: respondents' characteristics which serve as background variables to the groundwater governance. The groundwater governance, comprising groundwater institutions and governance structures, are the independent variables that influence individuals to groundwater governance. The effective groundwater governance as an

outcome of water governance structures performance on groundwater governance serves as the dependent variable. Effective groundwater governance is attributed to transparency, active participation, accountability, equality and responsibilities on groundwater governance issues. Thus, the attributes of the effectiveness of groundwater governance enhance the awareness of groundwater users about water institutions (game rules) at the local level. Nevertheless, the individuals' socio-economic characteristics such as age, sex, education level, income, occupation and family size may affect water governance both the water institutions and structures in influencing the related groundwater users behaviour for water governance.

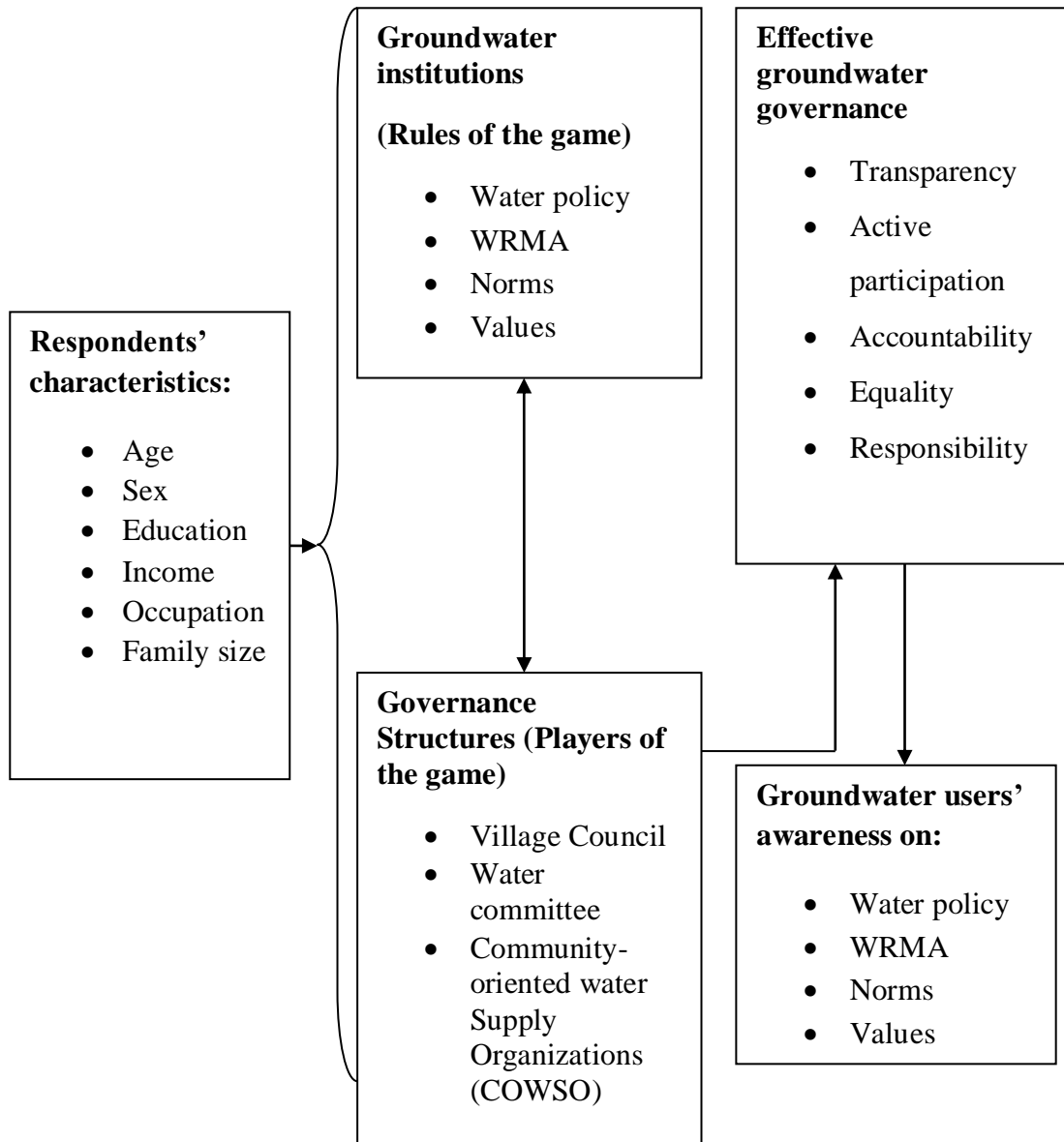


Figure 1: Conceptual framework on effectiveness of groundwater governance

Source: Authors' construct

1.7 Theoretical Underpinning on Water Resource Governance

Water governance is seen as a way of moving beyond simplified and structured approaches such as integrated water resources management to a more nuanced understanding of how people interact with each other and with institutions and organizations. Governance manifests in everyday practices, interactions and norms (Cleaver, 2012). As such, the most suitable institutional theory to analyze groundwater governance is an Institutional Bricolage Theory (IBT) or more recently referred to critical

or post institutionalism. The Institutional Bricolage Theory was developed by Frances Cleaver in 2002 and upgraded in 2012 as a tool of institutional analysis that can help to explore how the idea of power relations, differences, scales, multi-actors, multi-institutions and management of natural resource all fit together (Cleaver, 2002; 2012). The bricolage concept is described as a process in which people consciously and non-consciously represent on existing social formulae (styles of thinking, models of cause and effect, social norms and sanctioned social roles and relationships) to patch or piece together institutions in response to changing situations. These institutions are neither completely new nor completely traditional but rather a dynamic hybrid combining elements of modern, traditional, and the formal and informal (Cleaver, 2012).

The theory suggests that, in order for the institutions to be understood properly, one has to know the characteristics, constraints, incentives of people in a particular agency that enable them to behave in one way or another. Furthermore, Institutional Bricolage Theory puts into consideration social contexts and dynamics, such as power relations and individual agencies, in the formulation and enforcement of institutional rules (Gutu *et al.*, 2014). In this study, good groundwater governance as an outcome is influenced by robust institutions (both formal and informal) and the performance of governance structures such as state organizations, individuals, community-oriented groups related to groundwater management issues.

The Institutional Bricolage Theory recognizes local knowledge and participation of local actors promoting decentralization in decision making bodies. There is better access of local actors to participate fully on groundwater governance process. The study adopts Institutional Bricolage Theory since the theory gives social context realities into great position to influence resource governance (Cleaver, 1999; Gutu *et al.*, 2014). Thus, since

groundwater users are one of the key actors to implement the established institutions, awareness of water users on water institutions and water governance structures is very critical.

1.8 Organization of the Dissertation

The dissertation adopted a publishable manuscript format and it is organised into five chapters. Chapter one comprises an introduction of the general theme studied. Chapter two deals with existing situation of groundwater in Tanzania: Experience from Mbarali District, Tanzania while, chapter three deals with the awareness of groundwater users on water institutions. The effectiveness of water governance structures and institutions is presented in chapter four. Lastly, chapter five covers the overall conclusions and recommendations.

References

- Araral, E. and Wang, Y. (2013). Water governance: A review and second generation research agenda. *Water Resource Management* 27:3945-3957.
- Calder, I. (2005). *Blue Revolution: Integrated Land and Water Resources Management*. (2^{ed}). Earth scan in the UK. 376pp.
- Comte, J., Cassidy, R., Obando, J., Robins, N., Ibrahim, K., Melchioly, S., Mjemah, S., H., Bourhane, A., Mohamed, I., Noe, C., Mweha, B., Makokha, M., Join, J., Banton, O. and Davies, J. (2016). Challenges in Groundwater Resource Management in Coastal Aquifers of East Africa: Investigations and lessons learnt in the Comoros Islands, Kenya and Tanzania. *Journal of Hydrology Regional Studies* 5: 179-199.
- Cleaver, F. (2002). Reinventing institutions: Bricolage and the social embeddedness of natural resource management. *European Journal of Development Research* 14(2): 11– 30.
- Cleaver, F. (1999). Paradoxes of Participation: Questioning Participatory Approaches to Development. *Journal of International Development* 11: 597–612.
- Cleaver (2012). *Development through Bricolage: Rethinking Institutions for Natural Resource Management*. Abingdon, Oxon: Routledge. 219pp.
- Franks, T., Cleaver, F., Maganga, F. and Hall, K. (2013). Evolving outcomes of water governance arrangements: Smallholder irrigation on the Usangu plains, Tanzania. [<http://www.kcl.ac.uk/sspp/departments/geography/research/Research-Domains/Contested-Development/wp62Cleaver.pdf>] site visited on 3 August, 2016.
- Gutu, T., Wong, S. and Kinati, W. (2014). Institutional Bricolage as a New Perspective to Analyse Institutions of Communal Irrigation: Implications towards - Meeting

- the Water Needs of the Poor Communities in Rural Ethiopia. *Pinnacle Agricultural Research and Management Journal* 14:1-14.
- Iza, A. and Stein, R. (Eds) (2009). *RULE – Reforming Water Governance*. Gland, Switzerland.130pp.
- Kashaigili, J.J. (2010). Assessment of groundwater availability and its current and potential use and impacts in Tanzania.[http://gw-africa.iwmi.org/Data/Site/24/Sites/24/media/pdf/Country_Report-Tanzania.pdf] site visited on 24 May, 2015.
- Kangalawe, R., Mwakalila, S. and Masolwa, P. (2011). Climate Change Impacts, Local Knowledge and Coping Strategies in the Great Ruaha River Catchment Area, Tanzania. *Natural Resources Journal* 2: 212-223.
- Komakech, H. C., Van der Zaag, P., Mul, M. L., Mwakalukwa, T. A. and Kemerink, J. S. (2013). Sustainable Solutions for Global Crisis of Flooding, Pollution and Water Scarcity. *International Journal of River Basin Management* 10 (3): 213-227.
- Llamas, R. and Custodio, E. (Eds). (2003). *Intensive Use of Groundwater Challenges and Opportunities*. Balkema Publishers, Netherland. 475pp.
- Rajabu, K. R. M. and Mahoo, H. F. (2008). Challenges of optimal implementation of formal water rights systems for irrigation in the Great Ruaha River Catchment in Tanzania. *Agriculture Water Management* 95:1067-1078.
- Maganga, F. P. (2002) The Interplay between Formal and Informal Systems of Managing Resource Conflicts: Some Evidence from South Western Tanzania. *European Journal of Development Research* 14: 2: 51 -70.
- Miranda, L., Hordijk, M. and Molina, R. K. T. M. (2011). Water Governance Key Approaches. [http://sgpwe.izt.uam.mx/files/users/uami/citla/Lecturas_Temas_selecto_IV_AGUA/Chance2Sustain__Literature_Review_No.4__Water_Gover

- nance_Key_Approaches_An_Analytical_Framework1.pdf] site visited on 17 January, 2017.
- Mosha, D. B., Kajembe, G. C., Tarimo, A. K. P. R., Vedeld, P. and Mbeyale, G. E. (2016). Performance of water management institutions in farmer-management irrigation schemes in Iringa Rural and Kilombero districts, Tanzania. *International Journal of Asian Social Science* 6 (8): 430-445.
- Mwakalila, S. (2011). Vulnerability of People's Livelihoods to Water Resources Availability in Semi Arid Areas of Tanzania. *Journal of Water Resource and Protection* 3: 678-685.
- Ngailo, J. A., Mwakasendo, J. A. and Kisandu, D. B. (2016). Rice farming in the Southern Highlands of Tanzania: Management practices, socio-economic roles and production constraints. *European Journal of Research in Social Sciences* 4 (3):1-13.
- Ostrom, E. (1990). *Governing the Commons: Evolution of Institutions for Collective Action*. Cambridge University Press, New York. 280pp.
- Pavelic, P., Giordano, M., Keraita, B., Ramesh, V. and Rao, T. (2012). Groundwater-availability and use in Sub-Saharan Africa: A review of countries. [http://www.iwmi.cgiar.org/Publications/Books/PDF/groundwateravailability_and_use_in_subsaharan_africa_a_review_of_15_countries.pdf] site visited on 26 June, 2016.
- Rogers, P. and Hall, A. W. (2003). *Effective Water Governance*. Global Water Partnership, Technical Committee, Stockholm, Sweden. 48pp.
- Stommel, C., Hofer, H., Grobbel, M. and East, M. L. (2016). Large mammals in Ruaha National Park, Tanzania, dig for water when water stops flowing and water bacterial load increases. *Mamm Biology* 81: 21–30.

- Sokile, C. S. and Van Koppen, B. (2003). *Local Water Rights and Local Water User Entities: Unsung Heroines to Water Resource Management in Tanzania*. Proceedings of Waternet/Warfsa Symposium, Gaborone, Botswana, 15-17 October, 2003.pp.8.
- Sharma, B. R., Villholth, K. G. and Sharma, K. D. (2006). *Groundwater research and management: Integrating science into management decisions*. Proceedings of International Water Management Institute International Workshop, Roorkee, India, 8-9 February, 2005. 282pp.
- Sirima, A. (2016).The Social and Economic Impacts of Ruaha National Park Expansion. *Open Journal of Social Sciences* 4: 1-11.
- Vigna, F., Demiray, Z. and Mazza, R. (2014). Exploring the use of alternative groundwater models to understand the hydro geological flow processes in an alluvial context. *Journal of Environmental and Earth Sciences* 71: 10-25.
- Villholth, K. G., Tottrup, C., Stendel, M. and Maherry, A. (2013). Integrated mapping of groundwater drought risk in the Southern African Development Community Region. *Hydrogeology Journal* 21(4): 863-885.
- UNDP-Water Governance Facility.(2013).User's Guide on Assessing Water Governance.[<http://www.undp.org/content/dam/undp/library/Democratic%20Governance/OGC/Users%20Guide%20on%20Assessing%20Water%20Governance%201.pdf>]site visited on 18 September, 2016.
- URT (2002). National Water Policy. United Republic of Tanzania. [[http://www. National Water_policy.pdf](http://www.NationalWater_policy.pdf)] site visited on 13 February, 2016.
- URT (2009).*Water Resource Management Act No 11*.Dar es Salaam, Tanzania.73pp.
- URT (2012).Water Sector Status Report. Ministry of Water, Dar-es Salaam. [[Water_Sector_Status_Report-_Submitted_to_DPs_17-09-2012.pdf](http://www.Water_Sector_Status_Report-_Submitted_to_DPs_17-09-2012.pdf)]site -visited on 16 February, 2017.

URT (2014). Mbarali District Council Strategic Plan 2013/14-2017-18; Prime Minister's Office Regional Administration and Local Government. [<http://www.mbaralidc.go.tz/storage/app/uploads/public/58d/10/58d101fccce7f653574057.pdf>] site visited on 27 June, 2017.

Wijnen, M., Benedicte, A., Bradley, H., Ward, C. and Huntjens, P. (2012). Managing the Invisible-Understanding and Improving Groundwater Governance [<http://documents.worldbank.org/curated/en/450431468157768820/pdf/717420WPOBox370naging0the0invisible.pdf>] site visited on 11 September, 2017.

CHAPTER TWO

2.0 Groundwater Situation in Tanzania: Experiences from Mbarali District in Mbeya Region

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2.1 Abstract

This chapter examines groundwater situation in selected villages in rural areas of Mbarali District where drinking water infrastructures for domestic use are poor and or lacking. The study adopted sequential exploratory research design to collect quantitative and qualitative data. The sample size, randomly selected, was 90 groundwater users and 50% were women. Descriptive statistics, one way Analysis of Variance (ANOVA), correlation analysis and independent T-test were used for quantitative data while qualitative data were subjected to content analysis. The results show that 66.7% of the respondents depended on the groundwater (deep wells) for domestic use. This was influenced by the perception that groundwater was clean and the only source available. The mean distance from a household to a groundwater source was 249.50 metres. The variation, in terms of distance from households to the groundwater source between the villages, was significant at 5%. In addition, the relationship between socio-economic characteristics of the household heads and the amount of groundwater used was generally weak. The socio-economic

characteristics involved were household heads' education level, household size, household annual income and distance from home to the groundwater source. The study concludes that groundwater is critical and dependable in supporting households' livelihoods. It is therefore pertinent, at a policy level, to enhance groundwater infrastructure development at the local level so long as surface water is dwindling. In addition, the question of groundwater governance in terms of groundwater quality, institutional structures and legal and policy issues worth an investigation to ensure sustainability of the groundwater resources.

Keywords: Groundwater, Groundwater sources, Groundwater accessibility, Groundwater usage, Groundwater challenges, Tanzania.

2.2 Introduction

In recent years, it is being acknowledged that a considerable proportion of the human population in the world is using groundwater resource for different purposes including domestic uses and irrigation. This trend is influenced by many factors. For instance, in developing countries like Tanzania, the increasing trend is influenced by, among other factors, diminishing of surface water because of changes in rainfall amount and its patterns, population growth and increasing economic development. Nevertheless, the interactions between groundwater resource and the society especially in rural Tanzania where infrastructures for domestic use including drinking water are poor and or lacking are not explored sufficiently. The importance of groundwater resource is acknowledged in many countries in the world. For instance, Garduño (2011) reports that 97% of the accessible freshwater in the world is groundwater resource. About 2 billion people in the world depend on groundwater for domestic use, industrial development and irrigation. This indicates that groundwater is one of the critical natural resources for peoples' livelihoods and for development in general.

Groundwater is defined as freshwater from rain or melting ice and snow that soaks into the soil and is stored in the tiny spaces between rocks and particles of the soil. As such groundwater is not isolated with surface hydrological system, but interacts with each other across a variety of physiographic and climatic landscapes (Yang *et al.*, 2014; Bhatt and Mall, 2015). Normally, people use deep wells, drilled shallow wells or dug wells to access groundwater resource. A deep well refers to the constructed well by either cable tool or rotary-drilling machines. It can be drilled more than 300 metres deep. The space around the casing must be sealed with grouting material of neat cement to prevent contamination by water draining from the surface downward around the outside of the casing. On the other hand, drilled shallow well is constructed by drilling a pipe into soft ground, such as gravel or thick sand. A perforated pipe or screen is attached at the end of the pipe to allow water to flow into the well as well as to filter out sediment (Collins, 2010; Van der Wal, 2010).

According to Wijnen *et al.* (2012), 70% of the population in the Southern African Development Community (SADC) depends on groundwater for various uses including agriculture, urban development, rural livelihood, livestock and safe drinking water supply systems. One of the factors that necessitate groundwater use is the dwindling of surface water particularly in semi arid and arid areas. Literature reveals that the diminishing of surface water is accelerated by a number of factors including decreasing and changing in rainfall patterns, increasing multi-sectors demands, degradation of water catchments due to increasing human population, over abstraction, poor land use practices, urbanization and industrial development (Kashaigili, 2010; URT, 2012a).

In Tanzania, groundwater use accounts for over 25% of the water supply for domestic use, livestock, agriculture and sustaining ecosystems (Water Resource Group, 2014). Despite

the fact that Tanzania is not mentioned as one of the water stressed countries, it has high rainfall variability suggesting decreasing amount of surface water in some areas. In some regions mostly semi-arid and arid areas are affected by frequent droughts. For instance, in the Southern Highlands the average annual rainfall is over 1200 mm while in semi-arid areas including Mbarali District the mean annual rainfall is less than 600 mm (Van Camp *et al.*, 2013; Water Resource Group, 2014; Kayombo, 2016). Climate variability and change are mentioned to be the main causes of the rain shortage in arid and semi-arid areas (Kashaigili, 2010; URT, 2012b; Mkonda, 2016). The aridity situation in Mbarali District accelerates people to depend on groundwater source to support their livelihoods (Kashaigili, 2010; Villholth, 2013).

Although literatures acknowledge the importance of groundwater in supporting peoples' livelihoods (Water Resource Group, 2014), little is known about groundwater situation in terms of types of groundwater sources, availability of groundwater, and challenges related with groundwater resource. Understanding the situation of groundwater in Mbarali District remains vital since it informs various groundwater stakeholders on the existing interaction between the resource and the local community. Also it reflects the magnitude of the local community dependency on groundwater resource in enhancing their livelihoods. This chapter is guided by the following research questions: What types of groundwater source exist in the study area and what are the challenges associated with groundwater sources? How far the households are from the groundwater source? What influences access to and or use of groundwater apart from using other water sources? The answers of these questions provide comprehensive knowledge about the interaction between the groundwater resource and community in the study area. This chapter is organized into four sections. Section one introduces the chapter and uncovers the research puzzle. Section two

presents the methodology used while section three is devoted to results and discussion. Conclusions and recommendations are presented in section four.

