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Cost and benefit analysis of water allocation among farmers and cattle herders in Mvomero District, Tanzania

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ABSTRACT

Tanzania comprises huge land of about 1 million square kilometers with plentiful water sources such as lakes, rivers, springs, wetlands and aquifers, but with poor allocation of water resource created conflicts among farmers and cattle herders who requires water for their conflicting water use activities. Farmers require water for irrigation and roaming cattle herders use it for their cattle. These two activities go together but water for irrigation when used for cattle, crops will be eaten up by cattle. When this happens, the conflict between farmers and cattle keepers arise. Water allocation conflict is rampant in Mvomero District due to the co-existence of farmers and cattle herded using the same source of water. Farmers have been migrating from different parts of Tanzania to settle there and start maize farming while cattle herders immigrate in Mvomero district searching for green pastures there. Also, seasonal roaming cattle keepers have moved from other parts of the country to Mvomero district. The increasing conflicting use of water resource has resulted in conflicts among pastoralists and farmers. Therefore, cost and benefit analysis of water allocation among water users, specifically cattle herders and farmers in Mvomero District was essential to find out how water could be governed and used more efficiently for economic gains. The study was conducted in Mkindo, Kambala and Mpapaa-Msufini villages in Mvomero district. The institutional arrangements which were used to govern water resource allocation in those areas were studied by triangulating the methods combining qualitative and quantitative research methodologies. The study was a case study design allowing explorative, descriptive and explanatory designs to be used following Yin (2003). The study intended to interview 89 pastoralists and farmers. The findings reveal that cattle herders generated more income from selling cattle than farmers. Thus, cattle herders were economically having more benefits more than farmers. The study concluded that allocating water resource to farmers and pastoralists required cost and benefit analysis. For the case of Mvomero district, pastoralists would have benefited more from the water resource allocated to them than when farmers could be allocated the same, therefore the water allocation to the pastoralists is suggested in this paper.

Keywords: Cost and benefits analysis (CBA), water resource allocation, maize farming, pasturing, Tanzania, sustainable agriculture.

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INTRODUCTION

Conducting a study on water resource was timely, because currently Tanzania is implementing many projects in urban rural areas to reduce water shortages, improve agricultural activities and increase water access to the community (Nganyanyuka et al., 2014). Availability of water facilitates agricultural activities as well as pastoralism as water supports crop production and cattle raising. Farming and cattle keeping are the main activities taking place in many rural areas of Tanzania including Mvomero District. Farming is for food security and commercial purposes. Also, cattle keeping is important for supplying meat and milk to cattle herders and other

consumers as well. Both farming and cattle keeping are sources of income when sold in the market. Those whose livelihood depend on cattle and crop cultivation in rural areas, depends much on the availability of water resources. The available water resource is becoming scarce country-wide because of global warming, inefficient use and poor governance. The study intended to analyze the socio-economic costs and the benefits gained by cattle herders and farmers from water allocation and identify institutions which were used to govern water resources, so as to determine if there was economic efficiency of water resources allocation to either farmers or cattle herders in the study area of Mvomero District.

Availability of water in the soil makes the land useful for cultivation, so it does for pastoralists. Availability of water in soil makes it possible for the land to grow grasses for cattle, goats and sheep. Calzadilla et al. (2010) studied land grabbing in China and South East Asia and reported that, the use of irrigation farming increases farm produce, which in turn increase income generation. Also, Donoso and Aldaya (2014) explained that water was highly used in agriculture and animals in the Caribbean and Latin America when it was well allocated to the users using user rights. The user rights have improved the well-being of farmers and cattle herders through income generation in those areas. Not only water improves income generation in Mvomero District, in other areas, it is also explained to be a basic natural resource to human. Water sustains life and provides social and economic well-being to rural livelihoods. Farming and cattle keeping depends on availability water (Mwakalila, 2008). Around the world, it is estimated that 70% of renewable water resources is used in the agricultural sector, while in some developing countries the figure even exceeds 90% (OECD, 2010). Further studies reveal that, because of inefficient use, poor governance and management of water resource, the social costs resulted from water use among cattle herders and farmers, such as pollution, water scarcity and water use conflicts are now growing in many rural areas of Tanzania. The study by Mbonile (2006) in the Pangani river basin, Kramm and Wirkus (2010) in the region around Lake Eyasi, reported that water use among cattle herders and farmers have resulted in social costs such as conflicts, water scarcity, farm destructions and land degradation. Therefore, studying the socio-economic costs and benefits of water allocation among water users, specifically cattle herders and farmers in Mvomero District was essential to find out how water could be governed and used efficiently for economic gain to resolve conflicting uses which in turn ignites conflicts and disputes among water users who resides in the same land of Mvomero district.

Statement of the problem

Although water use among farmers and cattle herders had economic benefits, the allocation of water resource among them had created social costs (conflicts and disputes) in many rural areas of Tanzania, specifically Mvomero District. Despite of water being a survival of farmers and cattle herders, in The Guardian Newspaper on 22nd May, 2015 it was reported that, water was a scarce resource in many rural areas of Tanzania because it was not well governed. On the other hand, it has been explained that, the inefficient use and poor management of water resource among farmers and cattle herders result in conflicts, contamination and scarcity (Peden et al., 2007). Further, it was as reported by Shittu (2007) that, in many rural areas of Tanzania agriculture and cattle keeping are the main economic activities taking place. These activities increase demand for water and competing for water use is increasing among users of wetlands and other water sources (Mkonda 2015). Tanzania have water policy (URT, 2002), customary land laws and the National Land Act (1999) governing water use. Land and water conflicts and disputes are intertwined as famers need land and water for irrigation while pastoralists are on move searching for water and grazing grasses from the land, when both are increasing in number as the population of cattle and human is on increase, the land with water (wetland) and water source became battle ground if not well allocated to them.

