ASSESSMENT OF WATER USER ASSOCIATIONS FOR EFFECTIVE MANAGEMENT OF CLOSED WATER DISTRIBUTION SYSTEM: TIMAU DIVISION, KENYA

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A thesis submitted to the Graduate School in partial fulfillment for the requirements of the Master of Science Degree in Natural Resources Management of Egerton University

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DECLARATION AND RECOMMENDATION

CANDIDATES DECLARATION

This thesis is my original work and has not, wholly or in part, been presented for an award of a degree in any other university.

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Signed _____ Date: 12/03/12

SUPERVISOR'S APPROVAL

This thesis is the candidate's original work and has been prepared under our guidance, and is submitted with our approval as University Supervisors.

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DEDICATION

Special dedication goes to my family in particular my Wife Winnie, Dad and Mum for their full support and love during my Masters Degree Course.

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ABSTRACT

The Kenya Water Act of 2002 emphasizes on the formation of Water Users Association (WUAs) for better management of water resources through integrated water management. According to the Act the water abstractors are supposed to benefit from fair and equitable water distribution. This study primary objective was to determine whether introduction of the Water User Association in Timau Division has led to improvement in the management of the closed water distribution system used. The study utilized a social-ecological survey to collect data in the Division, where a one-time cross-sectional survey was conducted among 67 Timau WUA projects to collect quantitative and qualitative data to test and answer to the study objectives. Both descriptive and analytical procedures were used in data analysis using the Statistical Package for the Social Sciences computer software version 17. The findings showed that Timau WUA was very effective in the provision of adequate water for domestic use while very ineffective in the provision of adequate irrigation water. Water supplied was also not treated before distribution. Water is not distributed equally to all the members and the situation worsens during the dry seasons. Members of the Association showed very high levels of commitment especially in attending committee meetings (83%), raising of funds towards the WUA (92.1%), volunteering of time, labor and resources (88.2%) and 93% of the members were very committed in matters pertaining to defending and campaigning for their WUA. Decision making was found to be influenced by factors such as: awareness of the Water Act ($P = 0.002$, $t = -3.129$), length of membership ($P = 0.004$, $t=2.797$), education level ($P = 0.000$, $t = 4.125$) and respondents age ($P = 0.007$, $t = 2.710$). Water conflicts were found to be influenced by social relationships of the members, political and administrative factors and conflicts arising from the technical/engineering work done on the closed system. Based on the findings there is need to improve on extension services aimed at educating farmers on appropriate and sustainable water management practices. This will form a foundation for well informed water management committees and members on various issues involved in integrated water management in the Division and elsewhere.

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LIST OF ACRONYMS AND ABBREVIATIONS

ADB	Asian Development Bank
ASCE	American Society of Civil Engineering
ASL	Above Sea Level
EC	European Commision
EWA	European Water Association
FAO	Food AgriculturEeOrganization
GOK	Government of Kenya
IBRD	International Bank for Reconstruction and Development
IIMI	International Irrigation Management Institute
IWMI	International Water Management Institute
MOW	Ministry of Water
WUAs	Water User Associations
SPSS	Statistical Package for the Social Sciences
WRMA	Water Resources Management Authority
UNICEF	United Nations Children Education Fund

DEFINITION OF TERMS

Water User Association: is a group of water users such as irrigators, who pool their financial, technical, material and human resources for the operations and maintenance of a water system. It elects leaders, handles disputes internally, collects fees and implements maintenance.

Closed Water Distribution System: refers to the use of pipes (as opposed to open furrows) to transfer water from flowing streams at various intake locations to the various use destinations not served by surface water (Abdel Hakim, *et al* 2004).

Water Intake: this refers to a concrete wall constructed across a flowing stream; it has an opening through which water enters into a pipe from the river.

Terminus Distribution designs: this refers to the various devices used to allocate water to the members at the destined point.

Water Conflict: these are disputes arising due to inequitable distribution and access to available water resources.

CHAPTER ONE: INTRODUCTION

1.1 Background of Study

Timau Division, a major producer of horticultural crops relies more on irrigation than on rain-fed farming as this is an all year round activity. Agricultural production has experienced a boom. With a 20-fold increase in export value between 1983 and 2002 for the country as a whole, it is now second to tea and has surpassed coffee as an export commodity (Wiesmann *et al,* 2006) People with common interest of piping stream water for irrigation come together and form Water User Associations (WUAs) in accordance with the Water Act of 2002. The Act emphasizes on the formation of WUAs for better management of water resources through integrated water management. According to the Act the water abstractors are supposed to benefit from fair and equitable water distribution (WRMA, 2006)

In Timau Division WUAs are formed through the efforts of the major water users within a given river sub catchment, who aside from mobilizing the local community, also provide the necessary financial and logistical support. Existing water projects in the respective river sub catchment provide a basis for formation and recruitment of members. Once a WUA is formed, an Executive Committee is elected. Timau Water User Association comprises of 67 registered water projects with a total membership of 2,303 (TARDA, 2009).

The formation and institutionalization of the WUA is followed by documentation of the main water uses in the sub catchment, as well as sharing of information and experiences to create general awareness of the water situation among the various water users. This is a very important step in the effective functioning of the WUAs with respect to conflict prevention and resolution, as it helps to create common understanding among the user groups. It is at this point that people's perceptions and attitudes change, and they begin to appreciate the need for concerted efforts and action to ensure that water is available to all deserving users downstream. All WUAs meet 4 times a year (every 3 months); the local District Officer and other local administration are invited to the meetings. However, the Executive Committees may meet more frequently since the meeting act as good management tool for the association for instance where issues arise that require immediate attention

While decentralization of water management to the community led to the formation of water user associations, effective management of the associations is required to ensure that the available water meets the demand of people, animals and ecological restoration. The European Commission (EC) on water management in developing countries support the activities of water user association in developing countries and emphasizes on the following key areas to ensuring effective management of water by the associations (Sylvain , 2006).

1. Users Awareness and Participation

Users must be aware of the importance of water as a resource and their responsibilities in relation to sound management of this precious resource. Ownership is a key factor in the success of the policies and the participation of actors at all levels is thus essential.

2. Institution Capacity Building

The success of the associations activities depends largely on the capacity, resources and expertise of the institutions concerned. Support must be provided for the institutions responsible for water management;

3. Demand-Based Management

It is not enough to just manage only water distribution; supply must also be managed. The challenge is to reduce demand while increasing output through initiatives such as reuse of water, protecting water resources, reduce loss etc;

4. Expanding The Knowledge Base

The necessary knowledge and information are essential for drawing up effective policies; this entails carrying out education and awareness programmes within the water association

After the decentralization, members form their own project management committees. The committees typically have the following responsibilities:

- Equal distribution of water to all the farmers all the time
- Reallocation of water shares among farmers in situations where some farmers do not want to use the water for a limited period (such as a season or a year) or decide to leave the water association for good;
- Mobilization of farmers for voluntary work to reconstruct, repair, or maintain irrigation structures;

- Organization of communal meetings, such as regular (often monthly or as need be) meetings to determine and communicate the timing, rotation, raise awareness on water use, collection of water fee and water allocations among farmers;
- Enforcement of bylaws and mediation of conflicts between irrigating farmers; and
- Collection and banking of funds contributed by farmers (or, in very few cases to date, outside agencies) and registration fees from newly registered members (Abdel, *et al* 2004).

The implementation of some of these tasks, especially water distribution and reallocation and mediation of conflicts, is normally left to water distributors also known as water route scouts, who are elected by the farmers or appointed by the committee. Each closed system may have one or several water distributors, each in charge of a subsection of manageable size.

Where operational issues cannot be resolved by a water distributor, they are passed to the committee. Water distributors are usually not salaried but work as volunteers. However, their pivotal position in the day-to-day management of water resources and irrigation schedules brings them benefits through "informal" gifts, in cash or in kind, from farmers wishing to keep good relations or to gain special favors (Kiteme and Gikonyo, 2002) .

The current situation

The greater Mount Kenya region has experienced rapid and far-reaching social economic change over the last 50-60 years. Population has increased manifold, both in rural and urban areas, and traditional subsistence farming has incorporated coffee and tea production, and most recently horticulture, which have all become major export earners for Kenya. These developments have put increasing stress on natural resources, especially water, which is important not only for agriculture and the growing urban centers in the areas immediately adjacent to the mountain, but also for pastoralism and tourism (also a major foreign currency earner) which are located further downstream (Wiesmann *et al*, 2006)

Development has put increasing pressure on regional water resources and resulted in growing competition and conflicts among the different user groups. Increasing demand from upstream users such as small-scale farmers and horticultural firms, as well as from growing urban areas which has virtually cut off supplies of water to downstream areas, especially during dry season (Wiesmann *et al*, 2006)

A major challenge currently facing Timau WUAs is ineffective management of the closed water distribution system. While in the past the water was used for domestic purposes and was adequately supplied, with the current irrigation uses, the water system has been overburdened and inefficiently performing as was found in this research.

Population increase in the division has worsened the situation through increased demand for water, and has led to formation of more WUAs. This in turn has led to the rise in conflicts regarding various technical and social issues including the location of water intakes, the pipe sizes used, the reduced amounts of water reaching the downstream intakes, the routes followed by the major pipes, and damages to the system especially during the dry season when the water volumes are reduced.

With fluctuating water volumes in the dry seasons the downstream intakes receive little or no water; this has consequently led to abandonment of these intakes by the WUAs members who in turn move up stream to look for other appropriate location to build their new intake. The size of pipes which are used to convey the water from the intake is also another bone of contention among the WUAs, some use larger pipes which are deemed inappropriate since they draw large volumes of water opposed to the others. This brings about the question as to whether there is appropriate technical consultation involved in the designing of the project, and if consultation is done, the law has it that follow up activities should be done to check on the activities of the water user associations. The routes followed by the major pipes also bring about controversies leading to damages of the system by the land owners along the piping routes. This leads to situations where leaking pipes are left open on the *shambas* leading to crop damage. In other circumstances open ditches are left unburied and when it comes to planting seasons the farmers damage the pipes at these points so that those who come to repair the system can bury the open ditches.

Management of the Timau water association Closed Distribution system is challenging especially when it comes to meeting the demands of all the water users depending on the river. Effective management of the resource and the users is required in order to achieve the primary objectives of the Water Association as set by the Kenyan Water Act.

1.2 Statement of the Problem

Despite the introduction of the Water User Associations to improve on the management of water resources in the country, Timau Water User Association is faced with management challenges which include Inequitable water distribution to members especially during the dry season, Increased water loses along the piping system, abandoned expensive distribution systems and increasing water conflicts between the Old (Downstream users) and New (Upstream Users) especially during the dry seasons. In order to have a functional water user association there is need to assess management indicators of water users associations (Abdel ,*et al* 2004) Timau Water User Association is of no exception hence the need to assess the management of water resource to its members.

1.3 Broad Objective

To assess and determine whether introduction of water user association in Timau division has led to improvement in the management of the closed water distribution system used.

1.3.1 Specific Objectives

1. To determine the effectiveness of Timau WUA in terms of provision of accessible, adequate, reliable and safe water supply to both members and non members households..
2. To determine the extent of members involvement in running the water user association.
3. To assess the level of leadership training in aspects of management of the water user association.
4. To determine the extent and prevalence of water related conflicts in Timau and identify strategies to mitigate these conflicts.

1.3.2 Research Questions

1. How effective is the Timau WUA in providing the members with accessible, adequate, reliable and safe water?
2. To what extent are the members involved in running the water user association?
3. Do leaders of water user association undergo any training in water resource management?

4. Are there conflicts among the members over the use, distribution and distribution of water? If so how are they solved?

1.4 Justification

Water is life hence water as a resource is a very important commodity for both human and animal consumption and for irrigation purposes. Water is also essential for maintaining ecological systems as well as for achieving sustainable development. The water sector is a core government priority and is a vital element in the pursuit of achievement of the Millennium Development Goals. Water is also a rare commodity for Kenya where more than 80% of the country is arid and semiarid meaning all efforts must be put in place to ensure its sustainable use and conservation.

The management of the distribution system needs to be addressed in order to ensure sustainable utilization of the available piped water through equitable distribution to all the members. It is through addressing this issue that greater profits can be realized by the farmers and they will also be given greater flexibility in managing their available water resources in the best way and according to their needs. There is thus a need to assess the current situation and problems so as to derive workable solutions towards facilitating an efficient and effective Timau closed water distribution system

Where there is no effective management of the Water Association, conflicts prevail among the members of the Water User Association and no progress can be achieved hence creating conditions and situations where poverty can set in. Ineffective management can also lead to shortages of safe drinking water as well as water for agriculture and livestock posing a significant constraint to social economic development and therefore hamper poverty eradication (UNICEF, 2008) Improved management of the Water User Association will lead to improved accessibility of adequate and safe water by all the members for both irrigation and domestic chores. Accessibility of water throughout the year will mean that more land will be put under irrigation hence availability of food crops throughout the year.

1.5 Scope of the study

The study covered only the 67 Timau water user association projects in the division. Projects abstracting water from the same river but not in Timau division were not studied.

1.6 Operational Definition of Terms

Water Accessibility: In this study accessible water refers to water which is convenient in terms of distance and time spent in fetching the water for example the time spent in queue for water..

Reliable Water Supply: This refers to consistency of the closed system to supply required amounts of water all the time without failure for example during dry seasons and Wet seasons.

Adequate Water Supply: This refers to ability of the system to meet domestic and agriculture water needs of the members and community.

Participation and Motivation in water management: This refers to frequency of attending the association meetings, prioritizing of problems and giving of solutions, involvement of members in fund management, Length of membership, volunteering of time and materials to the WUA and whether women participate in running the WUA.

WUA Leadership Capacity: This refers to levels of training undergone by the staff and community leaders and also their education levels and the involvement of stakeholders in policy formulation and project evaluation.

Conflicts: This refers to the presence and frequency of household/members quarrels over the distributed water resulting to physical harm or damaging of property.

Community: All the people within Timau Division but are not members of Timau water user association.

Water system effectiveness: refers to a system that has adequate amounts of water flow with minimal water losses along the system. The water is also expected to be equitably distributed to all the members at the terminus.

Water user association member's awareness: Refers to how knowledgeable and conscious the members are in legal and technical matters of the water association. For example whether they understand the Water Act of 2002, Importance of attending meetings, Use of modern farming techniques, Attending trainings on good water use practices.

Mortaa: Refers to a distribution design which is a long pipe with finger like extensions used to distribute water at the terminus. Plate 1.

Closed water distribution system: This refers to the use of pipes to transfer water from flowing streams at various intake locations to the various use destinations not served by surface water

CHAPTER TWO: LITERATURE REVIEW

2.1 Importance of Forming Water User Association

Water Users Association (WUA) is a group of farmers, all served by a common source of water, who join together to allocate, distribute, and manage water. The aim of establishing Water Users Associations (WUA) is to develop a participatory irrigation management concept for increasing water use efficiency through the involvement of all stakeholders as much as possible in the various management activities. (Sallem, 2004). WUA allows farmers to perform activities that are more difficult or impossible to do individually. The creation of Water Users Association is justified by the participatory approach in water management to allow farmers to efficiently concentrate their efforts and means for joint actions aimed at the optimum utilization of water resources on irrigated and reclaimed lands (MOW, 1991).

One of the most significant contributions of water user associations is in the prevention and resolution of water conflicts through direct interventions to deal with the major causes of conflicts such as over abstraction of water, illegal water distribution, wasteful means of conveyance and irrigation and delayed issuance of water permits. Those guilty of such offences are compelled by the respective association to take the necessary collective measures, otherwise they are reported to the relevant authorities for appropriate legal action (Kiteme *et al,* 2002) The ministry of water and Irrigation through District water officer also transfers the management of the water supply schemes to the communities to act as custodians of the water supply schemes, including the assets, when they take over the responsibility for operating and maintaining them." But, the goal of community management should be ownership of the water supplies, including the associated assets (Mumma, 2005).

The purpose of involving a Water User Association in improving water resources management is not only to increase supply of irrigation water to farmers' fields but also improve the quality of irrigation management' practiced by farmers. Physical improvement when accompanied by improved irrigation management lead to improved irrigation efficiency, farming practice changes and increased economic benefits (Lowdermilk, 1991).

There is need is to organize farmer participation in design and construction of water projects; as it makes the famers to feel that they own the project hence they can participate in decision making and management of the project (Bryan, 2006, 1999)

The ability of rural communities to provide water services through community groups is demonstrated by the fact that presently no less than 2.3 million people get water services from systems operated by self-help (community) groups – traditionally known as "water users associations." These systems are diverse in nature and capacity, ranging from fairly sophisticated systems with well structured tariffs to simple gravity schemes operated without any formal processes (Njonjo, 1997).

2.2 Characteristics of Well Managed Water Users Association

Ostrom (1990) has identified seven important characteristics of organizations which manage common resources well. These characteristics include having clearly defined boundaries; appropriation; rule and local conditions congruence; collective-choice; members having the opportunity to play a role in changing the rules in monitoring graduated sanctions and conflict resolution mechanisms. WUAs are fundamentally a participatory, bottom up concept. WUAs have been organized in many developing countries such as Thailand, Turkey, Somalia and Nepal among others.