2.3 Study Area

This study was conducted in Mbarali District, Mbeya Region. Mbarali District is located at latitude 8° 51' South, longitude: 33° 51' East. The altitude ranges from 1 000 to 1 800 meters above sea level (Kangalawe *et al.*, 2012). The minimum temperature is 19°C (June-July) while the maximum is 35° C (August to December) (Kangalawe *et al.*, 2012). The district covers an area of 16 632 square kilometres and has a population of 300 517. Administratively, the district is divided into 20 wards with a total of 99 villages (URT, 2014). The main soil characteristics in Mbarali District are dark grey and prismatic cracking clays. The water sources including groundwater laid in the Great Ruaha River Catchment, which is one of the four sub-basins of the Rufiji River Basin. The mean annual rainfall is 600 mm which falls between December and April and hence the District is vulnerable to water scarcity (Kayombo, 2016; Sirima, 2016).

2.4 Methodology

2.4.1 Research design

The study employed sequential exploratory research design with two phases. The first phase involved collection and analysis of qualitative, and the results of this phase were used to refine questionnaire for the second phase. The second phase involved collection of quantitative data through household survey using a structured questionnaire. Focus Group Discussions (FGDs) and key informant interviews guided by a checklist of items were used to collect qualitative data.

The study population encompassed groundwater users in the study sites. The sampling procedures involved purposive selection of three villages based on various criteria including accessibility and use of groundwater by household, groundwater degree of dependence, public use, degree of collective action arrangements in managing and use of groundwater. The villages were Nyeregete, Ubaruku and Mwaluma from Rujewa, Ubaruku and Ihahi wards respectively (Figure 2.1).

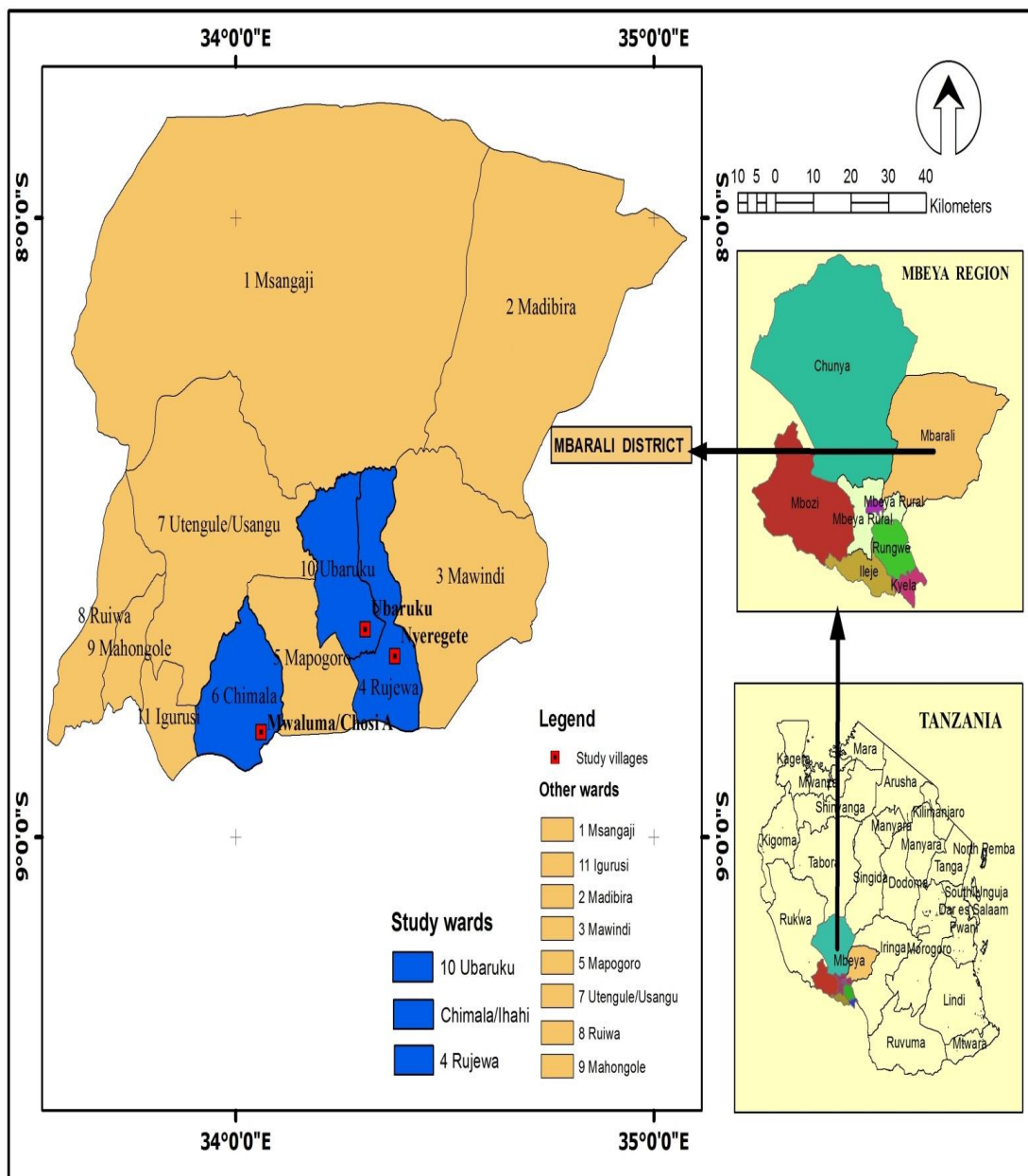


Figure 2.1: Map of Mbarali district showing study villages

The selected villages constitute some areas for the Groundwater Futures in Sub-Saharan Africa (GroFutures) Project whereas this study is a part of the project. The GroFutures Project is a four years research project (2015 – 2018) funded by the United Kingdom (UK) government. The overall aim of the GroFutures is to develop scientific basis and participatory management processes by which groundwater resources can be used sustainably for poverty alleviation in Sub-Saharan Africa. This study contributes knowledge to the specific objective of constructing a set of plausible and stakeholder-informed groundwater development pathways. In each village, 30 respondents were randomly selected making a sample size of 90 respondents. This sample size is appropriate because it allows statistical analysis leading to the reasonable conclusions (Bailey, 1994).

One Focus Group Discussion was conducted in each village making a total of three FGDs. In order to get different experiences and perceptions on groundwater, sex and age were the criteria used to select FGDs participants. Each FGD comprised 8-12 participants. The proportion of women FGDs participants ranged from 5 to 7 in each group. Women were involved in FGDs because they are responsible to collect water for domestic uses. The information gathered during FGDs captured groundwater usage, type of groundwater sources, groundwater availability, factors that influence the household to access groundwater source, other water sources accessed by the households, socio economic activities and challenges of using groundwater sources. The Village Executive Officers (VEOs) from each village and the chairperson and secretary of Ubaruku Mpakani (UBAMPA) were involved as the key informants. UBAMPA is a Community Water Supply Organization (COWSOs) that serves for Ubaruku and Mpakani villages.

The key informant interviews were conducted to obtain information about the number of groundwater sources in the villages and the intervention supporters of the constructed

groundwater sources. The key informants were selected based on the fact that they were well informed and responsible for keeping all information related to groundwater facilities in a village. In addition, household survey guided by a questionnaire was used to collect quantitative data on demographic characteristics and the situation of groundwater in the selected villages. The situation of groundwater included groundwater usage, types of groundwater source, factors that influenced the households to access groundwater source, other sources of water accessed by the households, distance from a household to the groundwater source and estimated amount of water used at the household per day per capita.

2.2.4 Data analysis

Content analysis was used to analyze qualitative data by summarizing field data based on objectives of the study. The quantitative data were analyzed by using Statistical Package for Social Sciences (SPSS) by computing descriptive statistics to obtain means and percentage distribution of the responses. To determine the normality of data, the Shapiro-Wilk test was used and it showed no significant ($P > 0.05$) difference between the normal curve and the curve of the amount of water used at the household per day and distance of a household to the groundwater source. This implies that the population from which the data were collected was normally distributed.

Therefore, one way Analysis of Variance (ANOVA) was used to test differences of the amount of water used at a household level per day and distance from the groundwater source to a household between the villages. The Post hoc particularly Tukey's Honestly Significant Difference (HSD) was used for multiple comparisons. The test is designed to make all pairwise comparisons while maintaining the experiment wise error rate at the pre-established level (Hinkle *et al.*, 1988). In addition, the Independent T-test was used to

compare the amount of water used at a household level reported by men and women respondents. This test is useful to compare mean difference on continuous variables for two different groups if the data are normally distributed (Pallant, 2007).

The analysis also involved running correlation whereby Pearson correlation coefficient was computed to determine whether there was any relationship between the estimated amount of groundwater in litres used at a household per day and respondents characteristics including years of schooling of the household head, household size, annual income of the household, number of years a household resided in the village, and distance of a household to the groundwater source in metres. The Pearson correlation coefficient (r) is a measure of the strength of a relationship between two continuous variables. The value of ' r ' normally ranges between -1 and 1 (Fenton and Neil, 2012). The strength of the relationship can be categorized into three groups. If ' r ' ranges from 0.10 to 0.29 the relationship is considered to be weak whereas if ' r ' ranges from 0.30 to 0.49 the relationship is said to be moderate. In addition, a strong relationship exists when ' r ' ranges from 0.50 to 1.0 whereas a perfect relationship exists if ' r ' is either -1 or 1 (Pallant, 2007).

2.5 Results and Discussion

2.5.1 Respondents' socio-economic characteristics

Table 2.1 presents respondents' characteristics. The results showed that half (50%) of the respondents were females. The results also show that 58.9% and 33.3% of the respondents were household heads and spouses respectively. The rest were the grown-up other household members. The analysis also show that 62.2% of the respondents depended on farming activities as their main source of income followed by 18.9% who depended on small scale businesses. This implies that majority of the respondents were smallholder farmers. Most of the United Republic of Tanzania reports indicate that more than 70% of

the Tanzania work force depends on agricultural sector for the livelihoods (Lwoga *et al.*, 2011).

Table 2.1: Respondents' socio-economic characteristics (n=90)

Sex	Nyeregete	Ubaruku	Mwaluma	Total
Male	15(50)	15(50)	15(50)	45(50)
Female	15(50)	15(50)	15(50)	45(50)
Relationship to the Household head				
Head of Household	22(73.3)	16(53.3)	15(50)	53(58.9)
Spouse	7(23.3)	8(26.7)	15(50)	30(33.3)
Another Male Household member	0(0.0)	3(10)	0(0.0)	3(3.3)
Another Female Household member	1(3.3)	3(10.0)	0(0.0)	4(4.4)
Main source of income				
Farming	20(66.7)	20(66.7)	16(53.3)	56(62.2)
Livestock keeping	1(3.3)	2(6.7)	1(3.3)	4(4.4)
Small scale business	6(20.0)	7(23.3)	4(13.3)	17(18.9)
Casual labour	0(0.0)	0(0.0)	2(6.7)	2(2.2)
Salary	3(10.0)	1(3.3)	7(23.3)	11(12.2)

Note: Numbers in brackets are percentages

Table 2.2 presents respondents' response on other sources of income apart from what is considered as a main source. The results show that 37.8% of the respondents reported livestock keeping. The rest reported farming, casual labour, remittance and small scale business as their households' supplementary sources of income. Livestock keeping and crop production as sub sectors are the leading households' other sources of income. This implies that majority depended on farming and or livestock keeping in supporting their livelihoods. These results are in line with literature which indicates that about 35% of the households in Tanzania are engaged both in crop production and livestock keeping (Engida *et al.*, 2015).

Table 2.2: Other sources of income (n=90)

Source of income of the household	Nyeregete	Ubaruku	Mwaluma	Total
Farming	5(16.7)	5(16.7)	9(30)	19(21.1)
Livestock keeping	10(33.3)	13(43.3)	11(36.6)	34(37.7)
Casual labour wages	9(30)	3(10)	5(16.7)	17(18.9)
Remittances	3(10)	1(3.3)	2(6.7)	6(6.7)
Small scale business	3(10)	5(10)	0(0)	8(8.9)
None	0(0)	3(10)	3(10)	6(6.7)
Total	30(100.0)	30(100.0)	30(100.0)	90(100.0)

Note: Numbers in brackets are percentages

Table 2.3 shows the respondents' marital status and education levels. The findings show that 72.2% of respondents were married. Out of married couples, 55.4% were male. This indicates that the married males were many in number than the married females. With regard to the respondents' education level, 53.3% of the respondents held primary education. This implies the majority had acquired basic education. Education is a major means of providing individuals with opportunity to achieve their full potential. This involves the ability of acquiring knowledge, skills, values and attitudes needed for various social and economic roles, as well as for their all-around personal development (URT, 2000). Thus low education level may constrain development at the household level.

Table 2.3: Respondents' marital status and education level (n=90)

Marital status	Male	Female	Total
Married	36(80.0)	29(64.4)	65(72.2)
Single	4(8.9)	2(4.4)	6(6.7)
Divorced	1(2.2)	5(11.1)	6(6.7)
Widowed/widower	4(8.9)	9(20.0)	13(14.4)
Education level			
Non-formal education	10(22.2)	8(17.8)	18(20.0)
Primary education	26(57.7)	22(48.9)	48(53.3)
Secondary	3(6.7)	12(26.7)	15(16.7)
Tertiary education	3(6.7)	2(4.4)	5(5.6)
Higher Learning education	3(6.7)	1(2.2)	4(4.4)

Note: Numbers in brackets are percentages

Table 2.4 shows respondents' age, household size, total number of years a household resided in the village and household annual income. The results show that the mean age of the respondents was 43 years. This implies that majority of the respondents were young adults who are potential workforce on households' socio-economic development. Furthermore, the findings show that the mean number of persons per household was 5.9. This number is above 4.9 persons reported at the national level (URT, 2012a). With regard to the total number of years in which respondents resided in the village; the results show that the mean number was 18.4 years. This implies that respondents had enough experience with regard to water resource in the villages. The results also show that the mean annual income of household was Tanzania Shillings (TZS) 3 074 500, equivalent to TZS 256 208 per month per household. This amount is higher than the mean income at a national level. Literature shows that the mean household income is TZS 146,000 per month per household in Tanzania (URT, 2012a). The higher household income in the study area can be associated with potential socio-economic activities including paddy production that are undertaken in the Usangu plain including Mbarali District.

Table 2.4: Descriptive statistics on respondents' characteristics (n=90)

Category	Minimum	Maximum	Mean	Std. Deviation
Age of the respondent	22	72	43.2	12.1
Number of people in the household	2	11	5.9	1.8
Number of years the household heads resided in a village	3	50	18.4	10.9
Annual household income	350 000	15 000 000	3 074 500	3 177 319

2.5.2 Groundwater sources and their challenges

Table 2.5 presents types of groundwater sources reported by the respondents. The results indicate that 66.7% of the respondents used deep groundwater wells. The rest used drilled shallow wells.

Table 2.5: Groundwater sources used (n=90)

Type of groundwater source	Nyeregete	Ubaruku	Mwaluma	Total
Deep well	0(0.0)	30(100)	30(100)	60(66.7)
Drilled Shallow well	30(100)	0(0.0)	0(0.0)	30(33.3)
Total	30(100)	30(100)	30(100)	90(100)

Note: Numbers in brackets are percentages

These results deviate from the 2012 Population and Housing Census (PHC) report, which show that dug wells were the main source of water in rural areas in Tanzania (URT, 2012a). About 25% of households in rural areas in Tanzania depend on unprotected water dug wells (URT, 2014). Possibly, this difference can be associated to lack of groundwater intervention in most of rural areas. The key informants reported that all groundwater sources in the study area were financed by the international donors via the Tanzania Government as an initiative to support local governments as well as the entire community to improve water services for domestic uses. For instance, the constructed deep and drilled wells at Ubaruku, Mwaluma and Nyeregete villages were constructed by local government at the district level with financial support from the World Bank (WB), United Nations Children's Fund (UNICEF) and Danish International Development Agency (DANIDA) water programme. This connotes that there was no direct internal initiatives established by community to finance groundwater interventions. Dependence on external financial support jeopardizes sustainability of the groundwater facilities. Apart from deep and drilled wells, direct observation and Focus Group Discussion (FGDs) revealed several dug wells owned by individual households. Even though, they were used communally. In addition, FGDs at Nyeregete and Ubaruku villages reported that: *“People tend to construct wells around their houses for various purposes such as livestock use, brick making, domestic use and small scale irrigation”*. This indicates that apart from deep and drilled

wells, dug shallow wells were commonly used by the respondents for various socio-economic activities.

By definition, hand dug wells are wells excavated and lined by human labour, usually by entering the well with a variety of hand tools. They may be as small as 80 cm diameter, and can range in depth from about five metres deep, to deep wells over 20 metres deep (Collins, 2010). The key informants reported that the average depth of deep wells and drilled shallow wells were 85 and 8 metres respectively. During FGDs, it was also reported that both deep and drilled shallow wells provided enough water throughout a year. *“all the time our well provides a lot of water. Therefore people can access water at any time except when they are under maintenance”* (FGD at Nyeregete village).

The use of groundwater has various advantages such as accessibility to water source in terms of distance, cleanness and adequacy of groundwater resource. However, during the Focus Group Discussions, it was said that groundwater use had a number of challenges. One of them is lack of knowledge on how and where to construct dug wells at a household level as it was acknowledged by one of key informants that: *“We use our own indigenous knowledge to dig wells around our homes to satisfy our household water needs but most of us know nothing about location. For instance, most of dug well users in this village are not well informed about the proper distance from pit latrines to the groundwater sources”* (FGD at Nyeregete). Literature recommends that the bottom of pit latrines should be at least 2 m above groundwater level, and a minimum horizontal distance of 30 m between a pit latrines and dug well. This recommendation aims to limit exposure to microbial contamination (Fenner *et al.*, 2007).

Another challenge is poor wells protection. Through direct observation in all villages, the study found most of the dug wells were not and/or were poorly protected. Although this challenge is well known by the village authorities there was no seriousness in managing it. *“Those dug wells are constructed by the households themselves for their own uses. Thus it is their responsibility to ensure that wells are well protected. I, sometimes, remind them to do it, but most of them are not protecting their wells properly”* (Source: key informant at Nyeregete). Although Water Resource Management Act (WRMA) no 11 and 12 of 2009 directs that all groundwater sources have to be protected (URT, 2009) the reality is the reverse. As such, groundwater sources can endanger household members.

In addition, uncertainty on groundwater safety for human consumption was also mentioned as a challenge. Even if the resource is perceived by the groundwater users as cleaner than surface water, FGDs reported groundwater from dug and drilled shallow wells were not treated. *“We thank God that we have a lot of water from our groundwater sources. But to what extent the resource is safe for our health remains a mystery. We do not treat our drilled shallow wells or dug wells”* (said by key informant in Nyeregete). According to the Secretary of COWSO it was reported that groundwater sample from the deep well is taken by UBAMPA once per year to the regional laboratory to test whether the resource is still healthily for human consumption. However, the UBAMPA had no say about status of dug wells owned by individual households. *“Water from this source is treated every month to ensure safety to all groundwater users. We know that if the source is not protected as well as if the resource is not treated can lead into health problems. But we have no access to enforce water sources protection and water resource treatment to dug wells that are normally constructed and controlled by individual households”* (Key informant at Ubaruku village). Generally, the findings related to dug wells indicate that the situation of dug wells in terms of protection and hygiene were not well known by the

villages authorities. Thus, there is a possibility of the groundwater users using these sources to get diseases such as typhoid and cholera.

Other water sources reported by the respondents apart from groundwater wells are presented in Table 2.6. The results show that 34.4% did not report other water sources apart from groundwater source while 30% and nearly 29% of the respondents reported water from springs and canals respectively. Literature defines springs as a land to which water rises naturally from below the ground flows by gravity. Normally, it occurs where the water table is very near or meets land surface (Awadh *et al.*, 2013). Canal is defined as the main ditch which is used to convey water from an intake built from a river. The conveyed water from the canal is led to paddy fields through field(s) ditches or furrow(s). Therefore, village dwellers around the canal tend to use it as other source of water for domestic uses.

Participants of Focus Group Discussions reported that most of people did not prefer using canals and springs sources because of pollution caused by socio-economic activities such as irrigation whereby mortars to pump water from springs or canals are used. Water becomes contaminated since some fuel drops remain in the water. In addition, human behaviour such as bathing or dumping solid wastes also discourages the use of water from springs and canals for domestic uses particularly for drinking. This was revealed by FGDs participant as: *“sometimes when we fetch water we see a lot of things such as plastic materials, tarnished clothes, faeces just few metres in or around water sources. I think such a situation also accelerates the use of groundwater at the households.”* (Source: FGDs in Mwaluma village). However, it should be noted that groundwater like surface water is also prone to pollutants. Thus, to deviate from using surface water to groundwater

because of pollution created by the resource users themselves, is likely to shift the problem from the visible to the invisible resource.