Sharing water for animal use has ignited land use conflicts in the area. Marginalizing some farmers and cattle herders provoked conflicts and drove them into poverty. Moreover, the studies conducted in different parts of Tanzania as well as in Mvomero district concerning water use reported that, the allocation of water resource among cattle herders and farmers had brought negative impacts among these communities. The study by Turpie et al. (2005) in Pangani Basin-Tanga, the study conducted by Facius (2008) in Usangu plain-Mbeya, and the study by Mung'ong'o and Mwamfupe (2003) in Kilosa all in Tanzania (East Africa) reported that when two groups of (pastoralist and farmers) had different motives towards water use, conflicts and disputes arose. Pastoralists would like to use water to let their cattle drink from the well. Farmers would like to use water for irrigation. When every individual group interest does not match, each group fight another to possess the use of water to be either dominated by cattle grazing or be used for irrigation only while at the village level no clear enforceable land rights assigned for irrigation farming or/and cattle raising. Struggling for water use has caused conflicts, pollution and water shortage among farmers and cattle herders. Therefore, this paper intended to analyze socio-economic costs and benefits of water allocation among cattle herders and farmers and advise on how water resource can be well allocated after analyzing cost and benefit of it. It identifies institutional alignments and arrangements which were used to govern water resources in Mkindo, Kambala and Mpapaa Msufini village in Mvomero district, are among areas in Tanzania with land disputes related to cattle herders and farmers

living together while sharing water resources. The overall objective of this study, was to analyze the socio-economic costs and benefits of water allocation among cattle herders and farmers in Mvomero District, specifically:

- To identify water governance institutions in the area to govern water resources.
- To describe socio-economic costs of water use.
- To explain benefits of water use among cattle herders and farmers.
- To suggest proper and scalable land resource use institutional arrangements to resolve conflicts and disputes.

The research questions guided this research study were:

- What institutional arrangements were responsible for water allocation among pastoralists and farmers?
- Why socio-economic costs of allocating the water to the farmers were higher than that of allocating water to the cattle herders?
- Why socio-economic benefits of allocating the water resource to the cattle herders were higher than allocating water resources to the farmers?
- How alternative institutional arrangements were likely to create economic efficiency of allocating water to use?

LITERATURE REVIEW

Socio-economic benefit is a change that increases human well-being, whilst a socio-economic cost is defined as a change that decreases human well-being (WHO, 2012) whilst socio-economic efficiency is a situation of society getting the maximum benefits from its scarce resources (Whiting, 2015). It is about making the best use of our scarce resources among competing ends so that economic and social welfare is maximized over time (Mann, 2008). According to Anderson (2013), weighing benefits against costs is a rational way to identify worth. Cost and Benefits Analysis (CBA) technique provides a logical assessment of the costs and benefits associated with an intervention made or an intervention required to minimize costs, it is mainly used to assess adaptation options when efficiency is the decision-making criteria. The comparison of costs and benefits can help to inform decision makers concerning the likely efficiency outcome (Lichte, 2010). McConnell et al. (2008) explains that cost benefit analysis involves the comparison of Marginal costs (MC) and Marginal benefits (MB) of a particular phenomenon. The purpose of cost benefit analysis is to facilitate the allocation of resources to their most valuable uses to achieve economic efficiency. Economic efficiency is a wide term which has been discussed by different Scholars and economists. Whiting (2015) argues that, economic efficiency is a state where every resource is allocated optimally in such a way that, each person is served in the best way while inefficiency and waste (socio economic costs) are minimized. Mann (2008) explains that economic efficiency is about making people “better off”. If someone can be made better off without making anyone else worse off, that is an efficient change. A win-win situation is economically efficient if no third party is made worse off. He is a modern Parato efficient theory follower.

Pareto efficiency theory

Pareto efficiency is associated with resource allocation. Pareto’s concept is based upon Pareto’s criterion of social welfare. Pareto criteria of social welfare states that if any allocation of economic resources does not harm anybody and makes someone “better off”, it indicates an increase in social welfare. However, with the notion of Pareto efficiency, equity is a priority. The modern economic efficiency ignores such equitable allocation of resources to embrace the need for differences in capabilities. We are able to reach Pareto efficiency even if few people enjoy the benefits of a resource, as long as nobody is made worse off than before (Wigmore, 2013). Coase (1960) in Coleman (1980) pointed out that allocations which are Pareto superior increases at least one person’s utility (enjoyment) without affecting the utility of another person, they produce winners but no losers. Coase (1960) shows the relationships between wealth maximization and Pareto criteria. Coleman argues that, suppose a farmer and a rancher own land nearby to one another. Each person expects to maximize revenue from the activities they conduct.

In the absence of the other activity, the rancher would raise cows until the Marginal benefit equaled his Marginal cost, also the farmer would grow corn until her Marginal benefit equaled her Marginal private cost. These two activities affect one another, more cows will mean less corn and vice versa. This is the cause of an externality problem among the farmer and cattle herder (Coleman, 1980). In order to reach an efficient solution of this externality problem (cost), Marginal revenue (MR) is equal to Marginal cost (MC), but Marginal cost (for the rancher) is equal to the sum of his Marginal cost (MC) in raising cows plus the Marginal damage (MD) each cow causes the farmer's corn crop.

From Figure 1, vertical axis represents the monetary value of cattle or crops (cash) and horizontal axis is the number of cows owned by the rancher. The graph presents that, in the absence of farming, the rancher will ranch to point A and enjoy the big number 100 cows. In case the land is allocated between farmers and rancher les cows will be accommodated less than 50 at point B 50. Thus, **B** represents the wealth-maximizing solution to the externality problem on the assumption that, the rancher and farmer, both intend to gain profit while

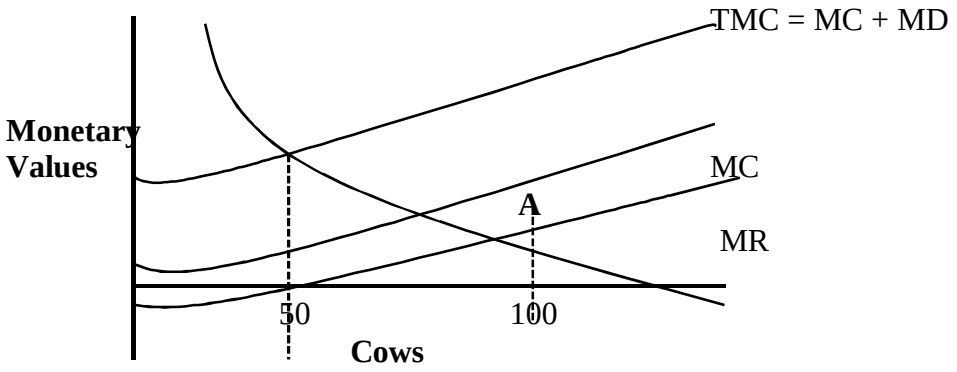

Figure 1. Conceptual framework of cow wealth maximization-based Pareto criteria. Source: Coleman, (1980) Efficiency, Utility, and Wealth Maximization. Page 522. Where: TMC = Total marginal cost; MD = Marginal damage; MC = Marginal cost; MR= Marginal revenue/benefit; Y-axis= Cash; X-axis= Number of cows.

internalizing the costs. Therefore, point **B** is not only the wealth maximizing but also Pareto efficiency where both a rancher and farmer gain benefits. At point **B** no one is made worse off over the other, but rather all becomes better off (Coleman, 1980).