Continued development and strengthening of Water User Association will depend in part on the initiative of farmers and water users' association officials. But it will also depend on the quality, quantity, technical and financial assistance as well as training provided to support the development of WUAs. For instance in Pakistan each on-farm water management directorate conducts short courses at its water management training institute to train members who in turn offer the training in the future for new members (Kerry, 1999). WUA development will be more successful if it is focused in the same way. Flexible, responsive intervention and an enabling institutional framework can provide resources - legal, technical and financial - to assist WUA in developing just enough organization to manage irrigation systems well. (Montgomery 1983).

Many of the most important tasks required to keep an irrigation system running are not always a routine. Repairs must be made, conflicts resolved, resources mobilized in connection with a crisis such as a landslide or drought. Thus the key capacity needed for effective irrigation

management is to be able to carry out such tasks quickly and effectively, without extensive planning or scheduling. In existing locally managed irrigation systems, institutions for carrying out such tasks almost always exist and they usually function fairly effectively (Bryan, 2006)

Farmers have many demands on their time and would like to avoid wasting their efforts on unnecessary meetings and paperwork. Local collective action grows out of community life, where farmers are already linked in many ways and irrigation organization may be embedded in community institutions (Hunt *et al* 1976 and Bates, 1988). It is crucial that farmers are able to maintain the canals and quickly make repairs when canals are damaged by landslides or other problems. The institutions developed to solve this key problem then shape the ways in which farmers distribute water, share costs and make other arrangements (Martin and Yoder 1983). Controversy and failures have surrounded many heavily financed irrigation programs which invested only in the physical canal networks but neglected to create the social institutional structures in the dispensable to, and appropriate for the newly physical structures (Kerry, 1999).

Large distribution irrigation systems have played an important role in the distribution of scarce water resources that otherwise would be accessible to only a few. Also they allow for a sound water resources management by avoiding the uncontrolled abstraction from the primary source such as ground water, rivers e.t.c. Traditional distribution systems have two common shortcomings, as the water must be distributed through some rotational criteria that guarantee equal right to all beneficiaries. The inevitable consequence is that first crops cannot receive the water when needed, and second reduced yields are unavoidable. However this compromise is necessary to spread the benefit of the scarce resource (FAO, 2000).

Among the distribution systems, pressurize system have been developed during the last decades with considerable advantages relative to open canals, in fact they guarantee better services to the user and higher distribution efficiency. Therefore, a greater surface may be irrigated with a fixed quantity of water. They overcome the topographic constraints and make it easier to establish water fees based on volume of water consumed because it is easy to measure the water volume delivered. Consequently a large quantity of water may be saved since farmers tend to maximize the net income by making an economic balance between costs and profits. Thus because the volume of water represent an important cost, farmers tend to be efficient with

their irrigation. Operation, maintenance and management activities are most technical but easier to control to maintain a good service (Zaccaria, 1998).

By definition, an irrigation system operating on demand, farmers decide when and how much water to take from the distribution network without informing the system managers, usually on demand delivery for irrigation and domestic water is more common in pressurized irrigation systems. The pressurized delivery systems offers a greater potential profit than other types of irrigation systems and gives a great flexibility to farmers that can manage water in the best way and according to their needs. Of course, a number of preliminary conditions have to be guarantee for on demand irrigation. The first one is adequate water tariff based on the volume effectively withdrawn by farmers probably with increasing rates for increasing water volumes. The delivery devices (pipes) have to be equipped with flow meter, flow limiter, pressure controls and gate valves. (Mays *et al*, 2001).

2.3 Designing a Closed Distribution Irrigation System

A pressure piped irrigation system is a network installation consisting of pipes, fittings and other devices properly designed and installed to supply water under pressure from the source of the water to the irrigable area (James, 2004).

The basic differences between traditional surface/open irrigation and piped irrigation techniques are:

a) The water flow regime: With traditional surface methods the size of the stream should be large, while in pressure piped irrigation systems very small flows, even 1 m3/h, can be utilized.

b) The route direction of the flow: With traditional surface methods the irrigation water is conveyed from the source and distributed to the field through open canals and ditches by gravity following the field contours. The piped system conveys and distributes the irrigation water in closed pipes by pressure following the most convenient (shortest) route, regardless of the slope and topography of the area.

c) The area irrigated simultaneously: With traditional surface methods the water is applied in large volumes per unit of area, while piped irrigation systems distribute the water at small rates over a very large area.

d) The external energy (pressure) required: Traditional surface gravity methods do not need external energy for operation, while piped irrigation systems require a certain pressure, 2–3 bars, which is provided from a pumping unit or from a supply tank situated at a high point.

Advantages of closed system over the open system

Irrigation efficiency. In open canal distribution networks, the water losses are estimated at up to 40 percent in unlined ditches and up to 25 percent in lined canals. These losses are due to seepage, phreatophytes and leakage in gates, spillways, etc. In piped systems, no such losses occur. During the application to the plants, the water losses range from 10 percent in localized micro-irrigation to 30 percent in overhead conventional sprinkler and surface methods. As a result, water losses can be minimized and an irrigation efficiency of 75–95 percent can be achieved. In open canals, the irrigation application efficiency ranges from 45 percent to a maximum of 60 percent (Meinzen-Dick, 2007)

Economic return per unit of water. Piped systems facilitate the manipulation of the irrigation water under more favorable conditions than do open canals. This can result in a yield increase of 10–45 percent and an improvement in quality(Meinzen-Dick, 2007) .

Operation and maintenance (O&M). The man-hours needed in the piped systems range from one-tenth to one-quarter of those required for open canals. Any person can easily operate the piped systems, while the open canals can require skilled labour. In the open canals, expensive operations are carried out to prevent damage caused by roots; seepage through banks; the spread of weeds; siltation and sedimentation; clogging of outlets and gates; etc. In the piped systems, no maintenance or continuous repair of constructions is required. The basic component parts of the piped systems require minimal maintenance during the first seven years. The complete piped system requires a yearly maintenance costing about 5 percent of the initial investment (Meinzen-Dick, 2007).

Cost. The use of thermoplastic pipes and fittings, made of unplasticized polyvinyl chloride (rigid PVC), low density polyethylene (LDPE), high density polyethylene (HDPE), and polypropylene (PP), which are manufactured in almost every country in many sizes and classes, has reduced the cost of piped irrigation installations to a relatively low level at a time when open canal networks are becoming increasingly expensive (Meinzen-Dick, 2007).

An irrigation system should meet the objectives of productivity which will be attained through the optimization of investment and running cost. A number of parameters have to be set to design the system. These parameters may be classified into environmental parameters and decision parameters. (Lammaddalena 1998 and Lammaddalena et al, 2000).

The socio-economic conditions of farmers have to be taken into account, they are important both for selecting the most appropriate delivery schedule and the most appropriate on farm irrigation method. Several advantages have been realized by use of pipelines for conveyance in water distribution projects, as well as for distribution of on- farm requirement. Because of their capacity to transmit pressure, pipelines facilitate the use of flexible schedules. It is however important to note that is very difficult to make changes once the pipelines have been installed, the designer must use great care when selecting the type of pipes, diameter and materials to ensure that the initial installation is technically and economically acceptable and limiting for the future.

A large number of on demand irrigation networks have been developed over the past thirty years. While the majority of them have been found to perform below the expectations, a closer analysis of the cases with poor performance records shows that many of the cases with poor performance records shows that many of the criticisms leveled against on demand pressurized systems are attributed to shortcomings in: unsuitable size of family holdings, low levels of irrigation and farm management knowledge, non volumetric prizing of water, incorrect estimate of the design parameters and Lack of qualified staff for the operation and maintenance of the system. Water charges when wisely applied encourage profitable and efficient use of water and discourage wasteful use. (IWMI, 2004).

2.4 Leadership, Gender and Water Distribution Rules

The widespread trend to transfer water management responsibility from the state to the communities or local user groups has by a large extent, ignored the implications of intra-community power differences for the effectiveness and equity of water management. Gender is a requirement of such differences, despite the bias on women participation, a review of evidence from South East Asia shows that female participation is minimal among water user associations. One reason for this is that the formal and informal membership criteria exclude women.

Moreover the balance between cost and benefit of participation is often negative for women because complying with the rules and practices of the organization involves considerable time, cost and social risks. Whereas other ways to obtain irrigation services are also typically less secure more formal participation of women can strengthen women bargaining position as resource users within households and communities. Greater involvement of women can also strengthen the effectiveness of the organization by improving women compliance with rules and maintenance (Ruth *et al,* 2004)

In Nepal one of the key factors behind uneven success rates has been unequal participation among the users, In particular for women roles as irrigators, water users and farmers have often been overlooked. Gender issues that are considered in Nepal WUAs project design include strengthening WUAs and to increase women participation in each subcomponent, provision of gender training to WUAs members and finally to facilitate an agreement between department of irrigation and WUAs on a quota for women participation (Tulin, 1994) Inconsistencies in water distribution rules create difficulties in system operations and this leads to an inefficient and inequitable water distribution performance (Jeffrey *et al,* 1996) Publicly recognized water distribution rules give decision makers and potential users a basis for agreement and reducing the potential room for reducing water distribution conflicts (Sampath *et al*, 1990).

To be effective water distribution rules must be accepted as valid by most of interested parties including those who have the power to flout the rules for their own benefits. This calls for most of these rules to be codified, however not all distribution rules need to be codified, they may be publicly accepted rules that are passed via word of mouth even to a larger community (Ostrom *et al*, 1993) (Perry, 1995) offers a broad and persuasive hypothesis about the relation of water distribution rules and system performance. He argues that if physical infrastructure and management personnel are not capable of delivering water as specified by water distribution rules, the results will be poor system performance.

2.5 Conceptual Model

As illustrated in the conceptual model below the most influential problem is lack of inadequate involvement of the WUAs members in the planning and implementation of the water system. This influences ineffective leadership in the water user associations, conflicts among the

members, members' unawareness of technical and legal provisions in the use of the water system and system malpractices by the members. Full involvement of members occurs when they can identify their own problems, come up with solutions and work together in the community to bring them about. The conceptual model has borrowed the concept from the virtual water theory which states that your cup of coffee requires 140 litres of water. This theory pioneered the development of key concepts in the understanding and communication of water issues and how they are linked to agriculture, climate change, economics and politics.

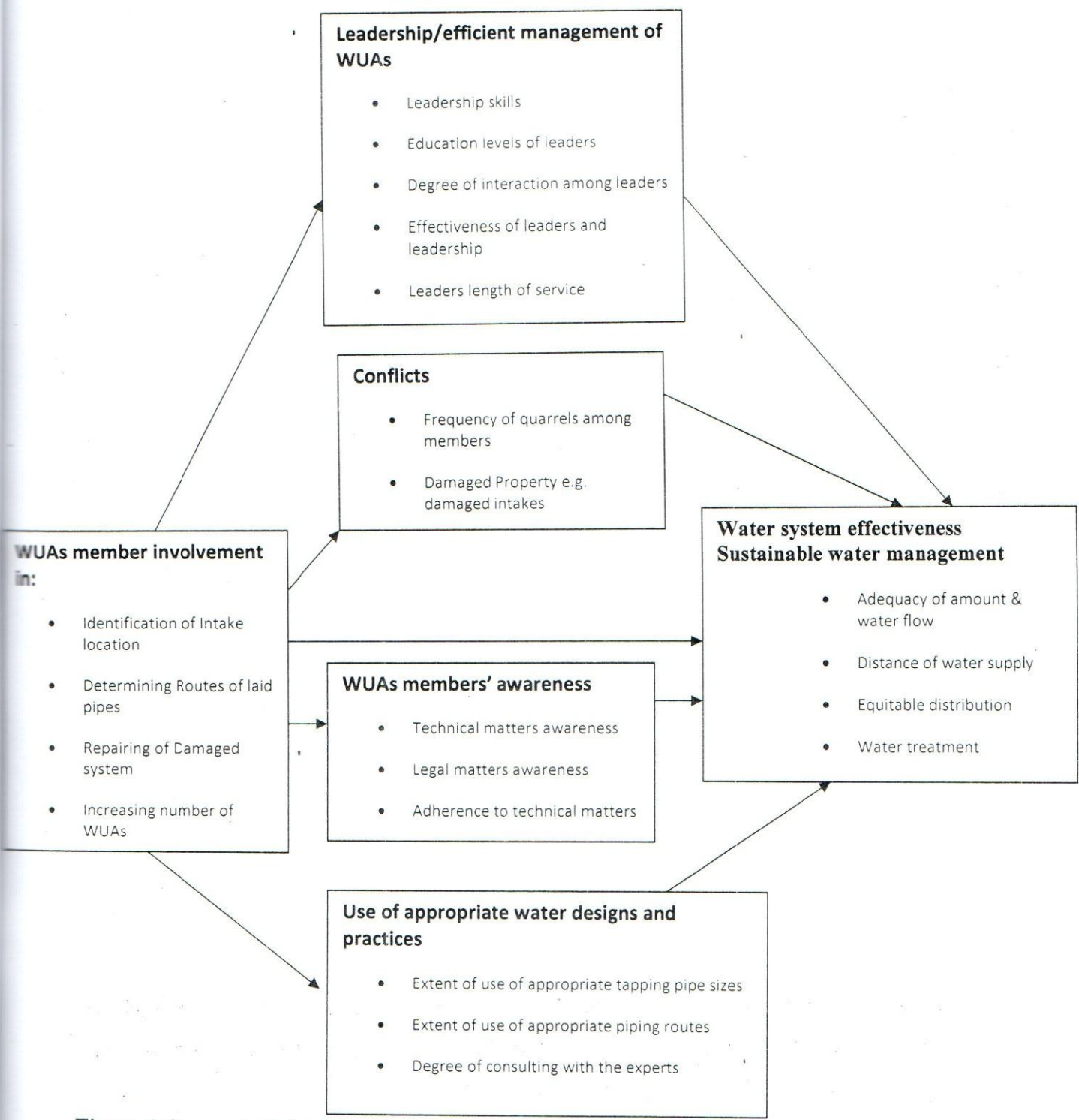


Figure 1 Conceptual framework

CHAPTER THREE: METHODOLOGY

The study utilized a social-ecological survey to collect data in Timau Division of Buuri District as discussed below.

3.1 Study area

The study was undertaken in Timau division. The division is located on latitude 0^0 9 N and on longitude 37^0 1 60^0N at an altitude of 2233mASL. It covers an area of 1060 square kilometers, with five locations. In Buuri District Timau Division has the least population because most of the land area is occupied by large white settler farms, with an estimated population of 48,536 persons. The population density is estimated to be 46 (GOK, 2002).

3.1.2 Physical Features of the Study Area

The area has moderate to highly fertile loam soils. The dark loam has been derived from volcanic turf. These soils owe their origin to complex formations and volcanic rocks from Mount Kenya (GOK, 2002). The maximum mean annual temperature ranges between 23^0 C and 32^0 C, while the minimum mean annual temperatures vary between 13^0 C and 21^0 C, with an average annual temperature of 24^0 C. The Division has two rainy seasons; March-May (long rains) and October- December (short rains). Rainfall ranges between 900mm and 1200mm per year, the short rains are more reliable than the long rains (GOK, 2002). There have been drastic climatic changes in the Division whereby rainfall patterns have changed and have become unpredictable. This situation has made the farmers to turn to irrigation for the growth of their horticultural crops.

3.2 Research Design

The design used in data collection was one time cross-sectional survey to selected households that are members of water user associations. The design was used because the study collected information only once from the respondents without any follow-ups to be made later. To improve the validity of findings, triangulation was used by integrating quantitative and qualitative techniques. The quantitative techniques involved single-round retrospective

household surveys whereas the qualitative techniques involved focus group discussions, key informant interviews and observations.

3.3 Cross-Sectional Household Survey

As stated above, a onetime cross-sectional survey was conducted among project members of Timau Water User Association in Timau Division to determine the role played by the Water User Association in sustainable management of water resources. In order to compare determinants of efficiency among the members of WUA's, the Associations water projects were further categorized according to membership as shown in the Table below.

Table 3.1: **Membership Classification of Community Water Projects.**

Classes	Number of projects	Number of members (Households)	10% membership
10-20	15	248	24
21-30	9	234	23
31-40	10	375	37
41-50	10	477	47
51 and above	13	959	95
Individual farms	10	10	1
TOTAL	67	2,303	227

A standard questionnaire was used to collect primary data from heads of all selected households. The questionnaire was administered in the form of an interview schedule since some of the respondents were illiterate. The principal researcher administered the questionnaires by himself. The questionnaire had both open and closed-ended questions that addressed the objectives of the study.

3.4 Sampling procedure

Multi stage cluster sampling was used in the study. This technique is the most economical over the other probability sampling techniques, particularly if face-to-face interviewing is to be used. As its name suggests, it is a combination of several different samples. The entire population (all water projects in Timau WUA) was divided into classes/ clusters according to the number of members in each class. The total number of members in each class/clusters was constituted and a 10% of the members in each class/cluster was computed to form the study sample, and a random sample of these classes/clusters was selected. The water projects were grouped into 6 classes according to the number of members in the project as shown in the above table.

3.5 Focus Group Discussions

Three focus group discussions (FGD) were held with all the key stakeholders. The groups comprised of administration (Two Chiefs from Kisima and Ngusishi Locations and Two village heads from Karimba (Situated Down Stream) and Kiambogo (Situated Upstream) villages), Association Committee (Manager, Vice Chairperson and Secretary), Four Selected Community Members, Pastoralist represented by their Assistant chief from *Chumbi* Location and a representative from the flower farms from Batian Flower farm.