Table 2.6: Other water sources reported by the respondents in percentages (n=90)

Source of water	Nyeregete	Ubaruku	Mwaluma	Total
Canal	0(0.0)	26(86.7)	0(0.0)	26(28.9)
Water spring	0(0.0)	0(0.0)	27(90.0)	27(30)
Rainwater collection	0(0.0)	3(10.0)	3(10.0)	6(6.7)
None	30(100.0)	1(3.3)	0(0.0)	31(34.4)
Total	30(100)	30(100)	30(100)	90(100)

Note: Numbers in brackets are percentages

2.5.3 Distance to the groundwater source

Table 2.7 presents approximate distance from home to the groundwater sources in metres. The results show that the overall mean distance from a household to a groundwater source was 249.50 metres with a standard deviation of 174.4 metres. The National Water Policy (NAWAPO) of 2002 defines water as accessible when one water point serves 250 persons within a distance of 400 meters and users spend no more than 30 minutes for a round trip (URT, 2002; Mandara *et al.*, 2016). This indicates that groundwater resource in the study area was accessible.

Although the national policy suggests a walkable distance to a water source, the reality is not the case. Literature shows that about 50% of households in arid areas obtain water service at the distance of more than 3000 metres from their home (Mkonda, 2016). This implies that groundwater resource has an advantage of being nearly accessed from home. Using ANOVA, the results of this study show that the distance from home to a water

source between the villages was significant ($P=0.0001$) (Table 2.7). Households in Ubaruku were closest to the water point while in Mwaluma they were farthest.

Table 2.7: Approximate distance from home to water source in metres (n=90)

Village Names	N	Mean	Std. Deviation	F	P-value
Ubaruku	30	174.83	120.32		
Nyeregete	30	227.00	156.14	9.036	0.001
Mwaluma	30	346.46	196.08		
Total	90	249.50	174.42		

Table 2.8 shows that there was significant difference in terms of distance in metres from household to the groundwater source between Ubaruku and Mwaluma villages ($P=0.001$). This means that households in Ubaruku village were closer to groundwater source than the households in Mwaluma village. There was also significant difference between Mwaluma and Nyeregete villages at 5% level of significance. These differences are largely associated to the total number of groundwater points within the villages. For instance, during key informant interviews, it was reported that there were 23 groundwater points in Ubaruku while Nyeregete and Mwaluma had 3 and 1 respectively. This justifies the mean of distance from home to groundwater source at Mwaluma, Nyeregete and Ubaruku villages (Table 2.7) in relation to a total number of groundwater points. Thus, proper water points' distribution in a given population is important for improving water accessibility. By definition, water point is a place whereby people get access of water service (URT, 2002). In this study, water point refers to a place whereby the households in the villages obtained groundwater from either deep or drill shallow well.

Table 2.8: Compared mean difference on the approximate distance from home to the groundwater sources (n=90)

Compared village		Mean Difference	Std. Error	P-value	95% Confidence Interval	
					Lower Bound	Upper Bound
Ubaruku	Nyeregete	-52.167	41.448	0.422	-151.00	46.67
	Mwaluma	-171.833	41.448	0.000	-270.67	-73.00
Nyeregete	Ubaruku	52.167	41.448	0.422	-46.67	151.00
	Mwaluma	-119.667	41.448	0.013	-218.50	-20.83
Mwaluma	Ubaruku	171.833	41.448	0.000	73.00	270.67
	Nyeregete	119.667	41.448	0.013	20.83	218.50

2.5.4 Reasons for accessing and using groundwater

Table 2.9 shows the reasons that influenced use of groundwater apart from other sources. The results show that 40% of the respondents used groundwater because they perceived it to be clean. Other reasons include: it is the only source of water available and near walking distance to groundwater source. This is in line with the qualitative results. For instance, FGDs reported that majority of the people in Ubaruku village used groundwater source than canal water source because groundwater was considered clean while people from Nyeregete village reported that groundwater was the only source available. With regard to the situation of water availability in Nyeregete, one of the key informants reported that *“I thank God for groundwater availability at Nyeregete village. I sometimes ask myself, what would happen in our village if we had not have groundwater resource? Perhaps many people could migrate to other villages to sustain their livelihoods”*. This implies that the availability of groundwater contributes in supporting peoples’ livelihoods.

Table 2.9: Factors influencing access to and use of groundwater source (n=90)

Reasons	Male	Female	Total
Near walking distance to groundwater source	8(17.8)	6(13.3)	14(15.5)
Adequate groundwater source	2(4.4)	4(8.9)	6 (6.7)
Affordability to groundwater charges	2(4.4)	6(13.3)	8(8.9)
It is the only source available	14(31.1)	12(26.7)	26(28.9)
Groundwater is clean and safe	19(42.2)	17(37.8)	36(40.0)
Total	45(100)	45(100)	90(100)

Note: Numbers in brackets are percentages

2.5.5 Groundwater use at a household level

Table 2.10 shows the overall amount of groundwater used per day at a household level. The results showed that the overall mean of the amount of water used at the household per day was 221 liters. This is equivalent to 41 liters per person per day in the study villages. This amount is relatively high compared to a minimum amount of 20 litres per person per day as suggested at the national level (URT, 2015). The difference can be associated to the accessibility in terms of distance from the household to the water source and its adequacy in the study villages. However, this amount of water is low compared to the United Nations (UN) recommendations on the water poverty line suggesting that a sufficient amount of water is at least 50 to 100 litres per person per day obtained from a safe source (United Nations, 2012; Akoteyon, 2016). Thus, the amount of water used at the households' level in the study villages did not meet the requirement of the UN. Nevertheless, the results on Table 2.10 show that the amount of groundwater used per person per day at Nyeregete village met the UN recommendations. Likely, the types of socio- economic activities that used groundwater in Nyeregete led to high amount of groundwater used per day per person than other villages.

Table 2.10: Amount of groundwater used per household per day in litres (n= 90)

Village	N	Mean	Std. Deviation	F	P. Value
Nyeregete	30	261.00	105.02		
Ubaruku	30	236.00	96.22	8.966	0.00
Mwaluma	30	166.00	63.65		
Total	90	221.00	97.80		

Amount of water used per person per day

Nyeregete	30	49.97	37.39	1.249	0.292
Ubaruku	30	40.09	19.99		
Mwaluma	30	39.95	24.02		
Total	90	43.34	28.22		

The results also show that there was significant difference in terms of the amount of water used at a household per day in Nyeregete and Ubaruku villages ($P=0.0001$). Furthermore, findings indicate that there was significant difference between Mwaluma and Ubaruku villages ($P=0.01$). The difference can be attributed to a number of factors including availability of other water sources. For instance, in this study, 100% of the households in Nyeregete village used groundwater because it was the only water source available. The amount of water reported at a household in Nyeregete village was higher than the amount reported at a household level in Ubaruku and Mwaluma villages respectively (Table 2.11). This variation is caused by differences in economic activities that were using groundwater resource. Through FGDs in Nyeregete village, it was reported that smallholder farmers were watering gardens using groundwater. However, in Mwaluma and Ubaruku, smallholder farmers were not using groundwater to water their gardens because of the belief that groundwater is hard water, which is unsuitable for plants growth including fruits. This perception has to be technically verified.

The results also show that there was significant difference in terms of the amount of water used per person per day at Nyeregete and Mwaluma villages ($P=0.0001$). Similarly, there was significant difference on the amount of water used per person per day at Ubaruku and Mwaluma villages ($P=0.0001$). Since these significant differences were in line with the significant differences on the amount of water used at the household per day between villages, it implies that the factors that influenced the amount of water used at the household per day were likely to influence the amount of water used per person per day too.

Table 2.11: Multiple comparisons on the amount of groundwater used per household per day in litres (n=90)

Compared villages		Mean Difference	Std. Error	P-value	95% Confidence Interval	
					Lower Bound	Upper Bound
Nyeregete	Ubaruku	95.000	23.258	0.000	39.54	150.46
	Mwaluma	25.000	23.258	0.532	-30.46	80.46
Ubaruku	Nyeregete	-95.000	23.258	0.000	-150.46	-39.54
	Mwaluma	-70.000	23.258	0.009	-125.46	-14.54
Mwaluma	Nyeregete	-25.000	23.258	0.532	-80.46	30.46
	Ubaruku	70.000	23.258	0.009	14.54	125.46
Different amount of groundwater used per person per day in litres						
Nyeregete	Ubaruku	13.48987	6.30429	0.088	10.01	40.07
	Mwaluma	25.04517	6.30429	0.000	-1.54	28.52
Ubaruku	Nyeregete	-11.55529	6.30429	0.165	-40.07	-10.01
	Mwaluma	-25.04517	6.30429	0.000	-26.58	3.47
Mwaluma	Nyeregete	11.55529	6.30429	0.165	-28.52	1.54
	Ubaruku	-13.48987	6.30429	0.088	-3.4772	26.58

Table 2.12 shows responses of male and female on the amount of water in liters used per day at a household. The results of the independent t-test indicate that there was no

significant difference between male and female responses in reporting the amount water used at the household level per day ($P > 0.05$). This can be associated to various factors including the nature of activities. For instance, the experience from the study area shows that at the household both male and females engage in brick making, watering garden and animals. These activities consume a lot of water than the amount used for cooking, bathing and washing. Even though, female respondents can be more familiar than male on the amount of water used for cooking and washing. This is because; these activities are mainly undertaken by females at a household level.

Table 2.12: Male and female responses on the amount of water in litres used at a household per day (n=90)

Groups compared	n	Mean	Std. Deviation	P-Value
Male	45	223.11	103.415	0.426
Female	45	218.89	92.986	

Table 2.13 presents directions and strengths of the relationship between the amount of water used in litres per day per household and household head education level, household size, number of years the household resided in the village, household annual income and the distance of households to groundwater sources. The results show a positive relationship between the estimated amount of water used in litres/day per household and the household size, household annual income and the number of years the household resided in the village. This implies that as the household size, the number of years the household residing in the village and the household annual income increase, the amount of groundwater used in the household per day also increases.

Table 2.13: Relationship between amount of water used at a household per day and households' characteristics (n=90)

Correlation analysis	Education level	HH Size	Years the HH resided in the village	HH annual income	Distance from home to a water source
Pearson Correlation	-.334	.010	.104	.064	-.034
Sig. (2-tailed)	.001	.923	.330	.547	.748
N	90	90	90	90	90

*Significant at 0.1%

The positive relationship between the amount of water used at the household per day and the household annual income connotes that the amount of water used at the household per day increases with mean annual income. This can be associated to two things: affordability of paying water charges, which was TZS 25 per bucket and engagement on various socio economic activities that used water resource. This implies that households with low income used the available water carefully so as to serve their money for other expenditures. On the other hand, households with high income maximized the use of water and were likely to be involved in various socio- economic activities like animal keeping, home gardening, brick making among others as they could afford to pay for the water charges.

The results on Table 2.13 also show negative relationship between the estimated amount of water used per day at a household and education level and the distance from home to the groundwater source in metres. This indicates that as the education level of the household head and the distance from the household to the groundwater sources increase, the amount of groundwater used per day decreases. In relation to the education level this can be explained with the level of awareness on the value of water and the knowledge on proper amount of water to be extracted from groundwater source. Formal education can guide water users on where, when, why and how to use water resource. The decreasing

amount of water used at the household per day in relation to the distance from home to groundwater sources is obviously explained by different reasons including serving the time that should be spent by households to collect water. Literature shows that in some parts of arid and semi-arid areas in Tanzania people spend about 3 to 6 hours to collect water for domestic use (Mkonda, 2016). This reduces time for other socio-economic activities at a household level and therefore can negatively affect development.

The results also show that there was significant ($P < 0.05$) relationship between the amount of water used in litres/household per day and the respondents' education. The strength of the relationship between the estimated amount of water and number of years the household resided in the village and the household annual income was weak. This can be attributed by various reasons including the nature of socio economic activities that households were doing. Although 62% of the respondents, reported in section 2.5.1, depended on farming activities as their main source of income, yet the results indicate that groundwater resource is less utilized compared to the number of years the household resided in the village. The weak relationship between the amount of groundwater used per household per day and the household annual income can be attributed to the established water regulations. For instance, in Ubaruku village there was a regulation of water fee that consequently involved the household income while in Nyeregete and Mwaluma there was no water fee regulation. Thus, all groundwater users' households from Nyeregete and Mwaluma regardless their income conditions were not limited by their income to use groundwater resource. In addition, there was moderate relationship between estimated amount of water used per day at a household and years of schooling of the household head. The results are in line with the respondents' education level whereas the majority acquired basic education.

2.6 Conclusions and Recommendations

The main objective of this chapter was to examine groundwater situation in selected villages in rural areas of Mbarali District where there is increasingly groundwater use for domestic purpose. Based on the results and discussion, the chapter concludes that both deep wells and shallow wells are potential groundwater sources in supporting household livelihoods. However, its potentiality is threatened by lack of awareness of groundwater users particularly on dug wells proper construction, protection and groundwater treatment for human consumption. Furthermore, the chapter concludes that groundwater in the study area is accessible in terms of distance from the households to the water sources. Lastly, the chapter concludes that the majority depend on groundwater sources because they do not have alternatives.

Based on the conclusions, the chapter recommends that different water stakeholders including local government should put more effort in addressing the challenges that exist in the interaction process between groundwater and the groundwater users. Thus, the reasonable initiatives of establishing awareness to groundwater users about the dug wells proper construction, protection and groundwater treatment for human consumption should be taken into consideration.

References

- Akoteyon, I. S. (2016). Pattern of household access to water supply in Sub-urban settlement in parts of Lagos state, Nigeria. *Malaysian Journal of Society and Space* 12: 93-106.
- Awadh, S. M., Ali, K. K. and Alazzawi, A. T. (2013). Geochemical exploration using surveys of spring water, hydrocarbon and gas seepage, and geobotany for-determining the surface extension of Abu-Jir Fault Zone in Iraq: A new way for

- determining geometrical shapes of computational simulation models. *Journal of Geochemical Exploration* 124: 218–229.
- Bailey, K. D. (1994). *Methods of Social Research*. Free Press, New York. 588pp.
- Bhatt, D. and Mall, R. K. (2015). Surface Water Resources, Climate Change and Simulation Modelling. *Aquatic Procedia* 4: 730 – 738.
- Collins, S. (2000). *Hand-dug Shallow Well*. Swiss Centre for Development Cooperation in Technology and Management, St Gallen, Switzerland. 102pp.
- Engida, E., Guthiga, P. and Karugia, J. (2015). *The Role of Livestock in the Tanzanian Economy: Policy Analysis Using a Dynamic Computable General Equilibrium Model for Tanzania*. Proceedings of International Association of Agricultural Economists, Milan, Italy, 9 August, 2015. pp22.
- Fenner, R. A., Guthrie, P. M. and Piano, E. (2007). Process selection for sanitation systems and wastewater treatment in refugee camps during disaster-relief situations. *Water and Environment Journal* 21(4): 252-264.
- Fenton, N. and Neil, M. (2012). *Risk Assessment and Decision Analysis with Bayesian Networks*. Queen Mary University of London and Agena Ltd. 524pp.
- Garduño, H., Romani, S., Sengupta, B., Tuinhof, A. and Davis, R. (2011). India groundwater governance case study. [Garduño (2011) used.pdf] site visited On 23 March, 2017.
- Hinkle, D. E., Wiersma, W. and Jurs, S. G.(1988). *Applied Statistics for the Behavioural Sciences (2nd ed.)*. Boston: Houghton Mofflin Company.493pp.
- Kangalawe, R., Mwakalila, S. and Masolwa, P. (2011). Climate change impacts, local knowledge and coping strategies in the great Ruaha river catchment area, Tanzania. *Natural Resources Journal* 2: 212-223.

- Kashaigili, J. J. (2010). Assessment of groundwater availability and its current and potential use and impacts in Tanzania. [http://gw-africa.iwmi.org/Data/Site/24/Sites/24/media/pdf/Country_Report-Tanzania.pdf] site visited on 24 May, 2015.
- Kayombo, W. C. (2016). Assessing meteorological data for reference evapotranspiration in Kyela and Mbarali district. *Journal of Environment and Earth - Science* 6 (4): 1-7.
- Lwoga, E. T., Stilwell, C. and Ngulube, P. (2011). Access and use of agricultural information and knowledge in Tanzania. *Library Review* 60(5): 383-395.
- Mandara, C. G., Lammeren, R. and Niehof, A. (2016). *Assessing Water Service Coverage by Placeholders*. Proceedings of Social Media Simulation, Abidjan, Cote d'Ivoire, 29 November -02 December, 2016.
- Mkonda, M. Y. (2015). Assessment of Water Shortage and its Implications to Gender Role in Semi-arid Areas in Mvumi Ward, Dodoma in Tanzania. *Arts Social Science Journal* 6: 142-146.
- Pallant, J. F. (2007). *SPSS survival manual: Step-by-step guide to data analysis using SPSS for windows*. Open University press, England. 350pp.
- Sirima, A. (2016). Social and Economic Impacts of Ruaha National Park Expansion. *Open Journal of Social Sciences* 4:1-11.
- URT (2000). Education in a Global Era: Challenges to Equity, Opportunity for Diversity. [http://www.gov.go.tz/egov_uploads/documents/EDUCATION_IN_GLOBAL_ERA_sw.pdf] site accessed on 16 April, 2017.
- URT (2002). *National Water Policy, the Ministry of Water and Livestock Development*. Dar-es-Salaam, Tanzania. pp20.
- URT (2009). *Water Resource Management Act no 11*. Dar es Salaam, Tanzania. 73pp.

- URT (2012a). National Baseline Survey Report for Micro, Small, and Medium Enterprises in Tanzania. [MSME-National-Baseline-Survey-Report.pdf] site visited on 16/3/2017.
- URT (2012b). Water Sector Status Report. Ministry of Water, Dar es Salaam. [http://www.Water_Sector_Status_Report-_Submitted_17-0920_12.pdf] site visited on 16/6/2017.
- URT (2014). Mbarali District Council Strategic Plan 2013/14-2017-18; Prime Minister's Office Regional Administration and Local Government. [http://www.mbaralidc.go.tz/storage/app/uploads/public/58d/10/58d101fccce7f653574057.pdf] site visited 27/5/2017.
- URT (2015). Water Sector Status Report 2015. Dar es Salaam, Tanzania. [https://www.maji.go.tz/?q=sw/filebrowser/-download/649] site visited on 5/3/2016.
- Van Camp, M., Mjemah, I. C., Al Farrah, N. and Walraevens, K. (2013). Modeling approaches and strategies for data-scarce aquifers: example of the Dar es Salaam aquifer in Tanzania. *Hydrogeology Journal* 21(2) 341-356.
- Van der Wal, A. (2010). Understanding Groundwater and Wells in Manual Drilling: Instruction Handbook for Manual Drilling Teams on Hydro-Geology for Well Drilling, Well Installation and Well Development. *PRACTICA Foundation* 3: 1-4.
- Villholth, K. G., Tottrup, C., Stendel, M. and Maherry, A. (2013). Integrated mapping of groundwater drought risk in the Southern African Development Community (SADC) Region. *Hydrogeology Journal* 21(4): 863-885.
- Water Resource Group. (2014). Tanzania: Hydro-economic overview initial Analysis. [http://www.2030WRG_TANZANIA(USED).pdf] site visited on 17/2/2016.

Wijnen, M., Benedicte, A., Bradley, Ward, C. and Huntjens, P. (2012). Managing the Invisible Understanding and Improving Groundwater Governance. [<http://documents.worldbank.org/curated/en/450431468157768820/pdf/717420WP0Box370naging0the0invisible.pdf>] site visited on 11/9/2017.

Yang, Z., Zhou, Y. and Uhlenbrook (2014). Multi-method approach to quantify groundwater/surface water-interactions in the semi-arid Hailiutu River basin, northwest China. *Hydrogeology Journal* 22: 527–54.

CHAPTER THREE

3.0 Groundwater Users' Awareness of Water Institutions in Tanzania: A Case Study of Mbarali District, Mbeya Region

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3.1 Abstract

This chapter examines awareness of groundwater governance regarding water institutions. The chapter adopted sequential exploratory research design to collect quantitative and qualitative data. The sample size was 90 groundwater users; out of 50% were women. Descriptive statistics, Kruskal Wallis H Test and Mann Whitney U Test were used to analyze quantitative data while qualitative data were subjected to content analysis. The results show that 50% of the respondents showed average awareness of formal institutions whereas 70% and 57.7% of the respondents showed high awareness of norms and values respectively. In addition, the results showed statistically significant difference on the extent of respondents' awareness on water institutions ($P=0.0001$). Furthermore, there was no significant ($P>0.05$) difference on awareness of formal institutions between male and female respondents. The chapter concludes that there is higher groundwater users' awareness on the role of informal institution including norms and values than formal institutions such as by-laws, policy and Water Resource Management Act. The chapter

recommends that there should be initiatives to raise awareness of formal institutions at a local level because formal and informal institutions are equally important for groundwater governance.

