THE IMPACT OF SMALL COMMUNITY DAMS ON ARID AND SEMI-ARID LANDS (ASALs) DEVELOPMENT. A CASE STUDY OF GACHOKA DIVISION IN MBEERE DISTRICT.

BY

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DECLARATION

This thesis is my original work and has not been presented for a degree in any other university.

Signed .....Date 8/11/2001

Stephen Ngari

This thesis has been submitted for examination with my approval as a university supervisor.

Signed .....Date 9/11/2001

Professor, S.O. Akatch

DEDICATION

To my dear wife Lydia Njoki, my son Lincoln Mwaniki Ngari and the entire family of the late Joseph Mbogo Nyaga. I owe you this and much more.

Acknowledgement

I would like to express my sincere and profound appreciation and gratitude to everyone who assisted me during the preparation of this study. Special thanks goes to my Supervisor Professor S.O. Akatch for his advice and guidance from the inception of this work to the end.

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The view expressed in this study and errors of facts and interpretation are entirely my responsibility. They should not be interpreted as reflecting the views of those who assisted me.

Abstract

Gachoka Division of Mbeere District is a semi arid area. Water is scarce in most part of the division. In 1970, the area was supplied with a piped water but due to mismanagement, the water supply is no longer functional. In 1979, the Government through the Ministry of Agriculture established a Dam Construction Unit in the area with the aim of soil and water conservation. In order to effectively conserve the soil and water in the area they started construction of small community dams. Since then 43 small community dams have been constructed by the Government, Non-governmental Organizations and Religious Based Organizations. Due to rainfall unreliability in arid and semi-arid areas there is need to conserve water during the rainy season for use during the dry season through construction of both surface and subsurface dams. This study undertook to investigate the impact of these dams on the recipient communities. It analyzed the government policies on water and Arid and Semi Arid Lands (ASALs) rural development since independence. This study also analyzed the sources of water before dams were constructed, the sources of water during the rainy and dry season. It has also looked at the methods of water transport and the drawers of water. The study has also analyzed the various uses of the water and how the dams are currently managed by the users. The study has revealed that the dams are appropriate for storing water during the rainy season for use during the dry season. The study has confirmed that the water from the dams have been beneficial to the communities where the water is used for irrigation, which has created employment by people selling the water which is used for irrigation. This acts as a source of income during the dry season when there is no on farm employment. The water is also used for rearing exotic dairy cattle, watering tree nurseries

and selling the water in the local market centres. This study also looked at the management aspect of the dams, and it revealed that the dams require proper management to avoid siltation and misuse. Those dams where the communities were not involved from construction to implementation were found to have no management committees, were not fenced and there was no control on the use of the water leading to direct watering of animals in the dams which pollutes the water. Where communities were involved throughout the dam planning, construction and implementation the dams had user management committees, were fenced and there was control of the water use by the communities through their elected management committees.

The study has recommended that the construction of the small community dams should be combined with intensive soil conservation practices and catchment protection through afforestation. Since this area is part of the catchment area of Tana river with Kamburu, Gitaru, Kiambere and Kindaruma hydroelectric power generating dams downstream the combination of water and soil conservation through the construction of small dams would be beneficial to the local community by increasing their access to more water and at the same time reducing the siltation in Hydro Electric Power (H.E.P) dams hence enhancing their capacity to produce electricity, which will be beneficial to the nation as a whole.

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List of Abbreviations

ASALs- Arid and Semi Arid Lands.

FAO – Food Agricultural Organization.

UNDP – United Nation Development Programme.

GOK – Government of Kenya.

NGOs – Non- Governmental Organizations.

HEP – Hydro Electric Power.

TARDA – Tana and Athi River Development Authority.

WHO – World Health Organizations.

ALDEV – African Land Development Programme.

DCUs – Dam Construction Units.

AMS – Agricultural Mechanization Station.

CHAPTER ONE

BACKGROUND TO THE STUDY

1.0 General Overview

Water is a basic requirement for human as well as animal and plant life. People need water for drinking, preparing food and for sanitary purposes. Without water, life on earth would not exist because; from the very beginning, people have settled close to water sources, along river valleys besides lakes or near natural springs. Indeed where people live some water is normally available for drinking, domestic use and for watering animals (Curtis, 1994).

This does not normally mean that the available source is convenient and of sufficient quality nor that the water is safe. On contrary, in many countries people live in areas where water is scarce, often it has to be carried over long distances particularly during the dry seasons. Water has always been a subject of great interest to scholars since its essential for survival of man. Human beings has been involved in a battle to control water resources. Impressive works and facilities have been built to harness water for the benefit of humanity. Every project and almost every process in society and in nature needs water. Water is the life giver per excellence. It is the most fundamental substance that makes life possible on earth. While most resources have substitutes water fulfils a number of functions where these is no substitute (Clarke, 1991).

In Africa and many other parts of the third world, there is a manifest lack of access to potable water, consequently effecting individual and community health. The World Health Organization (WHO) in 1980 estimated that 30,000 people were dying every day from

water related diseases. It was also estimated that over 70 percent of the world rural population lacked access to safe water supply. The need for safe water for domestic use was recognized in the plan for Action of the United Nations Mar Del Plata Water Conference in 1977, which motivated the launching of the international water supply and sanitation decade (1980-90).

Currently water scarcity, has become a problem of global concern not only affecting small localities but whole regions and nations. According to Ornas (1996) by the year 2025 a third of the world population will be living in countries with water stress or chronic scarcity. The United Nation Water Decade focused attention in rural areas and encouraged increased investment by Government and other agencies in water. The Government of Kenya took the aim of the decade on board, with the goal of providing water for all by the year 2000. By this, the Government meant having an improved source within one kilometre in high and medium agricultural potential zones and within five kilometres in low potential zones. This has already proved difficult to achieve.

The 1999 Population and Housing Census Report indicate that the proportion of national households, which used streams or rivers as their main source of domestic water supply declined from 40 percent in 1989 to 27 percent by 1999. Those with access to piped water remained almost static for 10 years at 32 percent. The proportion of household who used other sources of water doubled from 14 percent to 29 percent with Nyanza and Western Provinces experiencing shifts towards other sources of water.

In rural areas, the proportion of households with access to clean water is 32.5 percent (Kimuyu, 1998). These averages mask huge regional disparities, with districts such as Kitui, Makueni, Mandera, Wajir, Homabay, Mbeere, Migori and West Pokot showing that less than 20 percent of the population has access to safe water. Many households in ASALs cover long distances in search of water. Due to scarcity, queuing at water point is a common phenomenon.

For billions or so people living in semi arid regions of the world vagaries of nature have to some extent been halted and controlled. But due to economic hardships, the heydays of construction of large dams and transfer systems are over. However, there are still untapped water resources and options to make better use of scarce water resource. Various means of rain harvesting have to be utilized. One of the ways of conserving runoff water is through construction of small dams in ASALs.

Water supply is perceived by many rural communities to be the most important input for agricultural and personal welfare. Investment in rural water supplies is seen as part of the policy supporting the strategic goal of rural development (GOK, 1970). Warner (1970) postulated that the provision of adequate water supplies to a rural area is of high priority on socio-economic ground. Economically, water is seen as an important input in agricultural production by re-directing labour and time used for fetching water to agricultural production.

Since the 1970s, the Government has been involved in programmes to bring water to all its population. The Government is still committed to this long-term goal of universal supply but there is recognition that competing demand may now require a review of objectives of water development. Supplying water and sanitation for all by the year 2000 has not been achieved and the efforts will continue for several decades to come. Experience has shown that there should be an orientation away from expensive sophisticated techniques towards appropriate low cost and socially acceptable techniques that are adapted to local conditions especially in ASALs (Nilsson,1988).

In ASALs there is need to dam ground or sub surface water flows. This is because every drop of water in ASALs is valuable and should be saved because these are areas of low and unreliable rainfall, which adversely affects crops. As the human population raises the impact of drought and subsequent food shortages in these areas is increasing in severity. Food security has become a major concern in these areas. The harbinger to the misunderstanding of development prospects in the ASALs emanates from considering these areas in zonal potential terms. Besides livestock ASALs are sources of millet, sorghum, cotton, cowpeas, paw paw, grapes and passion fruits. This fact proves that ASALs are not cast lands incapable of having economic produce, however appropriate technology need to be adopted for future expansion of food in ASALs (Hai, 1998).

People concerned with rural planning or development must pay more attention to these areas. Over 80 percent of staple food is grown on the 20 percent of land suitable for agriculture the rest being of marginal utility and characterized as ASALs. Water for agriculture has to be provided through large-scale irrigation project, however these are

too expensive and so the utilization of both surface and subsurface dams to conserve run off appears more promising (Oywa, 1989).

Water is scarce in ASALs and the available one must be used efficiently for the common benefit of the community. Water is located at the top of the list of resources, which determine the future of ASALs. Due to rainfall unreliability more emphasis should be on conservation of water to ensure its maximum utilization (Biwas, 1992). Kimuyu (1998) noted that, in semi arid and arid areas of Kenya, the main issue is that of getting water. The issue of quality comes next. That is why the role of public education in the management of water resources becomes inevitable.

The Sessional Paper No. 1 of 1999; on National Policy on Water Resources Management and Development recognized the fact that disparity in development of the country is as a result of availability or lack of water. Experience gained from the existing water supplies show that projects if planned and implemented in isolation, focusing mainly on raising the service coverage levels always fail to deliver sustainable water supply due to lack of institutional support.

1.1 Overview of Government Policies on Water and Rural Development since Independence

Safier, (1970) postulated that right from colonial days little attention was paid to organized settlement of Africans in the rural area. The colonialist were only motivated by economic interests of their capitalist countries in the west. Planned development seemed

to mean no more than urban development. The African village if not stagnant was becoming poorer and dull due to rural urban migration. Many people in the rural areas continued to live and work in the same manner as they did before and after colonialism. They continued to drink water from the same water holes and use the same methods of lighting as they had always done and their diet remained the same with little hope of changing. Compounded with these problems, some villagers expressed the feeling that independence was not for them. It is for these reasons that some African governments began to show increased concern over the problem of rural development.

After independence, the Kenya government realized that the provision of water was to be a major factor in economic development. It committed itself to the supply of water to all by the year 2000 inorder to ensure that lack of water does not become an impediment to the development of the country. The government committed itself to improve rural water supplies, which it admitted had hitherto been neglected during the colonial period. Previously the responsibility of rural water supply was on county councils which due to financial and manpower problems were unable to achieve much. The government took over the direct responsibility for rural water development in 1968. This was because the government regarded development of rural water supplies as an important component of the overall rural development strategy (G.O.K, 1970:11). In 1974, the government upgraded the water department that initially operated from the Ministry of Agriculture to a full-fledged Ministry; and embarked on an intensive water programme both in rural and urban area.

The potentials and possibilities of development are still much greater in the rural areas than in other sectors. According to Chambers (1973) increased involvement in development at the local level by people can be traced back to late President Kenyatta's Harambee (let do it together) call in 1964, and his subsequent speeches urging people to go back to land. This emphasized the need to develop our rural areas by focusing on agriculture.

The first two-development plan laid their focus on rapid economic growth through agrarian revolution. Land consolidation and registration received special emphasis so that farmers could have legal right over their land to increase chances of obtaining loan. The government belief then was that it was only through an accelerated development of the rural areas that balanced economic development could be achieved and that public participation was necessary in the development process.

The government intended to give new meaning to phrase rural development so that the principle of African socialism involving equitable distribution of the benefits of prosperity could be given greater reality in a nation enjoying a high level of general prosperity.

The Second National Development Plan of 1970-74 recognized the fact that it was only through an accelerated development of the rural areas that balanced economic development could be achieved. The basic strategy of the plan was to direct an increasing share of total resources of the nation towards the rural areas. Programme for rural development as identified in the plan was to improve the quality of life as well as providing an important economic stimulus. This was to include a comprehensive plan for the

provision of rural water supplies. The plan was to take 30 years to complete and it was envisaged to cost approximately 400 million shillings by the end of the plan period.

The plan recognized that apart from education, rural water supply was to have the most important impact on the lives of people living in rural areas. The fullest benefit from the water supply could only be realized in systems, which provided for individual connection. But the government soon realized that provision of water services to this standard was beyond its capacity to support or the people to pay. The basic rural service was defined as a communal water point to serve the domestic and livestock of a population within, two kilometres in high potential areas, five kilometres in the medium potential areas and, an appropriate larger radius in areas of low potential and sparse population.