Therefore, the idea of Pareto as explained by Coleman (1980) and other scholars has been used in the study, to make income comparison as among of the benefits generated by farmers and cattle herders in relation to the social costs caused by the increase number of cattle, so as to determine, if there was any community made "better off or worse off" over the other due to the fact that, these two activities affect one another in different places of Tanzania specifically Mvomero District where the research was conducted. However, CBA model is not explained by Pareto alone, it was further improved by Kaldor-Hicks's efficiency.

Kaldor–Hicks's efficiency theory

Kaldor–Hicks's criterion is a measure of economic efficiency that captures some of the intuitive appeal of Pareto efficiency (De Soto, 2009). The Kaldor–Hicks's approach analyses the principle of possible compensation; it recognizes two situations which are explained as two alternatives. In case alternative one makes someone worse off, alternative two will be based on compensation, the author calls those alternatives situations. That "situation **II** is considered more efficient than situation **I** if those who benefit can compensate those who lose, or if those who are made worse off by situation **II** cannot prevent the change by 'bribing' those who stand to gain from it" (De Soto, 2009: 21).

Under Kaldor–Hicks's efficiency, an allocation of resources is more efficient if the "winners" could (in theory) compensate the "losers" and still remain winners. The key difference in this theory from the idea of Pareto is the idea of hypothetical compensation. Kaldor-Hicks does not require compensation actually be paid, just that the possibility for compensation exists. If compensation can be done to those who are made "worse off" by situation **II** then both parties will benefit and achieve efficiency (Lawrence, 2009). Thus, the idea of compensation as proposed by Kaldor-Hicks has been taken into consideration in this study in resolving the social costs which arise from land water use among cattle herders and farmers in Mvomero District. Parato and Kudoh-Hicks's efficiency has been used to suggest the solution which count make every individual using happy (maximize utility) of using water from the land resource. The view is on the possibilities if cattle herders can compensate farmers for the damage they cause on their farm and other social costs caused by the increasing number of cattle in the study areas.

The Coase theorem

The Coase theorem emerged from an argument in Ronald Coase's "The Problem of Social Cost" (Coase, 1960). In "The Problem of Social Cost", Coase explains the difference between account cost and transaction costs. Coase (1960) considered the nature of bargaining to reach a consummation of an agreed term. He looked into the process of reaching an agreement on the enforceable contract without causing conflicts and/or disputes. For him the costs of disputes settlements are high when the parties sue each other in the court of law to seek truce, alternatively they may negotiate following a well stipulated contractual right. By using an example of crop damage caused by straying cattle, he could show the meaning of damages costs, hence transaction costs. He noted that, negotiations among affected parties would result in an efficient outcome if the costs of transacting are zero in case the rights were well-defined (Medema, 1997).

The Coase theorem states that, "If property rights are

clearly delineated, parties can negotiate at negligible costs, then the parties will always negotiate an efficient solution to the externality" (Coase, 1960). Thus, the Coase theorem assumes that, externality problems such as cattle trespasses will be resolved efficiently through private transactions if the following three conditions are met:

- Property rights are well defined, in Mvomero case for example, every land parcel is assigned to the owners and the land for grazing is assigned to the pastoralists.
- Parties can negotiate using the assigned rights.
- Transaction costs are adequately affordable, that is they are well known.

Therefore, Coase suggests that negative externalities can potentially be solved if property rights are clearly assigned and negotiation among parties is feasible as well as the transaction cost is low. If one or more of these conditions fails, we should expect externalities to be a problem (Coase, 1960) and the socio-economic costs such as pastoralists and farmers fighting will continue to happen. Hence, a key inference in Coase theorem is that the best solution to resolve costs may not be to regulate externality out of existence, but to assign property right in order to facilitate bargaining so that the affected parties will achieve an economically efficient solution. In relation to this study, the idea of Coase plays part in the governance of land water resources use. If cattle herders or farmers are assigned rights to land water use prior cattle transgressing, negotiate on compensation to reach Kudoh-Hicks economic efficiency of compensation to the farmers will be achieved and reduce the socio-economic costs which Coase called "the problem of Social cost".

Water use and its benefits

The land with water which is study called "Land water" has been a battleground for farmers and pastoralists. The African Water Vision (2025) pin pointed that water is a valuable natural resource for development, life and the environment. It can be a matter of life and death, depending on how it occurs and how it is managed. When too little, it can bring destruction, misery or death. Water resource is used for different social and economic activities such as irrigation activities, cattle watering, as well as other domestic activities (URT, 2006).

Different studies have been conducted worldwide, for example, in the study conducted by Calzadilla et al. (2010) in China and South East Asia found out that, the use of irrigation system increased agricultural farm produce which in turn reduced the production costs and farm produce prices. Lugendo (2013) studied the benefit of water use in irrigation schemes of Mvomero district in the Mkindo village to assess the economic viability and economic impact of the Mkindo irrigation scheme project. The study found that irrigator farmers obtain more yields per acre compared to non-irrigator farmers; hence they generate much income from selling farm produces. Moreover, the study investigated the water used among animal keepers. The researcher concluded that animal keeping and agriculture activities are the source of income to households as the Net Present Value (NPV) of the studied project was positive, indicating that it was economically viable. Another study was conducted in Mong'ola Barrazani by Kramm and Wirkus (2010) and found out that, water provided economic benefits to farmers who were involved in gravity irrigation. Furthermore, the non-governmental organization called GLOWS-FIU (2013) conducted a study in Mvomero District, which assessed extent the iWASH program had brought long-term changes in health and economic resiliency. The study was conducted in Kanga and Pemba Villages involving cattle herders and farmers in the sample. The study findings showed that availability of water brought by iWASH program had supported cattle herders to supply water to their animals, improved crop production and income generation in the area, though the agro-industrial sector lacked technical support to carry out efficient irrigation schemes. Also, Ngereza (2005) conducted a study in Pangani river basin to assess Water use and Environment. The study found that, water within a basin serves human needs such as for drinking, sanitation, and irrigation farming. Not only that also pastoralists use water for their cattle. According to van Koppen et al. (2004), who studied catchment areas of water, they argue that Mkoji sub-catchment is a true replica of the current water reform in Tanzania, including its key component: the need to obtain water rights and pay water fees, in this context water fees seemed to be crucial, but allocation of water to farmers and pastoralists is still not studied.