The topics discussed focused on: wetland degradation along river Timau, River pollution, soil erosion, distribution and storage, water conflicts, water charges and water laws as per the Water Act of 2002. The aim of this phase was to elicit descriptions from selected groups of people among the community. The focus group discussions had specific questions that sought information on people's own personal experiences, attitudes and opinions, with particular emphasis on water management in the area. Information derived from the focus group discussions was used to complement that from household survey while at the same time improve on some aspects of the research questionnaire.

Key themes and sub-themes on participant's statements were indicated on the left margin whereas researchers' comments and first interpretations were indicated on the right margin. Afterwards, the data was transferred to compilation sheets which were organized in different themes and objectives.

The focus group discussions has the advantage of being economical yet still yields detailed qualitative information from a relatively large number of respondents. It is often an excellent technique to use for examining group or community consensus about a particular issue (Fisher *et.al.*, 2002).

3.6 In-depth Interviews

In order to investigate community attitudes on performance of Water User Associations and obtain meaningful answers to sensitive questions on personal topics, the study used in-depth interviews with some key informants who were identified after the household survey. The in-depth interviews were designed to collect more detailed information over and above what was collected from focus group discussions and household surveys. The main categories for in-depth analysis included community leaders, government officers, and leaders of WUAs. Purposive sampling was used to identify five respondents from each of the above category in the study area in total fifteen key informants were interviewed. The key issues addressed during the in depth interviews included challenges faced during distribution of water to members, appropriate ways for resolving conflicts and training competences of the WUA leaders

3.7 Observation

Throughout the research period observations were made to complement the information being sought by the questionnaire. Observations were made on the various types of distribution designs used by different WUA projects, sizes of the pipes used, leaking pipes, irrigation methods used and the piping routes used.

3.8 Data Analysis

Different methods were used to analyze data obtained. After each focus group session, the moderator and the recorder would meet to review and complete the notes taken during the FGD. Afterwards, a full report (transcript) of the discussion that would reflect the discussion as completely as possible,,using the participants' own words was prepared. After the transcription of the data, coding was done. Key themes and sub-themes on participant's statements were indicated on the left margin whereas researchers' comments and first interpretations were indicated on the right margin. Afterwards, the data was transferred to compilation sheets which were organized in different themes and objectives. The household questionnaires were pre-coded and thereafter data coding and data entry began. Crosschecking and cross matching between files

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was done until all the cases with inconsistencies were cleaned. Both descriptive and inferential statistics were used in data analysis, using the Statistical Package for the Social Sciences computer soft ware. Appropriate descriptive analyses were used to generate frequency distribution tables and cross-tabulations to show distribution and relationship of various independent and dependant variables. A summary of analytical methods used is presented in below the table.

Table3.2: Summary of Analytical Methods for each Research Objective

Specific Objective	Statistical Methods	Output
To determine the effectiveness of WUA's in terms of household access to adequate, reliable and safe water supply for domestic and irrigation use.	• Descriptive statistics: percent distribution of households with adequate, safe, reliable water sources. • Cross-tabulations	• Bar graphs, pie charts • Measures of central tendency
To estimate the prevalence and determinants of water related conflicts in Timau Division and identify strategies to mitigate these conflicts.	• Descriptive statistics: percent distribution of households who experience conflicts; percent distribution of major causes as reported by respondents • Bivariate statistics to measure association: Chi-square, • Cross-tabulations	• Frequency distribution tables • Graphs • Statistics
To determine the effectiveness of WUA's in their activities aimed at raising community knowledge and awareness on water use; raising the levels of community involvement in their project activities.	• Descriptive statistics: percent distribution of members participating in management; % distribution of members with knowledge of water conservation; etc • Cross-tabulation to show variations across background characteristics	• Frequency distribution tables • Graphs • Statistics
Determine extent of members involvement and Assessing the level of leadership training in aspects of management of the association.	• Descriptive statistics: % of trained leaders,rating leaders levels of education • Logistic regression analysis	• Frequency distribution tables • Graphs • Statistics
To identify strategies for improvement of water user associations in the study area.	• Descriptive statistics: percent distribution of strategies as suggested by respondents in FGDs, In-depth interviews and household survey	• Frequency distribution tables • Graphs • Statistics

Further to this bivariate and multivariate analyses were conducted to measure the strength of relationships between various dependent and independent variables.

CHAPTER FOUR: RESULTS AND DISCUSSION

This chapter focuses on the findings of the study; the first section discusses the socio economic characteristics of the members and indicators of a well managed closed water distribution system Such as frequency of route line monitoring, presence of water leakages along the system, water rotation among others. The results have been presented in tables, graphs, pie charts, photographs and inferential statistics have been used for qualitative data.

4.1 Household Characteristics

Household characteristics were studied to understand their relationship to effective management of the Timau Water User Association. The household characteristics studied comprised of respondent's age, gender, education level and income levels of those engaged in horticulture. However the respondents declined to give information concerning their income levels. Those interviewed said that they had previously been interviewed during census hence the government had all the information. It was also noted that most of the respondents did not keep farm records which could give clear information on their income levels. Other household characteristics studied comprised of routine activities carried out by the management of the Association, since routine activities give a clear indication of effective management of any water association. The routine activities studied included equal distribution of water at the terminus, methods of irrigation used, awareness of the water act, frequency of carrying out pipeline checkups, use of shifts/water rotation schedules during the dry season and the levels of consulting embraced by the management before and after commencement of the activities of the association.

4.1.1 Age and gender

Among all the respondents interviewed 16.2 % constituted of respondents below 30 years of age, of these 11% were men and 5.3% were women. Majority of them represented their parents who were the actual members of the water project while others represented the youth who had formed and registered new water projects. 31.6% and 33.3% constituted of respondents in the age brackets of 31-45 and 46-55 years respectively, they formed the majority of the total

respondents. 43 % of the respondents within this age were male while females represented 21.9%. Those above the age of 55 were 18.9% of the total respondents; most of them were the initiators/founders of the water projects and they were among the oldest members of the water projects. Table 4.1 below shows the respondents' age distribution between male and female respondents interviewed.

Table 4.1: Respondents Percentage Age Distribution

Repodents age	Respondents gender		Total
	Male	female	
<30yrs	11.0%	5.3%	16.2%
31-45yrs	8 21.1%	10.5%	31.6%
46-55yrs	21.9%	11.4%	33.3%
above 55yrs	13.6%	5.3%	18.9%
Total	67.5%	32.5%	100.0%

n=228

In total 67.5% of the respondents interviewed were men while 32.5% women. It was noted during the survey that most of the women did not identify with the membership and ownership of the water resource. Most of the women respondents were either widows or they represented their husbands who were away. Some of the women used mobile phones to call their husbands so that they could be granted the go ahead with the interview. Previous studies have shown that those women who are active members of Water' Associations usually are de facto heads of household: either they are not married or their husbands work elsewhere in the country. These women are active irrigators and make most of the operational day-to-day decisions since waiting for a far-away husband to make decisions is not practical. This tends to put women in situations of greater responsibility and to lessen women's marginalization (Hartmut, 2006)

4.1.2 Education level

The survey found out that 59% of the respondents had attained basic primary education which is considered to be very vital in the management of water resources. 21% had attained secondary education, 1.8% had attained post secondary education and 0.9 % had attained university education. 3.1% had attained pre-primary education while 14% had not gone to school. Figure 4.1 shows the respondents education levels.

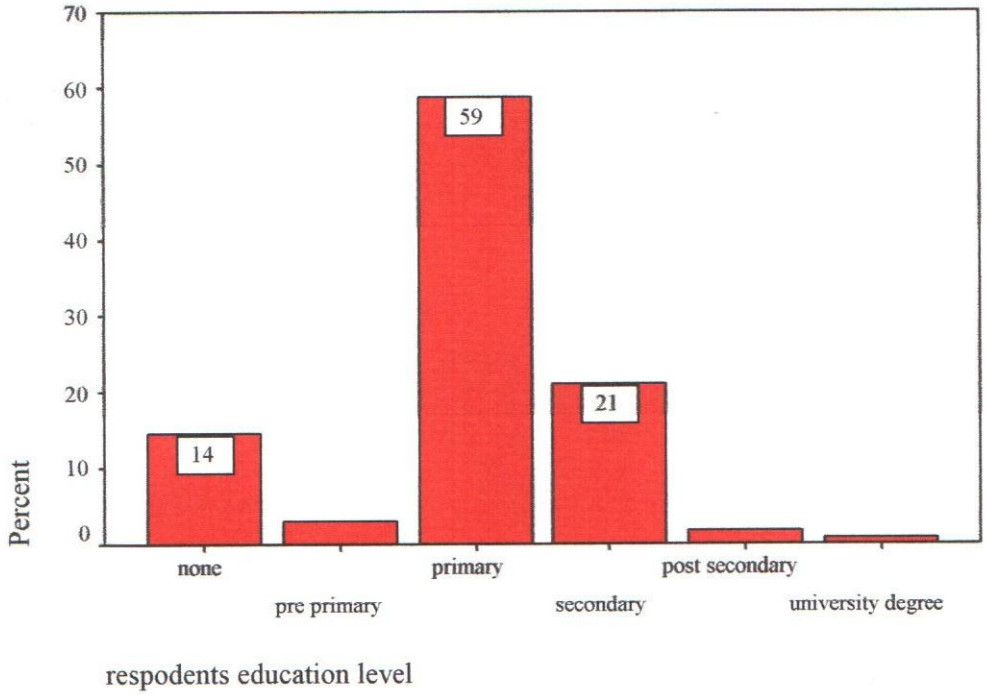


Figure 4.1: Respondents education Levels

It was noted that many of the respondents did not find the reason to continue with their education after attaining the basic primary school education because they were readily absorbed by the flower farms where they worked in key positions such as spray supervisors, green house supervisors and pack house supervisors. Others engaged in the horticulture farming which they said that it was more rewarding than being employed elsewhere. Some actually sited themselves to being more successful than fellow villagers who had gone to school.

4.1.3 Length of Membership in the Water User Association

Length of membership was considered to be the number of years from which ones household was connected with water from the main pipeline this is represented in Figure 4.2 below.

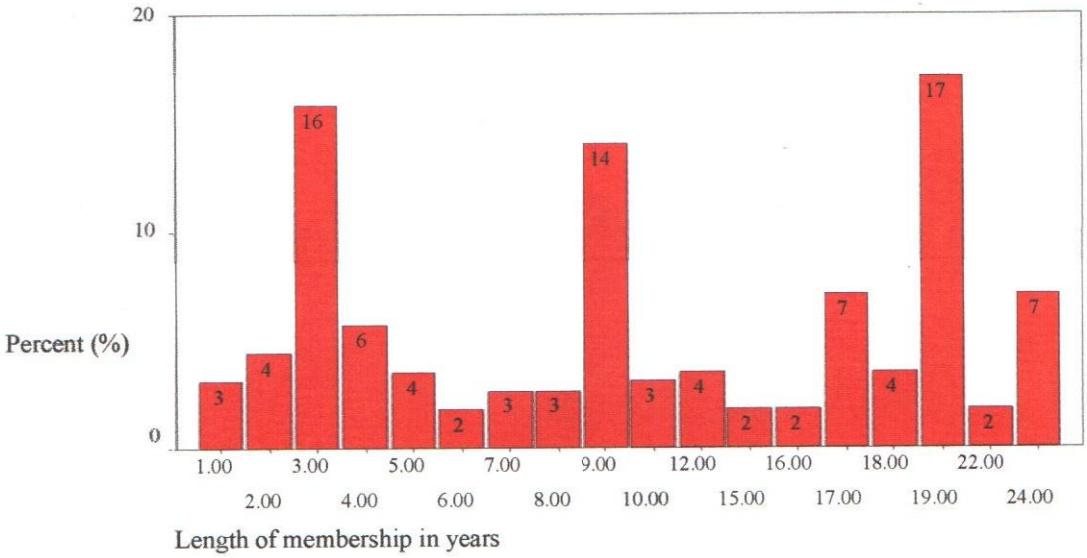
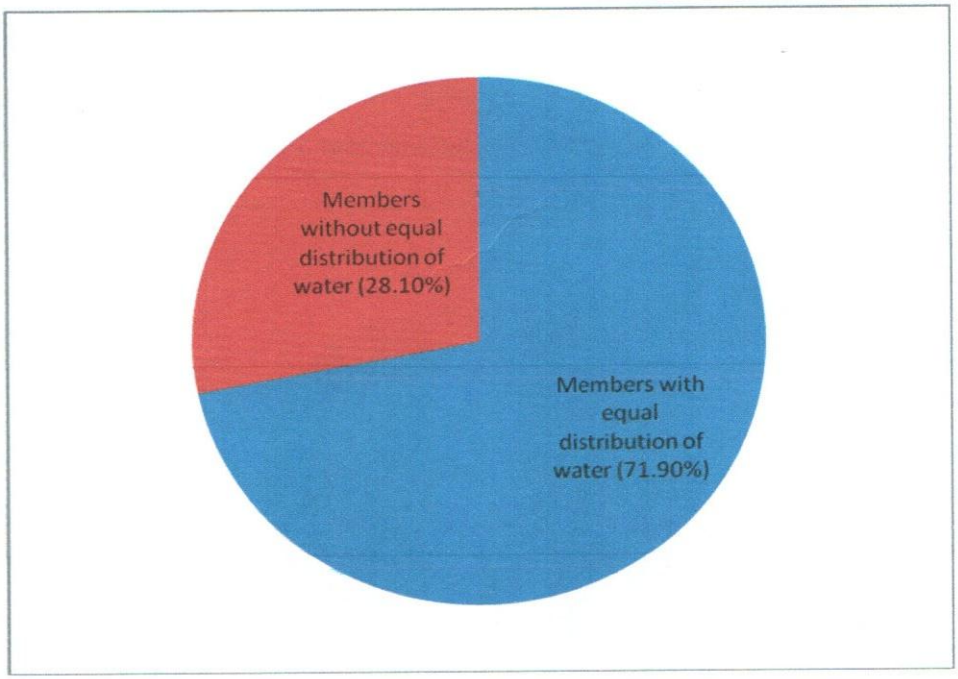


Figure 4.2. Length of membership in WUA

As shown in figure 4.2 17% of the respondents had been members of the water projects for 19 years and they formed the majority. These were the initiators of the water projects. This group was above the age of 55 as indicated earlier in table 4.1. 16% of the respondents had been members for three years, this also represented the youth mainly aged 30 years and below, this is almost an equal number to those who had been members for 19 years, this group comprised of the youth who had formed their own water projects after splitting up from the old water projects which they felt had bad leadership and also due to increased domestic demand of the water supplied. The youth funds being provided by the government also contributed to the increase of the new water projects. The longest membership term was that of 24 years and it comprised of 7% of the total respondents. While membership of one year indicated that some projects had open membership, this group represented those members who had delayed in the payment of connection fee.

4.1.4 Equal distribution of water to members

As indicated in Figure 4.3 28.1% of the respondents felt that water was equally distributed to all the members' while71.9% felt that their projects did not distribute water with equality. This was mainly attributed to poor location of the terminus distribution points, the leaders of the association were blamed for this because they did not address the issue on time. From the focused group discussions, poor location of the water intakes was highlighted as also a major cause of inequality in water distribution this mainly affected the old water projects,



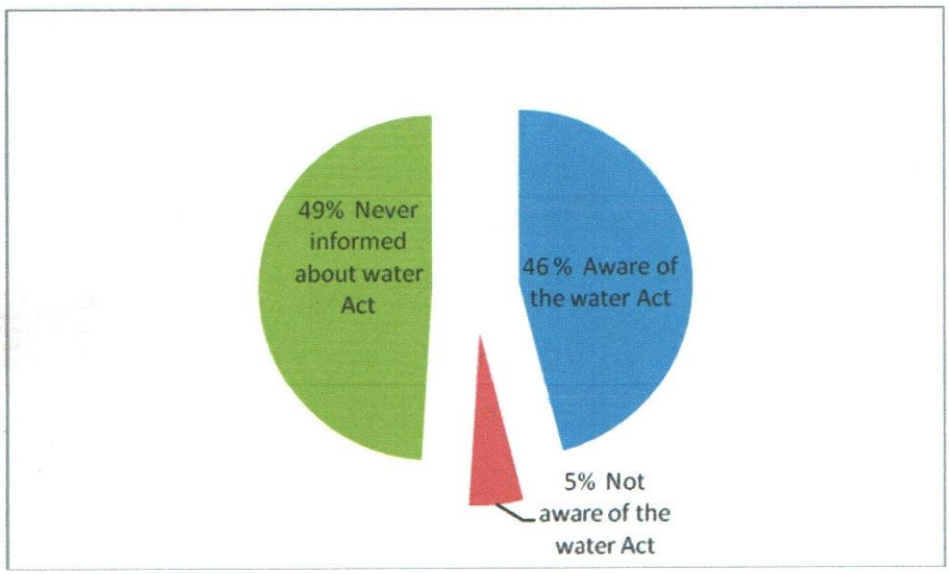
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Figure 4.3 Equal Distribution of Water to Members

Old water projects had most of their water intakes located far away (downstream) from the catchment areas hence little water was reaching their distribution points. With the increasing number of water projects they have resulted to building their water intakes upstream near the catchment zones. This has led to decreased water volumes reaching the old intakes located far downstream. most of the old water projects had been financed through donor funds where water had been tapped using very large pipes hence as a result of reduced water volume the pipes didn't fill their volumes leading to very little water reaching the distribution points.