It was the intention of the government that a fee be charged for services higher than the basic rural standard usually taken to mean an individual water connection. During the same plan period, (1970-74) the conservation of surface and subsurface run off in drier regions received a lot of attention. The plan recognized that in these areas rainfall was erratic and highly seasonal. Further, heavy rains are followed by a long dry spell during which surface supplies dries up (G.O.K 1970).

The government through its dam construction unit supported a dam construction subsidy scheme through which private individuals were encouraged to construct water conservation works. Subsidies to a maximum of 38,000 shillings for such efforts ranged from 25 percent of total cost in high rainfall areas to 40 percent in areas of low rainfall.

Even in areas where Government constructed dams; operation and maintenance costs were to be met by the locals, whenever possible.

The Fourth Development Plan (1979-1983) continued with the emphasis of rural development. The main emphasis of the plan was poverty alleviation throughout the country by creation of income generation activities and provision of basic needs in the field of health, nutrition, education, housing, social services and water. The plan emphasized that the major problem affecting water development was its inadequate storage, distribution, and not water availability. The existing potential for supplying water for human consumption and livestock needs was found to exceed by a considerable amount the demand of water by then and so with appropriate investment the country would be able cope with a much larger population.

The ASALs were given higher priority than before in the Development Plan of 1979-83. Water conservation received a lot of priority as a development strategy. The Plan appreciated the fact that these areas constitute 80 percent of Kenyas total land with 50 percent of its livestock and 20 percent of its population living in these areas but had received limited benefits from past development programmes.

The ASALs were to receive special attention so as to alleviate the twin problem of poverty and rehabilitation of land and water resources for sustained development.

The Sixth National Development Plan (1989-93) also appreciated the fact that ASALs were given low priority in colonial period, a situation that had persisted during the first three-post independence plan periods. However, in the 1970's the government took a major evaluation of the potential contribution of ASALs to the national economy. From the evaluation, it was realized that ASALs had substantial potential for development though at a higher cost than the rest of the country. But there was increasing problem of soil erosion, environmental degradation, threat of desertification and negative consequences of such phenomenon such as hunger and malnutrition manifesting themselves severely in these areas thus calling for public resource diversion in famine relief operation. The Seventh Development Plan (1994-96) put water resource as one of the main factor that limits the pace of development in ASALs. The periodic droughts, which are rather unpredictable, compounds further the problem of water.

ASALs suffer from lack of water than all other areas in Kenya. One very dominant characteristic that pervades all people living in ASALs in Kenya is their relative lack of control over the supply and availability of food and water. Indeed this lack of control over these two basic human needs constitutes a pivot around which most of their other problems revolve. It does not take along acquaintance with ASALs and people inhabiting them to realize that the problems these areas face are complex, relatively unclear and poorly defined. The solutions of some of these problems are purely technological. For example, harvesting water from the river, streams and runoff water using surface and subsurface dams can provide water for human and livestock consumption as well for small scale irrigation during the dry season. These areas suffer serious drought one out of

every four or five years; where they loose their subsistence crops and that only famine relief supplies saves these people from starvation. These people actually live too close to the margin of survival (Ngethe, 1982).

The Eighth National Development Plan (1997-2001) recognizes that majority of people in the rural areas derive their livelihood from agriculture and livestock and that policies that aim at rural development must focus on this sector. The Plan aim was to improve the quality of life of people in the rural areas by improving agriculture and livestock production. The government according to Sessional Paper No. 1 of 1999 on National Policy on Water Resource Management and Development has realized that the provision of adequate water facilities to meet all national's water need is an enormous task and big challenge. The government is now encouraging full participation of communities, donors, Non-governmental Organizations (NGO's) and private sector and the role of the government will be to create an enabling environment for actors and will adopt a diminishing role in direct implementation of water supply.

1.2 Statement of the Problem

The mere fact that over 80 percent of total land of Kenya is ASALs is thought provoking in itself. As population continue to increase and the high potential areas becomes less available for agricultural production and settlement, the medium potential zones (often called marginal land or semi arid) are increasingly being used for both crop and livestock production (UNCHS- Habitat, 1991).

The vulnerability induced by water scarcity is the main cause of famine and food shortage in these areas. The amounting levels of water scarcity in ASALs should be taken seriously and this requires an increased awareness among policy makers and planners at all levels of the significance of water in the development of these areas. The key issue is how to provide adequate, reliable water resources for population living in the ASALs. It is for these reasons that this research undertook to investigate the impact of small community dams as a form of improved water supply in ASALs. Technical and economic feasibility studies are needed but equally important are the social and environment impact studies. Without such studies, public understanding and acceptance of the project may not be possible.

Planners and Engineers must learn from past mistakes committed and should become more sensitive to the economic, social and environmental problems since long term sustaining development can only take place within the frame work of appropriate environmental guideline, otherwise, the overall strategy of development will be self defeating (Biwas, 1978).

Evaluation of rural water programmes can produce valuable information on how programmes may be improved. Researches on impact of water supplies are not done to know whether to built more water supplies. Water supplies will continue to be built irrespective of the evidence of health benefits because they fulfill the legitimate political objectives of many government. We should conduct research in order that water supplies may be built better and may have a greater impact on lives of the recipient communities.

The ASALs communities have special needs, because of the extreme environment they live in and their nomadic or semi nomadic lifestyle. In general the purpose of construction of small dams and pans in rural areas and ASALs in particular is to supply water generally untreated at fixed public water points including cattle drinking troughs and public taps to serve the local population (G.O.K, 1992). This was done in recognition of the fact that access to adequate and reliable supply of water is key to stimulating rural development. Results of various studies among them the participatory poverty assessment study (G.O.K, 1999) indicates strong correlation between water availability and level of socio-economic status of the people. Income generating projects like poultry, kitchen gardening and zero grazing which require low capital to operate and are ideal for alleviating poverty in both rural and urban areas have water as their entry point. Therefore to tackle poverty, strategies that aim at providing water to the poor, should be emphasized.

For steady supply of water of good quality at efficient quantity to alleviate poverty in both rural and urban areas the government emphasis will be on water programmes that have a direct impact on vulnerable section of the society (G.O.K, 1999). In ASALs this is expected to be achieved through harnessing rainwater by constructing appropriate dams and pans in strategic locations and desilting existing ones to provide water for small scale irrigation, livestock and other income generating projects (G.O.K, 1999: 34) and intensifying ground water exploration and exploitation to provide alternative source to surface water.

These strategies are to be pursued within a participatory framework involving the communities and other water actors in project design, implementation and management of water utilities to enable communities "own" their water storage facilities. This right to ownership implies that the entire responsibilities for operational and maintenance are assumed by the community. Routine inspection and maintenance of small dams is a technically uncomplicated and inexpensive undertaking, which is nevertheless essential for long-term sustainability.

The area under study was among the six divisions selected for the implementation of Special Rural Development Programme (SRPD), in 1971 and it was realized that lack of water was to be the major bottleneck to the success of SRPD. The aim of SRPD was to promote crop and livestock production and consequently improve the standards of living. In 1970, the area under study benefited from Ena water supply. This was a piped water supply and the water was piped raw (Kinyua, 1977). By 1977, a total of 90 kilometres pipeline had already been laid down with 30 communal water points which were less than 3 kilometres apart and 23 watering troughs. This was a temporary remedy to water problems due to vandalism and mismanagement of water facilities.

In 1979, the government through the Ministry of Agriculture established a dam construction unit in the area under Machanga Agricultural Mechanization station. The objectives of the station was to implement water and soil conservation programme by introducing appropriate farming systems to the immediate project area; and to increase land productivity and hence raise the standard of living of the local people. In order to achieve their objectives they had to construct small dams. Since then 43 community

owned dams and pans have been constructed by the government and some by the communities in partnership with other development partners like NGOs and the churches.

The dams have proved useful to the local communities who are now using them. And since a country's level of development is not only measured by the capability to initiating new projects but also maintaining the already existing one, this study set out to assess the impact of these small dams on the recipient communities. For these areas where water is the most valuable resource it is good to assess the impact of the already existing water supply, so that we can learn from the past in order to influence the future. There are for instance many people talking and writing about the fact that over 50 percent of rural water supplies have broken down in this or that country but there are very few people in the villages trying to find out why (Niv, 1974:5). A great deal more field study and evaluation are necessary if the reasons for success or failure of the rural water programme are to be clearly understood. This is because resources are scarce and should be utilized where programmes meet the intended objectives and maximizes benefits to the community.

1.3 General Objective

The general objective is to examine the impact of the water from the dams on the recipients community and show how the utilization of the dams can be made more sustainable.

1.3.1 Specific Objectives

The specific objectives are to:

- Examine how the recipient communities uses water from the dams;
- Assess how the dams are managed currently and how the communities were involved in planning and the implementation of the dams and
- Propose recommendation, that can enhance sustainability of the dams as a source of Water;

1.3.2 Assumptions

The assumptions are that the:

- Construction of the dams has not led to a decrease in the distance traveled to obtain water;
- Availability of water has lead to increased livestock production especially exotic dairy farming;
- Access to water there are some households who are now practicing kitchen gardening;
- Receipt communities were not involved in planning and implementation of the dams and
- Economic benefit of water may be increased by using them for small-scale irrigation.

1.4 Research Questions.

This research intends to answer the following questions.

1. Whether the construction of small dams as a source of water led to an improvement in the standard of living of recipient communities.
2. Given that the water sources are outside the homestead and that human portage is still the common means of transporting water what recommendation should be made to make water transport much easier.
3. What should be done to ensure that sustainability of the water resources is enhanced.

1.5 Operational Definition of Terms

Rural development: Defined as the process of improving the living standards of the low-income population living in rural areas on a self-sustaining basis, through transforming the socio-economic structure of society. The process involves the enlarging of the rural people's choice. These choices can be infinite and change overtime. Rural development should be seen as the process of increasing people's capacity to access basic requirement such as food; health, shelter, clothing, water and ensuring a steady source of income.

Weir dam: This is a structure of concrete, brick or masonry constructed across a stream to hold water, and water flow over when the storage is full.

Earth dam: Is a structure constructed by laying soil down and rolling it in layers to form earth embankment. An earth spillway (or by wash) is created at one end to pass excessive flood. The spillway protects the embankment from being overtopped by water. Soil that is

placed on the embankment should be sufficiently impervious in order to reduce water seepage.

Pan: It is similar to an earth dam, only that it does not have an embankment wall. It is a depression surrounded by continuous earth bank. The earth for the bank of the pan is obtained from the excavation inside the depression.

Subsurface dam: Is constructed when a subsurface vertical wall is constructed across the river bottom in the alluvium and down to the bedrock to intercept subsurface water flowing within the alluvium. The wall is constructed of stone masonry with a cement plaster for water proofing in the upstream face.

Sand dam: Is a low dam with a few metres high built across the luggas retaining only low velocity flow, which carry sand. After a few flood flows the space behind the dam is filled with sand.

Catchments: - Is defined as the area from which water drains to a common point in a natural or artificial basin. It is the area contributing flow to a given place or a given point on a stream.

Sustainability: For small dam and pans sustainability will be taken to mean, use of the water resources from the dams, in a way that allows the structures to have a useful lifetime of 20 to 25 years before the need for a major rehabilitation arises (G.O.K, 1992). The overall goal of a water supply programme should be to provide sufficient water overtime. Where good environmental managements are observed the surface water should be available in quality and quantity that are acceptable for benefit of the entire community. Soil erosion control and catchments protection are vital for sustainability of small dams. This has direct bearing on management in terms of lifetime of the dam as well as for the

long-term environment stability of the affected area. Soil erosion control and catchments protection measures including appropriate farming methods; and grazing control should be incorporated in order to minimize silting of dams and reduce the rate of sedimentation.

1.6 Justification:

The construction of small dams in Kenya dates back in the mid 1940s when water conservation structures were built for storing flood runoff. Most of these structures were constructed by farmers in the high agricultural potential areas while other were constructed under the African Land Development Programme (ALDEV) in ASALs. Investment in public supplies for small farmers and cattle owners was initiated by ALDEV in 1945. In the period between 1945 and 1962, 1590 permanent and temporary dams and 310 sub-surface dams were constructed.

Construction of water conservation structures in Kenya gained momentum in 1979, when the Ministry of Water established six Dam Construction Units (DCUs). Subsequently these DCUs were deployed in various parts of the country where they were engaged in construction of dams and pans. Some of the dams have silted; due to poor management, while others have breached their embankment walls particularly following the *El- Nino* weather phenomenon of 1997/98 leading to reduced water storage capacity. Consequently, as a result there has been a drastic reduction in water use. It is against this background that the Government realized the need to have these dams and water pans rehabilitated; and new ones constructed as enhancing water supply in ASALs is one of the measures towards poverty alleviation. Indeed the seasonal paper No 1 of 1999 on Water

Policy and Management, clearly stipulated that the availability of water in quantity and quality would enhance food and livestock production, improve domestic and industrial water supply and other related economic generating towards poverty alleviation.