Social costs caused by water use among cattle herders and farmers

Cost is defined as a change that decreases human well-being (WHO, 2012). These are negative impacts caused by water use, which put human beings endanger as well as put water resource in stress. Social costs occur if an activity creates harm or discomfort for uninvolved people. It happens when an individual's consumption of resource reduces the well-being of others who are not compensated by individual beneficiary (Gruber, 2007). A study conducted in Pangani found out that population increase among farmers and pastoralist had an effect on water pollution as well as cause water conflicts among users (Mbonile, 2006). Also, Mung'ong'o and Mwamfupe (2003) conducted a study in Morogoro and Kilosa districts specifically in Kambala, Wami Dakawaa and Dumila. The study found that the increase of pastoralists in these areas has increased stress in water resource and cause scarcity, as well as conflicts between farmers and cattle herders were reported. Several conflicts on water use

were observed in that area, including conflicts among pastoralists and farmers. Moreover, Kramm and Wirkus (2010) conducted a study at Mang´ola Barrazani village in the region around Lake Eyasi. The study found that, water use is a source of conflicts between farmers in the area. Facius (2008) conducted a study at Rujewa village in Usangu plain Tanzania to examine the relationship between water use management institutions and local water conflict. The study found that, the irrigation use of water cause conflicts among water users. Conflicts were reported between pastoralists and domestic users in the area.

METHODOLOGY

The area of the study was Mvomero District as a case study. Villages where the research was conducted include Mkindo, Kambala and Msufini. These villages are about 10 km away from each other. Moreover, these villages differ in vegetation. For example, in Mkindo and Msufini there was a wet savanna because of rivers which cross cut the village while in Kambala there were both dry savanna and wetlands. The battlefield were wet savanna, where everybody wanted to use water for either irrigation or to bring cattle there for drinking. The research design was a case study (Yin, 2003) of Mvomero district. Ccross sectional design applicable to Hembeti and Mkindo Ward was designed according to Yin (2003) within the three designs categories, namely, explorative, descriptive and explanatory designs. Explorative design used at the beginning at the time the researcher went to Mkindo exploring the area like Vasco Da Gama did (Yin, 2003) to get the snapshot of the area of the study. A focus group discussion was conducted, almost 16 representatives attended. The appropriate sampling technique was snowballing and Hembeti, Mkindo villages were visited. Descriptive design was also used to provide an accurate description of observations of a benefits and costs as a major phenomenon under study. Descriptive research design included surveys and fact-finding inquiries from ethnographic to other qualitative designs. The major purpose of descriptive research was to describe the conflicts and disputes settlements possibilities through analyzing cost and benefits arose from water use among pastoralists and farmers existed when this research was conducted (Kothari, 2004). Also, the research followed Yin (2003) who explains this type of case study that is used to describe an intervention or phenomenon and the real-life context in which it occurs and its prevalence. Therefore, triangulation of methods was employed using Denzin (1978) techniques to explain the combination of methodologies in the study of the same phenomenon. Focus group discussion, interviews, as well as the observation were employed to collect data. The sample of this research consists of two groups, which are farmers and cattle herders. A total of 89 respondents were included in the sample size of this study, 55 farmers and 34 cattle herders. Snow balling sampling techniques was applied to reach respondents during data collection because of the nature of the area. This sample is representative according to Brockington et al. (2003) who suggest that a rule of thumb of 30 cases is the minimum requirement to make legitimate generalization on the case studied. Focus group discussion was employed to collect information in groups. Hamlet meeting was conducted in Kambala, Msufini, and Mkindo village whereby people were organized in small groups of 5 to 15 people, then asked questions concerning water sources, costs and benefits of water bearing land. Snowballing was used whereby respondents received information concerning the meeting from Village Executive Officer and Village Chairman to inform their fellows of the target group to attend. According to the nature of the environment and settlement patterns, the groups did not include both farmers and cattle herders at the same time, but rather, each one was visited at different time.

Data processing and analysis involve editing, coding, classification, tabulation of collected data and estimating the value of unknown parameters of the population in order to test hypotheses for drawing inferences (Kothari, 2004). The collected data were analyzed by descriptively and explanatorily. Computer programs used Statistical package for social sciences (SPSS) Version 20 and MS Excel. The data were presented in bar charts and tables to show percentage and frequencies. The validity and reliability were observed.

FINDINGS

We selected water resource as one of important resource human being require for different use. Specifically, pastoralist and farmers in Mvomero district are scrambling for the land bearing water that is where every group wants to dominate either by watering cattle raising or watering (irrigating) crops. Our interest was to find out the current institutions governing water before analyzing the cost and benefits of that land bearing water attracting farmers and pastoralists resulting in never ending stories of conflicts and disputes related to fighting and killing each other in Mvomero district. Out of 89 respondents, only 79 (100%) farmers and pastoralists' respondents responded to the questions, while other 10 respondents did not provide information as they could not speak the Swahili language.

The findings in Figure 2 reveals that, 29 (36.7%) out 79 (100%) of interviewees responded that, there were Village Water Committees (VWC) dealing with water issues in their village. Most of these respondents were from Mkindo and Kambala village. In Mkindo there was water committee, which deals with water issues, the committee consists of village leaders and other representatives. The committee was responsible for planning water issues, arranging costs of water service and solving some technical problems of water wells and some taps and ensured that water was available in the village. It was found that, this committee was active in this village and it had contributed to water project to be implemented in this village as a result there were water taps almost in every village hamlet. Moreover, respondents from Kambala village reported that, there was a water committee, which dealt with water problems in the village. But there were blaming that, this committee was not active as a result, people did not access tap water for more than six months. The water pump machine had stopped working for long time and some of water taps had been destroyed and no repair which was done although water users paid for water services.

The respondents from Mpapaa Msufini did not mention water committee as a governance instrument due to the fact that, there were no water taps allocated in the village. People in this village depended on a collectively owned community well shared by both farmers and cattle herders.

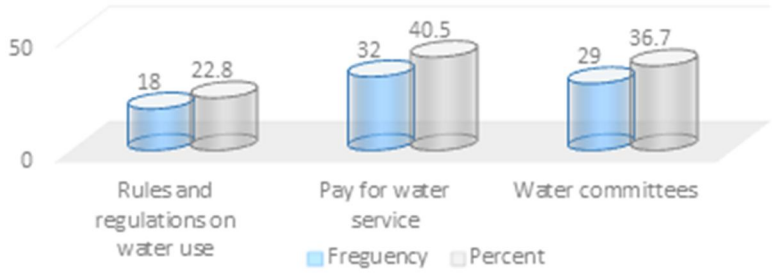

Figure 2. The institutions used to govern water resource in the area.