4.1.5 Awareness of Water Act 2002

As shown in the figure 4.5 46% of the respondents were aware of the water Act 2002, and they appreciated the decentralization of water management to the grassroots. When asked on how they had been informed about the Act, it was clear that they came to learn when they began to pay water charges and through water license application fee which every member contributed towards. Also they had been informed of the water Act through the various meetings held by the water user association officials. 5% of the respondents had not been informed about the water act while 49% had never been informed about the Act but they did notice that there were new changes in water resources management, for example they had began paying monthly water bills which was a phenomena they had mainly associated with the urban.



n=228

Figure 4.5 Water Act Awareness Levels

There are several impacts which can result from having members who are not informed about the water laws governing them. Members become uncooperative especially where policies touching on water demand and supply are involved. In the Timau Water user association most members didn't understand why they had begun paying monthly water bills. Laws are put in place to manage natural resources which the public deem to be public goods because with the absence of laws the tragedy of the commons situation sets in. From the information gathered it

was also found out that women respondents were less informed about the water Act. Only 5.8% of the women respondents were aware of the water Act while majority of them (23.5%) had never been informed about the water Act.

Table 4.2 Percentage distribution of Water Act awareness by respondents Gender

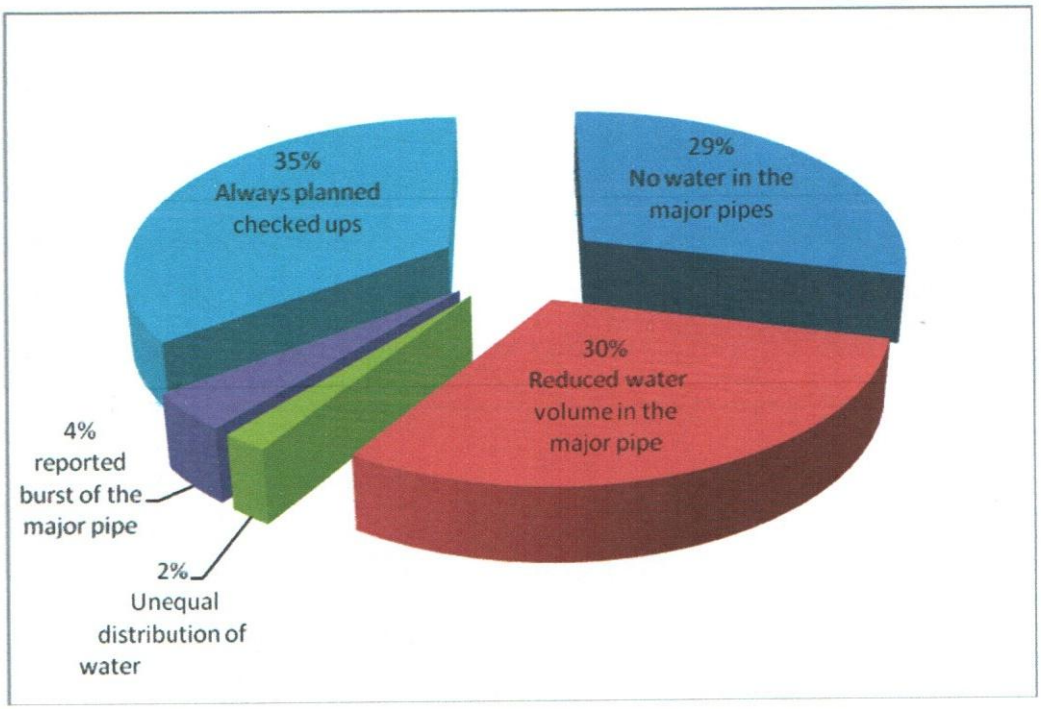
	awareness of water act			
Respondent gender	aware	not aware	never been informed about it	Total
male	39.8%	1.8%	25.7%	67.3%
female	5.8%	3.5%	23.5%	32.7%
Total	45.6%	5.3%	49.1%	100.0%

n=228

Compared to women men had an upper arm with regard to their levels of awareness, 39% of them were aware of the water Act and complied by it requirements. Women play a greater role in water management hence need also be informed equally about the water Act. Women are left with the roles of water management once a homestead has been connected to the system. Conflict management is also best done by women because they value peace more than men (Ruth *et al,* 2004)

4.1.6 Frequency of carrying out pipeline route checkups

The frequency of routine pipeline checkups is one of the key indicators of a well managed water user project. As shown in figure 4.4 35% of the respondents said that their water projects had planned patrols on their pipelines, planned patrols are encouraged by the water resources management authority because planned patrols assist in the identification of illegal abstractors of water, water leakages, monitoring the water volume in the stream and cleaning of the intakes.



n=228

Figure 4.4 Frequency of route checkups

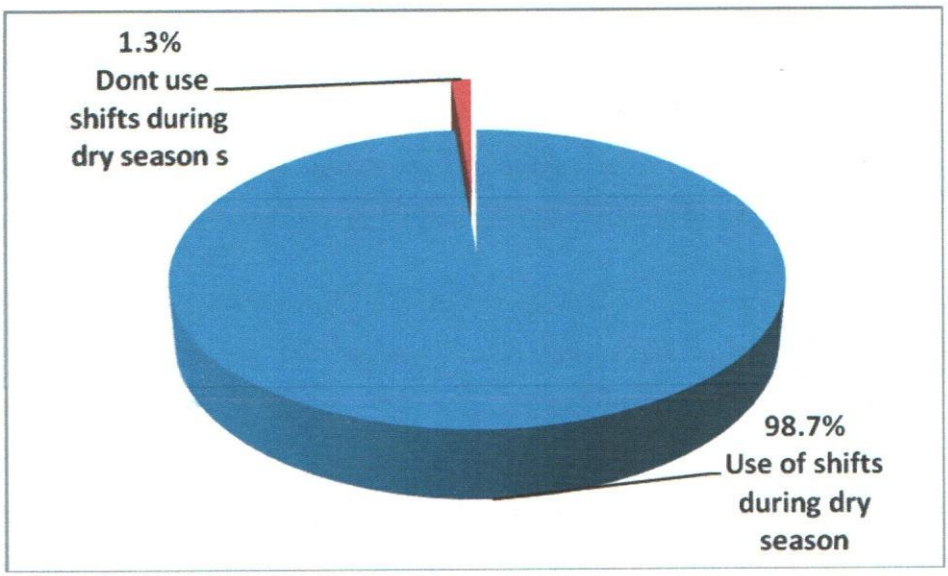
This helps in ensuring that the closed system supplies sufficient water to the members all the time, for example during the drought members of *Katharatandi* water projects indicated that they are usually informed three months in advance that due to reduction in water volume , they are to begin water rotations/shifts. This ensures reduction of conflicts among the members; members also reduce the size of land under irrigation when such notices are given. This helped to reduced domestic competition of the available water. 29% carried out their pipeline checkups when their closed system went dry while 30% carried out the checkups when there was reduced water volume in the closed system.

The only causes to reduced volume and drying up of the system were mainly identified to be blocked intakes, system malpractices from illegal abstractors, heavy floods when it rained in the forest and wild animals damage. Failure to have routine checkups was attributed to lack of incentives to those patrolling, others felt their systems had sufficient supplies for everyone hence there was no need for routine pipeline checkups. In a few cases especially those respondents from the upstream said that they feared fights from the downstream patrollers who were responsible for reduced water volumes reaching their intakes. 4% carried out their checkups

when there were reported bursts while 2% carried their checkups when they experienced unequal distribution.

4.1.7 Use of shifts/rotations during dry seasons

Use of shifts in water distribution refers to water rotation criteria to ensure that every member accesses water during the dry seasons when the stream flow goes down. Water rotation is used in Egypt where the canals are closed in one section and opened in another section in alternating days. This helps in the reduction of water resource conflict.



n=228

Figure 4.5 Use of shifts during dry season

As shown in figure 4.5 98.7% of the respondents practiced shifts in their projects during the dry seasons; this ensured that every member got access to the available water. The frequency of getting water depended on the number of members in the project and the amount of water reaching the distribution point. Projects that had more than 30 members formed shifts with a frequency of 2 to 3 days. Other shifts especially those formed by the downstream projects alternated within a given number of hours, for example Mwenda water project had shifts which alternated after every 8 hours in a day. This water project had 50 members and the amount of water reaching their distribution point was enough for only 10 members.

To ensure that everyone had domestic water then 8 hour shifts were formed and members were also forced to shelf irrigation for some time. 1.3% of the respondents didn't form shifts; these included the large scale flower farms, those projects that ensured all the members had water

storage tanks and the new projects that had located their intakes near the river source. one of the major reasons identified to contribute to little water reaching the distribution points was that the size of pipes used in the piping of water was large hence water lost pressure required to flow under gravity especially during the dry season. Most of these water projects did not also involve technical experts in the designing of the project at the initial stages. The oldest water project in the WUA is 24 year old Muguna water project; the project has used a 6 inch pipe to tap the water from the intake. Other projects that were formed later on continued using the same size of pipes regardless of the number of members. With the subsequent decline in stream flow the available water no longer fills these pipes. Replacement of the pipes with smaller pipes is the only alternative left. Most of these projects were donor funded and the members only contributed towards the project through labour provision. The process of changing the systems pipe size has become very expensive hence the members are forced to form shifts almost throughout the year

4.1.8 Level of consulting in water management

Consultation in water management is and should be a continuous process before and after completion of the water projects, this ensures that the resource is managed efficiently and also incorporates time as an aspect of management (Perret et al 2006.) As indicated in the figure 4.6 below 26% of the respondents did consult at all the stages. This explains clearly the 28% proportion that gets equal distribution of water. Consultation with experts at all stages in the project cycle ensures that the system is designed not only to meet the present needs but also the future needs of water. The various experts involved in the various stages include, surveyors to determine the appropriate routes, water engineers to site the intakes and make recommendations for the appropriate pipe sizes, irrigation officers to recommend on the appropriate land sizes to be put under irrigation and public health officers to check on the quality of water.

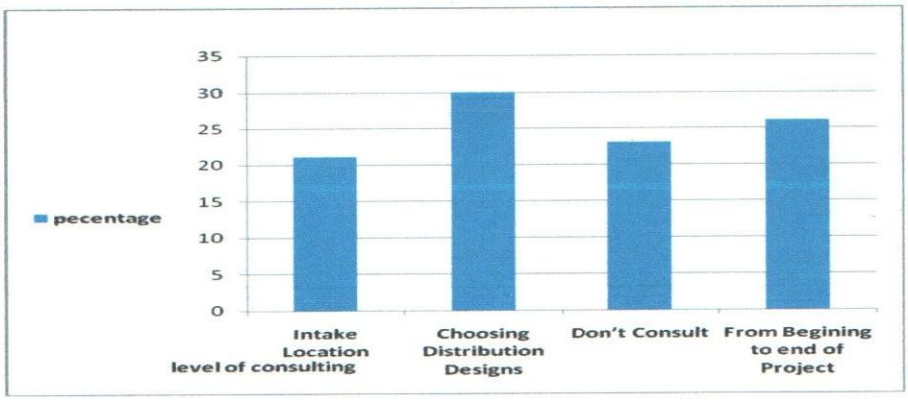


Figure 4.6 consultation levels by members of the Association

Twenty three percent (23%) of the respondents didn't consult, most of them managed their water resources through experiences that they had in other water projects. For example they followed the same piping routes that had been followed by other projects, used similar pipe sizes and used similar distribution designs. However other keys issues like the number of members in the projects need be incorporated to ensure water is availed to everyone. these projects that didn't consult were also blamed for poor citing of intakes for example "Milimani B"water project was a splinter project from "Milimani A", when they built their water intake they made sure that it was located upstream far away from Milimani A water project, they designed their intake in a manner intended to abstract more water than Milimani A. A lesson learnt from these two water projects is that weak water governance exists in the Water association. This was also identified as one of the constraints and key issues affecting the association. 21% consulted during intake locations, this was mainly done to avoid conflicts with the existing intakes and also to identify the sites that had plenty and clean water.

Intakes should be located 50 metres away from each other and they should also abstract 70% of the total volume of water applied for as per their water abstraction permit and leave 30% for sustainability of the river (WRMA Draft rules 2006) 30% consulted only in the choosing of the appropriate distribution design, equal distribution of water is a major concern to everyone, members are entitled to have equal amounts of water all the time. Most members felt that some of the designs used favoured some members, for example tanks favoured those members whose land was located at lower grounds, those living at high grounds got little water because the slope would not allow pressure to build up and push the water under gravity uphill. Others used a locally designed device known as "*mortaa*" for water distribution. This design has a fall back of because of numerous water leakages and difficulties in unblocking. This design has been accepted by the water officer in the division since it also makes water rotation patterns efficient. Plate 4.1 below shows a water *"mortaa"* used for to distribute water to members.



Plate 4.1 Mortaa used to distribute water

4.1.9 Irrigation methods used

The various irrigation methods used in agriculture depends on various ecological and economic factors; one of the key considerations is affordability and ease of use. 99.1% of the respondents indicated that they used overhead irrigation. This is an old method of irrigation which has been surpassed by time. Only 0.9% of the respondents practiced drip irrigation, they included the large scale farms within the division. Water conservation needs to be incorporated within the methods of irrigation used, overhead irrigation has been used in farming for quite a long time despite the inefficiencies associated with overhead irrigation. With the water crisis which has been facing Kenya as a country, improved irrigation methods of farming like drip irrigation need be adapted by horticulture farmers not only in Timau but also in other parts of the country. Overhead irrigation contributes to loss of soil fertility through leaching of nutrients, it was also observed that there were cases where the water couldn't rotate the sprinklers which led to flooding, and this is waste of available water: see plate 4.2 below.



Plate 4.2: Flooding caused by use of overhead irrigation when the water is of low pressure

Unlike use of drips where use of low pressure drip pipes ensures that pressure builds up depending on the available water. The reason why the farmers did not embrace drip irrigation was mainly due to the perception that this was a technology for the white farmers and the rich, one farmer interviewed said " *hii drips inatumika na wazungu pekee yake na wafrika wazungu*" this meant that the drip pipes are only used by the whites and rich Africans. This calls for more irrigation extension services to empower the farmers.

4.1.10 Water storage methods used by the members

Water storage is one of the conservation measures which are being encouraged to the rural communities around the country. Credit services are also being offered by many finance institutions to facilitate the buying of water storage tanks. Water storage has not been embraced by the members of the association as can be observed from figure 4.7.

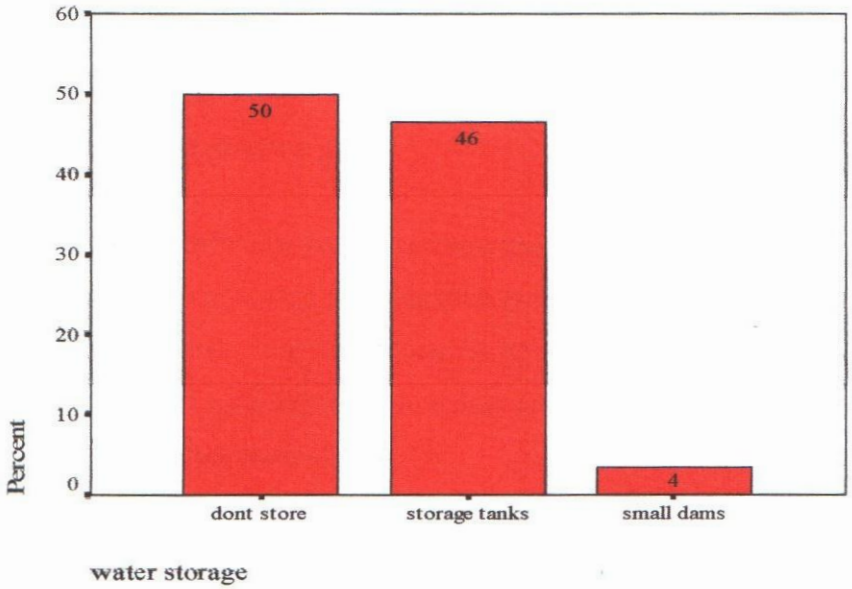


Figure 4.7 Members water storage methods

Fifty percent (50%) of the respondents didn't store the water, and 46% used storage tanks while 4% used small dams. Storage of water was not embraced because most of the farmers believed that their closed water systems were reliable for provision of water for domestic uses. They did not consider buying big tanks for storing irrigation water which was already proving inadequate. There is no provision for on-river storage (like dams). Therefore, at any given time, the availability of irrigation water depends entirely on the yield of the springs that discharge into the river. As shown in table 4.3 below.

Table 4.3 Percent Distribution of access to adequate irrigation water by storage methods

Variable	Adequate	Inadequate	Occasionally Adequate	Total%
Don't Store	**0**	**44.2%**	**0.9%**	**45.1**
Storage Tanks	**4.3%**	**29.8%**	**12.2**	**46,3**
Small Dams	**0**	**8.6%**	**0**	**8.6**
Total %	**4.3**	**82.6**	**13.1**	**100**

n-228

From table 4.3, members with storage tanks and small reservoir dams still don't get enough water for irrigation.