Questions of water supply are inseparable from those of development; and the basic assumption is the creation of conditions, which will raise the standard of living of the poor. Thus, the true significance of development lies in the contribution it makes to man and to the most needy. The development of ASALs is essentially an attempt to overcome the physical difficulties imposed by nature. People living in humid regions may find it impossible to understand what a constant water shortage is. As Kimuyu (1998) notes, in ASALs water is regarded as the most valuable resource determining movement pattern, economic activities and probability of survival. A number of factors have contributed towards an increased concern in the development of ASALs. The population growth in higher potential lands has resulted in serious shortage of land relative to demand. Continued concern of famine and overgrazing; and growing demand for cattle products have lead to desire to improve ASALs.

The area under study receives torrential rainfall twice a year; and where arrangement have not been made this water disappears into the Indian ocean. Where water holding structures have been constructed; they have been able to hold the runoff. This water is available for domestic use; for use in education institution, market centers and for livestock use. There are areas in this country where piped water supply is not available and in some cases, the small dams may be the only major source of water. As stated earlier, in ASALs, the issue of quality of water is second to quantity. It is for this reason that it is important to assess

the impact of the already existing dams on the recipient communities. This will form a basis on how the use of water from the dams can be tailored toward sustainability.

Indeed conservation of water and soil are among the top priorities of those concerned with agricultural production and rural development. A study done in Lesotho by Feachen in 1978 indicated that there are two main reasons for wishing to evaluate a rural water programme or any other rural development activity. The first is to discover what benefits are being achieved or might be achieved in order that specific economic, social and environmental goals may be built into the programme. The second one is that whatever the expectation of the benefits might be it is desirable to build rural water supplies cheaply and efficiently.

Evaluation of past experience can form a basis on which rural water programmme may be improved. The impact assessment might show the main benefits, whether the water is adequate or inadequate to realize any benefit. Periodic assessments are essential if the problems of the past are to be clearly identified and resolved. It is also of interest that water supplies once initiated should be operational over reasonable time. Planning is for people and planners must give adequate emphasis to social economic and environmental consequences stemming from water development projects (Biwas, 1978).

In rural communities especially in ASALs; where they do not have access to water supplies and women have to walk five to ten kilometres to fetch water. Water is badly needed in these areas of whatever quantity or quality. The benefit of water supply will be measured by reducing daily task of fetching water and not necessary in improved health.

Accessibility is the immediate and often felt need, safety of the water supply is not seen as important and this is where planning intervention should come in.

Kinyua (1977) did a study on water resource planning in rural development in the area under study and came up with the conclusion that the installation of Ena water piped supply would accelerate the opening up of more land for development where lack of water was the major obstacle. The study also recognized that the area is semi-arid and that there was room for livestock development provided water was made available. The area also was assessed to have the scope for the development of commercial agriculture especially fruit farming. The water supply project was expected to be a relief in accessing water because in some places one had to walk 8 to 30 kilometres to access water during the dry period when intermittent streams and subsurface dams dries up.

But due to mismanagement the piped water supply has not been functional in the study area since 1986. The people who would have otherwise been relying on the piped water supply are now using other sources of water. It is for this reason that this study is justified to investigate the impact of small community dams in the recipient communities. There is also a strong case for undertaking a study on the impact of small dams on communities in ASALs because water is one of the factor that limit development in these areas and development strategies should place a higher premium on water conservation because this is likely to have direct impact on the lives of local people. Small community dams if well managed can be able to cushion the inhabitants of ASALs against the vulnerabilities induced by water scarcity.

1.7 Methodology

The success of any research depends on the methodology followed. In this section the method used in data collection and analysis is presented. It is on the basis of the data collected and analyzed that conclusion are made in subsequent chapters.

1.7.1 Sampling Framework

First and foremost a reconnaissance survey was carried out to familiarize with the study area. The actual numbers of the small dams in the study area was established from the district water office. There are 43 small community dams of which 33 are earth and weir dams while 10 are sand storage dams. The ten sand dams were built between 1999 and 2000 and it was established from the district water office that they have not been in use for more than a year and so this study did not include them in the sampling framework. This meant that only 33 dams were considered for sampling. After establishing the number dams the next step was to sample the population that uses the water from the dams.

The research identified the accessible population as the number of households in the study area that uses small dams as their main source of water. According to the 1999 population and housing census report the study area had 12,905 households. The census report also give 9.6 percent as the number of households in the district who uses small dams as their main source of water. This percentage was used to establish the approximate number of households using small dams as their main sources of water in the study area. The households using small dams as their main source of water was approximately 1238.

According to Mugenda *et al* (1999) the desired sample size for the target population of 1238 households would be 131 households. Due to time and financial constrains it was not possible to sample the 131 households and only 100 households were sampled. Because of the same reasons, it was not possible to sample all the 33 dams and five dams were sampled purposively for analysis. When sampling the five dams the following factors were considered. First, the agro-ecological zones had to be taken into account because they determine water availability. There are two major agro-ecological zones in the area. These are the marginal cotton zone and the lower midland livestock zone. Two dams were sampled from the marginal cotton zone and three from the lower midland livestock zone.

There are some areas where ground water sources are more dominant than the small dams and so, the dams and the boreholes in each location within the two agro-ecological zones were used to decide which areas use small dams as the major source of water. Locations were only used to determine the number of small dams and boreholes in two agro-ecological zones. The number of boreholes in comparison with small dams also was used as a criteria for selecting the dams because in some areas ground water may be the major sources of water and hence no need of including these areas in the sampling.

The number of dams sampled are shown in Table 1.1.

Table 1.1 Criteria for Dam Selection

LOCATION	DAMS	BOREHOLE	DAM SAMPLED	AGRO-ECOLOGICAL ZONE
Mbita	5	3	*	Marginal cotton zone
Kianjiru	6	5	*	
Mbeti south	2	15		
Kithunthiri	7	8	*	Lower midland livestock zone
Maruria	10	5	*	
Gichiche	7	9	*	
Mutuobare	2	10		
Kiambere	4	7		

* Where one dam was selected Source: (Researcher 2001)

After selecting the five dams the next step was to sample the households using the water from the dams. Twenty households were sampled from each dam. Systematic random sampling was used; from concentric zones that were established around the dam at an interval of approximately half a kilometre from each other. This was done so as to establish whether distance influences the use of water. After establishing the concentric lines, five households were sampled from each zone. The first household to be sampled was established from a trascent line established from the dam going outward. Every second household was sampled

1.7.2 Data Collecting Methods

1.7.2.1 Primary Sources of Data

The acquisition of primary data involved administration of questionnaire, conducting and recording interview schedules. Observation and key informats interview was also conducted. Key informats were:

1. Manager, Machanga Agriculture Mechanization Station (A.M.S). This is a Ministry of Agriculture dam construction unit in the region. The station has constructed and rehabilitate a number of dams since it was established in 1979 in the region. The manager provided information on the issue pertaining to the role of the station in dam construction and rehabilitation in the region.
2. The district water office – provided information on the water resources in the division and district at large.
3. Engineer Catholic Diocese of Embu. The Catholic Church is an active actor in the water sector in the study area, having assisted in the construction of ten sand storage dam. The engineer provided information on the cost of the sand storage dams and their role in the water management.

The actual field survey was conducted during the month of December 2000. Data was collected through administration of structured questionnaires to the sampled households. The questionnaires sought to generate information on the uses of the water from the dams by the people and the management of the dams. The questionnaires were also used to get in depth information on sources of water during rainy and dry season, the time taken to fetch water before and after construction of the dams and the uses of water. Not all the information could be collected through the questionnaire method and observation became

very necessary in the field. The information collected using this method included the catchments conditions of the dams, whether the dams were fetched or not, the embankment condition of the dams, and the method of water draw off especially for the livestock. Photographs were taken to supplement other method of data collection. Photographs were taken to illustrate the method of water transport; the dam embankment and the crops and animals reared using the water from the dams.

1.7.2.2 Secondary Sources of Data

Library research was the main source of secondary data. The information was gathered from various sources which included public libraries, published and unpublished material which gave background information on the impact of water supply in rural development.

1.7.3 Data Analysis

This involved data validation and coding of questionnaires. After coding, the data was analyzed using statistical package for social scientists (s.p.s.s.). Both qualitative and quantative methods were used to analyze the data. Qualitative data was analyzed using descriptive techniques. These include computation of frequencies, percentages and measures of central tendency. Maps and photographs were also used to highlight spatial issue. Correlation coefficient was used to test the relationship between distance to the water source and time taken before and after the construction of the dams.

1.8 Scope and Limitations of the Study

The study covered Gachoka division of Mbeere district. The study looked at the impact of the water from the small dams on the recipient community, the management and the sustainability aspect of the small dams as a source of water. Impact studies are important and need to be carried frequently. Impact can be both positive and negative. The engineering aspects were not dealt with in this study.

One of the limitations of the study was time and budgetary constraints which made it difficult to utilize a more detailed design. There was very limited data on earth and weir dams, especially concerning costing and capacity of the dams. Neither was location map of the dams available. It appears like the government officers do not consider small dams as an important source of water, despite the fact that 9.6 percent of the total households use water from the dams, which is the same percentage as those served by piped water supply in the whole district (G.O.K, 1999).

Despite the difficulties the researcher was able to gather, enough information to enable him examine the effect of the water from the dams on the recipient communities. Information on the impact was gotten from the consumers and since the consumers cooperated, this formed the background for assessing the impacts. The benefits that were considered were those most important in terms of national goals and aspiration and those benefiting the community at large.

1.9 Organization of the Study Structure

The study is divided into five chapters. The first chapter deals with the general introduction of water and rural development especially the need to conserve water by constructing small community dams. The chapter also highlights the government policies on water and ASALs development. The second chapter deals with the study area. It highlights the major water resources in the study area, which include both ground water and surface water.

The third chapter highlights issues of rural development and the rationale behind the construction of small community dams. This chapter also looks at the issues of community management of water supply. This is intadem with the objective set at the onset of the study to look at the issues of community participation and management of the small dams.

The fourth chapter looks at the impact of the water from the small dams on the recipient communities. This is necessary to as to be able to know whether there are any benefits that are realized or not. This section also looks at how the dams are managed with a new of making necessary recommendation.

Chapter five deals with the recommendation that need to be instituted in the use and management of the dams in order to alleviate the water problems and enhance sustainable utilization of scarce resources in order to realize the expected benefits to all members of the community.

CHAPTER TWO

2.0 THE STUDY AREA

2.1 Introduction: Location and Size

The study area is Gachoka division in Mbeere district. Mbeere district is one of the twelve districts that form Eastern province. It was curved out of Embu district in 1996. The district shares common borders with Embu district to the northwest, Mwingi to the east, Machakos to the south and Kirinyaga and Maragua to the west. The area of the district is approximately 2097 square kilometers. The district is subdivided into four administrative divisions as shown in Table 2.1.