Comparing Mpapaa Misufini had not yet having a Village Water Committee (VWC) and based on the interviews and focus group discussion it had many waters related conflicts, scarcity and water pollution was evident at the well and among the community members. Water committee is very important in water governance.

As in Figure 2, a few respondents 18 (22.8%) among 79 responded that, there were rules and regulations used to govern water in the study areas. This was revealed in Mpapaa Msufini where cattle herders and farmers shared water from the well. The village government had arranged shift to use water so as to deter conflicts which might arise among cattle herders and farmers. However, it was discovered that, these regulations were not officially documented but rather the village chairman called up the meeting, which included both farmers and cattle herders to discuss water issues. Through that meeting it was agreed that, there should be a shift in using water from the well. Farmers were allowed to fetch water early in the morning up to around 09:00 hours while cattle herders were free to use water from that time up to 15:00 hours or more. This implies that the cattle herders had been allocated more time and more water to feed their animals than the farmers who used time just for a few hours from 6:00 to 09:00 hours. If one observes this time line, from 6:00 to 10:00 hours would mean 4 hours (44%) for using water, the rest of 09:00 hours to 15:00 hours which means the cattle herders were allocated 5 hours (56%) out of day time from 6:00 to 15:00 which is 9 hours (100%) for all. The Village Water Committee (VWC) by-laws were skewed to the cattle herders. However, the informal institutions infuriated water users as those rules were not written and therefore, they were not easy to enforce.

Transgressing those informal orally described rules were easy, but created commotions, conflicts and disputes among users especially when there were transgressors who could fetch or irrigate crops during the time allocated for cattle drinking. Those transgressors who fetched water from the well at any time created quarrel, conflicts and disputes among water users.

However, it was found that, no river and well water rights had been assigned to the users. Water was regarded to be provided for “free” from God. Consequently, this increased the social costs of water use in the three villages of Mvomero District. As the allocation of water in terms of time was skewed to the cattle raisers made cattle herders better-off without compensating the farmers who had been made worse-off and further being the victims of socio-economic cost problems. As a result, the number of cattle is increasing in Mvomero districts and cattle raisers continue to enjoy their informal rights without compensating the farmers. Coase (1960) proposed that, if property rights are clear on the use of the resource, it will be possible for parties to negotiate and reach an efficient solution of the problem. These findings imply that, improper allocation of land water rights among users had led to the increase of social costs in Mvomero district.

The findings in Figure 2 reveal that out of 79 (100%) respondents, only 32 (40.5%) respondents reported that they paid for water services in the area. It was found that, water service or bills were only for water taps especially in Mkindo village. River water and water from wells were free, thus, people were free to use depending on how they accessed it. Moreover, respondents from Mkindo village who were mostly farmers explained that, the village government has set water price to community taps as one among the ways to govern tap water. The Mkindo villages were paying Tsh 500 for community water taps per month, whereby the collected cash was used for maintenance of machinery and water taps. Also, in Kambala village cattle herders mentioned that, previously there was a system to pay for water services, especially tap water whereby each person was supposed to pay Tshs 50 per a 20-L bucket when fetching water. The amount of cash collected, was used to run water services. The findings imply that, there was little concern in governing river and water from wells because people in the area believed that, rivers were natural resource and therefore must be used freely.

Social costs resulting from water use among cattle herders and farmers

When farmers and cattle raisers (pastoralists) were asked to mention the negative impacts (socio-economic

costs) which arose from water use and how those impacts affected them, they responded as represented in Figure 3.

Figure 3 shows that the overwhelm majority 77 (87.5%) among 89 (100%) of respondents, responded that cattle were polluters of water as they drank water directly from the well.

Washing clothes, dishes and showering in the river and the well, the farmers polluted the water too. Also furrow irrigation polluted the water. In the Mpapaa Msufini village researchers observed cattle polluting water. One of the women in Mpapaa Msufini reported on the example of her experience on conflict, she said "We need to wake up very early in the morning to fetch some water from the well. Otherwise, anybody who goes there later will fetch dirty water after Masai (cattle herders) have brought their cattle to drink, in the well because cows pollute water". This implies that, while the pastoralists were enjoying the benefits of keeping cattle, farmers were made "worse off" through animal pollution which made water unsafe for their health (socio-economic costs). The findings concur with Mung'ong'o et al. (2003) in Kambala and Dakawa who found that cattle pollute rivers and water from wells if are not managed during watering.

The findings in Figure 3 indicate that 41 (46.6%) of respondents out of 89 (100%) responded that the cattle destroyed farms near by water wells on the way to and from drinking water at the well. All of them were farmers from Mkindo and Msufini who complained that, their farms and crops were destroyed by cattle when cattle herders took their cattle for pasture and water. It was found that some of cattle herders had a larger herd size, which was more than 200 cattle. It was reported in the focus group discussion that farmers who had farms near the river and along the paths or corridors where cattle passed were destroyed because cattle herders normally look for wetland to have their cattle getting drinking water while farmers like to plant crops near the river to irrigate their crops. Therefore, the wetlands which this research call "land water" attract both farmers and pastoralist because of the benefits they obtain from water, when those areas do not give intended benefits but turning into land water struggling "battleground", creates socio-economic costs (the problem of social cost). "We are disgusted by the Maasai because they graze their cattle in our farms and destroy our crops and if any of us invite them for negotiation, they do neither attend nor listen. We have tried to stop them but they are fierce, they use swords in fighting us. They may chop our heads off if we continue confronting them" said one of the famers in the meeting.

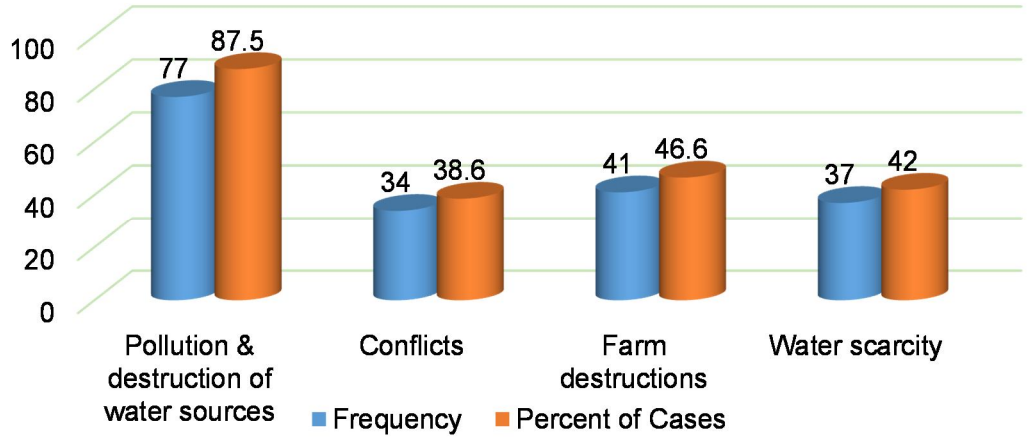

Figure 3. The problem of socio-economic cost.