4.1.11 Size of distribution pipes

The size of distribution pipes used was used as an indicator of efficiency and adequacy of the supplied water for domestic and irrigation purposes. Table 4.4 below shows that 48.2% of the respondents had their water distributed by half inch pipes, 29.8% used three quarters, 21.1% used one inch and 0.9% used pipes of more than one inch.

Table 4.4 Size of distribution pipes

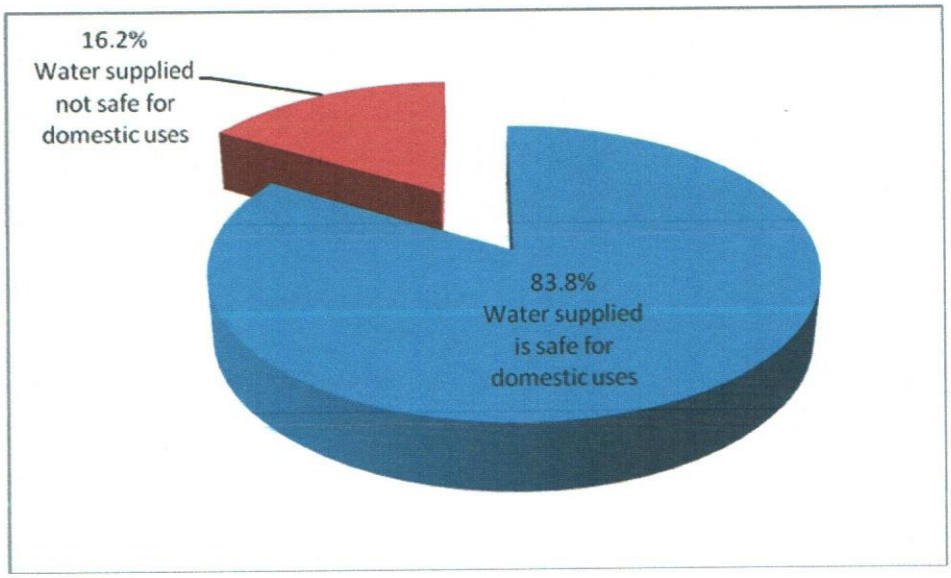
Pipe Size	Percent
half inch	48.2
three quarters	29.8
one inch	21.1
more than one inch	.9
Total	100.0

n=228

The respondents who used pipes of more than one inch are equal to 0.9% of the respondents who used drip irrigation. This explains further the reluctance to embrace drip irrigation. Most of the members believe that one needs to have large supplies of water to use drip irrigation. Use of small sized pipes allows water of low pressure to flow hence even during dry spells the available is able to reach the households. Large pipes allow for air locks which blocks water being distributed under gravity. There is need to harmonize the size of pipes being used so as to ensure equal volumes of water are distributed to the members. This will also avoid conflicts arising from unequal distribution of water. Also agriculture extension services are required to educate the farmers on the advantages and requirements for establishing and embracing modern methods of irrigation.

4.1.12 Perception on Provision of Safe water for domestic use

Figure 4.8 shows that 83.8% of the respondents said that the water supplied was clean and safe for drinking; this explains why 78.5% of the respondents said that they do not treat the water supplied. Failure to treat water is an indication that the members are contented with the water quality supplied.



n=228

Figure 4.8 Provision of safe domestic water

Water is not treated because of the belief that the location of the intakes is near the headwaters and deep into the forests where there are minimal human activities which can pollute the water. Other reason given was that from the experience that they had from the water projects that treated their water was that water lost its natural taste, it was expensive to treat water and the treated water caused a decline in soil fertility. 16.2% of the respondents said that the supplied water was not safe for domestic use, the reason being that unlike the others; their intakes were located downstream away from the forests. Human activities especially horticulture farming on the riparian caused pollution of the river water abstracted. Plate 4.3 below shows clothes being washed on the river banks of Timau River.



Plate 4.3 showing washing of clothes on the river banks of Timau River

One of the pertinent issues brought out clearly was that those farming on the riparian washed their knapsack sprayers after use in the river; they also bathed and washed the clothes in the river. This has been a problem to those members whose intakes are located downstream. A similar problem of Water quality had earlier been identified in Rombo area (Hartmut Krugmann, 2006). Irrigated horticulture involves copious use of pesticides and toxic chemicals are flushed into the river during heavy rainfalls. Furthermore, people use the river to wash clothes, cars, or for bathing. At the same time, water downstream from irrigation schemes or other polluting activities is routinely used as drinking water and for other domestic purposes.



Plate 4.4 Horticulture farming activities on the riparian zones of Timau River

4.2 Effectiveness of the WUA in Provision of Accessible, Adequate, Reliable and Safe Water Supply to Members

Effectiveness of the WUA in provision of water to the members was assessed in terms of accessibility, reliability and accessibility of the water supplied to the members and community. The community meant all the people within the division who are not members of the WUA and aren't connected to any water supply system but rely on fetching their water. Accessibility of water referred to convenience of the water supplied, in terms of distance and time spent in fetching and watering crops the required amounts at any given time; for example time spent in queues to fetch water.

Reliability referred to consistency of the closed system to supply required amounts of water all the time without failure hence bringing sustainability of water supplied. Adequacy of the water supplied meant sufficiency to supply the required amounts of water to meet the needs (domestic and agriculture) of the respondents. From the research, 80.7% of the respondents are provided with accessible water for domestic uses. This means that domestic chores and water required by domestic animals is always within reach when need arises.

Table 4.5 Provision of accessible domestic water

	Frequency	Percent
Water accessible	184	80.7%
Water not accessible	30	13.2%
Occasionally accessible	14	6.1%
Total	228	100.0

Previous researches have showed that accessibility of water in most of developing countries is below 5% (John, 2006), In Timau division for every 10 households 8 are supplied with piped water (MoW, 1999). This means that the two households not supplied with water are within reach to access water from their neighbours. 13.2% of the respondents said that the water supplied was not accessible for domestic uses while 6.1% said that the water was occasionally accessible. The research was conducted during the dry season when the water was supplied in

shifts/rotations. When water is supplied in shifts, the community members are allowed to fetch the water during certain times of the day especially in the morning hours and in the evening. 50% of the members don't have water storage facilities while 4% use small earthen dams for water storage, during the dry seasons when shifts are in use and the water supplied is not reliable, these members go without water for domestic use.

Table 4.6 provision of accessible irrigation water

	Frequency	Percent
Irrigation Water accessible	54	23.7%
Irrigation water not accessible	148	64.9%
Occasionally accessible	26	11.4%
Total	228	100.0

Twenty three percent (23.7%) of the respondents said that the water supplied is accessible for irrigation while 64.9% and 11.4% said that water supplied was not accessible and was occasionally accessible respectively. During the dry season farmers are forced to reduce the size of land under irrigation because the water rotations affect the consistency of supply. Water theft and system malpractices also contributes inaccessibility of irrigation water, irrigation is practiced for 24 hours hence those intakes built downstream are faced with water shortages caused by illegal connections, blockages and abstraction of water by upstream members.

As shown in table 4.7, 88.6% of the respondents said that the water supplied was adequate to meet all their domestic needs while 11.4 % said that the water supplied was occasionally adequate.

Table 4.7 provision of adequate domestic water

	Frequency	Percent
Provided with adequate domestic water	202	88.6%
Not provided with adequate domestic water	0	0
Occasionally adequate	26	11.4%
Total	228	100.0

Inadequacy is mainly brought about by reduced water volumes in the system; some of the reasons include water leakages which reduce the amounts reaching the households, pressure differences along the system especially differences brought about by the slope. Members on high grounds receive little water compared to those whose land is located on lower grounds. Unequal distribution and use of ineffective distribution designs also contribute to inadequate domestic water supplies.

Table 4.8 Provision of adequate irrigation water

	Frequency	Percent
Provided with adequate irrigation water	10	4.3%
Not Provided with adequate irrigation water	188	82.5%
Occasionally provided with adequate irrigation water	30	13.2%
Total		100.0

n=228

Four point three percent (4.3%) of the respondents said that the water supplied was adequate for irrigation while 82.5% said that the water supplied was not adequate for irrigation. From the study 48% of the members use half inch pipes for piping while 29.8% use three quarter inch pipes. Use of large pipes to supply little volumes of water makes the water supplied to be of low pressure. Air locks also build up when the water doesn't fill the distributing pipes. From the Focus group discussion it was found out that members had put more land under irrigation than the water supplied could support.

Water supplied using half inch pipes can only irrigate a maximum of quarter an acre but the average size of land under irrigation was 0.75 acres. This clearly explains why the farmers have to carry out irrigation for 24hours. Use of overhead irrigation also contributes to inadequate water for irrigation because much water goes into waste. Drip irrigation is more efficient in terms of time spent to water crops, according to research done by Amiran Kenya, a 3,200 litre tank of water irrigates three quarters of an acre within two hours (KARI, 2008) These modern methods of irrigations need to be embraced in order to ensure the available water is fully utilized and adequate to meet the needs of irrigation.

Eighty five (85.1%) of the respondents said that the water supplied is reliable for domestic uses while 14% said that the water supply wasn't reliable.

Table 4.9 Reliability of domestic water

	Frequency	Percent
Provided with reliable domestic water	194	85.1%
Not Provided with reliable domestic water	32	14%
Total	226	99.1

n=228

Water for domestic use could be fetched from anyone as long as it was within the agreed time of fetching. When distribution was done in shifts reliability of the water supplied reduced because some households were located far away hence one is require walking for long distances to fetch water.

4.2.1 Challenges Hindering Timau WUA from Effective Provision of Accessible, Adequate, Reliable and Safe Water Supply to Members

From the Three focused group discussions and in-depth interviews held the following challenges were identified to be contributing towards the ineffectiveness of the WUA in providing accessible, adequate, reliable and safe water supply to the members.

- Acute water supply; this was attributed to the increasing demand for water which surpassed the supply from the Timau river especially during the dry season.

- Catchment degradation; as can be observed from the photograph below, this was particular to those communities that lived next to the Timau river catchment, it was noted that there was increasing eucalyptus planting along the river banks and farming activities on the riparian zones. Intensive land pressure, increasing land defragmentation and charcoal burning were also identified to be some of the contributing factors to catchment degradation.



Plate 4.5 Eucalyptus plantation on Timau river banks

- Environmental degradation; this was a problem which was noted to be occurring in the lower zones of ole naish, ol-donyo and lolomaric. This was attributed to overgrazing from the pastoral communities in the lower zones. This led to high erosion rates, high runoff rates and incision of water courses.
- Soil erosion; this was attributed to the poor farming methods that had been embraced by the farmers. Farmers on the steep riparian zones were said to be practising horticulture farming, as a result of overhead irrigating soil was lost through splash and sheet erosion.
- Encroachment on springs' sources in the upper zones of the river. This is evident on the below photograph of Ngusishi spring.



Plate 4.6 Encroachment of Ngusishi spring. by farming activities.

- Effluent discharge from Timau Town, the major source of effluent was identified to be from the slaughter house.
- Social conflict due to over abstraction of water especially in the upper zones of the catchment. Failure to install individual water meters.
- Pollution of water resources from agro-chemical effluents in the agriculture areas
- Illegal abstraction and poor compliance to water laws.



Plate 4.7 showing an illegal intake constructed across river Timau



Plate 4.8 showing one of the members holding a sack used to build the illegal intakes

4.3 Members Extent of Involvement in Running Water User Association

Involvement of members in running the water user association activities is an indicator of a well managed and effective association. According to the IWIM-TATA water policy programme, involvement of the members of a water association can be indicated by frequency of suggestions and ideas being accepted and implemented, frequency or willingness of members to attend association meeting (annual & committee/executive meetings , assisting in raising funds, defending their association and volunteering time, resources and labor for the association (IWIM, 2005)

Based on the on these indicators the extent and level of involvement among the members of the Timau water user association was assessed. As shown in table 4.10 below, the study found out that 25.4% and 28.5% of the respondents had their ideas and suggestions being accepted and implemented very often and often respectively. This means that at least for one of every five WUA meetings attended their ideas were accepted for action and implementation

Table 4.10 Frequency of members' suggestions and ideas being accepted and implemented

	Count	%
very often	58	25.4%
often	65	28.5%
occasionally	103	45.2%
never	2	.9%
Total	228	100%

The ideas of one being accepted and implemented were found to be influenced by Awareness of the Water Act (P = 0.002, t = -3.129), Length of Membership (P = 0.004, t=2.797), Education Level (P = 0.000, t = 4.'125) and Respondents age (P = 0.007, t = 2.710). Old members of more than nine years are said to have experience enough to address issues facing the projects.

Table 4.12 Regression output

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
(Constant)	.832	.439		1.897	.059
awareness of water act	-.132	.042	-.232	-3.129	.002
holding administrative- working position in project	.125	.091	.095	1.379	.169
length of membership	.014	.005	.249	2.797	.004
respondents education level	.217	.053	.264	4.125	.000
leadership role in community	-.084	.133	-.046	-.635	.526
respondents gender	.174	.122	.098	1.433	.153
respondents age	.013	.005	.211	2.710	.007

Dependent Variable: frequency for suggestions & ideas being accepted & implemented by WUA

Table 4.13 Influence of length of membership to ideas of members being accepted and implemented

		length of membership	frequency for suggestions & ideas being accepted & implemented by WUA
length of membership	Pearson Correlation	1	0.521(**)
	Sig. (2-tailed)	.	0.001
	N	228	228
frequency for suggestions & ideas being accepted & implemented by WUA	Pearson Correlation	0.521(**)	1
	Sig. (2-tailed)	0.001	.
	N	228	228

** Correlation is significant at the 0.05 level (2-tailed).

Previous studies done in India have showed that Members of WUAs can take initiatives geared towards better management of their water resources. Studies done by UNESCO showed that members felt that their suggestions, on what they need and do not if implemented would be sustainable and beneficial to them in the long run than implementing the standard schemes prepared for the state as a whole region (Chandrasekaran, 2008.) Decision making is always a holistic process and proper consultation and listening is required, Farmers quite often need the assistance of an external agency, be it an NGO, a research institution, or just an impartial but interested group of people, to energize interaction within the WUA members to sustain group action. When such information is available, WUA members could better decide what they want and also set priorities, make resource mobilization, set water resource allocations and mobilize resources to fund common needs (Chandrasekaran, 2008)

As shown in Table 4.14, 83% of the members attend executive meeting of their association very often. This meant that any time a meeting was scheduled for by the association they would not fail to attend. One the reason for not failing to attend the meetings is due to Fines set in their constitution.

Table 4.14 Frequency of attending executive meeting

	Count	%
very often	190	83.3%
often	26	11.4%
occasionally	4	1.8%
never	8	3.5%
Total		100%

n=228

Missing the meetings for more than five times without an apology led to disconnection of the water supply for a period of one month. Members wanted also to stay informed about their association, for example due to the changes that were being implemented in the water sector, members always had a fear that the government had a plan to take water management from them. Introduction of water charges for both irrigation and domestic water supplies sent mixed signals to them, with this most of the leaders said that attendance to the meetings improved. Others said that their association had disputes which took long time to resolve hence they would attend the executive meetings with the hope that the disputes will be resolved. Attending executive meeting is a measure of how committed and involved members are to their association, when the members get involved in the meetings they will feel to own the WUA.

Previous studies done by (Abdullaev, 2007) indicate that attending executive meeting by WUA members is also a good starting point to initiate farmer debates and discussions on public participation, which should ultimately lead to a truly farmer-owned process and action. Thus, through holding meetings many members and water managers have had to resort with variable success, to some alternatives such as water distribution methods to meet challenges facing their association. The willingness of members to assist in raising funds for running the WUA is another indicator of a well managed association.

From the findings, 92.1% of the respondents said that they were always willing to raise money to ensure smooth management of their association.

Table 4.15 Frequency of members' willingness in raising Funds for the WUA

	count	%
very often	210	92.1%
often	7	3.1%
occasionally	9	3.9%
never	2	0.9%
Total		100%

n=228

Most of those interviewed acknowledged that the Association cannot run without money, the money raised is used to pay the employees, water bills and for operation and maintenance activities such as buying of pipes for repairs. 3.1% and 3.9% of the respondents said that they raised money for their association often and occasionally respectively. Often meant that they only paid their monthly water bills and any other extra cost had to be clarified well before they paid. They expressed the fear that some committee members mismanaged the money. Those members who raised the money occasionally said that most of the time they didn't get equal supply of water as their fellow members. The bill is usually divided equally to all the members, so, whether one has used the water or not he/she has to pay the bill. Some member's farms are located at higher elevations hence they receive little water supplies compared to other members whose farms are on the lower grounds. This is a challenge which is facing the association because they use a master meter on the major pipe. Unlike other Associations water meters are installed on individual members distribution pipes, the installation of the water meter on the major pipe means that there is no monitoring of how much water is used by an individual member.

The few members who don't use their water for irrigation or those who have adopted water conservation measures end up paying bills for quantities of water they haven't used. This is a challenge which needs to be addressed to improve on the management of the association. This has also contributed to these members failing to attend annual executive meetings because any time they raise their claim most of the other members don't agree and listen to their pleas. 0.9% of the members don't participate in raising funds for the association; these are the few large scale farms that have been issued with individual water permits to abstract water from the river. They

also form the 0.9 % of members who use drip irrigation and those who have piped their water using pipes of more than one inch. Most of these farms have organized activities in their calendars, for example Homegrown has days set aside for Catchment rehabilitation where they plant indigenous trees as they also carry out cleanup exercises on the river banks.