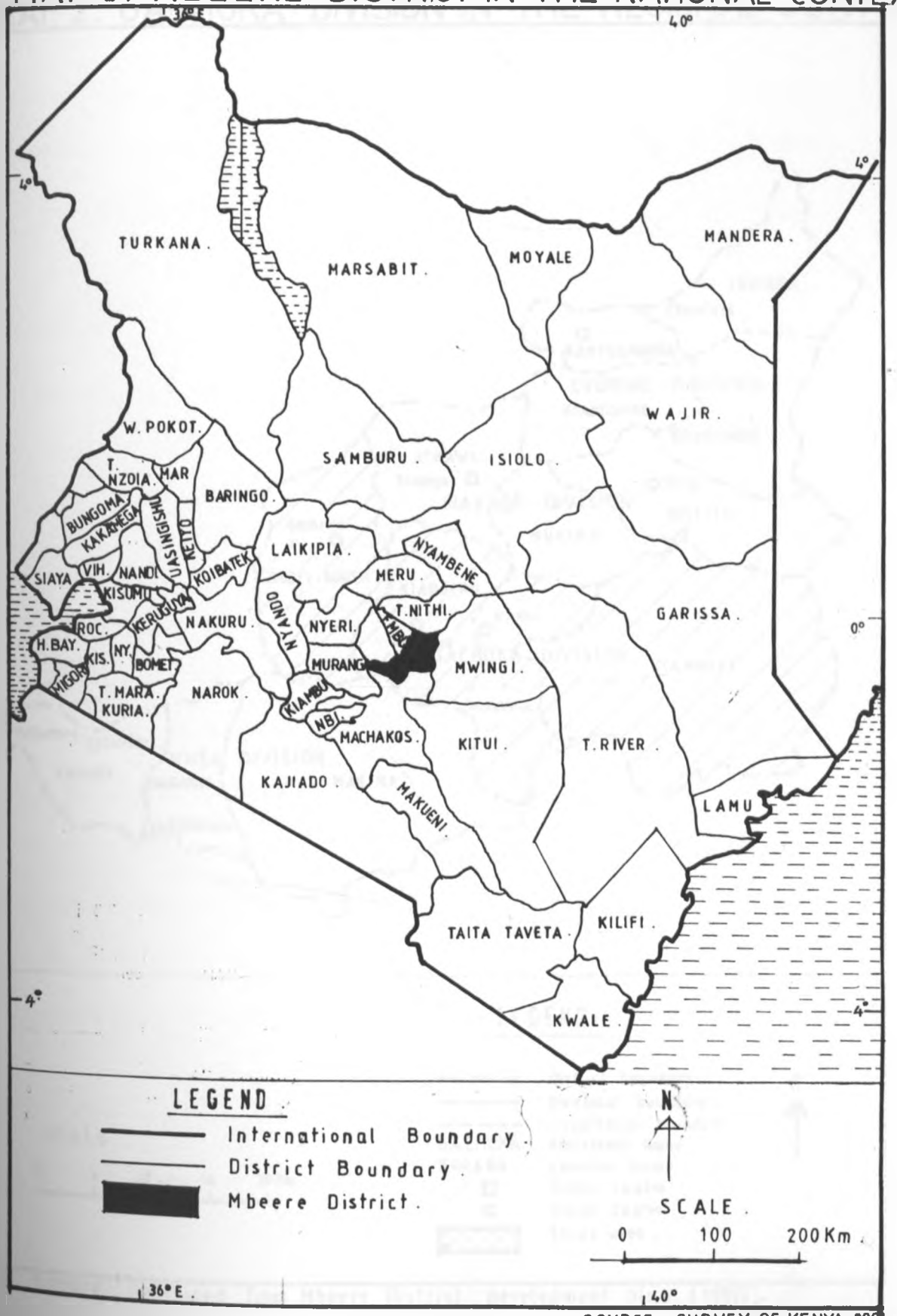
Table 2.1: Area of the District by Divisions in Kilometres Squared

Division	Areas (Km^2)
Gachoka	806
Mwea	508
Evurori	419
Siakago	364
Total	2097

Source: *(Mbeere District Development Plan 1997-2001).*

Gachoka is the largest division making up to 38.4 percent of total area of the district. The division is divided into 8 administrative locations.

MAP I. MBEERE DISTRICT IN THE NATIONAL CONTEXT.



SOURCE: SURVEY OF KENYA 2001.

MAP 2. GACHOKA DIVISION IN THE REGIONAL CONTEXT

LEGEND.

- District boundary.
- Divisional boundary.
- Locational boundary.
- GACHOKA Divisional Name.
- KARABA. Location Name.
- Urban Centre.
- Rural Centre.
- Study area.

N.

SCALE.

0 5 10 15 20 Km.

SOURCE: Developed from Mbeere District development plan. (1997).

2.2 Topography

The study area slopes in a northwest to the southeast direction. The attitude ranges from around 1200 metres above sea level to about 500metres on the Tana River basin. The slope is however broken by existence of Kianjiru and Kiambere hills which rises 1560 and 1525 metres above sea level respectively. The lowest part is the Tana valley which falls below 600 metres; reaching its lowest point at the confluence of Tana and Mutonga rivers at approximately 570 metres.

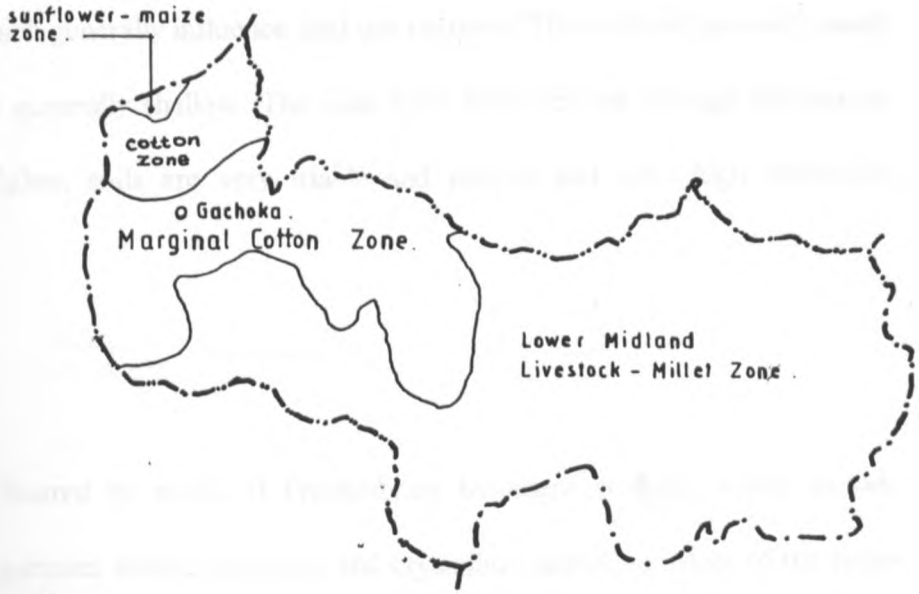
2.3 Drainage

The drainage system consists of numerous seasonal streams draining into the Tana, Thiba and Rupingazi which are perennial rivers. Thura, Itabua and Nguu are the most important seasonal rivers. These are a number of springs along the foothills of Kiambere and Kianjiru hills.

2.4 Rainfall

Rainfall is bi-modal with long rain falling between March and June; while short rains fall from October to December. The rainfall is however not reliable and it ranges between 640 to 1100 millimetres per year. Most parts receive less than 550 millimetres of rainfall per year giving the area marginal status. Temperature ranges from 20 to32°c. August is usually the coldest month with average minimum monthly temperature being 15°c. March is the warmest month with average monthly maximum temperature rising to 30°c.

MAP 3. GACHOKA DIVISION: AGRO-ECOLOGICAL ZONES.



LEGEND.

- District boundary.
- Divisional boundary.
- Agro-Ecological zone boundary.

N

SCALE.

0 5 10. 15 20 Km.

SOURCE: Developed from Mbeere District development plan. 1997.

2.5 Agro-Ecological Zones

The study area is covered by two main agro-ecological zones. The marginal cotton zone (LM4) and lower midland livestock millet zone (LM5). The marginal cotton zone presents the transitional zone from semi humid to semi arid zone. It rises 980-1220 metres above the sea level and rainfall ranges between 800-900 millimetres per annum.

The lower midland livestock millet zone presents the semi arid area. The zone rises 830-1130 metres above sea level. Rainfall ranges between 700-800 millimetres per annum.

2.6 Soils

The altitude and climate coupled with nature of the underlying geology have given rise to varying soil type, which generally influence land use patterns. The soils are generally sandy and stony which are generally shallow. The soils have been derived through exfoliation. Where rainfall is higher; soils are very friable and porous and have high infiltration capacity.

2.7 Geology

The study area is floored by rocks of Precambrian basement systems, which include grainitoid gneisses, gneisses schist, granulites and crystalline limestone. Most of the rocks are ancient sediments which have been metamorphosed and highly altered and have undergone folding, shearing and faulting during the past geological periods (Ondigo, 1979). However igneous rocks associated with the Mount Kenya volcanic also occur. The rock types are mostly Mount Kenya phonolites, kenytes and tracytes. The Precambrian

series are characterized by a series of intrusive of Meta dolerites and quartzites, which have given rise to some hills in the area because of their resistance to erosion.

The period between the Precambrian and tertiary was largely marked by large-scale erosion affecting the whole area. The metamorphosed series are mostly varieties of gneisses and crystalline limestone. These gneisses have a high content of silica and consequently are resistant to chemical erosion and disintegration. This property results in slow rate of soil formation and explains why basement system areas tend to be covered by shallow soil. Also

their permeability is low resulting in rain being converted rapidly into surface runoff. This does not allow sufficient time for soil regeneration.

2.8 Vegetation

The natural vegetation is of savannah type with comiphora, acacia, combretum and various grass species. There is no gazetted forest in the study area but there are 1647 hectares of natural forest reserve under the Mbeere County Council. The forests are Kianjiru forest, which has 1004 hectares and Kiambere forest with 643 hactares (G.O.K, 1997). The river valleys and hills are covered by dense bushes and isolated woodland where little human activity takes place. The available forest resources provide wood fuel, timber for construction, fencing and furniture. However, population pressure in some parts has led to clearance of the natural vegetation for cultivation and pastureland. This coupled with charcoal burning posses a serious environmental threat and conservation measures need to be instituted to avert the problem of soil erosion and prevent the

siltation of the Hydroelectric Power Dams at the Lower Tana. These Hydroelectric Power Dams are Kamburu, Gitaru, Kindaruma and Kiambere.

2.9 Surface water

There is no gazetted water supply and water is scarce in most parts of the study area. Tana, Thiba and Rupingazi are the only permanent rivers. This means that majority of the people obtain water from the numerous seasonal rivers, dams, wells, and springs during the rainy season. Surface water from rivers is available mostly during the rainy season.

2.10 Ground Water

2.10.1 Shallow Wells

The success rate of shallow wells within the basement rock systems is significantly low. The transition areas between the volcanic and the basement rocks marking the boundary zone between the humid Embu district and study area forms a suitable zone for shallow wells. This zone is underlain by a shallow tuff acquifer. The tuff acquifer is suitable for digging shallow wells to a maximum depth of 25 metres but more typically up to 15 metres below ground level. According to Mbeere District Water Office, only 4 shallow well are recorded. There could be many more shallow wells than shown on record as there is no mandatory requirement to obtain permit for digging shallow wells from the government.

2.10.2 Deep ground water

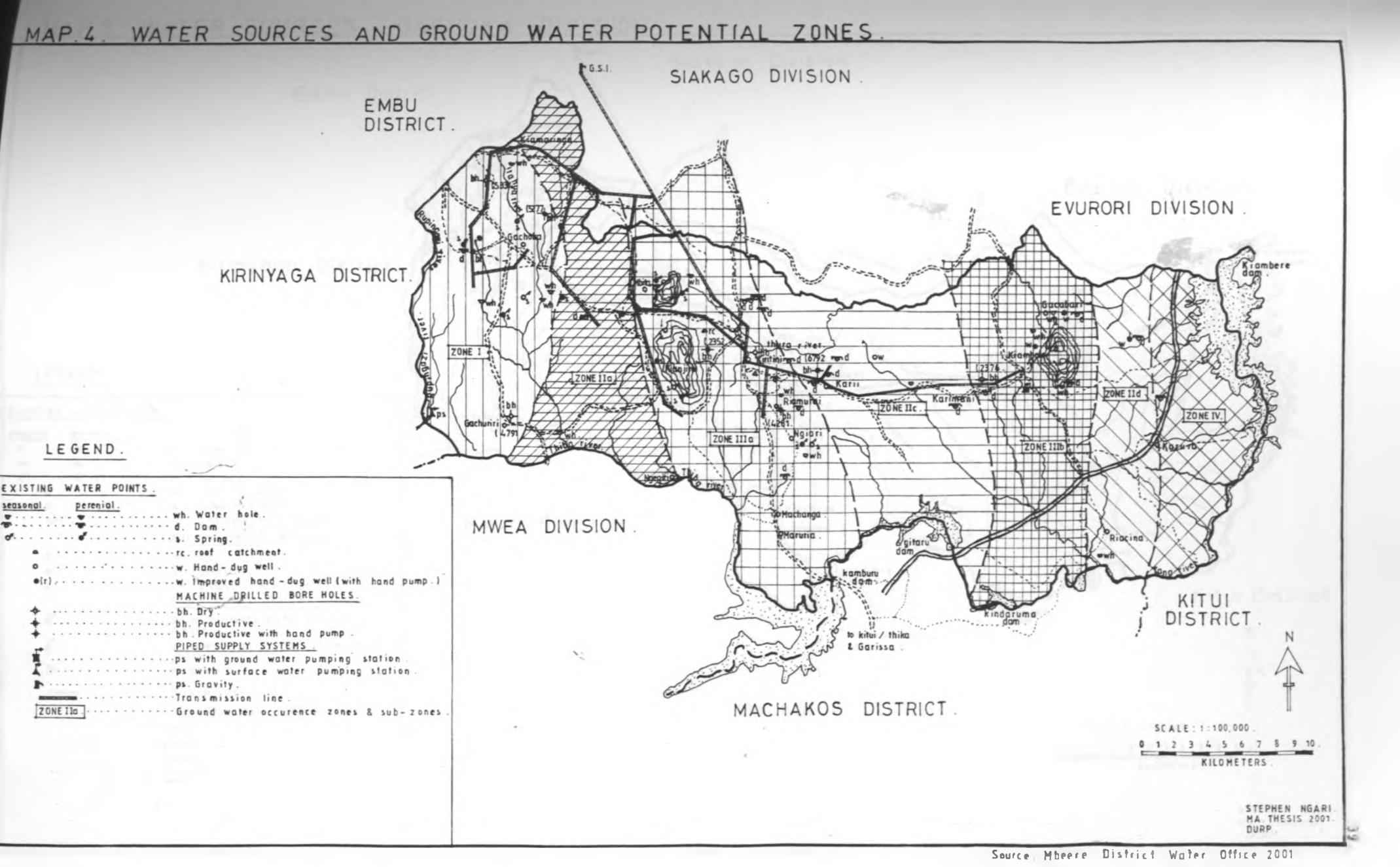
In parts of the study area, which do not have reliable surface water supplies, the only alternative way of improving water supply is by drilling boreholes. Boreholes can be sunk where the geology provides favourable conditions such as fracturing or deep sandy weathering. All ground water potential zones in the area except the very low potential zones are suitable for drilling of boreholes. The yield and possible success rate however decrease from high to the low potential ground water zones. Even the low ground water potential zones are suitable for drilling boreholes, except that it may be more difficult to find good site for borehole. In the very low ground water potential zones drilling boreholes is not advisable. The major advantage of a borehole is its sustained yield and the reliability of its water quality. The boreholes excepts for the very deep can usually be equipped by hand pump.