These conflicts among farmers and pastoralists are escalating due to the fact that as the cattle keep feeding on crops the farmers grow, the number of cattle is also increasing while cattle herders are migrating from other areas due to the fact that many areas are affected by climatic change (getting drier) to make many pastoralists keeping migrating to Mvomero district, farmers are continue made "worse-off" without compensation. These findings concur with that of Mbonile (2006) in Pangani river and Mung'ong'o and Mwamfupe (2003) in Kambala and Dakawa who found that conflicts among cattle herders and farmers arise when cattle destroyed the crops and farms of farmers as a result farmers revenge by killing those. Since Maasai have economic power and weapon to fight farmers, the farming activities are worsened because farmers are increasingly becoming afraid of cultivating near the river sources so as to keep their farm safe.

The example of the story on conflict from Kwaboga Village: When farmers realize that cattle had invaded their crop, they called up for "Mwano" (the village army) and start fighting with cattle herders. The majority of

people got injured and some died in the fight because they used sharp tools like spears, bow and arrows, also it was reported that some of cattle herders had guns. This was observed in Kwaboga village where the Maasai invaded the village and burnt the houses of farmers because they killed cattle that ate their crops. The Maasai complained that, "farmers had cultivated farms everywhere, so they lack paths and areas for pasture". It was witnessed by one pastoralist from Kambala that, "There are farms everywhere, where can we graze our cattle?" he said. The findings concur with the study conducted by Msuya (2013) at the Ruvu ward in Same District whereby he found that farmers tend to reduce the width of the livestock grazing corridor so as to enlarge their farmlands as a result some of the livestock passes across the farms and destroy crops as well as irrigation infrastructure. Also, the findings concur with the ITV News of Dec 12th, 2015 whereby it was reported that, conflict raised between Maasai (cattle herders) and farmers in a Dihinda village in Mvomero district because cattle destroyed farms, whereby more than 20 people were injured in that fight. Generally, if there are conflicts farmers fail to cultivate crops because of safety, same to cattle herders fail to take their cattle for pasture. This led to the death of cattle as well as farmers lose productivity, hence all of them generate nothing in terms of income. Thus, the findings imply that, water does not provide economic benefits if there are conflicts and disputes-this has exacerbated the problem of socio-economic costs.

Social economic benefits of using for cattle raising

The survival of cattle in the study areas specifically Kambala and Mpapaa Msufini depends on water use. It was observed that, cattle herders depended much on river and water from wells for watering their cattle. Further, it was reported that, if cattle get enough water, they provide enough milk to cattle herders. Apart from that, cattle were being kept for economic gain; therefore an average cow (bull) was sold much amount from Tshs 450,000 to 800,000 whereby cattle herders generated much income. It was reported that, cattle (bulls) can drink more than 20 Liters per day. This implies that, the much amount of water was needed for cattle in the study areas. The findings concur with the study of Mung'ong'o and Mwamfupe (2003) in Kambala and Dakawa and that of Ngereza (2005) in the Pangani river basin who found out that, water was required for cattle pasture in those areas.

The number of cattle owned differed from one cattle herder to another herder. The results in Table 1 indicate that the majority 14 (41.2%) of respondents among 34 (100%) cattle herders had a size of the livestock herd ranging between 101 to 300 cattle and few of them had their livestock herd less than 50 cattle which was 2 (5.9%) of respondents.

Further, 3 (8.8%) of cattle herders had the size of livestock herds which was more than 500 cattle. Cattle herders sold their cattle at different price depending on the kind of cattle which was sold. Cattle herders usually used to sell their cattle in the village market (Mnada) which happens once in every month especially in Mkindo and Mvomero. Usually bargaining was done between the buyer and the seller of the cattle in order to reach agreements on the price. Thus, there was no constant market price each cattle herder sold cattle depending on their agreements with the buyer.

Table 2 shows the range of prices of cattle, high number of cattle herders 18 (52.9%) among 34 respondents, reported that they sold their cattle between Tshs 300,000 to 600,000 while few of them 4 (11.8%) sold their cattle below Tsh 300,000. The rest 12 (35.3%) sold their cattle above Tshs 600,000. It was discovered that, those who sold their cattle at high price they sold bulls. Cattle herders earned their income from selling cattle in the study areas. A total number of 34 (100%) respondents (cattle herders) who were interviewed responded to the income and the level of incomes are shown in Table 3.

Table 1. Size of the livestock herd owned by cattle herders (n = 34).

No. of cattle	Frequency	Percent (%)
<50	2	5.9
50-100	13	38.2
101-300	14	41.2
301-500	2	5.9
>500	3	8.8
Total	34	100

Table 2. The price of cattle in the study areas (n = 34).

Price of cattle	Frequency	Percent (%)
< 300000	4	11.8
300000-600000	18	52.9
>600000	12	35.3
Total	34	100.0

Table 3. Income generated by cattle herders per year (Tshs).

Cattle herders income	Frequency	Percent (%)
<100000	0	0
100000-300000	0	0
310000-500000	1	2.9
510000-2000000	5	14.7
2100000-5000000	13	38.2
5100000-7000000	8	23.5
7100000-10000000	3	8.8
>10000000	4	11.8
Total	34	100.0

The results in Table 3 show the income earned by the cattle herders in the study areas. Out of 34 (100%) respondents, 13 (38%) earned the income ranging between Tshs 2,010,000 and 5,000,000 per year. The highest income earners from cattle were 4 (11.8%) of the 34 (100%) respondents which was more than Tshs 10,000,000 per year. The lowest income earners from the cattle herding were 1 (2.9%) of the respondents who earned up to five million shillings. Thus, the findings imply that, water resources provided more economic benefits to cattle herders.