Table 4.16 Member willingness to campaign for and defend the WUA

	Count	%
every 1 to 3 months	212	93.0%
every 4 to 6 months	2	0.9%
every 7 to 9 months	0	0 0
every 10 to 12 months	6	2.6%
Never	8	3.5%
Total	228	100%

Frequency of campaigning for and defending WUA by the members is an indicator of a high level of involvement in the management of the WUA. This indicates that the members are mindful of the sustainability and the high degree of efficiency required in water supply (Sylvain , 2006) 93% of the respondents said that they always campaign and defend their WUA every 1-3 months; this indicates that they are always ready to defend and campaign for their association. Campaigning for the association entails raising alarms when certain management organs of the association are not functioning efficiently. For example when Illegal abstraction of water is noticed, all the members are called to collectively demolish them.

Members also campaign for equity in water distribution along the river, Members interviewed said that they always have a big decision making role when new intakes are being constructed. For example intakes built without consultation of all the members have ended up being closed. Members are also keen to identify Intakes that are not fitted with water meters or those found abstracting the overflows. The large scale farms (0.9%) campaign for the association every 4-6 months. 2.6% of the respondents campaign and defend for the association every 10-12 months. These members mainly are not involved in campaigning for the operation and maintenance activities of the association; they only do so during the annual executive meeting. 3.5% of the respondents said that they don't involve themselves in campaigning and defending for their WUA.

A well managed WUA comprises of members who are always ready to give services to the association any time they are called upon to do so or in case of an urgency to attend to water issues like operation and maintenance activities (Meinzen, 1997) As shown in table 4.17 below, 88.2% of the respondents interviewed said that they were very willing to volunteer their time, labor and resources to their association most of the time they were called upon within one, two or three months.

Table 4.17 Frequency for volunteering time, labor and resources for the WUA

Frequency	Percentage
every 1 to 3 months	88.2%
every 4 to 6 months	7.5%
every 7 to 9 months	0.9%
every 10 to 12 months	3.5%
Total	100%

Operation and maintenance activities are routine activities, if an association lacks committed members who are willing to participate in such an activity it becomes difficult to manage. 7.5% were willing to volunteer after every 4-6 months, 0.9% after every 7-9 months while 3.5% were willing to volunteer annually. The following are the key areas where the members are always willing to volunteer any time they are called upon:

The respondents were asked to list various activities where they willingly volunteered their money, labor and time. They were also asked to give reasons as to why they volunteered. Table 4.18 highlights the key activities in which the members offered to volunteer.

Table 4.18 Key activities where members are willing to volunteer

Activity in terms of money, labor and time members are willing to participate in.	Reason for volunteering
Water Scouting.	• Check on illegal water activities along the closed system. • Monitor stream flow and alert the members when there is need to form shifts • Routine pipeline checkups • Check on those people growing Eucalyptus in the catchments zone
Operation and Maintenance (O&M)	• To repair reported Water bursts. • Cleaning of the intakes. • Transportation of members where the project intake is located far away. • Digging of trenches.
Fundraising.	• To buy pipes needed for routine Operation and maintenance activities. • Raise money to pay wages for Masons hired to repair intakes. • Paying land owners whose crops are damaged when repairing the pipes passing through their shamba. • Paying court fines charged to any of their members in the line of duty for example Members charged for trespass.
Formation of shifts during dry seasons.	• Reduced water volume in the stream. • To ensure equity in sharing the available water.
Land	• For building distribution and water storage Tanks • For building Associations project offices. • For building stalls (horticultural produce collection centers)

4.4 Assessing the Level of Leadership Training In Aspects of Management of the Water User Association

Training is supposed to be an important component for better water management and improved agricultural practices. Training is also useful for better management of any association. Assumption of the responsibility of managing irrigation system by farmers themselves, therefore, requires proper training in water management so as to derive optimum benefit out of available water (Findley,2006).

Training is also necessary to make management of water user association effective. It helps the members to build awareness and commitment to co-operative water and resource management; develop the operation and maintenance requirements of the irrigation system, including sound financial management of the resource; familiarize themselves with relevant farmer organizations and forthcoming conventions; gather information and develop a communication strategy; and develop water allocation plans for optimum agricultural production.

Training in the Timau WUA was assessed at five levels; Very adequate, Adequate, Moderately Adequate, Not adequate and Never Trained. Table 4.19 below operationalizes each of the five levels as they were assessed during research.

Table 4.19 indicators of various levels of training in Timau WUA

Level/Degree of training	Indicators (Areas of Training)
Very Adequate	1. Monitoring and evaluation 2. Conflict resolution 3. Water allocation planning 4. Water conservation methods • Water storage • Water harvesting techniques • Drip irrigation 5. Repair and maintenance 6. Book keeping 7. Types of crops to grow 8. Capacity building 9. Training on understanding the water A ct 2002 10. Water hygiene and sanitation
Adequate	1. Monitoring and evaluation 2. Conflict resolution 3. Water allocation planning 4. Water conservation methods • Water storage • Water harvesting techniques • Drip irrigation 5. Repair and maintenance
Moderately Adequate	1. Monitoring and evaluation 2. Repair and maintenance 3. Water allocation planning
Not Adequate	1. Monitoring and evaluation
Never Trained	No training on the above indicators

4.4.1Adequacy of Training staff/employees of WUA in Water Management

The staff of Timau water user association comprised of Project Manager, Field Officer, and Office Secretary. From the findings as shown in table 4.20 below, 21.5% of the respondents said that the WUA staff training is very Adequate; this is because the three staff members had attained secondary education.

Table 4.20 Adequacy of training by staff/employees of Timau WUA in terms of WUA management

Level of Training	%
very adequate	21.5%
adequate	20.6%
moderately adequate	14.0%
not adequate	17.5%
never trained	
Total	26.3%
	100%

n=228

They also said that the job description had been given during the recruitment exercise hence all are qualified since they met the criteria. An interview with the executive committee confirmed this, the researcher was also informed that Ewaso Ngiro North Office had spent three weeks training the staff before assuming office, the training exercise is a continuous process which goes on as the WUA grows and also as the staff get to understand the various issues facing the WUA. 20.6% of the respondents said that the staff had adequate training because despite them having the required Academic credentials for their job, they still didn't deliver in ensuring the members of whom all are farmers, got training on the types of crops to grow, Book keeping and record keeping skills, Water Hygiene and Sanitation and the staff didn't take time to fully educate them on the New water Act (46% were aware of the new water act because they had began paying water bills, 54% were either not aware or had not been informed of the Act but they were keen to observe the changes that were coming up in the water sector)

Fourteen percent (14%) of the respondents said that the training of the staff/employees of the WUA was moderately adequate, the researcher was keen to note that these respondents comprised mainly of those who attend the meetings occasionally or often. The respondents were keen to note that, staffs were efficient at convening them only when they were forming water allocation plans or when there were serious repairs to be done on the Major pipes. 17.5% and 26.3% of the respondents felt that the staff/employees of the WUA ,were not adequately and never trained respectively. Most of these respondents either attended the meetings of the association occasionally or didn't attend the meetings at all.

4.4.2 Adequacy of training executive members of WUA in terms of Management

The executive of the association comprises of the Chairman, WUA Secretary, Vice chairman and the Organizing Secretary. As shown in table 4.21 below, 21.9% of the respondents said that the training of the executive was very adequate because they taught them on most of the above indicators. They also said that they always accompanied the staff/employees to the training workshops held at Nanyuki (ENNCA Offices) WRMA offices. These respondents also said that the executive members impacted more than the staff because they were reachable by everyone and they were also members of the association. The members usually visit the homes of the executive members even without appointments and they were able to understand some of the issues facing their association.

Table 4.21 Levels of Training executive members of the WUA

Level of Training	%
very adequate	21.9%
adequate	23.2%
moderately adequate	10.5%
not adequate	18.9%
never trained	25.4%
Total	100%

n=228

One of the respondents said that the chairman of the association who happened to be his neighbour took time to make him understand the new water Act and the reason behind the introduction of water charges. 23.2% of the respondents said that the training on the executive was adequate, the main reason being that, by them being members of the association they also faced similar challenges as other members. This means that they really participated in issues concerning water allocation, monitoring especially the building of illegal intakes, conflict resolution and they also led by example on the matters concerning water conservation, for example the chairman used drip irrigation in his farm, most of the respondents were keen to note this. 10.5% said that the training of the executive was moderately adequate, 18.9% and 25.4% said that the training of the executive was not adequate and never trained respectively.

4.4.3 Adequacy of training stakeholders of WUA in terms of Management

The stakeholders of the association comprises of Homegrown flower farm, Batian flower farm, Meru Central Municipal Council, WRMA, Division Administration (DOs office), Ministry of Agriculture, Ministry of Water, North Imenti Member of Parliament and all the water projects in the division. 60.5% of the respondents said that the stakeholders were well trained in matters pertaining to water resources management. They noted that all the above indicators (though not always) were discussed in all the meetings they attended. For example the DO always addressed the issues pertaining to water conflicts, Need for paying water bills and illegal water abstraction in all the meetings he held within the division. The respondents also said that all the stakeholders were highly educated people in the society hence they had the required training necessary for efficient water management within the association.

Table 4.22 Levels of stakeholder training in management of the WUA

Level of Training	Count	%
very adequate	137	60.6%
adequate	34	14.9%
moderately adequate	32	14.0%
not adequate	25	10.5%
Total		100%

n=228

Fourteen point nine (14.9%) said that the stakeholders were adequately trained; these respondents were keen to note that they needed extension services offered by the stakeholders. The farmers needed advice and guidance on the type, when (season) and where to market their horticultural crops. Despite the fact that the stakeholders are well trained it is evident that there is no much impact of their training to the farmers. 54% are either not informed or don't know and understand the water Act 2002, 71.9% are facing unequal distribution of water, 23% don't consult in water management issues facing their project and 50% don't have water storage facilities. Dissemination of information by the stakeholders in the association is necessary.

4.4.4 Adequacy of training ordinary members of WUA in terms of Management

Ordinary members of the association comprises of 2,303 registered members of various water project within the association. 3.5% of the respondents said that ordinary members were very

adequately trained. These were either the executive members of the association a few Educated members who had learnt water management skills elsewhere. 20.2 % were adequately trained, 30.3% were moderately trained while 25.0% and 21.1% were not adequately and never trained respectively.

Table 4.23 Levels of ordinary member training in WUA management

Level of Training	%
very adequate	3.5%
adequate	20.2%
moderately adequate	30.3%
not adequate	25.0%
never trained	21.1%
Total	100%

n=228

The respondents said that the training they had received was mainly on monitoring, water allocation plans and repair and maintenance. The researcher was keen to note that the training they had received was mainly on the various activities that the members were willing to volunteer for example Water Scouting, water allocation during the dry season and repair and maintenance of the closed system. Training on repair and maintenance training was done by the older and experienced members of the association. Training is needed for example in determining the type of crops to grow, piping routes, modern farming methods, water conservation measures and training on water conflict management.

The table 4.24 shows some contentment levels of very important indicators of training areas that the farmers felt they were lacking in their association.

Table 4.24 Extension services needed by Members of the Timau WUA

Extension service	No Need for extension Service	Need for extension service
	%	%
Irrigation methods	29.8%	70.2%
Types of crops to grow	4.4%	95.6%
water conservation measures	7.9%	92.1%

From the above results 70.2% of the members said that they didn't receive extension services on irrigation methods. 95.6% didn't get extension services on the types of crops to grow and 92.1% didn't get extension services on water conservation measures. The National Agricultural Sector Extension Policy (NASEP) puts it that all extension service providers should mainstream environment and natural resources related issues in extension messages by imparting knowledge related to: water catchments management, soil and water conservation, Agroforestry and wetland utilization, appropriate land use allocation and management of economically viable resources (NASEP,2007 – national agricultural sector extension policy implementation framework, MoA). The extension services,need to be improved so that the actions of the ordinary members can be geared towards good management of water resources within the association.

4.4.5 Adequacy of training Female members of WUA in terms of water management

To implement the principles of integrated water resources management that were stated at the International Conference on Water and Environment (Dublin, 1992), including the principle of involving all stakeholders in water related activities, Principle No. 3 emphasizes that women play a central role in the provision, management and safeguarding of water resource. Acceptance and implementation of this principle requires positive policies to address women's specific needs

and to equip and empower women to participate at all levels in water resources programmes, including decision-making and implementation, in ways defined by them (ICWE, 1992: 4).
From the research findings as shown in table 4.25 below, It was found out that 5.3% of the respondents said that women are very adequately and adequately trained in terms of water management. These respondents said that women were involved in most activities with regard to domestic and irrigation roles.

Table 4.25 Levels of Female Members Training

Level of Training	%
very adequate	5.3%
adequate	5.3%
moderately adequate	13.2%
not adequate	20.6%
never trained	55.7%
Total	100%

Women were in charge of moving the sprinklers from one point in the farm to another; they were also keen to notice and report fluctuation of water pressure reaching their farms. The respondents also acknowledged that women played a key role in solving water distribution conflicts, for example women were said to be the first people to propose water rotation during dry seasons or when some members didn't get equal share of the water after distribution. The researcher was quick to note that once the piped water reached the homestead, management of the same changed, men became the planners while women and children assumed the role of managers. This is evident for example in a case where one female respondent had to make a telephone call to the husband at work requesting whether to fill the questionnaire. Among the 32.5% female respondents interviewed, they said that engaging dialogue in times of conflict between two or more water projects always proved difficult when men were involved. In such situations their spouses attended conflict resolution meetings. 13.2% of the respondents said that women's training in aspects of water management was moderate. 20.6% said that women's training was not adequate while 55.7% said that women are not trained in aspects of water

management. These respondents said that few women were aware about the location of the intake, repairs done on the major pipes and other operation and maintenance activities carried out. This is because operation and maintenance was perceived to be an activity of the male members of the association.

From this assessment, the leaders of the association should take a lead role in training all the women in the association in the immediate issues regarding their association. For example women are not allowed to go into the forest where the intakes are built during routine pipeline checkups or when cleaning the intakes.

There is no doubt that delivery of education and training is essential in increasing awareness and equipping various stakeholders with the necessary skills and tools to enhance the management of the Timau Water User Association. At present there is limited capacity in the Division to drive water management and training programmes. One of the identified major constraints to the adoption of Water Management and Training measures is the absence of well structured educational and training programmes or courses suitably targeted to all stakeholders in the water management chain.

The manager of Timau WUA said that he had to develop a training manual which he still felt that it was not adequate because water management issues are not sectoral. As one unpacks the Pandora's Box of education and training certain key questions arise. What form of education and training in required? How does it fit in broader programmes like Integrated Water Resources Management (IWRM)? Who should be educated or trained and what are the target figures? And, importantly, who funds the exercise among the educators and trainers, public and private sectors, and possibly within the framework and mandate of the Water Sector Coordinating Unit. Cooperation would ensure that Water Demand Management knowledge and skills are imparted to a significant number of water professionals in the Division within the short-term.

4.5 Water Related Conflicts among Water User Associations

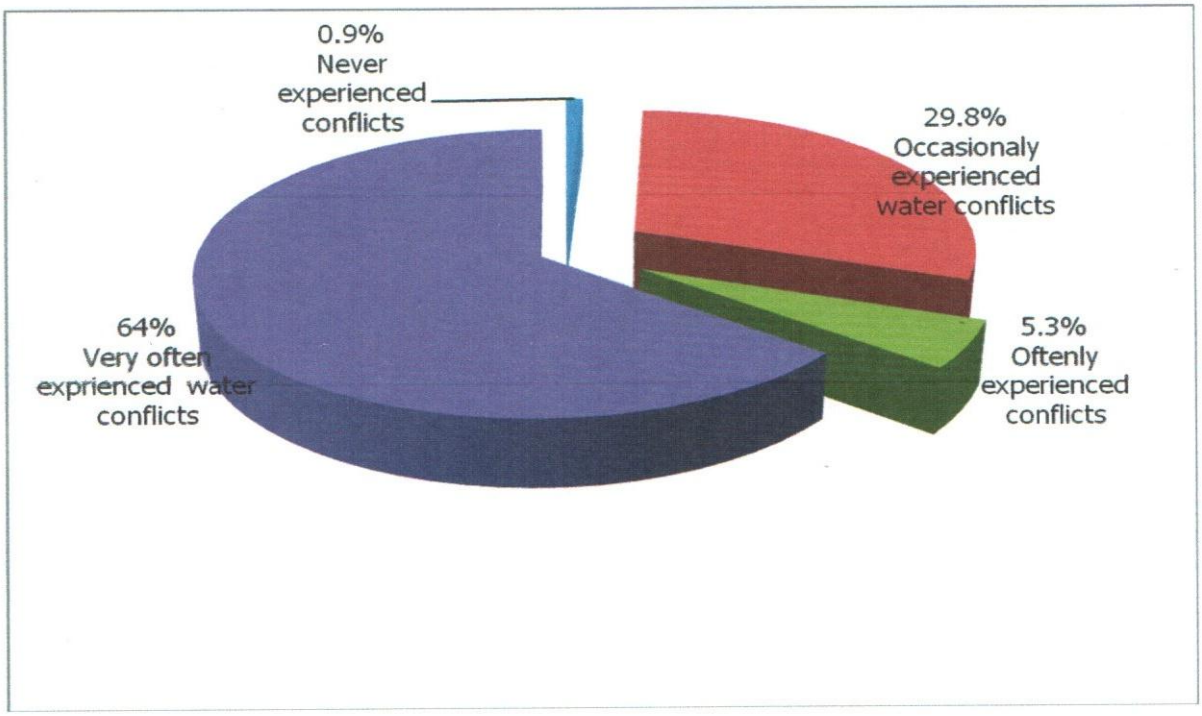
Poor water management can be a source of conflict (EU, 2007). Disputes between farmers over water distribution are direct indicators of the irrigation service and management efficiency. The number of disputes as well as their nature can help diagnose water-related problems (IWMI, 2004).