2.11 Deep Ground water zones (As shown in map 4)

2.11.1 High Ground Water potential (Zone 1 and 11a)

This is the area near the boundary between the study area and Embu district. The irregularity banded migmatitic gneisses of the basement system and the volcanic have a reasonably good ground water potential as borne out by some high yielding boreholes in Rwika and Gachoka area. Fracture interconnectivity is quite extensively developed and with relatively high annual rainfall recharge, the wells can produce substantive amount of water. Ground water potential is the highest in this zone, and it is enhanced by recharge from perennial stream feed by Mount Kenya forest zones (Thiba and Rupingazi rivers). Mean yield of boreholes in this zone is approximately 2.2 cubic metres of water per hour.

MAP.4. WATER SOURCES AND GROUND WATER POTENTIAL ZONES.



LEGEND.

EXISTING WATER POINTS.

seasonal. perenial.

- wh. Water hole.
- d. Dam.
- s. Spring.
- rc. roof catchment.
- w. Hand-dug well.
- w. Improved hand-dug well (with hand pump.)

MACHINE DRILLED BORE HOLES.

- bh. Dry.
- bh. Productive.
- bh. Productive with hand pump.

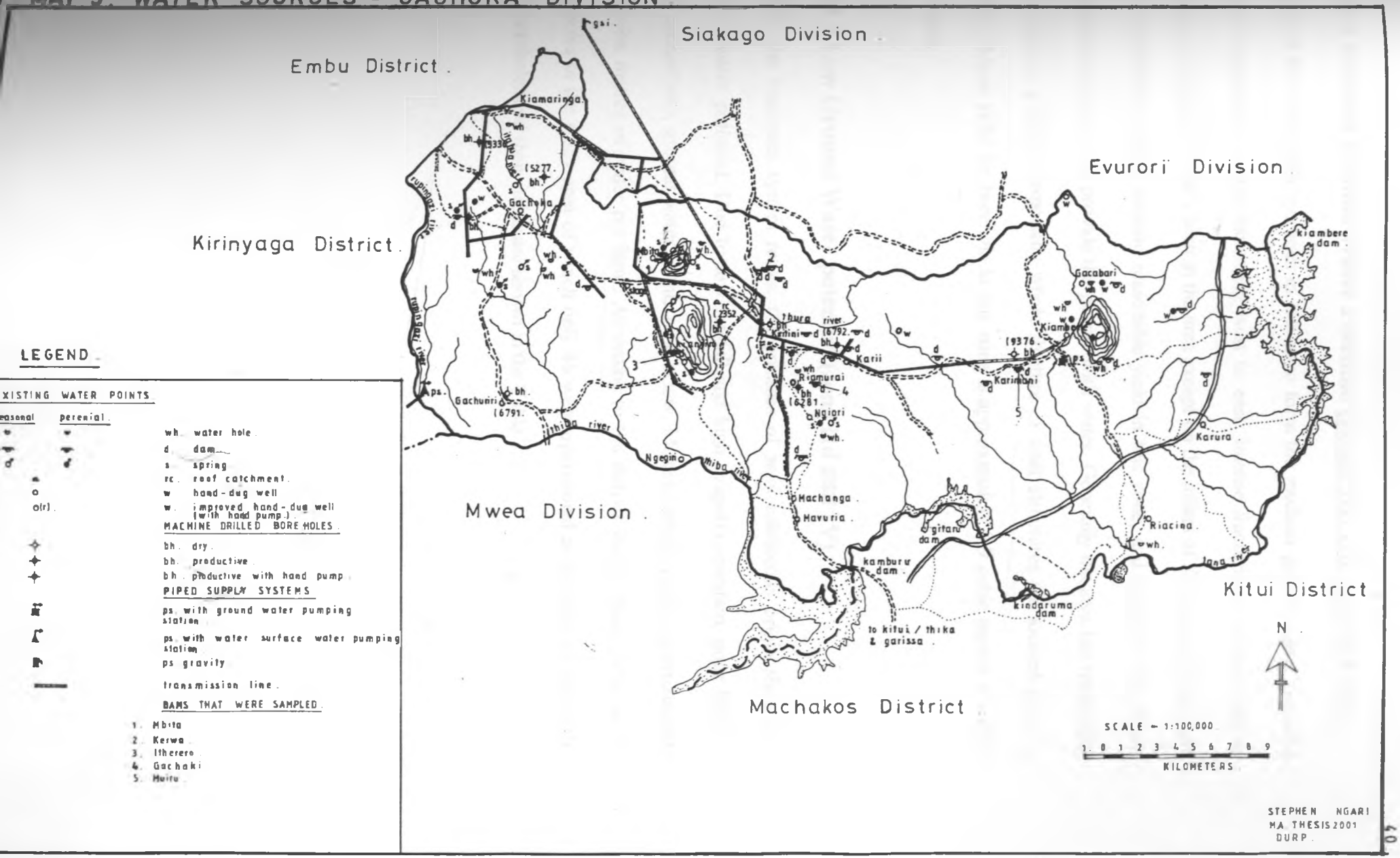
PIPED SUPPLY SYSTEMS.

- ps with ground water pumping station.
- ps with surface water pumping station.
- ps. Gravity.
- Transmission line.
- ZONE IIa — Ground water occurence zones & sub-zones.

STEPHEN NGARI.
MA. THESIS 2001.
DURP.

Source Mbeere District Water Office 2001

MAP 5. WATER SOURCES - GACHOKA DIVISION



LEGEND

EXISTING WATER POINTS

seasonal	perenial	
		wh water hole
		d dam
		s spring
		rc roof catchment
o		w hand-dug well
o(r)		w improved hand-dug well (with hand pump)

MACHINE DRILLED BORE HOLES

- bh dry
- bh productive
- bh productive with hand pump

PIPED SUPPLY SYSTEMS

- ps with ground water pumping station
- ps with water surface water pumping station
- ps gravity
- transmission line

DAMS THAT WERE SAMPLED

1. Mbita
2. Kerwa
3. Itherero
4. Gachaki
5. Huitu

STEPHEN NGARI
MA THESIS 2001
DURP

Source : Mbeere District Water Office 2001

2.11.2 Medium Ground Water Potential (Zones IIc, IId, IIIa and IIIb)

Granitod and migmatitic gneisses in this zone form the medium ground water potential zone. Evaporation is high increasing west to east. Intense fracturing is intense and its effect on drainage is clearly seen in the area except on the inliers of Kianjiru and Kiambere hills. Borehole records indicate reasonable yield in this zone, and together with dams, springs and water holes provide the people with water. Generally the area has reasonable groundwater potential especially where fracture or fault structures are located prior to drilling. Mean yield for borehole in this zone is approximately 0.9 cubic metres of water per hour.

2.11.3 Low Ground Water potential (zone IId and IV)

Within the basement system rocks, the gneisses of semi calcareous origin show low ground water potential. Due to low rainfall and high evapotranspiration, poor fracture interconnectivity, ground water in this zone is low. Mean borehole yield is approximately 0.3 cubic metres of water per hour. According to the district water office, there are 64 boreholes in the study area of which only 46 were operational at the time of this study. The boreholes and their status are shown in the Table 2.2.

Table 2.2: Number of Boreholes and Their Status.

LOCATION	TOTAL NUMBER OF BOREHOLES	NUMBER OPERATING	NUMBER NOT OPERATING	REASONS FOR MALFUCTIONING
MBITA	3	3	-	-
MAVURIA	5	3	2	One borehole had its pump broken down, the other one had its drop pipes blocked
KIANJIRU	5	3	2	One borehole had its pump broken down, and the other one was abandoned, because water was very saline
MBETI SOUTH	15	12	3	One borehole had low water level and the other two had their hand pumps broken down
KITHUNTHIRI	8	7	1	Low water level
MUTUOBARE	10	5	5	Four boreholes had their pumps broken down while one borehole had low water level
KIAMBERE	8	7	1	Pump broken down
GICHICHE	9	7	2	One borehole had very saline water while the other one had its hand pump broken down
TOTAL	64	46	18	

Source: (*Mbeere district water office, 2001).*

2.12 Ground Water Quality

In 1992 before the district was curved from Embu district, when study area was part of present Mwea division and some parts of Embu district, the Eastern Provincial Water Office sampled 69 boreholes for chemical analysis. Apart from boreholes in Mbeti south most boreholes in the area were found to have generally hard water with high content of dissolved mineral matter. The major contributing factors to hardness of water were calcium and magnesium ions. There is no evidence of adverse health effects specifically attributed to high level of calcium or magnesium in drinking water.

Presence of objectionable taste was encountered in a number of boreholes. Objectionable unpleasant taste may have been attributed to inorganic substance in water for example calcium, magnesium, sodium and potassium. Presence of objectionable taste may force consumers to seek alternative sources. Over 95 percent of the entire sample tested exhibited clear and colorless water. Several samples however, exhibited excessive content of fluoride. High concentration of fluoride in drinking water may cause (fluorosis) mottling of teeth. Levels of up to one milligrame per litre reduces incidence of dental caries but mottling may occur when the level rise from 1.5 to 2 milligramme per litre of water. Skeletal fluoris occurs to persons when water contain 3 to 6 milligramme per litre of fluoride depending on intake from other sources.

According to World Health Organization (WHO) water for human consumption should not exceed 1.5 milligrams of fluoride a litre. Many people living in area with high fluoride in water have moderate to severe cases of dental and skeletal fluorisis. Out of 69

boreholes sampled 12 exhibited adverse chemical quality and were considered unfit for human consumption. The issue of appropriate water quality standards in the rural content has been discussed extensively over the past decades. It is clear that while guideline value such as those published by the WHO are desirable and indeed should be considered long term goals they are inappropriate in the rural development content especially in ASALs where water availability and socio – economic consideration usually over ride other factors.

2.13 Earth and Weir Dams

As stated earlier rainfall unreliability is a major constraint to development in the study area. The problem is that of storing water during a rainy season for use in the dry season when water shortage is acute. One method used for storing water during the rainy season for use during the dry season is through the construction of small dams. There are 51 small dams of which 43 are community owned 33 of them being surface earth or weir dams and 10 community owned sand storage dams while eight are privately owned. The ten sand dam were built between 1999-2000 by the Catholic Diocese of Embu with assistance of the local communities.

The estimated cost of the ten sand dams is given in the Table 2.3.

Table 2.3: Approximate Costs of Sand Storage dams in Gachoka Division.