Keywords: Water users, awareness, formal institutions, informal institutions, water governance, Tanzania

3.2 Introduction

In recent years, water governance has been considered critical worldwide. Majority of Sub-Saharan African countries have undertaken transformation on water governance aspects particularly water institutions to enhance water management. According to Calder (2005) and Mosha *et al.* (2016), the transformations on water governance correspond to the Integrated Water Resource Management (IWRM) approach that highlights decentralization principles of water management to local water users. Water institutions guide the responsible ones including groundwater users to manage water resource.

In Tanzania, the government acknowledges the importance of both formal and informal water institutions in influencing individuals' behaviour for water management. Water management, both for surface and groundwater, is governed by the National Water Policy (NAWAPO) of 2002 and the Water Resource Management Act (WRMA) no 11 and 12 of 2009, Water Supply and Sanitation Act of 2009 parallel with the informal institutions like norms, values and beliefs (Maganga, 2002; Sokile and Van Koppen, 2003). As long as local community is formally recognized and encouraged by the water policy and WRMA to participate fully on water resource management, the importance of understanding their awareness of water institutions becomes necessary.

Although literature (Pavelic, 2010; Ngailo *et al.*, 2016) reports awareness of local communities on water institutions in general, little is known about the extent of local

community awareness particularly on groundwater related water institutions. This chapter is guided by the following questions: To what extent groundwater users are aware of groundwater related institutions? What is the overall difference on the extent of awareness among groundwater users? What is the overall difference on the extent of awareness of water institutions between male and female? Understanding the extent of awareness of groundwater users about the institutions related to groundwater governance is necessary. This is because; it reflects the potentiality of those institutions in influencing the individuals' behaviour into water governance. This chapter is divided into four major parts. The first part introduces the chapter and the research gap. Part two presents methodology used while part three presents results and discussion. The last part presents conclusions and recommendations.

3.3 Methodology

3.3.1 Study Area

This study was conducted in Mbarali District, Mbeya Region. The district is located at latitude 8° 51' South, longitude: 33° 51' East. According to Kangalawe *et al.* (2012), the altitude of the study district ranges from 1 000 to 1 800 meters above sea level. The average of temperature ranges between 19°C to 35°C. In addition, the district covers an area of 16 632 square kilometres and has a population of 300 517. Furthermore, the district is divided into 20 wards with a total of 99 villages. The main soil characteristics in Mbarali District are dark grey and prismatic cracking clays. According to Kayombo (2016) and Sirima (2016), water sources in the district include groundwater laid in the Great Ruaha River Catchment, which is one of the four sub-basins of the Rufiji River Basin. The district obtains 600 mm mean annual rainfall which falls between December and April. This amount of rainfall indicates that the district is vulnerable to water scarcity.

3.3.2 Research design

The study adopted sequential exploratory research design with two phases. In the first phase, qualitative data were collected and analyzed and the results were used to refine questions in the questionnaire for the next phase of data collection that employed a household survey. To collect qualitative data, Focus Group Discussions (FGDs) and key informant interviews guided by checklist of items were used. Quantitative data were collected through household survey using a structured questionnaire.

Groundwater users for domestic use composed the study population whereas sampling procedures involved purposive selection of three villages out of 99 in the district and simple random sampling was used to select the respondents. Nyeregete, Ubaruku and Mwaluma from Rujewa, Ubaruku and Ihahi wards respectively were the selected villages. In each village 30 respondents were randomly selected making a sample size of 90 respondents. According to Bailey (1994), this sample size is appropriate because it allows statistical analysis leading to reasonable conclusions.

One FGD was conducted in each village. The study used sex as a criterion to select FGDs participants in order to understand whether there is difference in awareness of water institutions. Each FGD comprised of 8-12 participants. The proportion of women and male participants per group ranged from 5 to 7. Females were involved in the FGDs because they are responsible to fetch water for domestic uses and therefore they are likely to have enough information. The information gathered during FGDs captured groundwater users' awareness on groundwater related formal institutions, norms and values. The Village Executive Officers (VEOs) from each village and the chairperson and secretary of Ubaruku Mpakani (UBAMPA) were involved as the key informants. UBAMPA is a

Community Water Supply Organization (COWSO) that serves at Ubaruku and Mpakani villages.

The key informant interviews were conducted to obtain information about the mechanism used to inform groundwater users on water institutions. The key informants were selected based on the fact that they are responsible to ensure that water institutions within their localities are clearly understood and observed by the resource users. In addition, household survey guided by a questionnaire was used to collect quantitative data on demographic characteristics and respondents' awareness on formal institutions, norms and values.

3.3.3 Data analysis

Content analysis was employed to analyze qualitative data whereby filed data were summarized based on objectives of the study. Statistical Package for Social Sciences (SPSS) was used to analyze quantitative data by computing descriptive statistics to obtain percentage distribution of the responses. A Summated Index Scale was used to measure the extent of awareness of water institutions among respondents. A total of 15 statements were used to measure the extent of awareness both for formal institutions, norms and values. Every respondent was asked to respond whether he/she strongly disagreed (1 score), disagreed (2 scores), neutral (3 scores), agreed (4 scores) or strongly agreed (5 scores) on each item of the scale. The median was used as cut-off point between low, medium and high extent of awareness. The scores below the median represented low extent of awareness, the median represented medium and the scores above the median represented high extent of awareness on water institutions.

Overall, 6 to 20 scores represented low awareness, 21 scores represented medium and 22 to 30 scores represented high awareness of formal institutions. Additionally, 4 to 17 scores represented low extent of awareness of norms, 18 scores represented medium and 19 to 20 scores represented high awareness of norms. Furthermore, 5 to 11 scores represented low awareness of values, 11.50 scores represented medium and 12 to 25 scores represented high extent of awareness of values. Reliability analysis was done so as to assess internal consistence of the scale. In this study, the awareness of water institutions had acceptable internal consistency with a Cronbach's alpha value of 0.703. According to George and Mallery (2003), an alpha value of 0.7 and above is acceptable. Cross tabulation was used to compare the extent of awareness between the villages. The Kruskal Wallis H Test was used to determine whether there were statistically significant differences on level of awareness between the three villages. The test is a non- parametric statistic useful for determining significant differences between more than two independent groups for ordinal dependent variable (Pallant, 2007). The Mann Whitney U test was used to compare the median differences between the overall extent of male and female awareness on water formal institutions, norms and values. The test is useful to assess statistically significant differences for ordinal dependent variable by a single dichotomous independent variable (Pallant, 2007).

3.4 Results and Discussion

3.4.1 Respondents' characteristics

In relation to the respondents' characteristics Table 3.1, the results show that 50% of the respondents were females. It is because the study was planned to capture male and females' awareness. The results also show that 58.9% and 33.3% of the respondents were household heads and spouses respectively. The rest were other mature household members. The results also show that 62.2% of the respondents depended on farming

activities as their main source of income followed by 18.9% who depended on small scale businesses. This implies that majority of the respondents were smallholder farmers. According to Lwoga *et al.* (2011), about 70% of the Tanzania work force depends on agricultural sector for the livelihoods.

Table 3.1: Respondents' characteristics (n=90)

Sex	Nyeregete	Ubaruku	Mwaluma	Total
Male	15(50)	15(50)	15(50)	45(50)
Female	15(50)	15(50)	15(50)	45(50)
Total	30(100)	30(100)	30(100)	90(100)
Relationship to the Household head				
Head of Household	22(73.3)	16(53.3)	15(50)	53(58.9)
Spouse	7(23.3)	8(26.7)	15(50)	30(33.3)
Son	0(0.0)	3(10)	0(0.0)	3(3.3)
Daughter	1(3.3)	3(10.0)	0(0.0)	4(4.4)
Total	30(100)	30(100)	30(100)	90(100)
Main source of income				
Farming	20(66.7)	20(66.7)	16(53.3)	56(62.2)
Livestock keeping	1(3.3)	2(6.7)	1(3.3)	4(4.4)
Small scale business	6(20.0)	7(23.3)	4(13.3)	17(18.9)
Casual labour	0(0.0)	0(0.0)	2(6.7)	2(2.2)
Salary	3(10.0)	1(3.3)	7(23.3)	11(12.2)
Total	30(100.0)	30(100.0)	30(100.0)	90(100.0)

Note: Numbers in brackets are percentages

Table 3.2 shows respondents' marital status and education levels of the respondents. The results indicate that 72.2% of the respondents were married. In addition, 80% and 64.4% were married male and female respectively. The results connote that the married males were many in number compared to the married females. With regard to the respondents' education level, 53.3% of the respondents had primary education. This implies that the majority had acquired basic education. Education is a major means of providing individuals with opportunity to achieve their full potential. This involves the ability of acquiring knowledge, skills, values and attitudes needed for various social and economic

roles, as well as for their all-around personal development (URT, 2000). Low education may constrain the extent of awareness of groundwater users about formal institutions since they are in written form. For someone to read and understand water formal institutions properly requires formal education.

Table 3.2: Respondents' marital status and education level (n=90)

Marital status	Male	Female	Total
Married	36(80.0)	29(64.4)	65(72.2)
Single	4(8.9)	2(4.4)	6(6.7)
Divorced	1(2.2)	5(11.1)	6(6.7)
Widowed/widower	4(8.9)	9(20.0)	13(14.4)
Education level			
Non-formal education	10(22.2)	8(17.8)	18(20.0)
Primary education	26(57.8)	22(48.9)	48(53.3)
Secondary	3(6.7)	12(26.7)	15(16.7)
Tertiary education	3(6.7)	2(4.4)	5(5.6)
Higher Learning education	3(6.7)	1(2.2)	4(4.4)
Total	45(100)	45(100)	90(100)

Note: Numbers in brackets are percentages

Table 3.3 shows respondents' age, household size, total number of years a household resided in the village and household annual income. The results show that the mean age of the respondents was 43 years. This implies that majority of the respondents were young adults who are expected to have high awareness of water institutions. Furthermore, the findings show that the mean number of persons per household was 5.9. This number is above 4.9 persons reported at the national level (URT, 2012). With regard to the total number of years in which respondents resided in the village; the results show that the mean number was 18.4 years. Therefore the majority had enough time periods to share informal institutions for water governance.

The results also show that the mean annual income of the households was Tanzania Shillings (TZS) 3 074 500, equivalent to TZS 256 208 per month per household. This amount is higher than the mean income at a national level. Literature shows that the mean household income is TZS 146 000 per month per household in Tanzania (URT, 2012). The higher household income in the study area compared to the national level can be associated with potential socio- economic activities especially paddy crop grown in the Usangu plain (Mbarali District) (Ngailo *et al.*, 2016).

Table 3.3: Descriptive statistics on respondents' characteristics (n=90)

Variable	Minimum	Maximum	Mean	Std.Deviation
Age of the respondent	22	72	43.2	12.1
Total number of people in the household	2	11	5.9	1.8
Total number of years the HH resided in a village	3	50	18.4	10.9
Annual household income(Tshs)	350 000	15 000 000	3 074 500	1 177 319

3.4.2 Respondents' awareness of formal institutions

Table 3.4 presents respondents' awareness of formal institutions. Combining the columns for strongly disagree and disagree, the results show that 71% of the respondents were not aware of the regulations that require all groundwater wells to be registered by the water basin authorities. Based on the same columns, the findings also show that 61% of the respondents were not aware of water regulation that directs groundwater users to protect wells from pollution. Furthermore the findings show that 61%, 55.5%, 49.9% and 44.4% of the respondents were not informed on water charges, penalizing those who breach water rules, local community participation and women active participation on water management regulations respectively. This implies that the majority of groundwater users were not well informed of formal institutions related to the groundwater resource. Thus, the Integrated

Water Resource Management intentions of developing and managing the resource through active participation of the local community can be constrained if the resource users are not well informed about formal institutions (Araral and Wang, 2013).

Table 3.4: Respondents' responses on the awareness of formal institutions (n=90)

Statements	Disagree	strongly disagree	Neutral	Agree	Strongly agree
Groundwater well should be registered	33(36.6)	31(34.4)	5(5.5)	13(14.4)	8(8.8)
Groundwater well should be protected from pollution	37(41.1)	18(20.0)	9(10.0)	18(20.0)	8(8.8)
Groundwater users should pay water charges	35(38.8)	20(22.2)	5(5.5)	26(28.8)	4(4.4)
Anyone who breaches water rules should be penalized	39(43.3)	11(12.2)	11(12.2)	23(25.5)	6(6.6)
Community should participate in decision making over resource management	38(42.2)	7(7.7)	10(11.1)	28(31.1)	7(7.7)
Women should participate actively in decision making on groundwater management	29(32.2)	11(12.2)	13(14.4)	20(22.2)	17(18.8)

Note: Numbers in brackets are percentages

Table 3.5 presents respondents awareness of norms related to the groundwater management. The findings show that 95.4%, 89.9%, 92.2% and 95.4% of the respondents were informed on the restriction of washing buckets or any other object at the water point, pouring water on the ground at the water point, passing animals around water point and carrying human activities near water point respectively. This implies that groundwater users were well informed about the norms. This can be associated by the fact that groundwater norms are subjective to groundwater users in a given locality. It means that groundwater users are the ones who formulate and practice them as agreed. Literature shows that informal institutions including norms have great influence on water governance because they are implemented by the given society (Ndelwa, 2013).

Table 3.5: Respondents' responses on the awareness of water norms (n=90)

Statement	Disagree	strongly disagree	Neutral	Agree	Strongly agree
The restriction of washing buckets/objects at water point is well known	2(2.2)	2(2.2)	0(0.0)	34(37.7)	52(57.7)
The restriction of pouring water on ground at water point is well known	6(6.6)	2(2.2)	1(1.1)	34(37.7)	47(52.2)
The restriction of passing animal at water point is well known	6(6.6)	0(0.0)	1(1.1)	29(32.2)	54(60)
The restriction of carrying human activities nearby water point is well known	2(2.2)	1(1.1)	1(1.1)	24(26.6)	62(68.8)

Note: Numbers in brackets are percentages

The awareness of respondents on values related to groundwater management is presented in Table 3.6. The findings show that 93.3%, 94.4%, 91%, 95.5% and 95.5% of the respondents were aware about the importance of groundwater community based management, women participation on groundwater decision making, equal access to groundwater resource, mutual respect among groundwater users at the water point and sanitation at water point respectively. The results indicate that majority of the groundwater users were well informed on values related to groundwater management. According to Nkonya (2006), the awareness of local community on the informal institutions including values related to water governance increases their morale of participating for water management activities. Their participation in water management process reduces the cost of water management using formal institutions. Informal institutions are cost effective compared to formal institutions because formal institutions do not evolve among the water users (Maganga, 2002).

Table 3.6: Respondents' responses on the awareness of water values (n=90)

Statements	Disagree	Strongly disagree	Neutral	Agree	Strong agree
The importance of groundwater community based management is well known	1(1.1)	2(2.2)	3(3.3)	48(53.3)	36(40.0)
The importance of women participation on groundwater decision making is well known	1(1.1)	3(3.3)	1(1.1)	55(61.1)	30(33.3)
The importance of equal access to groundwater resource is well known	3(3.3)	1(1.1)	4(4.4)	50(55.5)	32(35.5)
The importance of mutual respect among groundwater users is well known	0(0.0)	2(2.2)	2(2.2)	49(54.4)	37(41.1)
The importance of water sanitation at water point is well known	0(0.0)	1(1.1)	3(3.3)	48(53.3)	38(42.2)

Note: Numbers in brackets are percentages

3.4.3 Extent of awareness of water institutions

The overall awareness of groundwater users on formal institutions is shown in Figure 3.1. Looking at the percentage at the medium category, the findings show that 50% followed by 28.9% of the respondents had a medium and low awareness of formal institutions respectively. This shows that the majority of groundwater users had little or no information about institutions related to groundwater management. This can be associated with the ineffectiveness of the responsible water governance structures from the district level to the village level in disseminating information to groundwater users related to groundwater regulations.

During key informant interviews, it was reported that there were no directives from the water basin or district level that orient groundwater users on the institutions related to groundwater management. For instance, a key informant in one of the villages reported that “ *I have been working here as a Village Executive Officer for more than five years, but I have never received or found any document or directives that stipulate how to*

manage groundwater. Thus, we have our own norms and values that guide us on how to manage groundwater resource.” This implies that formal institutions related to groundwater resource were not well understood at the lowest level of groundwater stakeholders.

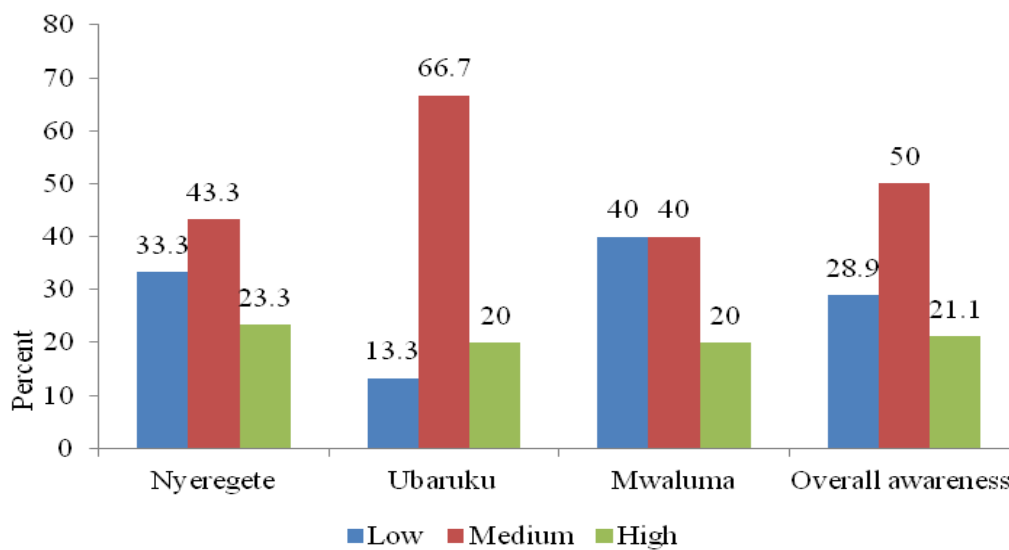


Figure 3.1: Overall awareness of formal institutions

Figure 3.2 shows the overall awareness of norms related to groundwater management. The findings show that 70% of the respondents showed high extent of awareness on the established norms for groundwater management in their respective villages. Water norms are restrictions developed by a particular group of people to enhance water resource management. Knowing the existing norms helps the individuals to live them. Literature (Kaize-Boshe *et al.*, 1994) shows that underrating informal institutions including norms will constrain water governance because informal institutions are well recognized and practiced by a given society. This also indicates that norms everywhere are well known in its context.

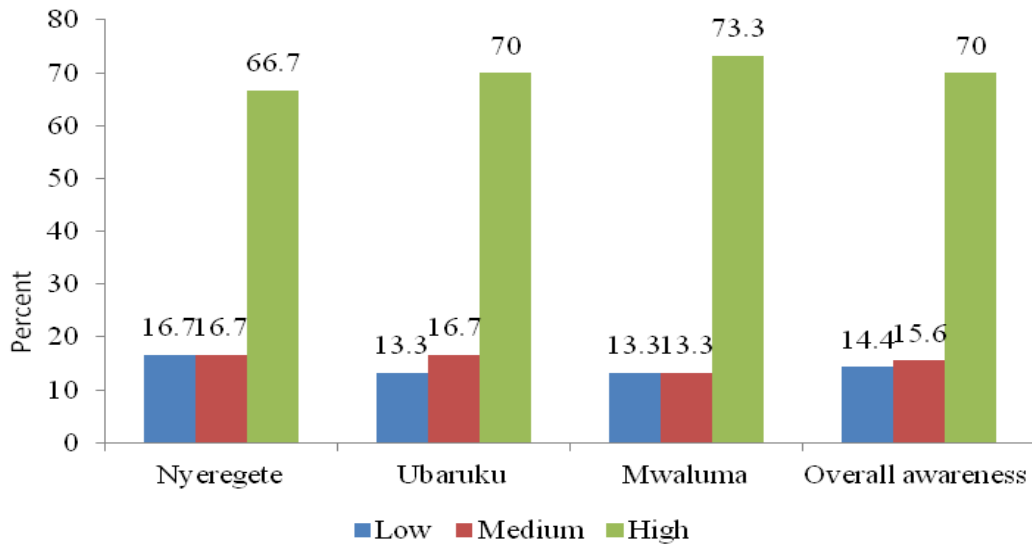


Figure 3.2: Overall awareness of norms

The respondents' awareness on the values related to groundwater resource management is presented in Figure 3.3. The findings show that 48.9% of the respondents showed high awareness of groundwater related values, followed by 41.1% of the respondents who showed medium awareness. However, there was a difference in the extent of awareness on groundwater related values between villages. For instance, in Ubaruku village, 63.3% of the respondents showed high awareness of groundwater values while in Mwaluma village 30% of the respondents reported high awareness. These findings imply that although the majority of the groundwater users at a local level were aware of the existing values, yet in some areas the awareness on groundwater values was low. This indicates that the extent of effectiveness of values in governing the resource can vary according to the extent of awareness of groundwater users on the established values between the villages.