Social economic benefits of farmers from using water for irrigation

The main crops cultivated by farmers in the three villages of Mkindo and Mpapaa Msufini were rice, maize and tomatoes. The results are multiple responses of the total number of 55 (100%) responses and presented in Figure 4. This means that, other farmers were practicing mixed farming and others could grow more than one crop as indicated in Figure 4. Figure 4 indicates that the majority of farmers 50 (90.9%) among 55 (100%) respondents reported to cultivate Maize while a few of them 6 (10.9%) cultivated tomatoes and vegetables.

Figure 4 shows that the rest 47 (85.5%) cultivated rice (paddy). It was found that farmers cultivated maize and rice for food security and for sell, in order to increase household income while tomatoes and vegetables were purposefully grown for commercial purposes and less for home use. Further, it was reported that, tomatoes and vegetables were cultivated in the dry season from June to September. Therefore, the cultivation of these crops depended on irrigation farming. Farmers used water from the wells and river water to irrigate their crops using cans.

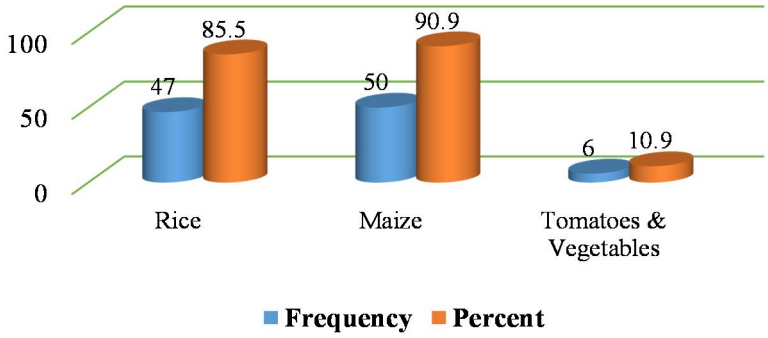

Figure 4. Types of crops reported to be grown for both case and in Mvomero District.

Sacks harvested per acre by farmers

The analysis results in Table 4 reveal that out of 55 (100%) farmers who were interviewed, the majority of respondents 36 (65.5%) harvested 6 to 10 sacks of maize and rice per acre and 11 (20%) harvested less than 5 sacks while few of them 1 (1.8%) harvested more than 15 sacks per acre.

Further, it was found that, people who used irrigation farming, harvested much yields up to 11-15 sacks of rice per acre than those who depended on rain fed only. Moreover, respondents reported that, farmers harvested little maize because crops were affected by diseases and insects.

Respondents (farmers) were asked to mention the price they used to sell farm produces (crops). It was found that farmers used to sell crops at different price whereby, most of them, they sold maize and paddy (rice) and tomatoes. Crops were sold in the village market (Mnada) and on the farm during harvesting time. The price of Maize ranges from Tshs 25,000 up to 65,000 per sack while the price of paddy (rice) ranges from Tshs 35,000 to 85,000 per sack. Further, it was found that people sold the farm produces at the market price (Mnada) than when they sold them in the farm. Also, it was discovered that, rice was sold at a high price than maize and tomatoes.

Table 4. Unit harvested by farmers per acre (n = 55).

Descriptions	Frequency	Percent (%)
Unit harvested per acre		
<5 Sacks	11	20
6-10 Sacks	36	65.5
11-15 Sacks	7	12.7
>15	1	1.8
Total	55	100

Income generation was among of the benefits gained by farmers from water use. Farmers earned their income from selling farm produces in the study areas specifically

rice, maize and vegetables. A question was asked to farmers if they sell crops, and mention the income they earned per year from selling crop produces. The intention of this question was to obtain such data which will help to determine the income variation among cattle herders and farmers in the study areas. Among 55 respondents who were farmers, only 52 responded sold farm produces while another 3 responded that, what they harvested was just for home consumptions. Table 5 presents the analysis of the finding.

Table 5. Income generated by farmers per year (Tshs).

Farmer income	Frequency	Percent (%)
<100000	3	5.8
100000-300000	26	50.0
310000-500000	15	28.8
510000-2000000	7	13.5
2100000-5000000	1	1.9
5100000-7000000	0	0
7100000-10000000	0	0
>10000000	0	0
Total	52	100.0

Table 5 shows theorem than half of farmers who responded to the questions, that is, 26 (50%) among 52 (100%) respondents earned their income between Tshs 100,000 to 300,000 per year, while a few of them 1 (1.9%) earned their income between Tshs 2,100,000 to 5,000,000 and the rest 3 (5.8%) earn their income below Tshs 100,000 per year from selling farm produce. Further, unlike cattle herders, no any farmer who reported to earn income of Tshs 10,000,0000.00 per year. It was found that those who earned a high income were those farmers who conducted irrigation farming whereby they harvested more farm produces than those who depended on rain fed; hence, they had excess to sell.

Comparing analysis of socio-economic-cost and benefit from water use on cattle raising and farming activities

Figure 5 shows how farmers and cattle herders had used water to raise cattle and irrigate their farms in order to benefit. The graph has been plotted to relate the social costs and benefits from either raising cattle alone in the study villages or leave farming activities in the area. Another policy would be to leave both farming activities and cattle raising taking place in the area if the Village Water Committees are well functioning to set up enforceable by-laws governing water use, allocating water and assessing cost and benefit as it is shown in Figure 5. Income generated by cattle herders and farmers has been used to indicate the economic benefits of water allocation in the study villages specifically Mkindo, Kambala and Mpapaa Msufini. There are three areas and different points in the graph which indicate the variation of income generation in relation to the social costs.