Dam name	Cost in Kenya shillings
Kamunyange	490,960
Muuri	532,280
Gathangare	428,060
Ngarera I	450,500
Uuya	413,120
Itherero	449,600
Ivondo	450,500
Ngarera II	428,060
Kithio	474,580
Mokui	390,430

Source: *(Catholic Diocese of Embu 2001)*

Topographical and geological conditions determine largely the method to be used when constructing the dam. The presence of impermeable bedrock is usually a prerequisite for the construction of the weir dams. Where due to the soil conditions it may not be possible to construct an earth embankment; then masonry or concrete structure is constructed across a river to hold water. But before the dams are constructed the following points must be taken into consideration. The site for the construction of the weir dam must have a bedrock so that the walls can be strong enough to resist the fast force of water on the stream. The river valley at the site should be relatively narrow but should open out upstream to provide a basin for the reservoir. There should be enough catchments area to fill the reservoir. In principle, the dam site should be located reasonably close to the community which will use the water from the reservoir. Where geological conditions allow, an earth embankment can be constructed across a river to hold the water.

2.14 Demography

The 1999 Population and Housing Census show that Mbeere district had a population of 170,953 people of which 81,885 were males and 89,068 were female. The total households in the district were 37,036; with a house hold size of 5 people. The population density was 82 people per square kilometer. Gachoka division, which is the study area, had a total of 59,102 people of which 28,772 were males and 30,330 were females. The total households were 12,905, with a household size of 5 people. The population density in the division was 74 persons per square kilometer as shown in Table 2.4

Table 2.4: The Population of the Division in order of Locations.

LOCATION	MALE	FEMALE	TOTAL	HOUSEHOLD	AREA (Km^2).	DENSITY
Kiambere	5,234	5,576	10,810	2,208	280.9	38
Kianjiru	8,570	8,887	17,457	3,722	138.9	126
Mavuria	8,157	8,983	17,140	3,654	211.1	81
Mbeti south	6,811	6,884	13,695	3,321	169.4	81

Source: (*1999 National Population and Housing Census Report)*

2.15 Agricultural Production Activities

Agriculture is one of the major economic activities undertaken in the area. The area is generally a low rainfall zone, and crop production is difficult. Food crops such as maize, beans and millet are grown mainly for subsistence. Green grams, cowpeas and sorghum

play the dual role as food and commercial crops. Small-scale farming is widely practiced and the average farm size ranges from 5 to 7 hectares per family.

Maize and drought resistance crops such as millet and sorghum are the main food crops grown throughout the study area. Miraa as a cash crop is widely grown in Kianjiru and Kithunthiri location. Fruits such as mangoes and papaw are widely grown. However farmers are discouraged by problems related to marketing. Big propositions of employees in the study area are engaged in floriculture activities. Horticultural crops are grown in areas near the Thiba and Rupingazi rivers where water is available for irrigation. The division has 25 farms with a total of 1326 Hectares of land under horticultural and floriculture (G.O.K, 1997).

2.16 Livestock Production

Livestock is second major occupation to crop farming. The main livestock reared include cattle, sheep, goats and poultry. The area is suitable for beef cattle as exotic dairy cattle can hardly survive in the area due to lack of water and pasture. Most of the cattle reared are of indigenous species. Generally indigenous breed require less fodder and are easily adaptable to the harsh climatic conditions. A few wealthy farmers also keep exotic cattle. The high-grade exotic breeds are expensive to acquire and maintain by the local farmers. Sheep and goats are reared for meat and for selling. For effective livestock production there is need for reliable sources of water.

2.17 Food Availability

Over the last few years, the area has experienced shortage of rain, which leads to crop failure. The area has not been self sufficient in overall food production. In view of the harsh climatic condition prevailing in the area especially in the year 1999 and 2000 there was acute shortage of food and water.

The food intake for the population fall below the annual average food requirement per person. This is particularly so of cereals and vegetables. However the area is self sufficient in protein giving food as the area produces drought resistant pulses such as grams and cowpeas. The drought resistant crops grown are usually traded for other staple food requirement and for immediate cash needs. The deficit in food supply in the area is met by imports from neighboring districts especially Kirinyaga and Embu. The area frequently receives famine relief food mainly from central government and some NGOs especially, Foster Parent Plan International and Catholic Diocese of Embu.

2.18 Fisheries

The main fishing activities in the study area are concentrated in the Hydro-Electric Power Generating Dams namely Kamburu, Gitaru, Kiambere and Kindaruma. Fishing activities in the area has however been declining over the year. In 1995 for example only 338 tonnes of fish were harvested compared to 753 tonnes in 1991 as shown in Table 2.5.

Table 2.5: Fishing Statistics in the District between 1991 and 1995

Year	1991	1992	1993	1994	1995
Weight of fish In kilogrammes	752,602	490,650	309,303	222,000	338,000
Value (Kshs)	4,085,729	2,680,000	3,811,289	5,600,0000	9,500,000

Mbeere District Development Plan (1996)

The common species of fish include Tilapia, Common Carp, Clarius, Barbus, Labeo, Momyrus and Eel. Among these Tilapia and Common Carp are the most dominant species constituting 77 and 12 percent respectively.

2.19 Mining

Sand and building stone are the main mining activity taking place in area. Quarries are mostly individuals owned and are located at the foot hills of Kianjiru hills. Sand is mainly scooped from the dry seasoned river beds particularly on the seasonal Thura river which form the boundary between the study area, Siakago and Evurore divisions. Some of the rivers especially Kiriiri near Kiritiri market has been over exploited and has very little sand and has been abandoned by sand harvesters. The river also does not retain water during the dry season as was the case before sand harvesting started taking place. Mining activities earn the Mbeere county council an average of 60,000 shillings per month or 720,000 shillings annually. Building stones and sand are in high demand by the construction industry locally and in Embu town.

CHAPTER THREE

LITERATURE REVIEW AND CONCEPTUALIZATION OF THE STUDY

3.0 Introduction

In order to understand what is rural development it is necessary to define the term development. This is because the term development is relative and may mean different things to different people. To an urban dweller, development may mean more job opportunities, more building and better facilities. To a rural person development may mean closer access to safe water supply; an irrigation scheme or primary health care (Gamba, 1994:14).

Uma Lele defined rural development as improving living standards of the mass of the low income population residing in rural areas and making it self sustaining. The process has three component, that is improving the standards of living involves allocation of resources. Participation requires resources to be allocated to low-income regions and that the resources reach them. Making the process self sustaining require development of appropriate skills and implementing capacity and presence of institution at local, regional and national level to ensure the effective use of existing resources and to foster the mobilization of additional finance and human resources for continued development of subsistence sector.[1]

[1] Uma L. (1975). The design of rural development lessons from Africa. International Bank for reconstruction and development Washington D.C. PP.20.

Deborah (1997) ascertained that development should be seen as the process by which vulnerabilities are reduced and capacities increased. If equality and equity are the goals of development then intervention must address the causes of people's weakness and recognize their sources of strength and understand the dynamic relationship between them.

Haq. M.U (1976) postulated that the objective of development must be viewed as a selective attack on the worst forms of poverty. Development goals must be defined in terms of progressive reduction and eventual elimination of malnutrition, diseases, squalor, unemployment and inequalities.

UNCHS (1991) defined human development as a process of enlarging people's choice. In principle these choices can be infinite and change over time. But at all levels of development the three essential ones are for people to lead a long and healthy life, to acquire knowledge and to have access to resources needed for a descent standard of living. If these essential choices are not available, many others remain inaccessible. Rural development is therefore concerned with the improvement of the living standards of the low income population living in rural areas on a self sustaining basis, through the transformation of the socio–spatial structure of their productive activities (Mabogunje, 1984).

Approximately 70 percent of the Kenya population reside in the rural areas and so an objective assessment of human needs and political pressure for the improvement of income and welfare are associated with rural population. As UNCHS (1991) puts it, a simple truth

often forgotten but currently re-emerging is that the primary source of a country is its people. They are the chief agents of development. They are not only the subjects of development but they are the power that drives the development wheels. They provide the skills and energies necessary for the development process. As producers and consumers, they provide the market for the products of development.

3.1 Small Community Dams Schemes

In this study, the term small dam is adopted from the National Water Master Plan Study of 1992, to mean water-holding structure having a height of less than 20 metres. A water pan is taken to mean a pond, which can be constructed in a depression where rain water flow can be pooled (Kenya, 1992). There are quite a number of small dam schemes in Kenya mainly constructed for domestic water supply and livestock use in rural areas. Ministry of Water Development, National Water Conservation and Pipeline Conservation, Ministry of Agriculture and other agencies carry the planning, designing and implementation of these dams. The number of existing dams and subsurface flow dams is not known but the following figures are estimates based on drainage area.

Table 3.1:Estimated Number of Small Dams and Subsurface Flow Dams.

Drainage basin	Small dams	Subsurface dams
Lake Victoria	769	-
Rift valley	392	-
Athi River	703	14
Tana River	286	24
Ewaso Nyiro	510	3

Source: *Kenya, (1992) Study on the National Water Master Plan (J.I.C.A.)*

Small dams are mostly constructed in semi humid and semi arid areas in such districts as Mbeere, Machakos, Kitui, Samburu, Tranzoia, Uashin Gishu. On average the National Water Master Plan study (Kenya, 1992) established that the average catchment area, dam height, storage capacity and construction material were as shown in the Table 3.2.

Table 3.2: Typical Characteristic of Small Dam

Small dam/pan	Catchment area	Dam height	Dam type	Reservoir area	Storage volume
91 dams/pan	About one kilometre squared	2 metres	Concrete/landfill	Less than 1 hactare	2,200M³
Subsurface flow dams 23 dams	2-3 kilometre squared	2 metres	Concrete	Less than 100M²	Less than 800M³

Source: *Kenya (1992). Study on the National Water Master Plan (J.I.C.A)*

3.2 Earth and Weir Dams

3.2.1 Small Earth Dams

Small earth dams are probably the most common type of man made water storage and on favourable sites are effective and economical. They do require some care in design and construction and they need regular maintenance (Hudson, 1987). They are perhaps the most common form of water conservation structures. No matter how carefully the earth is placed and compacted, there will be settlement over the years and an allowance must be made for this.

3.2.2 Small Weir Dams

Weirs are structures of concrete, bricks or masonry where the water flow over the top when storage is full. They may be more suitable than earth dams in some situation for example, when the flow is too big to pass through a spillway or where the soils may be too porous to be compacted especially sandy soils and when the objective of the dam is gully control or to trap sediments. Weirs can be entirely be made of concrete. Masonry can also be used to form the outside layer, and act as the shuttering.

Another kind of gravity weir is the rock fill dam in which a pile of rocks and boulders gives the stability and a concrete layer makes it water light. Weirs of about one metre can be built without professional or design calculation. An engineer should be consulted in for large weirs or incases where failures would cause serious damage.

3.2.3 Sand Dams

The most appropriate method of controlling evaporation of water is through the use of sand storage reservoirs. The technique has been successfully used in East Africa where the reservoirs are known as subsurface dams. The technique depends for its effectiveness on the availability of an extensive bed of coarse sand of the kind normally found in Precambrian basement areas (Hudson, 1987).

Sand can store substantial quantities of water in the voids between the particles if they are not filled by smaller particles. A coarse sand of uniform size could store up to 45 percent of its volume as water within sand. The volume of sand trapped behind a weir will depend on choosing a suitable site and the storage capacity can be increased over a period of time.

If the weir is built progressively in stages of one metre the flood will deposit coarse sand behind the weir but silt and clay will be carried over the weir by flood.

A second stage can then be added to the weir to trap a second layer and so on progressively to the required height. This technique has been used on rivers in the Kalahari Desert in Namibia and Botswana and some scheme supply sufficient water for small townships by pumping from a number of linked well points (Hudson, 1987). There are a number of advantages in storing water this way. This is because once the water level has sunk below one metre below the sand surface the evaporation loss is negligible. The risk of waterborne diseases such as malaria, or contamination by animals is greatly reduced and by installing a pipe through the weir, or installing a hand pumps, clean water can be supplied. This practice is used in Latin America where silt trap dams are known as *'trincheras'* and in Mexico where large sand dams are encountered called "*atajadizos*".

3.3 The Principal Behind Sand Storage Dams

The fact that dry sand riverbeds contain water at accessible depth is known and exploited by all dwellers of the desert both human and animals. According to Gezahegne (1986) villagers in ASALs collects water from the small seasonal streams at times when it carries water or from holes dug in the shallow river beds. The stored water is not sufficient to supply water to the villagers during the entire dry period.

By constructing a weir of suitable height across the stream bed coarse particles carried by the flood settle and eventually the reservoir is filled by sand. The artificial aquifer will be

replenished each year by the infiltrated runoff during the rain. If the dam is properly sited, and constructed water will be used during the dry season.