Water related conflicts facing the members of the Timau Water User Association were investigated by looking at;

I. Frequency of conflicts by household members
II. Classifying the causes of conflicts into either technical/engineering, social/political or administrative/regulative
III. Identifying conflicts whether they are within or across WUA
IV. Whether the conflicts are within the members of the WUA project or between members and non members.

4.5.1 Frequency of conflicts among household members

The frequency of conflicts among households was assessed at four levels as follows, very often meant that members had confrontations at least three times in a month. Members of Milimani A for example had confrontations even twice in a day especially during the dry season. Often meant that members had confrontations at least after every two months while occasionally meant that members had conflicts on rare occasions especially when it came to formation of shifts. Formation of shifts is a good management practice but it comes with handles especially on who is to begin the shift. Figure 12 shows the frequency of conflicts among the members.



n=228

Figure 4.3 Frequency of conflicts among households

Sixty four percent (64%) of the respondents experienced conflicts very often, 5.3% experienced the conflicts often, and 29.8% experienced the conflicts occasionally while 0.9% never experienced any conflicts. Those who never experienced any conflicts were those members who had distribution pipes of more than one inch. They included big farms and those individuals who had water permits to abstract water from the river for example Large Farms like Homegrown and Batian.

4.5.2 Causes of conflicts

A linear regression model was used to statistically test whether the predicted causes of conflicts had any significance in causing the conflicts. The results from the linear regression model showed that that the three causes were significant: $P<0.05$

Table 4.26 Regression model on causes of water conflicts in Timau WUA

	Unstandardized Coefficients		Standardized Coefficients	t	P<0.05 Sig.	95% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
(Constant)	0.750	0.091		8.280	0.000	0.572	0.929
Conflicts technical / engineering related	0.356	0.047	-0.536	7.551	0.000	-0.448	0-.263
Conflicts social / political	0.132	0.041	0.183	3.186	0.002	0.050	0.213
Conflicts administrative / regulation related	0.476	0.047	0.736	10.161	0.000	0.384	0.569

To investigate on the causes of conflicts, the conflicts were classified into those that were technical related, social/ political resulting and conflicts arising from the administration of the water user association. 63.2% said that the conflicts were technically related. These conflicts resulted due to poor consultation during the project cycle, most of the work is based on experience that the members had in other projects. Poorly designed distribution method like the *mortaa* is also another technical cause of the conflicts. The *mortaa* distributed water equally during the wet seasons and when the stream flow was high. During the dry seasons the *mortaa* didn't distribute water equally to all the members. In some instances some projects had their *mortaa* locked to avoid damage.

There were cases of *mortaa* theft and demolishing of distribution tanks during the dry seasons. This was done by angry members who had little amounts of water reaching their farms. The route followed by the distribution pipes is also another technical cause of conflict conflicts. Most of the projects had their piping route inspected up to the distribution point. From the distribution point to the homesteads there was no inspection and guidance from the technical expertise. Most of the individual piping routes are based on experience from what other project had previously done, for example new members followed the routes used by older members. This brings about conflict which is twofold, first when laying new pipes in the existing routes

and when unburying the existing pipes, these pipes get damaged and this marks the beginning of conflicts among members of the same association. In the existing bylaws there are no regulations guiding on the piping routes to be followed by members of the water associations. The second type of conflict that arises when laying new pipes is one between land owners where the pipes pass by and the individual members.

The land owners claim that pipes are left open, unburied and damage of crops occurs during piping. The pipes are damaged by grazing cattle more often, if it is during the rainy season the damaged pipes will be left unrepaired hence flooding their land and damaging their crops. These open pipes also formed points where members of the community would fetch water illegally. Plate 6 illustrates naked pipes left open in the shamba posing risk to damage and also form points of water theft.



Plate 4.9 Unburied pipes

This problem of choosing appropriate piping routes is attributed to the failure to involve and consult with the experts from the start to the end, only 26% of the respondents consulted during the whole project cycle. (21%) consulted only during intake construction, (30%) when choosing appropriate distribution designs while 23% didn't consult at any stage of the project. One of the most evident consequences is the change of piping routes during the dry seasons when the water volume goes down. During this process the land owners demand compensation for the unburying of pipes and in cases where there are crops on the land the compensation fee is very high. The current set rate is a hundred shillings for every pipe unburied. Studies done in

Zimbabwe have also high lightened failure to consult during the project cycle to be an indirect cause of conflicts among water user associations (SIWI, 2000)—Water development in the developing countries-a study commissioned by the European parliament (Safety science, Vol 35)



Plate 4.10 Changing of piping routes during the dry season

4.5.3 Social and Political causes of conflicts

Seventy one point one (71.1%) of the respondents strongly felt water conflicts in the association were escalated social and political relations among and between the members of the association. These included favors on some of the members and non members by the executive committee. Members who join old WUA projects always have conflicts with the older members. The older members feel that those who join the projects later are the main cause of unequal distribution and reduced water volumes reaching the households. Those who join water projects always have their pipes sabotaged by some of the older members.

The older members said that since those joining the projects had money enough to buy a share in the project, there was no reason as to why they could not sink bore holes and leave the

piped water to the older members. Conflicts arose from the different economic activities practiced by members of the association; the downstream members are mainly pastoralist bordering Laikipia District while the upstream members are mainly agriculturalist involved in horticulture. During the dry seasons when the stream flow is low, shifts are formed so that the available water can be shared by all the projects. Projects located upstream don't fully adhere to the shift schedules, instead during the night they open their intakes thus reducing the water volumes reaching the downstream intakes. When this happens angry members of the pastoral communities located downstream demolish the intakes. The demolishing of the intakes is supported by their political leaders and this escalates the conflict.

4.5.4 Administrative/ regulation causes of conflict

Fifty six point one percent (56.1%) of the respondents termed the conflicts facing the water management in their association as being related to administration in the association. Members interviewed felt that if there had been very effective leadership with the executive committee water conflicts would be minimized. The leadership was blamed for condoning the building of illegal intakes without water abstraction permits. Those building illegal intakes abstract water using large pipes and far upstream hence reducing the amount of water reaching the downstream intakes. When these cases are reported to the executive committee, there is delay before an action is executed. Illegal abstractors of water are the affluent community members who are also part of the WUA but have put more land under irrigation. When the other members demolish the illegal intakes they are arrested and prosecuted for sabotage.

The executive committee has also been blamed for allowing water projects that have been registered but with no hydrological survey done to build their intakes. The procedure before a project has been allowed to construct an intake is that, the members have to make surveys on the catchment and identify a site suitable for an intake. On identifying the site the project having been identified go ahead and build their intakes, these projects constitute the 23% that don't consult during the project cycle. Most of the intakes are built near existing intakes (less than 50 meters away from the existing intakes) or on the tributaries feeding the river. All projects are not allocated equal amounts of water hence when they construct intakes next to each other conflicts arise when the dry spells set in. Such conflict exists between Kigene and Kivu water projects, the

two have built their intakes along Kongoni stream which drains into river Timau. Kigene has been allocated 81.3 cubic meters per day while Kivu 13.7 cubic meters per day. Kigene are required to pipe the water using 3 inch pipes while Kivu use 1.5inch pipes. The former have used 3nch pipes hence the water is insufficient for Kigene which has more members. Conflicts have arisen where Kigene members have on several occasions demolished Kivu's intake. had there been effective leadership in the executive committees these two projects wouldn't have constructed their intakes next to each other.

The other most common cause of social water related conflict within and across projects is water theft. Because water is scarce and profits depend on having access to sufficient amounts at a particular time, farmers may try to extend the duration of their water allocation at the expense of the next one in the queue. This was noticed mainly to be occurring among the members whose water intakes are located downstream. During the night they damage the water intakes located upstream so that water can reach their intakes. Water theft is also practiced by the youthful members who block distribution pipes belonging to the elderly members at night and open them in the morning. This is aggravated by the fact that they engage in farming large tracts of land which require more water. Water stealing becomes very rampant during the dry spells. When the river discharge is low, irrigation is practiced throughout the whole day and night.

Previous studies have shown that , some farmers may tamper (often overnight) with the intake of other nearby farmers to get some water even when it is not their turn; this is easily done (and not always detected) because all intakes and furrows are simple, temporary, makeshift structures. Anger and conflicts can also be caused by reduced flows or complete lack of incoming water at the time when water has been officially allocated. This may occur quite frequently for irrigators toward the end of a furrow. This problem is often contributed to by farmers at the beginning of the furrow when they take advantage of their privileged location to clandestinely divert some of the water passing by (Ewaso, 1994)

Other social conflicts arise when members do not participate in mandatory communal work like cleaning of the intake, when they are not involved in making decisions pertaining to water management, in cases where there are issues of unequal distribution of water, when some pipes are leaking like the one shown below in Plate 4.11, and the owners are not repairing them. Other

conflicts arise when some members don't comply to form shifts/water rotations during the dry seasons.



Plate 4.11 Naked pipes burst on the roadside

The leakages have led to formation of water pools on the roads; this situation has been worsened by the absence of laws addressing leakages on individual pipelines after distribution. With such leakages equitable distribution of water cannot be attained in the association. In cases of low pressures in the pipes, contaminants may be drawn into the system hence domestic water supplies become unsafe for consumption.

Other conflicts arising from social related issues includes those cases where pipes are left unburied in routes passing on other peoples land, the open ditches formed are filled with water and in cases where the pipes are leaking, the landowners are forced to disconnect the water so that the owners can repair and burry the pipes. Disconnecting of the water causes fights which lead to conflicts, some of the respondents interviewed said that there were reported cases where one of their members was hospitalized after being hurt in a fight.

The conflicts which arose from technical issues were related to situations where the members were not contented with the water distributions designs being used. The most common design used for distribution was the "mortaa"(Shown in plate 4.12 on the next page) this device was designed by the farmers own innovativeness, the "mortaa" constitutes of a galvanized iron pipe

which is perforated with holes equal to the number of members in the project. Consultations from the division irrigation officer revealed that the device becomes inefficient because of water losses from the leakages. This device also acts as an instant break to the water pressure. The leakages result to unequal distribution of water to members.



Plate 4.12 Leaking "mortaa"

CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The research found out that 80.7% of the respondents did access the water for domestic use. Previous studies have shown that provision of accessible water in most developing countries is below 5% (John, 2006). Over the dry season's water is not accessible to everybody because water is rationed and community members not supplied are forced to fetch water only when the water is available. On the other hand the association is not effective in providing accessible irrigation water. This has contributed to irrigation being practiced for 24 hours. Water supplied is also adequate for domestic uses only but not adequate for irrigation. This is caused by reduced water volumes in the closed system, air locks since all the closed systems lack water breaks, water leakages along the system and unequal distribution which is mainly brought about by ineffective distribution design. Water supplied is also reliable for domestic uses. 85% of the respondents agreed that even during the dry season water for domestic uses was always within reach.

Water supplied by the association is not treated before distribution although 83.8% of the respondents said that the water was clean for domestic uses. There are farming activities taking place along the riparian zones of river Timau which have contributed to water pollution especially when farmers wash their knapsack sprayers in the river, washing of clothes and even bathing. These findings are similar with other studies done in Rombo by Hartmut Krugmann in 2006, He found out that copious use of pesticide, washing of clothes and bathing contributed to water pollution in Rombo River.

The Water User Asociation raises awareness on efficient use of water by its members through general meetings. One of the observations made is that the new water projects did not concentrate on raising awareness to their members because the water supplied was adequate, reliable and accessible to all their members. This was mainly attributed to the relative position of their water intakes which were located far upstream. On the other hand the extension services from the government were not efficient for example the members were not informed on the types of crops to grow, irrigation methods to use and water conservation measures to be put in place especially during the dry seasons. According to NASEP 2007, agricultural extension services

should impart knowledge to farmers on appropriate land use allocation and management of economically viable resources.

Members involvement in running the water user association is one of the pillars of any water user association and acts as an indicator of a well managed and effective association. Members attend meetings and they are involved in decision making process with 25.4% and 28.5% having their decisions being accepted and implemented by the association very often and often respectively. Involvement in decision making in the WUA depended on the length of membership, Older members are more involved in decision making than the new members. The exclusion of the new members in the decision making process is not appropriate.. Experiences from Tamil in India have shown that decision making should be holistic process where every member should be heard and even involvement of external agencies like NGO, Research Institutions or other impartial groups is necessary to sustain the sustain group action within the WUA (Chandrasekan *et al*, 2008)

Members fully participate and attend WUA meetings, this is a measure of how committed and involved members are to their association because when members get involved in the meetings they will feel to own their association hence commitment becomes a norm. Previous studies have indicated that attending executive meetings by WUA members is a good starting point to initiate farmer debates and discussions on public participation which should lead to a truly farmer owned process and action (Iskandar, 2007) Frequency of campaigning for and defending the WUA by the members indicates, 93% of the members are always ready to defend their association especially when there is no equity in the water distribution. Members collectively demolish illegal intakes and they are also keen to locate intakes without water meters and those abstracting the overflows. Members also volunteer in water scouting activities, operation and maintenance, fundraising, formation of shift during dry seasons and land.

Leadership training is not adequate in Timau WUA. This has been attributed to the low levels of awareness by the extension service providers. Women training on leadership skills has not been done with 55.7% not having been trained on leadership. Training mainly involved the employees of the association, executive committee and stakeholders. Women and ordinary members training should be emphasized more. Only 24% of the members have attained secondary, post secondary and university education meaning they have the knowledge in

leadership and also their awareness levels are high and this makes them to be elected in key positions.

Members of the Timau Water Association are keen at volunteering both materials and services that will see smooth running of the association. With good management of the association the members will show high levels of commitment and ownership of the association. This is a strong foundation which can be used to bring all the members together especially when it comes to conflict solving.

Water conflicts in the Timau WUA have taken three dimensions: those caused by social and political reason, technical/engineering and administrative/regulation causes of conflicts. The causes were attributed to poor consultation during the project cycle with only 26 % consulting over the whole project cycle. Other studies done in Zimbabwe have also indicated that failure to consult during the project cycle can be indirect causes of conflicts among the water user associations (SIWI, 2000), poorly designed distribution methods like the mortaa which only distributed water equally during the dry season, Water theft during the dry season, Piping routes especially where naked pipes were left unburied (plate 10)

The major causes of the social/political conflicts included favors made towards some member by the executive committee especially when it came to registration of new members, different social economic activities practiced by the members along the river for example the downstream users are mainly pastoralist while the up streamers are mainly horticulture farmers. The other major cause of the socio political conflict is failure to adhere to the set by laws and this escalates the conflicts especially when the offenders get support from their political leaders. Executive committees have also been blamed for condoning and being reluctant to handle cases involving illegal intakes built along the river this is made worse when the administration (Chief and District officer) is informed and takes time to handle the matter.

Distribution designs used to distribute water to the members are inefficient with little or no consultation done when constructing the *mortaa*. The *mortaa* leaks and consequently lowers the pressure in the closed system. This contributes to unequal water distribution especially to those members whose homesteads are located at higher grounds.