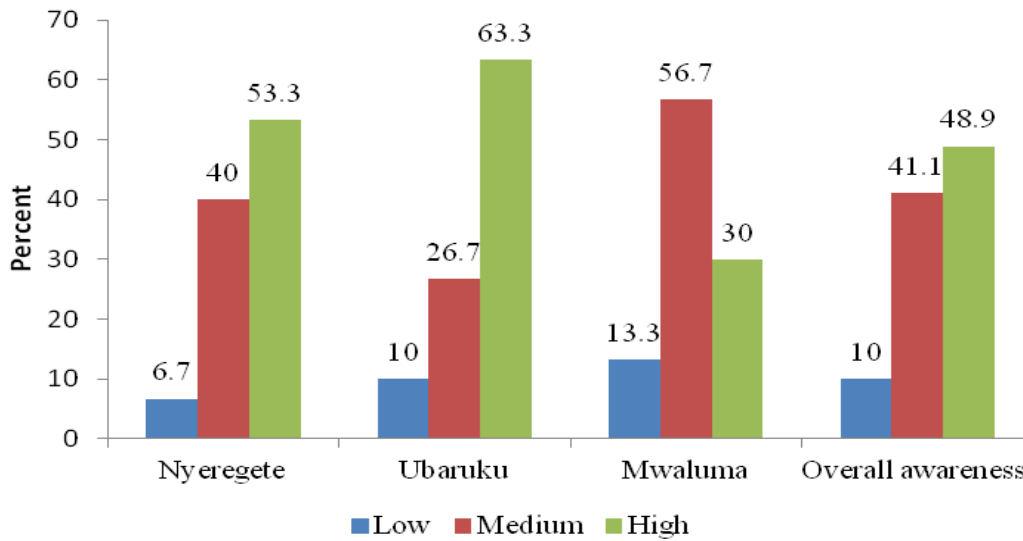


Figure 3.3: Overall groundwater users' awareness of values

Table 3.7 presents difference in responses on formal and informal groundwater institutions. Using Kruskal Wallis H test the results indicate that there was statistically significant difference in awareness of formal institutions ($P=0.0001$). Similarly, based on low, medium and high awareness, respondents' responses of awareness of norms showed significant difference ($P=0.0001$). In addition, the results showed significant difference on awareness of values ($P=0.0001$). This difference necessitates the importance of promoting formal and informal water institutions at a local level.

Table 3.7: Overall awareness of formal and informal institutions (n=90)

Formal institutions	n	Median	Chi-square	df	P-value
Low	26	7.00			
Medium	45	12.00	74.852	2	0.000
High	19	19.00			
Norms					
Low	26	15.00			
Medium	45	17.00	60.547	2	0.000
High	19	19.00			
Values					
Low	26	18.00			
Medium	45	21.00	61.087	2	0.000
High	19	23.00			

3.4.4 Awareness by respondents' sex

Table 3.8 presents male and female responses awareness of formal institutions, norms and values related to groundwater governance. Using the Mann Whitney U test, the results show that there was no statistical significant ($P>0.05$) difference on the extent of awareness of water formal institutions between male and female. During FGDs at Nyeregete and Mwaluma villages, it was reported that the groundwater related regulations were not addressed at the community level compared to norms and values. Participant of the Focus Group Discussion said that: *“Sometimes in our village through different gathering such as village meetings, and at funerals, we talk of observing the established groundwater restrictions and important behaviour or practices but we don’t talk about those formal institutions”*. This shows that both male and female were informed of informal institutions at the village level.

Table 3.8: Awareness by respondents' sex

Responses on :	n	Median	U	Wilcoxon W	Z	P-value
Formal institutions						
Male	45	12.00	909.500	1944.500	-.836	0.403
Female	45	12.00				
Norms						
Male	45	18.00				
Female	45	19.00	682.500	1717.500	-2.724	0.006
Values						
Male	45	18.00				
Female	45	19.00	716.500	1751.500	-2.432	0.015

Corresponding with key informants at Mwaluma and Nyeregete villages said that: *“we do not have any written document of formal institutions on water from the district level or water basin office that guides us on how to manage groundwater resource”*. This indicates that there was a lack of written documents from the responsible government officials about

the existing formal institutions. Since the village leaders were not aware about the institutions, it can affect negatively the process of disseminating groundwater related formal institutions to users.

The results also show that there was statistical significant ($P=0.0001$) difference between male and female respondents on the awareness of norms and values. This connotes that females were more aware about groundwater values than males. The findings correspond to the extent of awareness of norms. One can associate the female extent of awareness with the role of fetching water at the water point. The observation in the study area showed that females were the ones who fetched water at the water points. Therefore, this group is mainly experienced on groundwater values than a male group.

3.5 Conclusions and Recommendations

The objective of this chapter was to determine the extent of groundwater users' awareness of water institutions in the selected villages. Based on the results and discussion, the chapter concludes that groundwater users, both males and females, had medium awareness of formal water institutions responsible for groundwater governance. The chapter also demonstrates that groundwater users are highly informed on informal compared to formal water institutions. Women were more aware than men on informal water institutions.

Based on the conclusions, the chapter recommends policy makers and other water development stakeholders to enhance awareness about formal institutions to both male and female at the local level. Furthermore, there should be initiatives of raising males' awareness on informal institutions.

References

- Araral, E. and Wang, Y. (2013). Water Governance: A Review and Second Generation Research Agenda. *Water Resource Management* 27: 3945-3957.
- Bailey, K.D. (1994). *Methods of Social Research*. Free Press, New York.588pp.
- Calder, I. (2005). *Blue Revolution: Integrated Land and Water Resources Management*. Earth scan, United Kingdoms.376pp.
- George, D. and Mallery, P. (2003). *SPSS for Windows step by step: A simple guide and reference*. (4th ed.). Boston: Allyn and Bacon. 123pp.
- Kaize-Boshe, K., Kamara, B.,Mugabe, J. (1998). Biodiversity Management in Tanzania. [<http://www.publications.iwmi.org/pdf/H036028.pdf>] site visited on 26/8/ 2016.
- Kangalawe, R., Mwakalila, S. and Masolwa, P.(2012).Climate change impacts, local knowledge and coping strategies in the great Ruaha river catchment area, Tanzania. *Natural Resources Journal* 2: 212-223.
- Kayombo,W. C. (2016). Assessing meteorological data for reference evapotranspiration in Kyela and Mbarali district. *Journal of Environment and Earth Science* 6 (4):1-7.
- Lwoga, E. T., Stilwell, C., and Ngulube, P. (2011). Access and use of agricultural information and knowledge in Tanzania. *Library Review* 60(5): 383-395.
- Maganga, F. P. (2002). The Interplay between formal and informal systems of managing resource conflicts: Some evidence from South Western Tanzania. *European Journal of Development Research* 14 (2): 51 -70.
- Mosha, D. B., Kajembe, G. C., Tarimo, A. K. P. R., Vedeld, P. and Mbeyale, G. E. (2016). Performance of water management institutions in farmer-management Irrigation schemes in Iringa rural and Kilombero districts, Tanzania. *International Journal of Asian Social Science* 6(8): 430- 445.

- Ndelwa, L.L. (2013). Role of water user associations in the management of water use conflicts: a case of Ilonga sub-catchment in Wami-Ruvu Basin, Tanzania. [<http://hdl.handle.net/123456789/503>] site visited on 21/06/2017.
- Ngailo, J. A., Mwakasendo, J. A. and Kisandu, D. B. (2016). Rice farming in the Southern highlands of Tanzania: Management practices, socio-economic roles and production constraints. *European Journal of Research in Social Sciences* 4(3): 1-13.
- Nkonya, L. K. (2006). Customary Laws for Access to and Management of Drinking Water in Tanzania. [<http://www.lead-journal.org/content/06050leadpdf>] site visited on 24 /2/ 2017.
- Pallant, J. (2007). *Statistical Package for Social Science (SPSS) Survival Manual: A Step by Step Guide to Data Analysis Using SPSS for Windows 3rd Edition*. Open University Press, Berkshire. 335pp.
- Pavelic, P., Giordano, M., Keraita, B., Ramesh, V. and Rao, T. (2012). Groundwater-availability and use in Sub –Saharan Africa: A review of countries. [http://www.iwmi.cgiar.org/Publications/Books/PDF/groundwater_availability_and_use_in_subsaharan_africa_a_review_of_15_countries.pdf] site visited on 23/06/2016.
- Sirima, A. (2016). Social and economic impacts of Ruaha national park expansion. *Open Journal of Social Sciences* 4: 1-11.
- Sokile, C. S. and Van Koppen, B. (2003). Local Water Rights and Local Water User Entities: Unsung Heroines to Water Resource Management in Tanzania. [<https://www.gov.uk/dfid-research-outputs/local-water-rights-and-local-water-user-entities-the-unsung-heroines-to-water-resource-management-in-tanzania.pdf>] site visited 20/9/ 2017.

URT (2000). Education in a Global Era: Challenges to Equity, Opportunity for Diversity.[[www.gov.go.tz/egov_uploads/documents/EDUCATION_IN_GLOBA L_ERA_sw.pdf](http://www.gov.go.tz/egov_uploads/documents/EDUCATION_IN_GLOBA_L_ERA_sw.pdf)] site visited on 23 /2/2016.

URT (2012).Water Sector Status Report. Ministry of Water, Dar-es Salaam. [www.Water_Sector_Status_Report-_Submitted_to_DPs_17-09-2012.pdf] site visited on 16/7/ 2017.

CHAPTER FOUR

4.0 Influence of Groundwater Governance Structures and Institutions in Tanzania: A Case of Mbarali District in Mbeya Region

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4.1 Abstract

This chapter examines influence of water governance structures and institutions. The chapter adopted sequential exploratory research design to collect quantitative and qualitative data. It involved a randomly sample of 90 groundwater users whereas 50% were women. Descriptive statistics, Kruskal Wallis H Test and Mann Whitney U Test were used to analyze quantitative data while qualitative data were subjected to content analysis. The results show that 52.2% and 60% of the respondents showed that the village councils and Community Water Supply Organizations (COWSOs) respectively showed great influence, while 71.7% of the respondents showed that the influence of village water committees was average in governing the resource. Also, the results revealed that there was statistically significant difference on the overall extent of influence of the village councils in governing groundwater between villages ($P=0.0001$). Additionally, the findings show that there was no significant ($P>0.05$) difference between male and female

responses on the effectiveness of village councils, village water committees and COWSOs. Furthermore, 55.5% and 54.4% of the respondents showed high effectiveness of norms and values. The Mann Whitney U test showed that there was statistically significant difference between male and female responses on formal institutions, norms and values effectiveness ($P=0.0001$). The Kruskal Wallis H Test also showed that there was significant ($P<0.05$) difference on the extent of effectiveness of formal institution, norms and values between low, medium and high categories. The chapter concludes that COWSO was more effective in governing groundwater resource than other water governance structures. Similarly, groundwater related norms and values were more effective than formal institutions. The chapter recommends sensitization of awareness of formal institutions. This can make the formal institutions effective in terms of governing groundwater resource.

Keywords: Groundwater, governance, structures, formal institutions, informal institutions, Mbarali District, Tanzania

4.2 Introduction

In Sub Sahara African countries, the debate on water governance including groundwater has gained momentum in recent years. It is increasingly recognized that water governance is fundamental in enhancing effective water resource management. Thus, to achieve the intended objectives related to water management in a respective country; there should be well-built water governance both at national and local levels. According to Stefano *et al.* (2014), water governance comprises water governance structures or organizations and institutions. The role of the established water governance structures is to implement decisions about policies, laws, incentives and capacity development on water resource management (Durant *et al.*, 2004). Institutions are underlying practices that purposefully shape and control human behaviour in usage and management of water resource (Merrey

and Cook, 2012). These are shared social guidelines for governance structures and stakeholders on how, when, to whom, why, and where the resource should be managed, accessed and utilized.

In Tanzania, like other countries in the world, there are water governance structures that operate at various levels to govern both surface and groundwater resource. At the national level, water resource is governed by the Ministry of Water and Irrigation through Water Basin Authorities (URT, 2002). In line with the agreement from the International Conference on Water and Environment (ICWE) that was held in 1992 in Dublin-Ireland and in Rio de Janeiro-Brazil (Calder, 2005; Mosha, 2016), decentralization principle on water management in Tanzania is promoted. The concept of decentralization refers to changing power relation whereby public functions authority and responsibility are transferred from the central government to local authorities or quasi-independent government organizations or the private sector to enhance effective water management (Litvack and Seddon, 1999; Mirumachi and Wyk, 2010). Thus, the Tanzania Central Government has transferred the power of water management to the local government authorities at district and village levels. To that effect, governance structures including Village Councils, Community Owned Water Supply Organisations (COWSOs), Water Supply and Sanitation Authorities and District authorities are captioned by the Water Resource Management Act (WRMA) no 11 and 12 of 2009 being responsible for water management. In some villages, there are water committees instead of COWSOs.

Another area of concern on groundwater and surface resource management is about institutions. In Tanzania, there are no specific institutions dedicated to groundwater apart from water institutions that are established to serve both surface and groundwater (URT, 2009). The established formal water institutions including the National Water Policy

(NAWAPO) of 2002 and Water Resource Management Act (WRMA) no 11 of 2009 guide water agencies to construct rules and regulations for water governance (Mosha *et al.*, 2016) to govern the behaviour of the resource users. In addition, the formal institutions operate concomitantly with informal institutions in an overlapping fashion. Merrey and Cook (2012) differentiate formal and informal institutions as follows: formal institutions exist through constitutions, laws and defined property rights while informal ones exist through customs, norms, and codes of conduct, social taboos and practices related to resource use in a given locality.

Although governance structures and institutions look like different entities, it is undeniable that the two are dependent to each other in achieving intended objective of water governance. The effectiveness of the decentralized water governance structures is influenced by a number of factors including transparency, coordination, accountability and participatory manner in the process of water management (Hoekstra, 2006; Garduño, 2011). Furthermore, fair resource distribution, equal access to resource, mutual respect among water users and water management priorities among others are necessary for water management process.

Some authors, including Kabote and John (2017), dwell on performance of surface water governance structures and institutions in Tanzania. Their study indicated that some Village Water Committees and the Water Basin Office are weak with regard to influencing water users' behaviour to manage water resource. Furthermore, the work shows that informal institutions are more effective than formal institutions in water governance. However, to what extent water governance is effective in governing groundwater resource remains unclear. This chapter seeks answers to the following questions: What are the existing water governance structures and their roles in the study area? To what extent water

governance structures are effective in governing groundwater resource? What are the existing groundwater related water institutions and to what extent are they effective in governing groundwater resource? Knowing the effectiveness of groundwater governance enhances to maintain, develop and/ or improve the existing water governance system. This chapter is organised into four sections. The first section introduces the chapter and the research issue. Section two presents the methodology used while section three presents the results and discussion. The last section is devoted to conclusions and recommendations.

4.3 Methodology

4.3.1 Study area

This study was conducted in Mbarali District, Mbeya Region. Mbarali is one of the districts that are found in semi-arid environment in Tanzania. The district covers an area of 16 632 square kilometres and has a population of 300 517 (URT, 2014). It is located at latitude: 8° 51' (8.85°) South, longitude: 33° 51' (33.85°) East. Altitude is almost low range from 1 000 to 1 800 meters above sea level (Kangalawe *et al.*, 2012). The minimum temperature is 19°C (June-July) while the maximum is 35° C (August to December) (Kangalawe *et al.*, 2012). Administratively, the district is divided into 20 wards with a total of 99 villages. The main soil characteristics in Mbarali District are dark grey and prismatic cracking clays. In Mbarali, water resources including groundwater are laid in the Great Ruaha River Catchment, which is one of the four sub-basins of the Rufiji River Basin. The average rainfall is 600mm (450-750) per year, which falls between December and April and hence the district is vulnerable to water scarcity (Kayombo, 2016; Sirima, 2016). This explains the prevalence and high prominence of groundwater use, which is extracted from shallow-wells and boreholes (Pavelic *et al.*, 2012).

4.3.2 Research design, sampling and data collection techniques

The study employed a sequential exploratory cross-sectional research design that allows data collection at a single point in time and it is most appropriate for sample descriptive interpretations as well as determination of relationships between and among variables (Babbie, 2007). Time limit and resource available for data gathering led to the adoption of cross-sectional research design in this study (Casley and Kumar, 1988). The sampling procedures involved purposive selection of three villages out of 99 villages in Mbarali District. The villages were Nyeregete, Ubaruku and Mwaluma from Rujewa, Ubaruku and Ihahi Wards respectively. The villages were selected based on the evidence that there were groundwater sources mainly for domestic uses. In each village, 30 groundwater users were randomly selected making a sample size of 90 respondents.

Data collection methods included individual survey, Focus Group Discussions (FGDs) and key informant interviews. Quantitative data were collected using a structured questionnaire. One FGD was conducted in each village making a total of three FGDs. Sex and age were the criteria used to select FGDs participants in order to get different experiences and perceptions of groundwater governance issues. Each FGD comprised 8-12 participants. The proportion of female participants in each FGD ranged from 5 to 7. Females were involved in FGDs because they are responsible to collect water for domestic uses. FGDs and key informant interviews were used to explore the existence and responsibilities of local level water governance structures. The Village Executive Officers (VEOs) from each village and the chairperson of Ubaruku Mpakani (UBAMPA) were involved as the key informants. UBAMPA is a Community Water Supply Organizations (COWSOs) that serves at Ubaruku and Mpakani villages. The key informants were selected based on the fact that they are responsible for groundwater governance at the village level. In addition, household survey guided by a questionnaire was used to collect

quantitative data on demographic characteristics and respondents' responses on the extent to which water governance structures and institutions achieved the intended objectives with regard to groundwater governance.

4.3.3 Data analysis

Quantitative data were analyzed by using Statistical Package for Social Sciences (SPSS). A summated index scale was used to measure the extent of effectiveness of water governance institutions and structures. A total of 12 statements were used to measure water governance institutions including formal institutions, norms and values while a total of 21 statements were used to measure effectiveness of water governance structures including Water committees, Village council and COWSO. Every respondent was asked to respond whether he/she strongly disagreed (1 score), disagreed (2 scores), neutral (3 scores), agreed (4 scores) or strongly agreed (5 scores) on each item of the scale. The median was used as a cut-off point between low, medium and high effectiveness. The score below median represented low effectiveness, the median represented medium effectiveness and score above the median represented high effectiveness of water governance institutions and structures.

Reliability analysis was used to assess internal consistence of the scale. In this study, effectiveness of water institutions showed acceptable internal consistency with a Cronbach's alpha value of 0.81 and 0.73 for institutions and structures respectively. According to George and Mallery (2003), an alpha value of 0.7 and above is acceptable. Cross tabulations were used to compare the extent of effectiveness between the villages. The Kruskal Wallis H Test was used to determine whether there was statistically significant difference between the villages on effectiveness of the structures. The test is a non- parametric statistic useful in determining significant differences for more than two

independent groups for ordinal dependent variable (Pallant, 2007). The Mann Whitney U test was used to compare the median difference between the overall perceptions of effectiveness of water governance institutions and structures between male and female responses. The test is useful to assess statistically significant differences in ordinal data (Pallant, 2007).

4.4 Results and Discussion

4.4.1 Respondents' characteristics

Table 4.1 presents respondents' characteristics. The results showed that half (50%) of the respondents were males. This was intended to avoid bias between male and female groundwater users' perceptions of effectiveness of water institutions and structures. The results also show that 58.9% and 33.3% of the respondents were household heads and spouses respectively. In addition, 62.2% and 18.9% of the respondents depended on farming and small scale businesses as their main source of income respectively. This implies that majority of the respondents were smallholder farmers. Literature shows that about 70% of the Tanzania work force depends on agriculture sector for the livelihoods (Lwoga *et al.*, 2011).