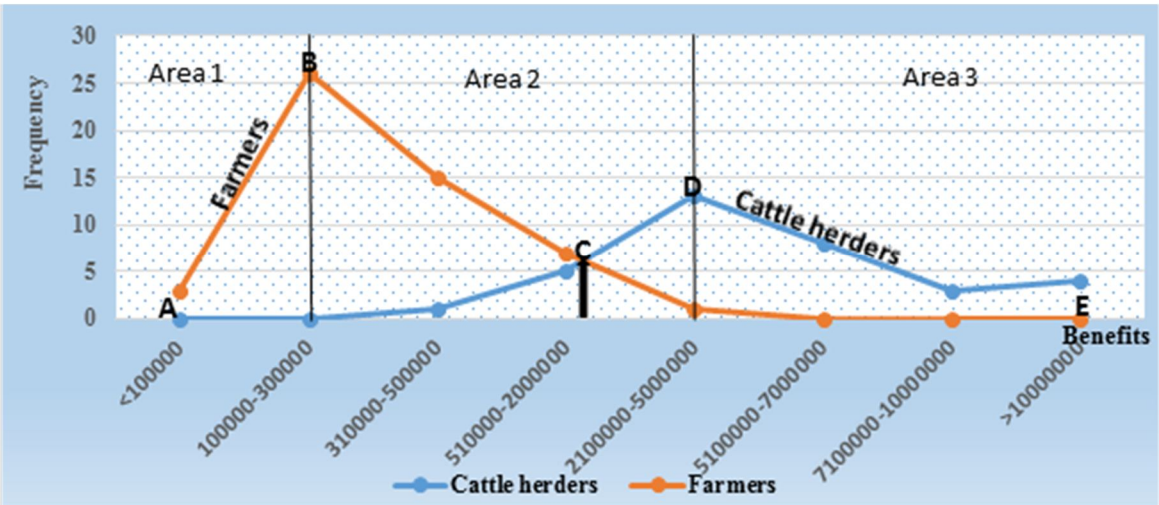

Figure 5. The variation of income generated by farmers and cattle herders (Source: Field data analysis 2016).

Figure 5 is a plane of income per year among farmers and cattle herders (benefits) in the horizontal axis. The vertical axis is the frequencies of occurrence of income status among the farmers and cattle herders. Figure 5 indicates that, at point **A** are the respondents who responded to have a very low income which is less Tsh

100,000 per year. Most of these respondents were farmers who depended on rain fed farming, whereby no any cattle herder reported to generate such income per year. From point **A** to point **B** the line is very steep within area **1** which is occupied by many poor farmers in this context, a poverty line of this area can be calculated as [(100,000 + 300,000) = (400,000/2) annually = 200,00/ (365 days) = Tshs 547.94 (approx. USD. 0.3<USD 1) per day, which is less than the poverty line set by the international standard measurement. This implies that, farmers in area **1** which is a poverty line are "worse off" because they use less than $1 (one dollar) per day which is Tshs 548. In this area still no any cattle herder responded to earn such income per year and therefore, the cattle herders do not fall in poverty line category.

In area **2** from point **B** to **C** and **C** to **D,** the graph shows that the number of farmers is decreasing as income increases while the number of cattle herders is increasing. At point **C** in area **2** is the optimal point of which is assumed to be the maximum number of both farmers and cattle herders water use in that area can bear. Cattle herders and farmers in this area generate the same income which is between Tshs 510,000 to 2,000,000. Moreover, further information shows that, most of the farmers who fall in point **C** are those few who conduct irrigation farming, while cattle herders are those who have few herd sizes from 40 to 76 cattle. In relation to the social costs; further information reveals that, there are low social costs in area **2** because cattle herders keep fewer numbers of cattle which can be easily managed and prevent damages on farms.

Furthermore, from point **D** to **E** in area **3** the graph shows the majority of cattle herders earning high income between Tshs 5,000,000 to 10,000,000.00 per year. This area presents respondents who are "well off" than other areas. In this area no any farmer reported to earn such income. Further findings show that cattle herders in area **3** have large herd size which is more than 200 cattle. Large herd size allows them to sell more cattle and generate much income. Although cattle herders generate a high income, it was reported that, there is an increase of the social costs such as farm destructions and water scarcity as the number of cattle increases in the area, thus farmers are made "worse off". According to Pareto, an allocation of the resource is Pareto efficient if it increases at least one person's utility without adversely affecting the utility of another person, this means that, it produces winners but no losers (Coleman, 1980). In order to attain efficient allocation of water to the two groups cattle herders need to reduce the number of cattle and keep about 40 to 76 cattle as well as farmers, should conduct irrigation activity in the area, whereby both they will end up between point **C** and **D** in area **2**, generating income less than Tshs 5,000,000 per year as indicated in the graph.

Although, efficiency might be achieved at that point, both farmers and cattle herders will remain poor in the area. Thus, there is a need to make Pareto improvement whereby the idea of compensation to those who are made "worse off" as proposed by Kaldor–Hicks can be applied that, cattle herders should keep on keeping cattle whereby, they become "better off" and compensate farmers for their loss. This implies that, water resource should be allocated to cattle herders specifically in Kambala and Mpapaa Msufini and assign water rights as proposed by Coase (1960). If water rights are assigned will facilitate negotiation between them and reach an efficient solution to the social costs which arise from water use, and lead to the efficient governance of water resources and increase income generation among cattle herders and farmers.

CONCLUSION

The paper has led the reader from the problem statement leading to the objectives of the case study in Mvomero district to explain socio-economic cost and benefit of water use for irrigation (farmers) of cattle keeping (cattle herders) as we take into consideration that conflicts and disputes happening in Mvomero District due land related issues. However, dry land does not matter a lot, wet land or the land which is likely to be cultivated matters a lot. The conflicts emanate from scarcity of land but much more the conflict on scarcity of land that bears water. As the land that bears water is becoming less and less those conflicts and disputes requires attention. The findings shows that there is call to the government and all stakeholders to address the issue of the size of cattle the land that bears water can carry and also allocating land to the users is very important.

Also, farmers who cultivate tomato and vegetable gardens conducted irrigation farming near the well at the same the well is commonly used by the farmers and cattle herders using informal non-enforceable rules. Moreover, the findings reveal that, institutions and systems which were used to govern water resource in both villages Mkindo, Kambala and in Mpapaa Msufini were weak. Poor governance contributed much to the social costs of water use such as pollution, farm destruction and water scarcity because there were no water rights, as well as strong rules and regulation which could be used to govern water. Consequently, few formal institutions were used to govern water in these villages. Water committees were mentioned in Mkindo and Kambala but were not strong and clear to all people that is why these committees failed to solve water issues as it was reported in Kambala village. Further, informal ways, such as time set on the shifts of using water from the well among cattle herders and farmers were observed in the Mpapaa Msufini village. Generally, there were few formal institutions governing water in both villages, also people were not well informed concerning the ways which were used to govern water. The findings reveal that, cattle

herders earned a high income from selling cattle than farmers who earned little income from selling crops in Mvomero District. Thus, the opportunity cost of allocating the water (land bearing water or wet land) for agriculture was greater than the opportunity cost of allocating water for keeping cattle in the study areas. If farmers will keep cattle, they will gain much benefit in terms of income generation. It can be concluded that, water provided more economic benefits to cattle herders than farmers in the study areas, thus, water resource should be allocated to cattle herders specifically in Kambala and Mpapaa Msufini village and assign water rights and find the way to compensate the farmer.

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