3.4 Improved Water Supply

3.4.1 Introduction

Planning for water supply may have to be seen more as a human right than an attempt by itself to improve health. Rural communities according to Agarwal (1981) can be classified into three groups. The first group is villagers who do not have access to water supplies all the year round. Their women have to walk 5 to 16 kilometres to fetch water. Water is badly needed in these villages. The benefits of water supply in these villages will be measured by reduced daily drudgery and not necessary improved health. The villagers themselves are keen to get water supplies and probably participate in construction and maintenance of the water supply systems. Accessibility is the immediate and often-felt need, safety of the water is not seen as important.

In the second group vast majority of villagers have reasonable access to water all the year round. The water may be contaminated by international standard but have been in use for centuries. There may be no real village demand for safer water supply. When the International Agencies or government put in a hand pump and the villagers are not involved when the pump fails they go back to their traditional sources. If may be they were consulted they would have chosen other development priorities before clean water.

The third group is the small rural town. Water is usually scarce and there is demand for improved supplies often piped water for every household. The towns are easily accessible to centralized administration. Health benefits can be achieved through more ample water plus improved sanitation and health education. According, to Agarwal (1981) the first and third group qualify for high priority in water supply programmes. The stress should be on accessibility of water.

3.4.2 Perception of water

People in the rural areas have a different perception about water. Their general outlook is different from their urban counterparts who are usually more concerned with quality as well as quantity. In many rural communities, people pay little attention to quality of water. That why public education should be part and parcel of water supply implementation (Curtis, 1994).

3.4.3 Why Improve the Water Supply

The reason why water supply should be improved is borne out of the fact that at least two thirds of humankind draw water from sources outside the household and has to be carried to their homes. In East Africa, the proportion is near nine out ten (Curtis, 1994). Even with the end of United Nation Water and Sanitation Decade in 1990, advances in rural water supply are slow. High population growth mean that more people will have to carry water often for long distances than before. The consumption is one variable that determine the time and energy that has to be spent on water collections which include the distance to the water source, the terrain to be traversed, the method of water transport, the time taken

queuing at the water source, the number of consumers in the household and the number of people available to carry water.

There are indeed various reason why improving water supply both in quality and quantity is necessary. Where quantity is limited increasing the supply can actually provide assurance against drought, allow for more hygienic behaviors which benefit health and improve food production if water is used for irrigation and to provide for livestock.
Improving the quality of water also benefits health and provides an amenity, which improves the quality of life.

3.5 Water Transport

The vast majority of rural people in developing countries do not have water on tap and this means that water has to be transported from the source. The task of carrying water falls mainly to women and their children. One of the purposes of improving water supply should be to reduce this burden yet it is apparent that convenient clean water has remained a pipe dream (Curtis, 1994). The distance between water source and household location should preferably be short, although this has to be balanced with the cost of providing such a service. As long as the distance is not excessive, the supply can be regarded as appropriate (Ornas, 1996).

Many women spend perhaps five hours out of a sixteen-hour working day collecting a single load even sleeping out at night to wait their turn to carry up to 30 kilogrammes of water back to their home. This work is tiresome and evidence show that the work of rural

women is getting harder (Curtis, 1994). Although much time and effort has been spent in, installing systems that can bring water closer home this has proved difficult. Breakdown of new installation is so high so that most African women are condemned to continue carrying water in their traditional way. Given that piped water supplies are few in ASAls, and water from the sources available has to be transferred, there is need to explore alternative methods of water portage.

3.6 Community Management

Although the concept of community management has gained publicity in recent years, some confusions still remain about its meaning. Part of the problem is that community can be defined in many ways. Warner *et al* (1990) defines community as a group of people living in a geographically defined area or a group of people with common economic or political interest. The term community management is sometimes used interchangeably with community participation to refer to community involvement in a development project.

According to Warner (1990) community management consists of three basic components:

Responsibility: The community takes on the ownership of and attendant obligation to the system.

Authority: The community has the legitimate right to make decision regarding the water supply.

Control: The community is able to carry out and determine the outcome of its decision

Community management here is concerned with all issues pertaining to responsibility (ownership) decision-making, authority and control over the project development and

operations of the system. These activities help ensure that the water project will be sustained. In order for community management to thrive its necessary to identify pre-conditions that creates enabling environment. It is necessary to establish the water needs of the community their social economic conditions and expected outcome and benefits of the project. The community must be empowered in making decision to control the system.

The community should have the institutional capacity to be able to manage the project. Effective support services must be available from the government or other supporting agencies on issues pertaining to technical advice, and rehabilitation.

In order to ensure that the small dams are sustainable its important that the beneficiaries are involved at all the stages in the development of the water supply scheme. The government has indeed encouraged the concept of community water supplies, which has gained popularity globally.

The most recent global event to voice this concern was the United Nation Conference on Human settlement (Habitat II) which called for a strong political commitment, cooperation across disciplines and sectors and an active partnership of all interested parties to meet the challenge of providing water (UNCHS, 1992).

The Kenya Government in the Sessional Paper No 1 of 1999 Water Resource Management and Development in consistent with this international resolution initiated a policy shift, where the government encourages participation by various water users. To ensure sustainability in water supply scheme there will be need to apply alternative

management option that are participatory rather that wholly recepient. The government role will be to facilitate and regulate the water sector.

This shift has been necessitated by the fact that access to safe water supply is a basic human right and a critical component of development and that its appropriate to apply demand responsive approaches and community based partnership as a foundation for sustainability as opposed to supply driven approaches applied earlier.

Until recently community management has generally been concerned with the questions of maintenance, the participation of women and in kind contribution which involve community participation and therefore was said to promote sustainability (Warner, 1990). Sustainability depends on more than community participation alone although community participation does appear to provide the environment required for successful community management.

Therefore, community participation in significant decision-making may be seen as one pre-condition for community management. Community participation implies that the beneficiaries are involved in development activities whereas community management refer to the capacities and willingness of the beneficiaries to take charge and determine the nature of the development affecting them. In water supply, community management means that the community exercises responsibility for decision making. It refers to capacity of the community to control or at least strongly influence the development and subsequent maintenance of their water supply.

Community involvement where the government or a development agency is assisting the local community should not be a last minute exercise in which the people are told that construction or rehabilitation of a dam has been decided upon. The beneficiary community should be involved in all stages of the construction from site identification, design stage, up to project implementation. Small dams are often constructed in areas where they may be only possible source of water for livestock and or domestic water supply. The construction of small earth dams and pans like other technologies utilized in the field of small-scale water supplies have specific characteristic, advantages and limitations. Its imperative to involve the beneficiaries from the earliest planning stages of the structure so that various aspects can be tacked. These include:

The creation of reservoir involves impounding of a certain area of land. Since land issues are generally very sensitive the land issues should be resolved by the beneficiary community with the help of local development committees. Cases where the people have been involved the locals have even voluntary donated land for construction of small dams free of charge. Involving the people becomes imperative especially when rehabilitation of the small dams is being undertaken. This is because rehabilitation should only be carried out if the required condition to ensure sustainability will be meet in future, for example if erosion control measures are introduced in the catchment's area. Where the community is being assisted, it should be ascertained that implementation capacity exist before going ahead with the project.

The main objective of rehabilitation programmes is to restore the water scheme to the original status at the lowest cost and to eliminate the existing hindrance in the operation and maintenance of the water supply system. Where rehabilitation particularly desilting of reservoir is involved especially for earth and weir surface dams the reason why need for rehabilitation has arose should be thoroughly examined by the beneficiaries. In case the useful lifetime of the reservoir has been less than expected, that is 20-25 years life span the issue of sustainability after the rehabilitation should be raised (G.O.K., 1992).

Community involvement should start with the establishment of formal contact with local leader that is the Assistant Chief, Chief, Councilors or the headmaster of the local schools as some communities will only participate fully when they know their leaders are informed of what is being planned. The limitations and constrains involved in the project implementation need to be explained at this stage. The community should be involved through a series of meeting to educate them on expected tasks, outline responsibilities for all parties involved and establish the existence of a committee in the community. It is also important at this stage to establish how other development project have been implemented in the area and educate the beneficiaries on the needs for proper fencing of the dam and reservoir area and the construction of draw off facilities.

As stated earlier the government has realized that the provision of adequate facilities to meet the nation water demand is an enormous task and a big challenge. And this now requires full participation of beneficiary communities, donors, NGOs and private sector (G.O.K., 1999). Community management has received favourable attention because the

system based on this principle appear to be more sustainable than those managed externally.

This is because Community managed systems place the responsibility of maintenance in the hands of users. In the long run Community management can be seen as the culmination of a long term effort by the government and other developing agencies in striving to help the community become self reliant and gain control over development. With the steady strengthening of the community to take charge of small water supply scheme the community may develop the capacity to manage even more complex development issues in future.

3.7 Conceptual Framework

This study focuses on the impact of water supply from the small community dams. Indeed the government in its interim poverty reduction strategy paper for period 2000-2003 recognizes that the main constraint to development, income generation and food security in ASALs is lack of inadequate water. The government appreciates the fact that it may not be economically viable to sustain large piped water schemes. In these areas, the government has identified dams and pans as one of the most appropriate technologies. The government has proposed rehabilitation and construction of these facilities in partnership with communities and other development agencies and partners.

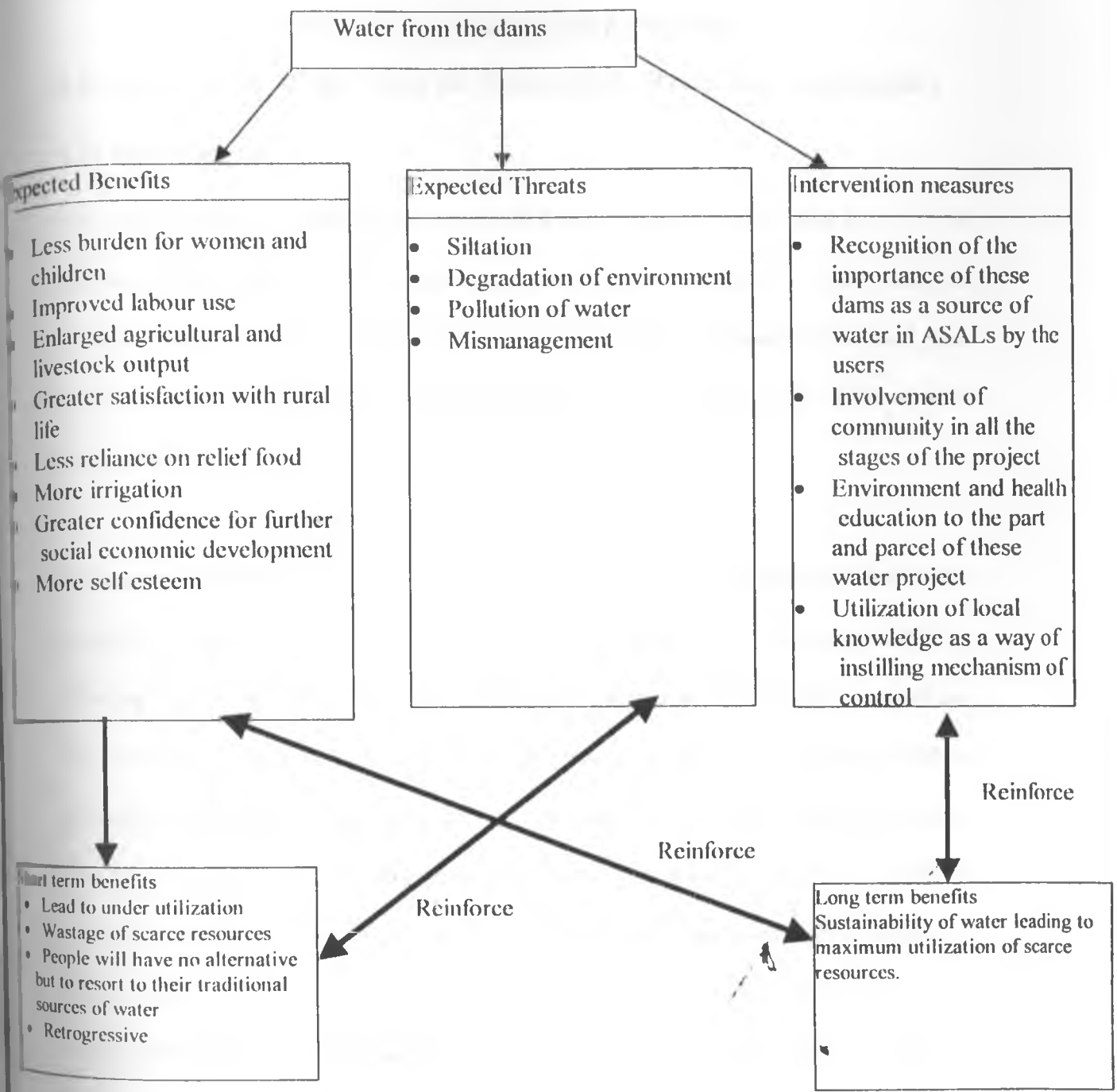
This study set to investigate the impact of the already existing small dams in order to see how appropriate land use and catchment management can be incorporated in the

construction and management of these dams. Improved water supply can have wide ranging health, economic, social and environmental impact on the lives of recipient communicates.