Table 4.1: Respondents' characteristics (n=90)

Sex	Nyeregete	Ubaruku	Mwaluma	Total
Male	15(50)	15(50)	15(50)	45(50)
Female	15(50)	15(50)	15(50)	45(50)
Total	30(100)	30(100)	30(100)	90(100)
Relationship to the Household head				
Head of Household	22(73.3)	16(53.3)	15(50)	53(58.9)
Spouse	7(23.3)	8(26.7)	15(50)	30(33.3)
Son	0(0.0)	3(10)	0(0.0)	3(3.3)
Daughter	1(3.3)	3(10.0)	0(0.0)	4(4.4)
Total	30(100)	30(100)	30(100)	90(100)
Main source of income				
Farming	20(66.7)	20(66.7)	16(53.3)	56(62.2)
Livestock keeping	1(3.3)	2(6.7)	1(3.3)	4(4.4)
Small scale business	6(20.0)	7(23.3)	4(13.3)	17(18.9)
Casual labour	0(0.0)	0(0.0)	2(6.7)	2(2.2)
Salary	3(10.0)	1(3.3)	7(23.3)	11(12.2)
Total	30(100.0)	30(100.0)	30(100.0)	90(100.0)

Note: Numbers in brackets are percentages

Table 4.2 presents respondents' response on other sources of income apart from what is considered as a main source. Again, the results show that 37.8% of the respondents reported livestock keeping. The rest reported farming, casual labour, remittance and small scale business as their households' supplementary sources of income. Livestock keeping and crop production as sub sectors are the leading households' other sources of income that supported household livelihoods. These results are in line with literature which indicates that about 35% of the households in Tanzania are engaged both in crop production and livestock keeping (Engida *et al.*, 2015).

Table 4.2: Other sources of income (n=90)

Source of income of the household	Nyeregete	Ubaruku	Mwaluma	Total
Farming	5(16.7)	5(16.7)	9(30)	19(21.1)
Livestock keeping	10(33.3)	13(43.3)	11(36.7)	34(37.8)
Casual labour wages	9(30)	3(10)	5(16.7)	17(18.9)
Remittances	3(10)	1(3.3)	2(6.7)	6(6.7)
Small scale business	3(10)	5(10)	0(0)	8(8.9)
None	0(0)	3(10)	3(10)	6(6.7)
Total	30(100.0)	30(100.0)	30(100.0)	90(100.0)

Note: Numbers in brackets are percentages

Table 4.3 shows the respondents' marital status and education levels. The results show that 72.2% of respondents were married. In addition, the results show that 80% and 64.4% were married male and female respectively. This indicates that married males were more than the married females. The analysis show that 53.3% of the respondents held primary education. This indicates the majority had acquired basic education. Education is a major means of providing individuals with opportunity to achieve their full potential. This involves the ability of acquiring knowledge, skills, values and attitudes needed for various social and economic roles (URT, 2000). In relation to water governance, low education may hinder the effectiveness of water governance structures for governing groundwater resource. For instance, governance structures members have to know both formal and informal rules of the game. Since formal rules of the game are documented, therefore it requires education to enable the players to practice them.

Table 4.3: Respondents' marital status and education level (n=90)

Marital status	Male	Female	Total
Married	36(80.0)	29(64.4)	65(72.2)
Single	4(8.9)	2(4.4)	6(6.7)
Divorced	1(2.2)	5(11.1)	6(6.7)
Widowed/widower	4(8.9)	9(20.0)	13(14.4)
Total	45(100)	45(100)	90(100)
Education level			
Non-formal education	10(22.2)	8(17.8)	18(20.0)
Primary education	26(57.8)	22(48.9)	48(53.3)
Secondary	3(6.7)	12(26.7)	15(16.7)
Tertiary education	3(6.7)	2(4.4)	5(5.6)
Higher Learning education	3(6.7)	1(2.2)	4(4.4)
Total	45(100)	45(100)	90(100)

Note: Numbers in brackets are percentages

Table 4.4 shows respondents' age, household size, total number of years a household resided in the village and household annual income. The results show that the mean age of

the respondents was 43 years. This connotes that majority of the respondents were young adults who are potential for water resource governance. Furthermore, the findings show that the mean number of persons per household was 5.9. This number is above 4.9 persons reported at the national level (URT, 2012).

Furthermore, the total number of years in which respondents lived in the village was 18.4 years. This shows that respondents had enough experience with regard to water resource governance in the villages. The results also show that the mean annual income of household was Tanzania Shillings (TZS) 3 074 500, equivalent to TZS 256 208 per month per household. This amount is higher than the mean income at a national level. Literature shows that the mean household income is TZS 146 000 per month per household in Tanzania (URT, 2012). Possibly, this can be associated with potential socio- economic activities including paddy production that are undertaken in the Usangu plain including Mbarali District (Ngailo *et al.*, 2016).

Table 4.4: Descriptive statistics on respondents' characteristics (n=90)

Variable	Minimum	Maximum	Mean	Std. Deviation
Age of the respondent	22	72	43.2	12.1
Total number of people in the household	2	11	5.9	1.8
Total number of years the HH resided in a village	3	50	18.4	10.9
Annual household income	350 000	15 000 000	3 074 500	3 177 319

4.4.2 Governance structures of groundwater resource

Through FGDs and key informant interviews, the findings show that there were two governance structural set-ups in the study area. Figure 4.1 presents the structural setup at Nyeregete and Mwaluma villages while Figure 4.2 presents water structural arrangement at Ubaruku village. The figures indicate the existing relationship among the structures in

governing groundwater resource. The Water Committees and Village Councils were responsible structures in the villages. In addition, water governance involved other external responsible structures within the District such as Ward Development Council (WDC), Rujewa Small Urban Water Sanitation Authority, Mbarali Water Department and Mbarali Local Government Authority. Water governance structures within the District had to fulfil their responsibilities in accordance to the Rufiji Water Basin Authorities.

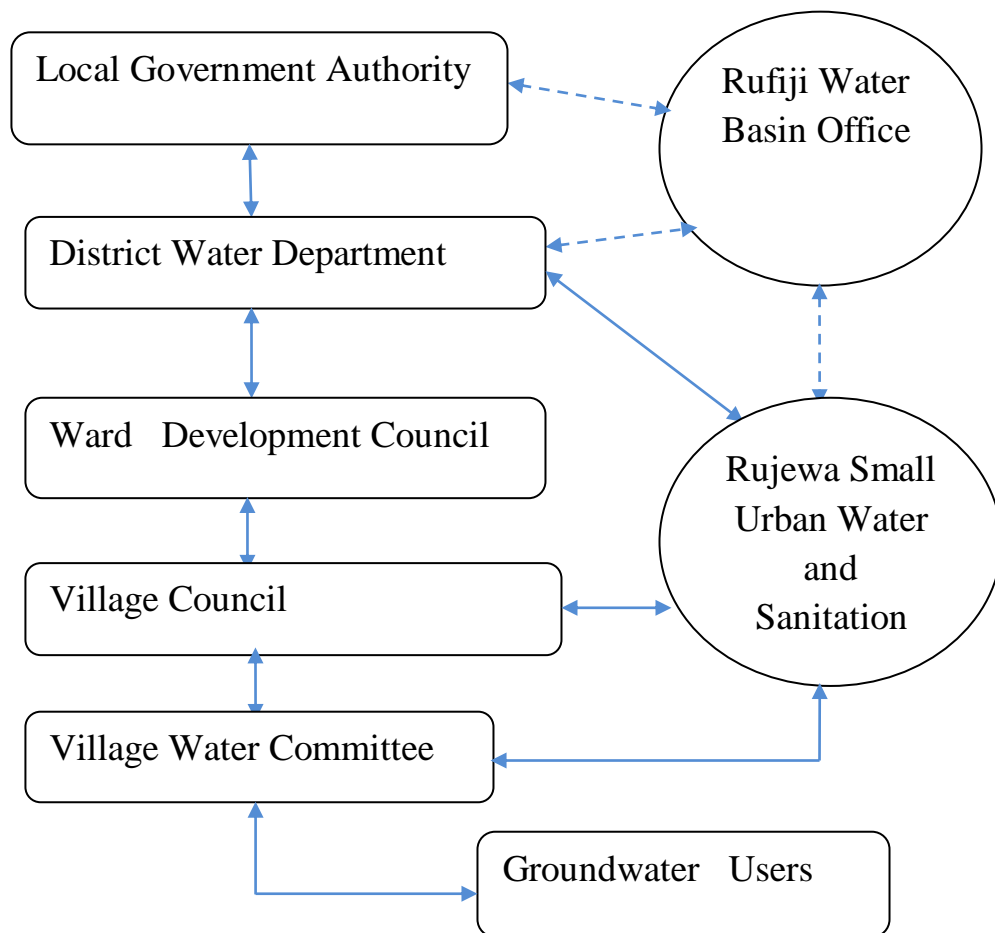


Figure 4.1: Groundwater Governance Structural setup in Mwaluma and Nyeregete villages

NB: \longleftrightarrow Means two-way strong exchange of information between the water governance structures
 \longleftrightarrow Means two-way weak exchange of information between the water governance structures

During key informant interviews participants reported that there were two-way exchange of information from the Local Government Authorities to groundwater users through established groundwater governance structures. However, they also reported weak relationship between the Rufiji Water Basin Office and the Local Government Authority through District Water Department or Rujewa Small Urban Water and Sanitation Authorities. This is in line with the quotation: *“We as a District Water Department officials work closely with all water structures at the local level. For instance, we receive water development plans from villages via WDC to the Mbarali District Council; we provide technical support of groundwater related issues such as maintenance of water pumps. But the Rufiji Water Basin is not close to the local government water related offices to make follow-up on groundwater governance issues* (Key informant interview with district water department official).

At Ubaruku village, the governance structural setup was a bit different compared to Nyeregete and Mwaluma villages (Fig. 4.2), the village had COWSO instead of water committee. The COWSO was registered since 2015 at the district council. The objective of COWSO was to ensure that water service is accessible to the people. Since COWSO is registered and responsible to the District Council, the results show that there was direct relationship between the COWSO and the District Council as well as groundwater users. There was weak relationship between COWSO and other structures such as Village Council, WDC, Rujewa Small Urban Water and Sanitation Authorities. Such situation led to misunderstanding between COWSO with the Village Council and the groundwater users. The COWSO leaders failed to provide financial report to the groundwater users because they did not have mandate to call for public meetings to provide the report. This is in line with the quotation:

“We have a report but the village leaders are not willing to call village meetings until we agree that COWSO will be operating under the Village Council. We are not willing to become responsible to the Village Council because the COWSO is already registered and responsible to the district level” (A key informant, COWSO leader). In addition, the village chairperson reported that *“in this village we don’t have Water Committee but we have COWSO known as Ubaruku Mpakani (UBAMPA). The COWSO is composed of 5 members from each hamlet and two members of the Village Council. Although the COWSO is registered it is a structure that should operate under the Village Council. They have to provide a report to the Village Council meetings then we as a Village Council should call for public meeting so as to present groundwater related financial report”*. Furthermore, the Village Council is the fundamental structure that oversees all village development activities including groundwater governance. The structure via the Village Executive Officer had to channel water development plans to the WDC then to the district council via Rujewa Small Urban Water and Sanitation Authority or District Water Department.

The contradictions that existed in Ubaruku between the COWSO and Village Council can raise some questions. For example, to which structure the COWSO should be responsible? Does the registration at the District Council shift the power of Village Council to oversee groundwater management? Are there clear directives that guide how COWSO and the Village Council should operate interdependently? A good thing is that WRMA no 12 of 2009 states clearly the functions of the district authorities, Community Owned Water Supply Organisations and Village Councils on water management. One of district authorities’ functions is to facilitate the registration of community organisations while the Village Council is responsible to promote establishment of COWSO, coordinating COWSO budgets with Village Council budgets and resolving conflicts arising within the

community organisations (URT, 2009). The existed contradiction related on groundwater governance between the Village Council and COWSO leadership in Ubaruku village highlights that there was a limited clarifications on how COWSO should operate parallel with other water governance structures at a village level.

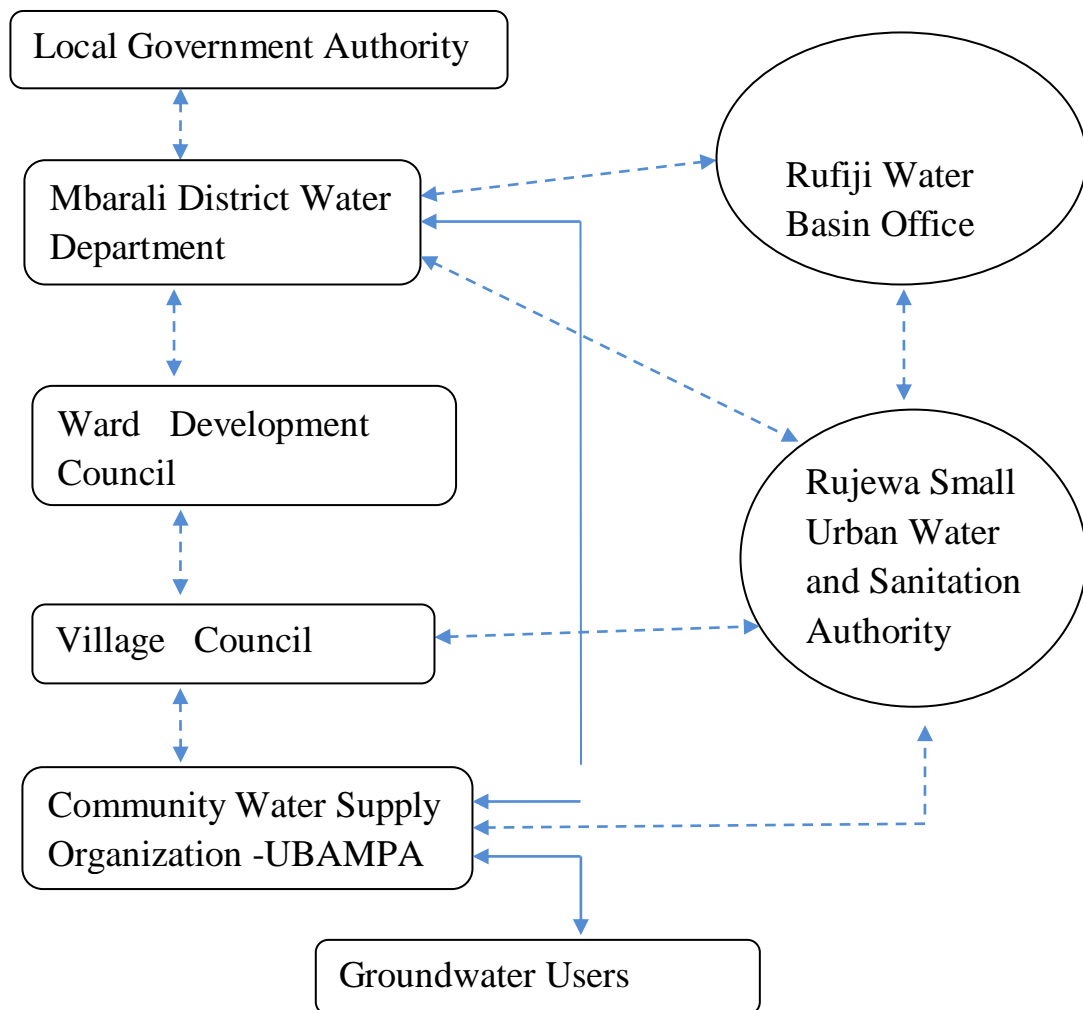


Figure 4.2: Groundwater Governance Structure in Ubaruku Village

NB: \longleftrightarrow Means two-way strong exchange of information between the water governance structures
 \dashrightarrow Means two-way weak exchange of information between the water governance structures

Based on the presented governance structural arrangements, the study proposes that the water governance structural setup (Fig. 4.2) is likely to be more effective to groundwater governance, since all the responsibilities of the related structures including Village

Council and COWSO are clearly stipulated in WRMA. This gives power to the water governance structures to fulfil their responsibilities cordially to the water management decentralization objectives. However, a clear line with regard to information of structures, responsibilities and accountabilities remain essential to avoid and/or minimize conflicts among the actors.

4.4.3 Responses on the effectiveness of water governance structures

Table 4.5 presents degree of success of Water Committees in governing groundwater resource. Overall, the columns for disagree and strongly disagree suggest that the Village Water Committees were not effective in terms of contributing money for pump maintenance, allocating fair distribution of water points, resolving groundwater related conflicts, providing financial report to the groundwater users and enhancing accountability to all groundwater users on groundwater management. However, the results indicate that the committees were effective in terms of sensitizing groundwater source protection against pollution and overseeing the implementation of groundwater norms and values in the villages.

Table 4.5: Respondents' responses on the effectiveness of water committee (n=60)

Statements	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Water committee facilitates groundwater users to contribute money for pump maintenance	11(18.3)	18(30.0)	9(15.0)	21(35.0)	1(1.6)
Water committee has led to fair distribution of groundwater points	12(20.0)	17(28.3)	9(15.0)	22(36.6)	0(0.0)
Water committee resolves groundwater related conflicts effectively	3(5.0)	35(58.3)	16(26.6)	4(4.4)	2(3.3)
Water committee provides financial report to groundwater users timely	2(3.3)	38(42.2)	3(5.0)	15(25.0)	2(3.3)
Water committee has led accountability to all groundwater users on groundwater management	3(5.0)	28(46.6)	9(15.0)	17(28.3)	3(5.0)
Water committee sensitizes strongly on groundwater source conservation	5(8.3)	7(11.6)	4(6.6)	26(43.3)	18(30.0)
Water committee oversees the implementation of groundwater related norms and values in the village	5(8.3)	6(10.0)	5(8.3)	42(70.0)	2(3.3)

Note: Numbers in brackets are percentages

Table 4.6 presents respondents' responses on the effectiveness of the Village Council on groundwater governance. Looking at the columns for agree and strongly agree the results show that the Village Councils were effective in addressing groundwater issues in public meetings, enhancing community active participation, providing groundwater related financial reports, setting priorities, plans and activities related to groundwater governance, promoting accountability of groundwater users on water management and overseeing the implementation of the related groundwater bylaws, norms and values.

Table 4.6: Respondents' responses on the effectiveness of Village Councils (n=90)

Statement	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Village council addresses groundwater management issues at the public meetings	1(1.1)	12(13.3)	1(1.1)	(60.0)	22(24.4)
Village council enhances active participation of the community on groundwater management	5(5.5)	27(30.0)	12(13.3)	39(43.3)	7(7.7)
Village council provides groundwater related financial reports	5(5.5)	16(17.7)	12(13.3)	0(44.4)	17(18.8)
Village council sets priorities, plans and activities related on groundwater management	5(5.5)	21(23.3)	19(21.1)	(43.3)	6(6.6)
Village council promotes accountability of groundwater users on water management	5(5.5)	15(16.6)	10(11.1)	(62.2)	4(4.4)
Village council oversees the implementation of the related groundwater bylaws ,norms and values	15(16.6)	15(16.6)	10(11.1)	(51.1)	4(4.4)

Note: Numbers in brackets are percentages

Table 4.7 presents respondents' responses on the effectiveness of COWSOs on groundwater governance. Based on the columns for agree and strongly agree the results show that COWSO was effective on locating groundwater points fairly, resolving groundwater related conflicts, establishing relationship with other water governance structures, enhancing accountability to all groundwater users on groundwater governance and overseeing the implementation of the related groundwater bylaws, norms and values. Nevertheless, the results show that COWSO was not effective in providing groundwater

related financial reports and enhancing fair say to all groundwater users on the related groundwater issues.

Table 4.7: Respondents' responses on the effectiveness of COWSO (n=30)

Statement	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
COWSO has led to fair distribution of groundwater points	1(3.3)	5(16.6)	2(6.6)	17(56.6)	5(16.6)
COWSO resolves groundwater related conflicts efficiently	2(6.6)	5(16.6)	2(6.6)	15(50.0)	6(20.0)
COWSO provides financial report to groundwater users timely	11(36.6)	12(40.0)	4(13.3)	3(10.0)	0(0.0)
COWSO has led fair saying to all groundwater users on resource management	6(20.0)	10(33.3)	8(26.6)	5(16.6)	1(3.3)
COWSO has a proper relationship with other water governance structures	8(26.6)	2(6.6)	5(16.6)	13(43.3)	2(6.6)
COWSO promotes accountability of all groundwater users on water resource management	3(10.0)	3(10.0)	3(10.0)	14(46.6)	7(23.3)
COWSO oversees the implementation of the related groundwater bylaws ,norms and values	3(10.0)	3(10.0)	3(10.0)	16(53.3)	5(16.6)

Note: Numbers in brackets are percentage

4.4.4 Extent of effectiveness of water governance structures

Table 4.8 presents an overall influence of COWSO in governing groundwater for Ubaruku village. The results show that 60% of the respondents' responses reported high influence. This is in line with FGDs that reported that COWSO was effective in fulfilling its roles on groundwater governance. *“COWSO is very active and close to groundwater users. It has established a system of paying water charges per bucket, fetching water at the presence water agent at every water point who collects water charges. Generally COWSO oversee all groundwater management activities properly”* FGDs at Ubaruku village.