5.2 RECOMMENDATION

The following recommendations are suggested based on the findings of the study.

a) Proper Demarcation of the Sub catchment zone. This will reduce the conflicts between the down streamers and up streamers and to allow effective monitoring because defaulters of set by laws can be easily identified.

b) There is need to raise awareness on the importance of water treatment at both the domestic level and intake levels.

c) Improve on extension services aimed at educating farmers on appropriate and Sustainable water management practices. Most of the conflicts arising from social related factors will be best addressed through the extension services. Members need be informed on the type of crops to grow at different seasons of the year when there are varying volumes of water. The water officers will also advice and should be available for consultation at all stages of the water association development (From start to the end). Embracing the extension services will assist in preventing some unforeseeable conflicts which could have been avoided at earlier stages.

d) Educate members about the new water Act, raise awareness levels, engage and facilitate WUA's to improve compliance and develop water allocation plans. Compliance of set by laws will mean members who are well informed of the impacts which result from failure to observe the bylaws. Members will also learn to respect the right of others for example water theft will cease and water rotation schedules will be observed.

e) Individual members to purchase their own water meters for installation. This will enable the members to embrace water conservation measures because the water supplied will be paid for individually. Unlike before where the total cost was shared equally by all members.

f) Enhance Water Scouting Activities, The water scouts operate on a voluntary terms, they should be motivated through small allowances to appreciate their work and also to facilitate their work. Failure to give them allowances will lead them to being corrupt and allow them to receive bribes from defaulters of the by laws. They should also be taken for training on water management.

g) Formation of Water Rotation Schedules during the dry season will help to curb conflicts resulting from unequal distribution water during the dry season. These schedules have proved to be solution to water conflicts in Asia where they are termed as *wabaradi.*

h) Develop sub catchment management plans (SCMP) that include storage development and also promote rain water harvesting at the household level.

i) Improve on solid waste disposal especially herbicide jerry cans this will be achieved through Improvement on extension services aimed at educating farmers on appropriate solid waste management

j) Further research on water quality reaching the households needs to be conducted to ensure water supplied is safe for domestic uses

6.0 REFERENCES.

Abdel Hakim M, Inas K. El-Gafy (2004) *Assessment indicators for water users association in Egypt*, European water association (EWA)

Bates H Robert (1988) *Toward a Political Economy of Development: A Rational Choice Perspective.* Berkeley: University of California Press

Bryan Bruns (1992) *Just enough organization, water user associations and episodic mobilization.* WWW.BRYANBRUNS .ORG

Bryan Bruns edt 8, (2006) *Design for Participation: Elephant Ears, Crocodile Teeth and Variable Crest Weirs in Northeast Thailand.* Paper Prepared for TRIMNET-IIMI Workshop on Design Issues in Farmer Managed Irrigation Systems,Chiangmai,December 1989, International Irrigation Management Institute (IIMI)

Coward, E. Walter (1980) *Irrigation Development: Institutional and Organizational Issues in Irrigation and Agricultural Development in Asia*: Perspectives from the Social Sciences. Cornell University Press

Eva Hunt and Hunt Robert.(1976). *Canal Irrigation and Local Social Organization. Current Anthropology* 17:389-411. Chicago Journals

FAO (2000) *Performance analysis of on demand pressurized irrigation system*, FAO

Galand M, Labye, Y.; Olson and Tsiourtis, N (1998) *Design and optimization of irrigation distribution networks*, FAO Irrigation and drainage paper, FAO

GOK (2002) *Meru Central District development plan*, Government printer

International Water Management Institute (IWMI) (2004). *Key role of user associations in integrated water resource managemen*t. Published by the Global Water Partnership

James Bourchier. (2004), *Water Management for Dryland Agriculture.* Kondinin Group West Australia

Jeffrey D Brewer, Sakthivadivel R, and K. V Raju (1996) *Negotiating water allocation rules in government managed irrigation system, conflicts in Kirindi Oya, paper presented at the annual meetings of international association for the study of common property* 5th-8th June 1996, International Irrigation Management Institute (IIMI)

Kerry J, Brynes (1999) *water user associatiations in the World Bank assisted irrigation projects in Pakistan.* International Bank for Reconstruction and Development (IBRD)

Kiteme B.P and John Gikonyo (2002). *Mitigating conflicts over scarce resources in the highland–lowland system of Mount Kenya.* Mountain Research and Development. BIONE

Lamaddalena Nicola (1998) *Integrated simulation modeling for design and performance analysis of on* 15*demand pressurized irrigation system.* PhD dissertation, technical university of Lisbon, Lisbon

Lamaddalena Nicola Sagardoy, J.A. (2000) *Performance analysis of on demand pressurized irrigation system.* FAO

Lowdermilk M (1991) *Farmer involvement planning guide, water management synthesis guide.* Colorado, Cornell University, New York.

Martin Edward and Robert Yoder. (1983). *"Water Allocation and Resource Mobilization for Irrigation: A Comparison of Two Systems in Nepal." Paper presented at the 1983 Annual Meeting Nepal Studies Association, Twelfth Annual Conference on South Asia*, University of Wisconsin, Madison, Wisconsin.

Mays L and Sou Y (1987) *Reliability* based *optimization for water distribution systems* pg 589-596. Journal of hydraulic engineering, American Society of Civil Engineers (ASCE)

Meinzen-Dick, R. (2007) "Beyond panaceas in water institutions." Proceedings of the National Academy of Sciences **104**(39), 15200-15205.

Meinzen-Dick, R. S., M. S. Mendoza, L. Sadoulet, G. Abiad-Shields and A. Subramanian. (1997b). Sustainable Water Users' Associations: Lessons from a Literature Review. Pp 7-87 in A. Subramanian, N. V. Jagannathan and R. S. Meinzen-Dick (eds). *User Organizations for Sustainable Water Services.* World Bank Technical Paper No. 354. Washington, DC: World Bank

Ministry of Water (MOW) (1991) *Meru district water development study, 1993-2013.* MOW

Montgomery, John D. (1983). *"When Local Participation Helps."* Journal of Policy Analysis and Management 3 (1): 90-105

Mumma Albert (2005). *Plural legislative framework for rural water management in Africa.* World Bank

Njonjo, A (1997) *Study of community managed water supply; Final report on case studies and experience exchange in World Bank, survey of community water supply schemes of Kenya* . World Bank

Ostrom E (1990) *some conventional conditions for water user associations* http://en.wikipedia.org

Ostrom, Gardener and Walker (1993) *Rules, games and common pool resources,* World Bank

Perry J. C (1995) *Determinants of functions and dysfunction in irrigation performance improvement,* Water Resources Development, pg 25-38

Robson C (1993) *Real world research,* blackwall, oxford press

Ruth Meinzen Dick and Margret Zwarteveen (2004) *Gender participation in water management, issues and illustrations of women participation in WUAs in South Asia,* Asian Development Bank (ADB)

Sallem (1984) *Decentralization and participatory irrigation management in Egypt 1984.* IWMI

Sampath and Young (1990) *'Optimum' Participation in Irrigation Management: Issues and Evidence from Sri Lanka." Human Organization 49 (1):26-40.* West view press

Sylvain Perret, (2006), water governance for sustainable development. Cirad Editions)

Tullin A and Pulley (1994) *building a gender responsive water user associations,* Asian Development Bank.

UNICEF (2008) *Country programme action plan, programme component five water and environment.* UNICEF KENYA

Uphoff N Norman, M.L. Wickramasinghe and C.M. Wijayaratna. (1990). *Optimum Participation in Irrigation Management: Issues and Evidence from Sri Lanka. Human Organization 49 (1):26-40.* West view Press.

Wiesmann U, Gichuki, F. Kiteme, B.P, Liniger. H.P. (2000) *Mitigating Conflicts over Scarce Water Resources in the Highland-Lowland System of Mount Kenya.* Mountain Research and Development, Vol. 20, No. 1: 2-7.

WRMA (2006) *Draft rules for water resources management in Kenya,* Water Resources Wanagement Authority

Zaccaria D (1998) *Reliability analysis of on demand irrigation system,* Msc thesis, Bari institute, Bari, Italy.

APPENDIX 1 : Survey questionnaire

Survey questionnaire
(For WUAs Members)

The questions in this questionnaire are for research purpose only. The information you provide will be treated with utmost confidentially. Your assistance in answering the questions truthfully and accurately will be highly appreciated.

A. WUA PROJECT MEMBER CHARACTERISTICS

WUA Project name: _____ sub location:_____

Name of the respondent (optional): _____

Respondent's age: _____ Respondent's Sex: Female ___ Male ___

Do you play any leadership role in your water project? Yes ____ No____
Specify_____

Do you play any leadership role in your community? Yes ____ No____
Specify_____

Total number of household members in your household: _____
Of these, how many are females?_____ Males?_____
How many of these provide household farm labour?:_____

Of the total household members, how many are adults (over 18 years old)?:_____
Of the total household members, how many are children (under 18 years old)?:_____
Of the children, how many are currently going to school?:_____

Respondent's highest education level reached: none _____ Pre-primary_____
Primary standard_____ (indicate the precise class reached)
Secondary form_____ (indicate the precise form reached)
Post-Secondary technical training: _____ Specify_____
Diploma training: _____ Specify_____
University degree earned: _____
Other_____

Household income from wage earning employment per year: KES_____
Household income from own farming per year: KES_____
Household income from own business/properties per year: KES_____

Household income from other sources per year: KES_____ Specify_____
Total household income per year: KES_____

B. EFFECTIVENESS OF THE WUA IN PROVISION OF WATER

1. Does your WUA provide you and your community easy access to: domestic water? Yes_____ No_____ Occasionally_____

2. Does your WUA provide you and your community easy access to: irrigation water? Yes_____ No_____ Occasionally_____

3. Does your WUA provide you and your community adequate domestic water? Yes_____ No_____ Occasionally_____

4. Does your WUA provide you and your community adequate irrigation water? Yes_____ No_____ Occasionally_____

5. Does your WUA provide you and your community reliable domestic water? Yes_____ No_____ Occasionally_____

6. Does your WUA provide you and your community reliable irrigation water? Yes_____ No_____ Occasionally_____

7. Does your WUA provide you and your community safe/clean domestic water? Yes_____ No_____ Occasionally_____

8. Does your WUA provide you and your community safe/clean irrigation water? Yes_____ No_____ Occasionally_____

C. EFFECTIVENESS OF THE WUA IN PROVISION OF COMMUNITY KNOWLEDGE AND AWARENESS

9. How often does your WUA teach and/or train you about good water use?
Every 1 to 3 months_____ Every 4 to 6 months_____
Every 7 to 9 months_____ Every 10 to 12 months_____ Never___

10. How often does your WUA inform and/or make you aware about good water use?
Every 1 to 3 months_____ Every 4 to 6 months_____
Every 7 to 9 months_____ Every 10 to 12 months_____ Never___

D. WUAs MEMBERS' INVOLVEMENT IN RUNNING THE WUAs

11. How long have you been a member of your WUA? _____ years

12. Do you hold any administrative/working position in your water project?
Yes ____ No____ Specify_____

13. How often do you attend WUAs' general meetings?
Every 1 to 3 months_____ Every 4 to 6 months_____
Every 7 to 9 months_____ Every 10 to 12 months_____ Never___

14. How often do you attend WUAs' committee/executive meetings?
Every 1 to 3 months_____ Every 4 to 6 months_____
Every 7 to 9 months_____ Every 10 to 12 months_____ Never___

15. How often do you assist your WUA to generate/raise funds?
Every 1 to 3 months_____ Every 4 to 6 months_____
Every 7 to 9 months_____ Every 10 to 12 months_____ Never___

16. How often do you campaign for, support and defend your WUA?
Every 1 to 3 months_____ Every 4 to 6 months_____
Every 7 to 9 months_____ Every 10 to 12 months_____ Never___

17. How often do you volunteer time, labor, money, and resources for your WUA?
Every 1 to 3 months_____ Every 4 to 6 months_____
Every 7 to 9 months_____ Every 10 to 12 months_____ Never___

18. How often are your suggestions/ideas accepted and implemented by your WUA?
Very often_____ Often_____ Occasionally_____ Never_____

E. WUA LEADERSHIP TRAINING IN WUA MANAGEMENT

19. How adequate is the training of the staff/employees of your WUA in terms of the WUA management?
Very adequate_____ Adequate_____ Moderately adequate_____
Not Adequate_____ Never trained_____

20. How adequate is the training of the Executive Members of your WUA in terms of the WUA management?
Very adequate_____ Adequate_____ Moderately adequate_____
Not Adequate_____ Never trained_____

21. How adequate is the training of the Executive Members of your WUA in terms of the WUA management?

Very adequate_____ Adequate_____ Moderately adequate_____
Not Adequate_____ Never trained_____

22. How adequate is the training of the stakeholders in your WUA in terms of the WUA management?
Very adequate_____ Adequate_____ Moderately adequate_____
Not Adequate_____ Never trained_____

23. How adequate is the training of the ordinary members of your WUA in terms of the WUA management?
Very adequate_____ Adequate_____ Moderately adequate_____
Not Adequate_____ Never trained_____

21. How adequate is the training of the female members of your WUA in terms of the WUA management?
Very adequate_____ Adequate_____ Moderately adequate_____
Not Adequate_____ Never trained_____

F. WATER RELATED CONFLICTS IN WUAs

23. How often have you and your household complained about water issues in your WUA, or in other WUA in your area?
Very often_____ Often_____ Occasionally_____ Never_____

24. How often have such complaints about water issues in your WUA, or in other WUA in your area generated into water use quarrels and conflicts?
Very often_____ Often_____ Occasionally_____ Never_____

25. How often have you personally experienced water use conflicts in your WUA in your area?
Very often_____ Often_____ Occasionally_____ Never_____

26. Are these conflicts technical/engineering related? Yes_____ No_____
Are these conflicts social/political related? Yes_____ No_____
Are these conflicts administrative/regulation related? Yes_____ No_____
Other types: Specify_____

27. Are these conflicts within your WUA_____ ? or across other WUAs?_____

28. Are these conflicts between members of WUAs? Yes_____ No_____
or are they between members and non-members of WUAs? Yes____ No____

29. Are these conflicts serious enough to affect the management of the WUAs?

30. What suggestions would you provide in way of identifying strategies to mitigate The conflicts?

1. _____

2. _____

3. _____

4. _____

5. _____

31. Does every member get equal amounts of water after distribution? Yes __ no __

If no, why

_____

_____

_____

32. Are there system malpractices e.g. illegal connections experienced in your project? Yes __No __. How are they addressed?

_____

_____

_____

33. . How aware are you with the new water Act of 2002 (a) aware (b) very aware (c) not aware (d) never been informed about it

34. Do you carry out routine checkups for your pipeline? Yes __ No __

35. If yes when do you carry out the checkups? (a) when there is no water in the pipes (b) when the water in the pipe has reduced (c) when some members don't get water (d)when there are reported bursts

36. Are you contented with the route followed by the major pipe? Yes __ No __

37. If no, give reason?

_____

_____

_____

38. How do you share the water during dry seasons when the water volume has reduced?

_____

_____

39. Do you consult experts during (a) intake location and construction? (b) laying of pipes (c) determining the appropriate design to distribute the water

40. Which irrigation methods do you use? (a) Use sprinklers (b) drip irrigation (c) furrow (d) others (specify)

41. When the piped water is not in use for example during the rainy season, how do you stop it from running or going into waste?

42. Does the irrigation officer advice you on (a) irrigations methods to use __ (b) types of crops to grow __ (c) water conservation measures __

KEY INFORMANT QUESTIONAIRE

NAME OF RESPODENT _____

OCCUPATION _____

1 Do you think the water user association members are fully involved in the water management ? Yes __No__

1.1 If yes why? _____

1.2 If no why?

_____

2 how are the women involved in running the water user associations ?

_____

_____

3. If women are not involved why? How can they get involved?

_____

_____

4. Are the community leaders trained in running the projects activities ? Yes__ No__

5. If yes, is this training enough? Yes __ No __

6. if the training isn't enough, what else are the supposed to be trained on?

_____

_____

7. Are the members of water user associations trained on water conservation? Yes__ No __

8. if not is this training necessary Yes __ No __.

9. If yes what matters should they be trained on?

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10. What are the major causes and forms of conflicts among the members?

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11. How can the problem of reduced water volumes be solved during dry seasons?

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12. What should be done to equally distribute the water during the dry seasons ?

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13. Is the water treated before distribution? Yes __ No __

14. If yes how is the water treated?

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15. Is the water tested regularly for treatment? Yes__ No__

16. How can you rate the communities level of awareness in regard to water conservation?

(a) Aware (b) Very aware (c) Not aware (d) others

17. Are the WUAs leaders competent in managing the projects? Yes __ No __

18. If not why?

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19. Describe the methods used to distribute water to the members from the mojor pipe?

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20. Are these methods effective ? Yes __ No __

21. If no how can they be improved?

Appendix 2: Main Research Variables and their Indicators

Variable	Indicators
WUA's members involvement and motivation in water management	• Household membership/participation of WUA's • Length of membership in WUA's • Household volunteer of time, materials to WUA's
WUA's member Participation in management of WUA's	• Whether members attend regular meetings • Whether women attend meetings • Whether members prioritize problems and suggest solutions • Whether members manage funds • Whether members obtain funds from external sources
WUA's leadership	• Are staff running the WUA's trained • Are community leaders trained in water management? • Participation of women in management of WUAs • Stakeholder participation in policy formulation and project evaluation
Members Awareness	• On technical matters (maintenance of water) • Legal matters (water bylaws and water act) • Water safety, utilization and conservation • Availability of community outreach programs on water use and sanitation
Education level	• Highest level of schooling for WUAs management • Whether leaders attend leadership workshops • Training of WUA staff on financial management, contract administration, and operation maintenance
Conflicts	• Complaints by household over use of water • Households quarrels over use of water
Availability of adequate water	• Household access to water for domestic use • Does the WUA supply enough water to every household? • Household access to water for irrigation
Household access to water	• Distance of water source to household • Cost of water

	• Is there a charge for water? Do all household afford the water charges
Effectiveness and Reliability of water systems	• Whether water is available throughout the day • Whether water is available throughout the week, month and year • Is the supply of water affected during the dry season?
Safety of the water	• Whether water is treated before distribution • Prevalence of waterborne diseases among households • Evidence of contamination of water by human activities • Whether community thinks water is safe to drink • Do none, some, most or all of the households treat water at home before drinking? • If water is treated, how do they treat the water? • Is water regularly tested for contamination
Maintenance of water and conservation	• Are there any leakages? • How long do breakages take before repair? • Who maintains supply pipes (community, WUA's, government)? • Does any community member know how to repair hand-pumps, pipes etc. If yes do they know where they can get the parts? • Is there drainage to carry excess water to soakage pits or larger drains? • Is there storage tank located in every household?
Water related diseases	• Diarrhea prevalence and treatment • Malaria prevalence and treatment
Quality of service	• Percentage of households without continuous water supply during the day • Percentage of households with water shortages during dry season • Percentage of households reporting satisfaction with WUAs

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