Table 4.8: Effectiveness of COWSO in governing groundwater in Ubaruku village**(n=30)**

Extent of influence	n	Percent
Low	3	10.0
Medium	9	30.0
High	18	60.0

Figure 4.3 presents an overall effectiveness of Village Councils on water governance. The results show that 52.2% of the respondent's responses reported high effectiveness of the village councils in influencing groundwater governance. About 53.3% of the respondents' responses in Ubaruku reported that the Village Council showed low effectiveness while 73.3% and 63.3% of the respondents' responses in Nyeregete and Mwaluma villages respectively reported high effectiveness. Poor relationship between COWSO and Village Council was associated to the factors that led to low effectiveness of Village Council in Ubaruku village. The governance structural set up in Ubaruku village indicates that there was strong relationship between the COWSO and groundwater users, but the relationship of Village Council and groundwater users was weak. Participants of FGD in Ubaruku reported that: *".....we appreciate the COWSO commitment in providing water services in our village. Recently, COWSO has a good plan to distribute water service in households. But, the Village Council is not cooperative to the COWSO initiatives about groundwater development"*. That quotation justifies the positive and negative perceptions of groundwater users to COWSO and Village Council respectively about groundwater governance.

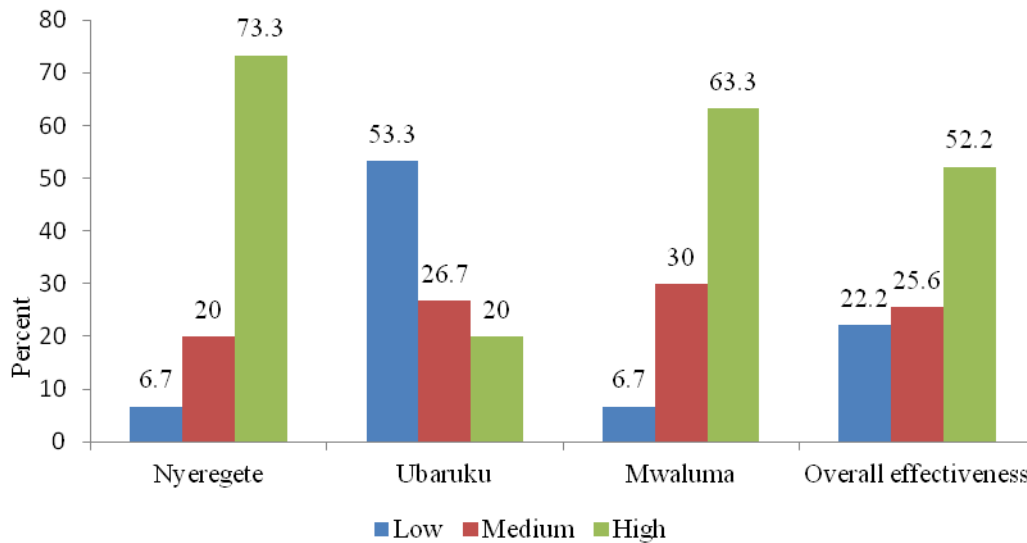


Figure 4.3: Effectiveness of Village Councils on groundwater governance

Figure 4.4 presents an overall effectiveness of Village Water Committee in governing groundwater resource. The results show that 71.7% of the respondents reported medium effectiveness. This was also supported by the key informant in Mwaluma village reported that *“we have a water committee working under the Village Social Services standing committee. The committee is responsible to coordinate all water management activities in the village. However, the committee is not directly accountable to the Village Council but to the Village Social Services Committee (VSSC)”*. The VSSC is responsible for health, education and water management issues at the village level. Thus, the extent of VSSC influence can also affect the effectiveness of water committee. The WRMA no 11 and 12 of 2009 do not recognize the presence of water committee like COWSO (URT, 2009).

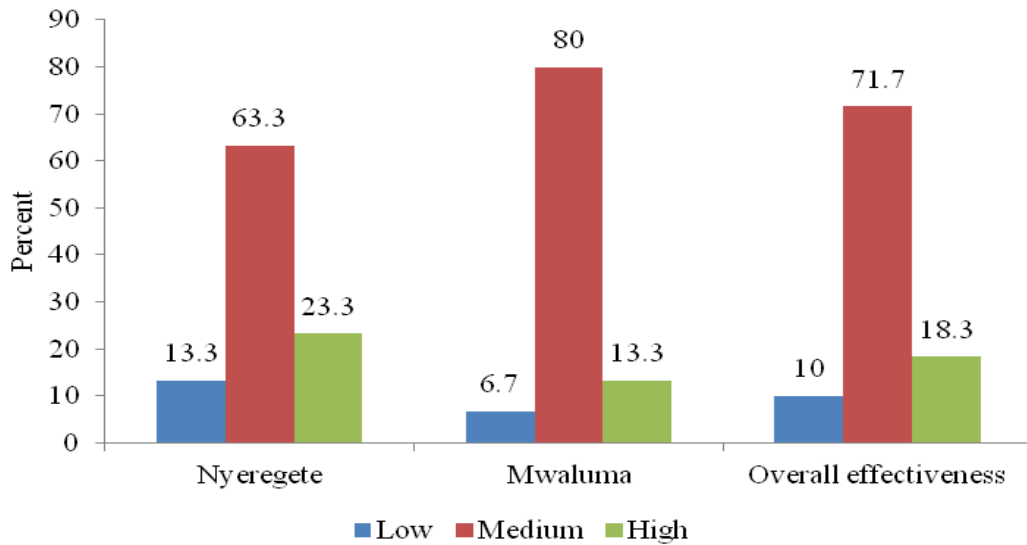


Figure 4.4: Effectiveness of Village water committees in governing groundwater

Table 4.9 presents differences of the respondents' responses on the effectiveness of water committee, village council and COWSO in influencing groundwater governance. The results show that the distribution of medians was high to the respondents' responses who suggested that water committee, village councils and COWSO were highly effective. Using Kruskals Walls H Test, the results showed statistically significant difference among the respondents' responses on the influence of Village Committee, Village Council and COWSO ($P=0.0001$). The difference can be associated with various factors. For instance, the misunderstanding that existed between the Village Council and COWSO may lead into different perceptions on the influence of those structures in governing the resource.

Table 4.9: Difference effectiveness extent of water governance structures

Water committee	n	Median	Chi-square	df	P-value
Low	6	15.0	37.370	2	0.000
Medium	43	24.0			
High	11	28.0			
Village council					
Low	20	15.0	51.259	2	0.000
Medium	23	27.0			
High	47	28.0			
COWSO					
Low	3	13.0	15.856	2	0.000
Medium	9	21.0			
High	18	29.0			

Table 4.10 presents male and female responses on the extent of water committee, village council and COWSO effectiveness. The results show that there was no statistically significant difference on the perceptions of male and female respondents on effectiveness of water committee, village council and COWSO on groundwater management. This indicates that both males and females had similar perceptions about the effectiveness of water governance structures in governing groundwater resource.

Table 4.10: Male and female responses on the effectiveness of water structures

Sex of the respondent	n	Median	U	Wilcoxon W	Z	P-value
Water committee						
Male	31	24				
Female	29	24	355.500	851.500	-1.400	0.162
Village council						
Male	45	22				
Female	45	22	864.500	1899.500	-1.200	0.230
COWSO						
Male	14	26				
Female	16	26	105.000	210.000	0.770	0.790

During key informant interview in Ubaruku village; it was reported that groundwater users through their COWSO had established water charges formal regulation. The regulation guide water users to pay 25 Tsh per bucket at the water point. Each water point there is a water agent who collects charges on behalf of the COWSO leadership. “*The COWSO’s treasurer receives the collected water charges from our agents before depositing it in our account*” COWSO Secretary said.

Table 4.11 presents respondents’ responses on the effectiveness of formal institution. The results show that water charges regulation had led into improvement of groundwater provision services, sense of ownership among groundwater users, facilitating water governance structures to fulfil their responsibilities and proper use of groundwater resource at the household level. During key informant interview, participants reported that, among other expenditures, water charges had been used to improve water services. For the time being, COWSO established 23 water points within a village whereas every water point had two bip cocks. The effectiveness of COWSO was in line with the objectives of WRMA no 11 and 12 of 2009. The objective of WRMA is to promote and ensure that

every person in Tanzania has the right of access to efficient, effective and sustainable water supply and sanitation services (URT, 2009). However the findings revealed that in the study area there was lack of formal institutions which are responsible for groundwater resource governance. For instance, in Nyeregete and Mwaluma villages formal institutions were not there at all. In Tanzania, there are inadequate regulations set for monitoring groundwater resource development (Kabote and John, 2017).

Table 4.11: Responses on the effectiveness of formal institutions in Ubaruku village
(n=30)

Statement	Stron disag	Disagree	Neutral	Agree	Strongly agree
Presence of water fee has led to improvement of groundwater provision services	0(0.0)	0(0.0)	2(6.6)	25(83.3)	3(10.0)
Presence of water fee has led to groundwater users sense of ownership	0(0.0)	2(6.6)	2(6.6)	16(53.3)	10(33.3)
Water fee facilitates water governance structures to fulfil their roles	2(6.6)	2(6.6)	1(3.3)	17(56.6)	8(26.6)
Presence of water fee has led to proper use of groundwater resource at the household	3(10.0)	1(3.3)	1(3.3)	19(63.3)	6(20.0)

Note: Numbers in brackets are percentages

Table 4.12 presents respondents' responses on the effectiveness of norms in governing groundwater resource. Based on the results that are shown on the columns of agree and strongly agree, the findings show that 92.1%, 94.3%, 94.4% and 95.4% of the respondents reported that groundwater related norms improved sanitation into water points, free of groundwater pollution at the water sources, mutual respect among groundwater users and pump safety respectively. Literature reports that water governance including groundwater at the local level is largely dominated by informal institutions including norms (Kabote and John, 2017). Informal institutions are a result of continuous interactions and practices of the water resource users in responding to the existing resource situation in a particular community.

Table 4.12: Respondents' responses on the effectiveness of water norms (n=90)

Statement	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Restriction of washing buckets/objects at water point led into water point sanitation	0(0.0)	1(1.1)	6(6.6)	50(55.5)	33(36.6)
Restriction of carrying human activities nearly water point leads into free of groundwater pollution at the water source	0(0.0)	3(3.3)	2(2.2)	53(58.8)	32(35.5)
Restriction of using an offensive language leads to mutual respect among groundwater users	0(0.0)	5(5.5)	0(0.0)	75(83.3)	10(11.1)
Restriction of using extra force during to pump out groundwater leads into pump safety	0(0.0)	2(2.2)	2(2.2)	62(68.8)	24(26.6)

Note: Numbers in brackets are percentages

Table 4.13 presents respondents' responses on the effectiveness of values in governing groundwater resource. Looking at the columns for agree and strong agree, the results show that groundwater related values had led to participation, accountability, integrity, transparency and equality on groundwater management issues for 94.4%, 92.2%, 87.7%, 87.7 and 92.2% respectively. This implies that values related on groundwater resource governance play great role in influencing an individual's behaviour to groundwater management.

Table 4.13: Respondents' responses on the effectiveness of water values (n=90)

Statement	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Groundwater community based management has led to participation on groundwater resource management	1(1.1)	3(3.3)	1(1.1)	64(71.1)	21(23.3)
Groundwater community based management led to accountability of all groundwater users on resource management	2(2.2)	4(4.4)	1(1.1)	65(72.2)	18(20.0)
Groundwater community based management led to integrity in protecting groundwater infrastructures	2(2.2)	7(7.7)	2(2.2)	57(63.3)	22(24.4)
Groundwater community based management led to transparency on the related groundwater matters	4(4.4)	6(6.6)	1(1.1)	56(62.2)	23(25.5)
Groundwater community based management led to equality on the access of groundwater resource management	4(4.4)	2(2.2)	1(1.1)	65(72.2)	18(20.0)

Note: Numbers in brackets are percentages

Table 4.14 presents the effectiveness of formal institutions in governing groundwater resource. The results show that 56.6% of the respondents reported that formal institutions had a medium effectiveness. During FGD in Ubaruku village it was reported that, there was a bylaw of paying water charges at the water point per bucket. This is in line with the quotation: *“Each water point has a responsible water agent who collects water charges of 25 TShs per bucket from groundwater users. The agent is accountable to the COWSO leadership”*. Also, the COWSO chairperson reported that the bylaw of water charges aims to generate fund for sustainable groundwater development in the village.

Table 4.14: Overall effectiveness of formal institutions in Ubaruku village (n=30)

Category	n	Percent
Low	3	10.0
Medium	17	56.6
High	10	33.3

Figure 4.5 presents respondents' responses on the extent of norms effectiveness in governing groundwater resource. The results show that 55.5% of the respondents agreed that norms had high effectiveness in influencing groundwater governance. Similar to the groundwater values, the results connote that groundwater related norms have power to manipulate people's behaviour, attitudes and perceptions about groundwater resource management.

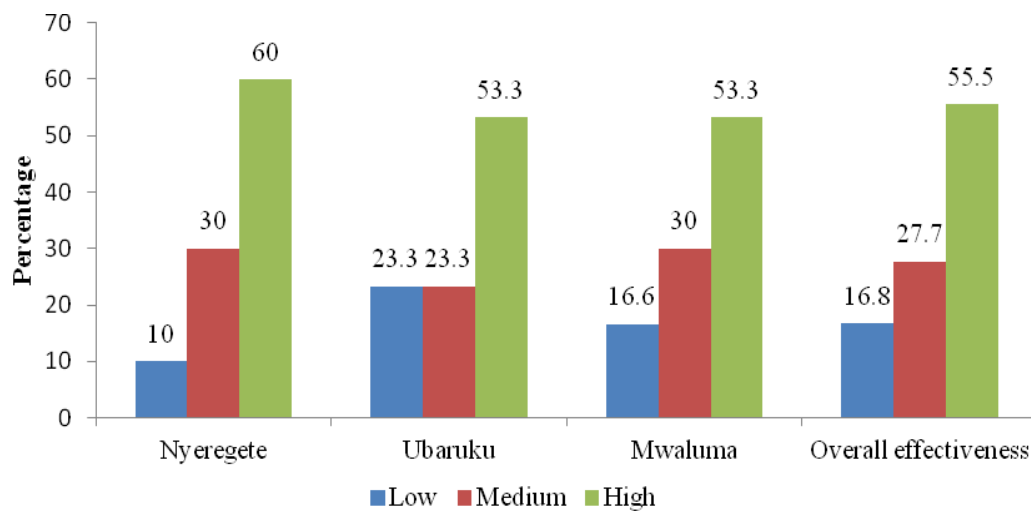


Figure 4.5: Effectiveness of norms in governing groundwater

Figure 4.6 presents respondents' responses on the effectiveness of groundwater related values. The findings show that 54.4% of the respondents' responses showed high effectiveness on groundwater management. This indicates that the existing water values are cooperative to groundwater governance process. Thus, water governance structures should acknowledge and promote the related groundwater values in mediating the local communities in groundwater management.

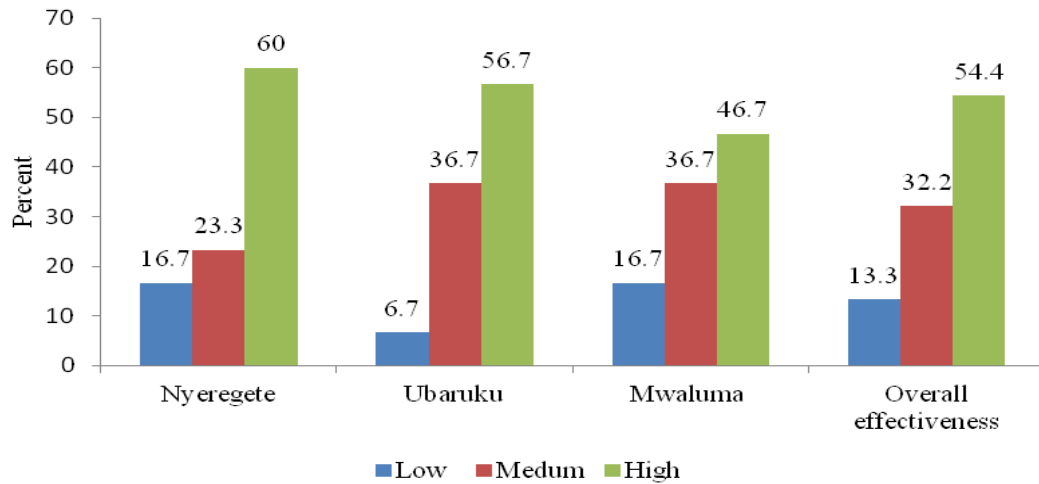


Figure 4.6: Effectiveness of values in governing groundwater

Table 4.15 presents the differences in responses between male and female on the extent of formal institutions, norms and value effectiveness on groundwater governance. Using the Mann Whitney U Test, the results show that there was statistically significant difference ($P=0.0001$) between male and female both on the effectiveness of formal institutions, norms and values. This indicates that females were more satisfied with the performance of water governance institutions through water governance structures in controlling individuals behaviours related on groundwater resource than males.

Table 4.15: Responses on the effectiveness on water institutions by sex (n=90)

Sex of the respondents	n	Median	U	Wilcoxon W	Z	P-value
Formal institutions						
Male	15	12	93.500	213.500	-.869	.000
Female	15	18				
Norms						
Male	45	16	970.500	1960.500	-.345	.000
Female	45	17				
Values						
Male	45	19	928.000	2009.000	-.703	.000
Female	45	21				

Table 4.16 presents the differences of effectiveness of formal institutions, norms and values in governing groundwater resource. Using the Kruskal Wallis H Test, the results show that there was statistically significant difference on the extent of effectiveness between low, medium and high perceived effectiveness of water governance institutions ($P=0.0001$). This shows that the power of water governance institutions to influence water governance structures as well as the whole community of groundwater users in governing groundwater resource differ. The influence of water governance institutions to mediate individual behaviours in governing water resource is manipulated by various factors including the extent of local communities' awareness on those water governance institutions (Sokile *et al.*, 2005).

Table 4.16: Responses on the effectiveness of water institutions (n=90)

Formal institutions	n	Median	Chi-square	df	P-value
Low	7	9			
Medium	9	11	37.710	2	0.000
High	14	12			
Total	30				
Norm					
Low	9	11			
Medium	22	14	66.208	2	0.000
High	59	18			
Total	90				
Values					
Low	8	11			
Medium	24	18	60.660	2	0.000
High	58	21			
Total	90				

4.5 Conclusions and Recommendations

The main objective of this chapter was to determine the effectiveness of water governance structures and institutions in governing groundwater resource in the study area. Based on the results and discussion the chapter concludes that overall, effectiveness of COWSO in

governing groundwater resource was high. Furthermore, the chapter concludes that informal institutions were more effective in governing individuals' behaviour on groundwater resource management than formal institutions. In addition, the study concludes that there is a contradiction between water governance structures in governing groundwater resource in the study area.

The chapter recommends the establishment of COWSOs in other villages where there is no COWSOs. In addition, it is recommended that policy makers' should provide capacity building to governance structures at local level on how to strength relationship among different water structures in fulfilling their responsibilities. Furthermore, Rufiji Water Basin Office should be closer watching the progress and challenges that water governance structures face at the local level.

References

- Babbie, E. (2007). *Practice of Social Research*. Oxford University Press, Cape Town, Southern Africa. 92pp.
- Calder, I. (2005). *Blue Revolution: Integrated Land and Water Resources Management* (2nd ed). Earth scan, United Kingdoms. 376pp.
- Casley, D. J. and Kumar, K. (1988). *Collection Analysis and Use of Monitoring and Evaluation of Data*. The International Bank for Reconstruction and Development, Washington DC, USA. 174pp.
- Durant, R., O'Leary, R. and Fiorino, D. (2004). *Introduction in Environmental Governance Reconsidered*. (eds). Mass Press, Cambridge. 27pp.
- Engida, E., Guthiga, P. and Karugia, J. (2015). *The Role of Livestock in the Tanzanian Economy: Policy Analysis Using a Dynamic Computable General Equilibrium*

- Model for Tanzania*. Proceedings of International Association of Agricultural Economists, Milan, Italy, 9 August, 2015.pp22.
- Garduño, H., Romani, S., Sengupta, B., Tuinhof, A. and Davis, R. (2011). India groundwater governance case study. [Garduño (2011) used.pdf] site visited on 23/10/ 2017.
- George, D. and Mallery, P. (2003). *SPSS for Windows step by step: A simple guide and reference. 11.0 update* (4th ed.). Boston: Allyn and Bacon. 123pp.
- Hoekstra, A. Y. (2006). The Global Dimension of Water Governance: Nine Reasons for Global Arrangements in order to cope with local water problems. [https://research.utwente.nl/en/publications/the-global-dimension-of-water-governance-nine-reasons-for-global-arrangements.pdf] site visited on 12/8/ 2017.
- Kabote, S. J. and John, P. (2017). Water governance in Tanzania: performance of governance structures and institutions. *World Journal of Social Sciences and Humanities* 3(1): 15-25.
- Kangalawe, R., Mwakalila, S. and Masolwa, P. (2012).Climate change impacts, local knowledge and coping strategies in the great Ruaha river catchment area, Tanzania. *Natural Resources Journal* 2: 212-223.
- Kayombo, W. C. (2016).Assessing meteorological data for reference evapotranspiration in Kyela and Mbarali district. *Journal of Environment and Earth Science Science* 6 (4): 1-7.
- Litvack, J. and Seddon, J. (1999).Decentralization Briefing Notes. [https://siteresources-worldbank.org/WBI/Resources/wbi37142.pd]site visited on 27 June, 2017.
- Lwoga, E. T., Stilwell, C. and Ngulube, P. (2011). Access and use of agricultural information and knowledge in Tanzania. *Library Review* 60(5): 383-395.

- Merrey, D. J. and Cook, S. (2012). Fostering institutional creativity at multiple levels: towards facilitated institutional bricolage. *Water Alternatives Journal* 5(1): 1-19.
- Mirumachi, N. and Wyk, E. (2010). Cooperation at different scales: challenges for local and international water resource governance in South Africa. *Geographical Journal* 176: 25-38.
- Mosha, D. B., Kajembe, G. C., Tarimo, A. K. P. R., Vedeld, P. and Mbeyale, G. E. (2016). Performance of water management institutions in farmer-management irrigation schemes in Iringa rural and Kilombero - districts, Tanzania. *International Journal of Asian Social Science* 6(8):430-445.
- Ngailo, J. A., Mwakasendo, J. A. and Kisandu, D. B. (2016). Rice farming in the Southern highlands of Tanzania: Management practices, socio-economic roles and production constraints. *European Journal of Research in Social Sciences* 4 (3): 1-13.
- Pallant, J. (2007). *Statistical Package for Social Science (SPSS) Survival Manual: A Step by Step Guide to Data Analysis Using SPSS for Windows 3rd Edition*. Open University Press., Berkshire. 335pp.
- Pavelic, P., Giordano, M., Keraita, B., Ramesh, V. and Rao, T. (2012). Groundwater-availability and use in Sub –Saharan Africa: A review of countries. [http://www.iwmi.cgiar.org/Publications/Books/PDF/groundwater_availability_and_use_in_subsaharan_africa_a_review_of_15_countries.pdf] site visited on 23 May, 2016.
- Sirima, A. (2016). Social and economic impacts of Ruaha national park expansion. *Open Journal of Social Sciences* 4: 1-11.
- Sokile, C. S., Mwaruvanda, W. and Koppen, B. (2005). Integrated Water Resource Management in Tanzania: Interface between formal and informal institutions. [<http://www.sciepub.com/reference/188029>] site visited on 3 May 2016.

- Stefano, L., Svendsen, M., Giordano, M., Steel, B., Brown, B. and Wolf, A. T. (2014).
Water governance benchmarking: concepts and approach framework as
- applied to Middle East and North Africa countries. *Water Policy* 16:1121–
1139.
- URT (2000). Education in a Global Era: Challenges to Equity, Opportunity for
Diversity.[[www.gov.go.tz/egov_uploads/documents/EDUCATION_IN_GLOB
AL_ERA_sw.pdf](http://www.gov.go.tz/egov_uploads/documents/EDUCATION_IN_GLOB
AL_ERA_sw.pdf)] site visited on 23 February, 2016.
- URT (2002). National Water Policy. United Republic of Tanzania. [[http://www. Nati
onal Water_policy.pdf](http://www.Nati
onal Water_policy.pdf)] site visited on 13 February, 2016.
- URT (2009). *Water Resource Management Act no 11*. Dar es Salaam, Tanzania. 73pp.
- URT (2012). National Baseline Survey Report for Micro, Small, and Medium Enterprises
in Tanzania.[MSME-National-Baseline-Survey-Report.pdf] site visited on
16 January, 2017.
- URT (2014). Mbarali District Council Strategic Plan 2013/14-2017-18; Prime Minister's
Office Regional Administration and Local Government. [[http://www.
mbaralidc.go.tz/storage/app/uploads/public/58d/10/58d101fccce7f653574057.
pdf](http://www.
mbaralidc.go.tz/storage/app/uploads/public/58d/10/58d101fccce7f653574057.
pdf)] site visited 27 September, 2017.
- Wijnen, M., Benedicte, A., Bradley, H., Ward, C. and Huntjens, P. (2012). Managing the
Invisible- Understanding and Improving Groundwater Governance.
[[http://documents.worldbank.org/curated/en/450431468157768820/pdf/71742
0WP0Box370naging0the0invisible.pdf](http://documents.worldbank.org/curated/en/450431468157768820/pdf/71742
0WP0Box370naging0the0invisible.pdf)] site visited on 11 September, 2017.

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

5.1.1 Groundwater-community interaction

The first objective of this study was to assess the interaction of groundwater resource and households in semi- arid areas of Mbarali District. Majority of households used the resource for domestic activities and small scale irrigation for vegetable crops and paddy nurseries, watering animals and bricks making. Therefore, groundwater provides great support to local communities' livelihoods in the study area. However, the groundwater users are challenged by poor knowledge for proper shallow wells construction and protection against pollution.

5.1.2 Groundwater users' awareness on groundwater governance institutions

The objective number two was to determine the extent of awareness of water institutions. The study concludes that there is low awareness on formal institutions related to groundwater governance. However, the majority of groundwater users had high awareness of informal water governance institutions.

5.1.3 Success of governance structures and institutions in governing groundwater resource

The last specific objective of this study was to determine the degree of success of both water governance structures and institutions in governing groundwater resource at a village level. The chapter concludes that there were two types of structural arrangement at village level. The one involving Village Water Committee and another one which involved

COWSO. Furthermore, the Village Councils and COWSO are more effective than Village Water Committees in governing groundwater resource. In addition, the study concludes that informal institutions are more effective than formal institutions in achieving their intended objectives of mediating individual behaviours to water governance. Lastly, the study concludes that the water governance structural setup that involves COWSOs is more effective in groundwater governance than the structural set up which involves Village Water Committees.

5.2 Recommendations

Based on the above conclusions the study recommends the following:

- (i) The District Authorities and other water stakeholders should build capacity to groundwater users being knowledgeable on where and how to construct wells and protect from pollution.
- (ii) Water policy makers in cooperation with other water development agencies should establish initiatives to broaden awareness particularly of formal water governance institutions related to groundwater resource.
- (iii) The study also recommends that the Village Councils where there are no COWSOs should promote the establishment of COWSOs. Since the experience has shown that COWSOs are more effective than Village Water Committees in governing groundwater resource.
- (iv) Nevertheless, the study recommends that the local communities have to maintain the existing informal water governance institutions related to groundwater issues.

5.3 Areas for Further Study

The study suggests that further empirical research has to be conducted in order to determine the factors that affect the potentiality of formal institutions on groundwater governance at local level. The study will generate knowledge for policy planning and implementation process related to groundwater governance.

APPENDICES

Appendix 1: Questionnaire for Individual Survey

Section A: Background Information

Respondents' Demographic and Socio-economic Characteristics

Questionnaire No.....Date of Interview.....
 Division.....Ward.....Village.....Hamlet.....
 Interviewer's name.....

1. Name of household head.....
2. Name of respondent.....
3. Relationship with the household head -----[1=Head of Household
 2=spouse, 3=son ,4 Daughter,5= other (specify)-----]
4. Age of the respondent
5. Sex of the respondent..... [1=Male, 2=Female]
6. Marital status of respondent [1=Married, 2=Single,
 3=Divorced, 4=Widowed/Widower, 5= other (specify)-----]
7. Level of education of respondent..... [1= No formal education
 2=Adult education, 3=Primary education, 4=Secondary, 5= tertiary education
8. Years of schooling of respondent-----
9. What is the total number of the people in the household?.....
10. Total number of years the household resided in the village-----years
11. Main occupation of the respondent

Main occupation	
Farming	
Livestock keeping	
Small scale business	
Other (specify)	

- 12 The main source of income of the household

Farming	
Business	

Salary	
Casual labour	
Other (specify)	

13. What other sources of income of the household-----,-----,-----

14. Estimate of household annual income per year from all sources -----

SECTION B. Groundwater Information

15. Total number of years the household engaged in the use of groundwater-----years

16. What type of groundwater source does your household depend?

[1] Deep well []

[2] Shallow well []

17. What is the mode of ownership of groundwater source?

[1] private []

[2] public []

[3] Other------(name) []

18. What is the main factor that influences your household to use groundwater?

[1] Near working distance to groundwater source ()

[2] adequate groundwater ()

[3] affordability to groundwater charges ()

[4] Is the only source available ()

[5] Other (specify)-----

19. In which period do you depend on groundwater source?

[1] Dry season ()

[2] Rainy season ()

[3] Throughout a year ()

20. What other source of water your household use? (*Multiple answers are accepted*)

Rainwater collection () Canal () River () () Other (specify)-----

21. Out of the sources you mentioned in question number 20, which source do you consider the most important?

22. When did you last experience groundwater related conflicts?

Did not experience () This year () 1 to 2 years ago () 3 to 5 years ago ()

Other (specify)-----

23. Who else was involved in the conflict?

Neighbour/s () Authorities responsible for water management () pastoralists () () farmers () groundwater users () other (specify)-----

24. What were the causes of the related on groundwater conflicts?

Restriction of water use () Water price () Destruction of water source () Distribution of groundwater services/networks to households () Misuse of resources donated by water users () Other (specify) -----

25. Who was involved in resolving the conflict? -----[1=UBAMPA members, 2=Village council , 3=Water committee ,4= Water department at the district level ,5= other (specify)-----]

26. Was the conflict successfully resolved (Yes or No)

27. What do you consider the most important use of groundwater at your household?

	Groundwater use	Response	Estimate amount(buckets) per day
1	Drinking		
2	Bathing		
3	Washing		
4	Brick making		
5	Cooking		
6	Watering garden		
7	Watering animals		
8	Irrigation		
	Other (specify)		

28. Does the groundwater source provides enough water to satisfy your daily household uses ----- (Yes= 1 No= 2)

SECTION C. Water fee

29. Does the paid water charges of 50 Tsh per bucket affordable for all groundwater users? ---- (Yes= 1 No= 2)

30. Do pay water charges to access groundwater? ----- (Yes or No). If Yes, specify the amount-----Tsh.

31.How do you participate in maintenance of water pumps-----

SECTION D: Water governance information

32. Are you a member of any of the following governance structures?

- i. Village Social Service committee()

- ii. Water committee ()
- iii. Community Water Supply Organization (UBAMPA) ()
- iv. Other (specify)-----

33. What are your basic roles on groundwater management

- (a) Protecting groundwater source point from pollution ()
- (b) Providing information related on groundwater to other water users/ authorities ()
- (c) Contributing materials for groundwater management ()
- (d) Paying charges for water service ()
- (e) Participating in decision making for various levels. (1= planning, 2= implementing 3=evaluating water management activities,4=both, 5= other (specify them)---)
- (f) Others () specify them-----

SECTION E: Distance from the home to the groundwater source

34. What approximate distance from your house to groundwater source?-----meters

SECTION F. Extent of awareness of formal and informal water institutions on groundwater management

The following question is intended to investigate your extent of awareness about formal and informal institutions on groundwater management. Thus, you are required to indicate whether the mentioned institutions are known or not (1= Yes, 2=No). After that, you are required to respond by choosing one of the indicated levels of awareness on those institutions.

Formal institutions	(1= Yes 2=No).	Extent of knowing them 5=Strongly Agree,4=Agree, 3=Neutral ,2 =Disagree, 1= Strongly disagree
Groundwater well should be registered at the water basin authority level		
Groundwater well should be protected against pollution		
Groundwater users should pay water charges		
Anyone who breach water rules should be penalized		
Local communities should active participate in decision making about groundwater management		
Women should participate actively in decision making on groundwater management		

Informal institutions	(1= Yes 2=No).	Extent of knowing them 5=Strongly Agree, 4=Agree, 3=Neutral ,2 =Disagree, 1= Strongly disagree
Norms: (impermissible practices for water management)		
Washing buckets or any other objects at the water point is restricted		
It is strictly restricted to pour water on the ground at the water point		
Passing animals around water point is strictly restricted		

Using extra force during pumping out water is strictly restricted		
Carrying out human activities nearby water point or on the groundwater pipeline is strictly prohibited		
Values: (Important behavior /practices for water management)		
Groundwater community based management is important		
Women participation on groundwater decision making is important		
Everyone equal access to groundwater resource is important		
Mutual respect among groundwater users at water point is important		
Sanitation at water point is important		

G: Extent to which governance structures achieve the intended objectives

The following question is intended to investigate the extent of structures achievements on groundwater management. Thus, you are required to indicate whether the structures have achieved or not the intended objectives (1= Yes, 2=No). After that, you are required to respond by choosing one of the indicated levels of achievement for a particular statement which is provided to each structure.

Governance structures	(1= Yes 2=No).	Extent of knowing them 5=Strongly Agree, 4=Agree, 3=Neutral ,2 =Disagree, 1= Strongly disagree
Water committee		

The committee facilitates groundwater users to contribute money for pump maintenance		
The committee has led to fair distribution of groundwater points		
The committee resolves groundwater related conflicts effectively		
The committee provides financial report to groundwater users timely		
The committee has led accountability to all groundwater users on water management		
The committee sensitizes strongly on groundwater source conservation		
The committee oversees the implementation of groundwater related norms and values in the village		
Village Council		
Village council addresses groundwater management issues at public meetings		
Village council enhances active participation of the community on groundwater management		
Village council provides groundwater related financial reports		
Village council sets priorities ,plans, and activities related to groundwater management		
Village council promotes accountability of groundwater users on water management		
The committee oversees the implementation of the related groundwater by-laws, norms and values		

Community Water Supply Organization (COWSO) (UBAMPA)		
COWSO has led to fair distribution of groundwater points		
COWSO resolves groundwater related conflicts efficiently		
COWSO provides financial report to groundwater users timely		
COWSO has led fair saying to all groundwater users on resource management		
COWSO has a proper relationship with other water governance structures		
COWSO promotes accountability on water resource management		
COWSO oversees the implementation of the related groundwater by laws, norms and values		

SECTION H: Extent to which governance institutions (formal and informal) achieve the intended objectives.

The following question is intended to investigate the extent to which governance institutions have achieved the intended objectives on groundwater management. Thus, you are required to indicate whether the governance institutions have achieved or not the intended objectives (1= Yes, 2=No). After that, you are required to respond by choosing one of the indicated levels of achievement for a particular statement which is provided to governance institution.

A: Formal institutions	1= Yes 2=No.	Extent of knowing them 5=Strongly Agree,4=Agree, 3=Neutral ,2 =Disagree, 1= Strongly disagree
Presence of water fee has led to improvement of groundwater provision services		
Presence of water fee has led to groundwater users sense of ownership		
Presence of water fee facilitates water governance structures to fulfill their roles		
Presence of water fee has led to proper use of groundwater resource at the household		

Informal institutions	1= Yes 2=No.	Extent of achievement 5=Strongly Agree, 4=Agree,3=Neutral ,2 =Disagree, 1= Strongly disagree
Norms:(impermissible practices for water management)		
Restriction of washing buckets/objects at water point has led into water point sanitation		
Restriction of carrying human activities nearly water point has led to free of groundwater pollution at the groundwater source		
Restriction of using offensive language at the water point has led to mutual respect among groundwater users		
Restriction of using extra force during to pump out groundwater has led into safety		

pump safety		
Values: (Important behavior for water management)		
Groundwater community-based management has led groundwater users into active participation on groundwater users management		
Groundwater Community-based management led to accountability of all groundwater users on resource management		
Groundwater Community-based management has led to integrity in protecting and utilizing infrastructures /resources related to groundwater management		
Groundwater Community-based management has led to transparency on the related groundwater matters		
Groundwater Community-based management has led to equality on the access of groundwater resource management		

Appendix 2: Check list for Focus Group Discussion (groundwater users)

1. What is the situation of groundwater in the village ?
2. What are the formal and informal institutions for water governance?
3. Are they useful in governing groundwater resources? Why
4. How groundwater users participate in decision making?
5. How groundwater users adhere to governance institutions?
6. How groundwater users become aware on the established institutions?
7. What challenges occur during implementation of the institutions?
8. How do you handle the challenges?
9. What are your opinions on water governance (institutions and structures)

Appendix 3: Check list for key informants (Village Leaders, COWSO leaders)

1. What is the situation of groundwater interventions in the village?
2. What governance structures do you have for governing groundwater resource in your village?
3. What are their functions related to groundwater resources?
4. What are their objectives related to groundwater resource?
5. What mechanism are there to ensure groundwater is used ,managed fairly, efficiently and sustainably
6. How the governance structures govern groundwater?
7. How many men and women are members of each governance structure?
8. In what ways are the structures linked with other authorities at different levels?
9. What are the procedures for water permits?
10. How groundwater fees system is practiced?

Appendix 4: Reliability Analysis on awareness of water institutions

Statement	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Groundwater well should be registered	57.40	22.917	.239	.701
Groundwater well should be protected free from pollution	57.22	22.894	.253	.698
Groundwater users should pay water charges	57.09	22.037	.308	.692
Anyone who will breach water rules should be penalized	57.17	22.725	.308	.690
Local communities should participate in decision making on groundwater management	56.94	22.547	.376	.681
Women should participate actively in decision making on groundwater management	57.01	23.921	.192	.703
Restriction of washing buckets/objects at water point	55.78	20.961	.596	.652
Restriction of washing buckets/objects at water point	55.94	21.918	.490	.668
Restriction of carrying human activities nearly water point	55.88	24.558	.156	.705
Restriction of passing animal at water point	55.80	24.094	.191	.703
Importance of Groundwater Community based management	55.91	23.992	.308	.691
Importance of women participation on groundwater management	55.58	23.842	.499	.682
Importance of equal access to groundwater resource	55.83	23.534	.279	.693
Importance of mutual respect of among groundwater users at the water point	55.97	24.145	.192	.702
Importance of water sanitation at water point	55.61	22.959	.445	.677
Reliability Statistics				
Cronbach's Alpha				N of Items
.704				15

Appendix 5: Reliability Analysis on the effectiveness of water institutions

Statement	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Presence of water fee has generated funds for groundwater infrastructure maintenance	41.48	47.466	.908	.731
Presence of water fee facilitates water governance structures to fulfil their roles	41.54	48.633	.912	.731
Presence of water fee has led to groundwater users sense of ownership	41.51	47.848	.895	.733
Presence of water fee has led to improvement of groundwater provision services	41.57	48.878	.881	.736
Restriction of washing buckets/any other objects has led to water sanitation	38.61	74.443	.182	.807
Restriction of carrying human activities nearby water point has led groundwater unpolluted	38.60	74.085	.213	.806
Restriction of using extra force during to pump out groundwater has led to safety of pump	38.71	75.983	.042	.813
Restriction of using offensive language at the water point has led to mutual respect among groundwater users	38.69	74.801	.195	.807
Groundwater Community Based Management has led to participation on groundwater management	38.74	74.485	.181	.807
Groundwater Community Based Management has led to accountability of all groundwater users on resource management	38.83	73.713	.187	.808
Groundwater Community Based Management has led to integrity in protecting groundwater infrastructures	38.81	73.705	.240	.805
Groundwater Community Based Management has led to transparency on the related groundwater matters	38.84	74.762	.099	.813
Groundwater Community Based Management has led to equality on the access of groundwater resource management	38.72	76.203	.016	.815
Reliability Statistics				
Cronbach's Alpha				N of Items
.805				13