Indeed the impact of water supply at the local can be felt in the aggregate at the national level. The productive capacities of the farmers and herdsmen often contribute a major share of the gross national product. Low cost dams built for water supply purposes can help prevent soil degradation and water shed loss. This coupled with community reforestation, soil conservation and environmental education; can contribute to overcome deforestation overuse of the land and soil erosion.

Where the dams have been constructed with disregard to the intervening measures this has lead to only short term benefits and wastage of scarce resources But where the dams have been constructed with expected benefits; expected threats in mind and then intervening measures employed in the implementation of the water supply this may lead to sustainability of the dams and ensure, long term benefits and maximum utilization of scarce resource. Always before undertaking to construct the small dams the three component should be analyzed carefully, because one component may reinforce the other. For example, if the expected benefits are reduced by the threats and no measures are put in place this will reduce the sustainability of the dam.

Figure 3.1: Conceptual Model



Source: (Researcher 2001)

CHAPTER FOUR

DATA ANALYSIS AND FINDINGS

4.0 Impact of the Water from the Dams on the Recipient Communities

4.1: Introduction

This study sought to examine the impact that the water from the dams have on the recipient communities. Impact can be both positive and negative. In line with the objectives set at the onset of this study it is critical that the management of the small dams be looked into in order that recommendations may be made that enhance their sustainability.

The argument advanced in favour of the construction of small community dams in ASALs emanates from the fact that water is always on top of the list of the major hindrance affecting development in these areas. Much of the water in these areas is lost as runoff and if it is harvested and stored it can be used during the dry period. The rationale behind the construction of small dams in the study area was to conserve water mainly for domestic and livestock use during the dry season. The initial intension in 1979 was mainly to construct dams for livestock water supply. During that time, the plans were to supply the people with piped water supply. All the dams sampled have a water main pipe passing nearby, but due to mismanagement the water supplies has since fallen into disrepair and this brought the need to a harness runoff through construction of small community dams. There are varieties of point water available to the people. The numbers of water sources in the study are shown in Table 4.1.

Table 4.1:Point Water Source in Gachoka Division

Location	Number of Dams	Status	Number of Bore hole	Status	Number of Spring	Status	Number of Rock catchment	Status
Mbita	5	All were operational but one require desilting	3	All were Operational	5	One was operational and developed while 4 were not developed		
Mavuria	10	4 were not operational 6 were operational but 2 required desilting	5	3 were operational but 2 were not operational	-			
Kianjiru	6	All were operational but 2 had leaking walls	5	3 were operational while 2 were not operational	8	one was protected the rest were not protected and developed		
Mbeti south	2	All were operational	15	12 were operational but 3 were not operational	1	Not developed	2	one was developed in 1995 by Embu county council and is still being used while the other one was not developed
Kithunthiri	7	3 were not operational while 4 were operational but required desilting	8	7 were operational while one was not operational	3	All were not developed		
Mutuabare	2	One was Operational and the other was not.	10	5 were Operational and 5 were not	-			
Kiambere	4	All were Operational but one required desilting		7 were operational and one was not	1	Operational and being developed for piped water supply.		
Kichiche	7	All were operational	9	7 were operational and 2 were not operational	15	All not developed		

Source; (Mbeere District water office 2001)

There are a total of 43 small community dams in the study area of which 31 were operational during the time of this study although 8 of them required desilting, while 12 were not operational because their embankment walls were leaking or they were completely silted. This meant that 58 percent were operational, 23 percent were operational but required rehabilitation while 19 percent were not operational. Out of 63 boreholes in the study area 47 were operational while 16 were not operational. This meant that 74 percent were operational while 26 percent were not operational. Out of the 43 community dams in the study area 5 were sampled and then 100 households using the water from the dams were interviewed. 49 respondents were males while 51 were females. The level of education of the households interviewed were as follows; 12 percent had post secondary education, 25 percent had secondary education, 51 percent had primary education while 12 percent did not have formal education. The average household size was six, with household sizes ranging from one to fourteen members.

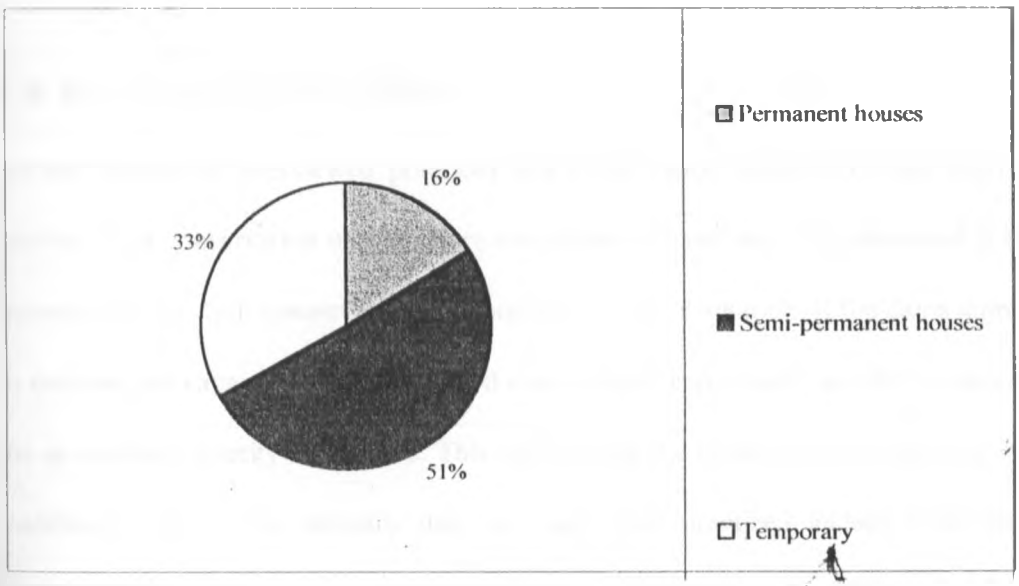
The occupation of the household head is an important determinant of the socio-economic status of the household. From the field it was established that 17 percent of the household heads were engaged in formal employment, while 70 percent were subsistence farmers, those engaged in business were 8 percent while those in casual employment accounted for 6 percent.

4.2: Housing

Housing can be used to determine the standard of living of people. The type of roofing material is also important in rainwater harvesting in that for effective rain water

harvesting people should have roof that can be used to collect rain water preferably roofs made of corrugated iron sheet. From the field survey, it was established that 16 percent of the households interviewed had permanent houses, 51 percent had semi-permanent houses and 33 percent had temporary houses. Classification was based on building materials used. A house built of stone or bricks and corrugated iron sheets was considered permanent while semi permanent houses were those built of mud wall and corrugated iron sheet and temporary were those built of mud walls with grass thatched roofs. Cumulatively 67 percent had permanent and semi permanent houses and 33 percent had temporary houses as shown in figure 4.1.

Figure 4.1: Type of Housing



Source: (Researcher 2001)

4.3: Rainwater Harvesting

Rainwater harvesting depend on the type of roofing used and the capacity of households to construct or buy reservoirs. In the field, it was established that only 60 percent of the respondent were practicing rainwater harvesting. Seven respondents were having a reservoir with capacity of 3780 litres, and were all donated by Plan

International. Two respondents had reservoirs with capacity of 9000 litres, which they use, as source of drinking water throughout the year. During the dry season, the water is only used for drinking while water for other uses is fetched from other water sources.

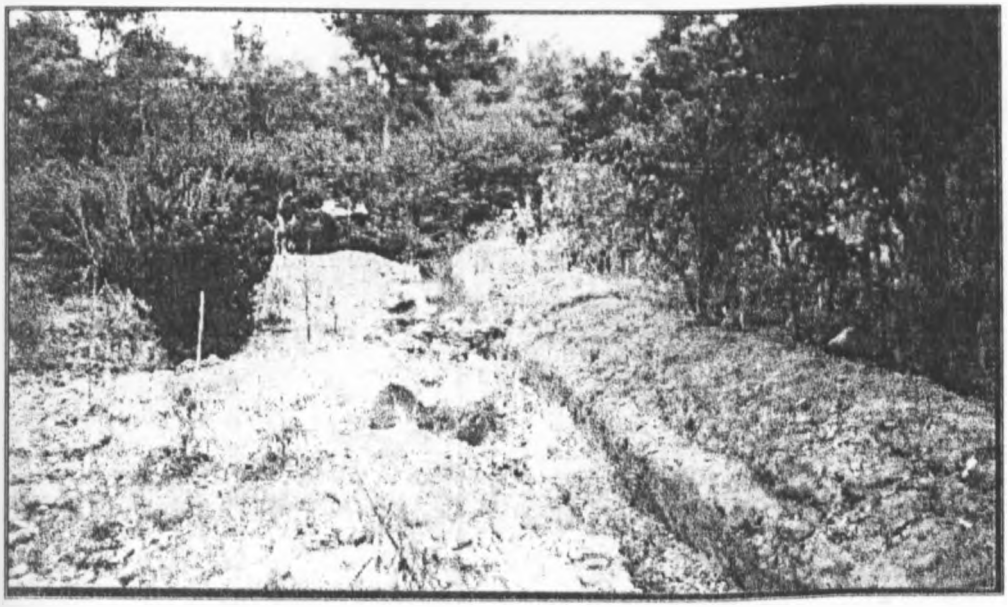
Three respondents had reservoirs with a capacity of 10,800 litres while 34 respondents were using 180 litres oil drums to harvest rainwater. This could only last a few days after the rainy. When asked the reason as to why they use the 180 litres reservoirs to harvest rain, all of them mentioned lack of finances to construct or buy big water tanks as the main reason.

4.4: Soil Conservation Practices

All the household interviewed practiced soil conservation methods of one form of another. Soil conservation measures are very important and must be addressed at the household level. Soil conservation is important to reduce siltation of the dams inorder to enhance the capacity of the dams. Soil conservation is necessary inorder to increase the productive capacity of the soils. This will increase the returns from agriculture. The traditional soil erosion methods that the respondent practiced include trash lines, stoneline, logline and grass planting along the contours. In 1992 Plan International financed the Fanya Juu terracing on all the farms in the study area through the food for work programme. Since then the terraces have silted and only 10 percent of the respondent interviewed had rehabilitated the terraces. The reasons that the respondent gave for not maintaining the terraces was that maintaining the terraces is difficult work, and since the terraces were dug communally it became difficult to maintain them as an

individual. And so they prefer their traditional method of soil erosion control which are less tasking.

Plate 4.1: A Farm with Well Maintained Terraces (Fanya Juu) to Control Soil Erosion.



4.5: Land Tenure and Sizes

Traditionally land was held communally by clans in trust for the individuals. Land demarcation in the study area started in 1970 and since then there has been a change of land tenure from communal ownership to private ownership. Land adjudication was not complete in Kiambere, Gichiche and Mutuobare locations. Although land has now been privatized, there is less individualism in that there is still exist free access to grazing land on land which is not being cultivated or fenced and traditional watering points have remained communal. There is no extensive landlessness. It is important to analyze land tenure and sizes because they are very important in siting and location of small community dams in that if the pressure on land is high displacement of people to create surface reservoir may add extra cost to the dam construction and also the ease at which land is acquire for dam construction will depend on pressure on land. From

the survey, it was established that the average landsize per household was 7.3 acres with parcels of land ranging from one acre to 40 as shown in Table 4.2. There was no problem of acquisition of land because all the sites on which the 43 community dams are located were donated by local people free of charge.

Table 4.2: Land Sizes in Acres

Land size (acres)	Frequency	Percentage of household
1	5	5
2	11	11
3	12	12
4	14	14
5	9	9
6	13	13
7	5	5
8	1	1
10	16	16
12	3	3
15	2	2
16	1	1
20	4	4
24	1	1
30	1	1
35	1	1
40	1	1
Total	100	100

Source: (Researcher 2001)

4.6: Sources of Water

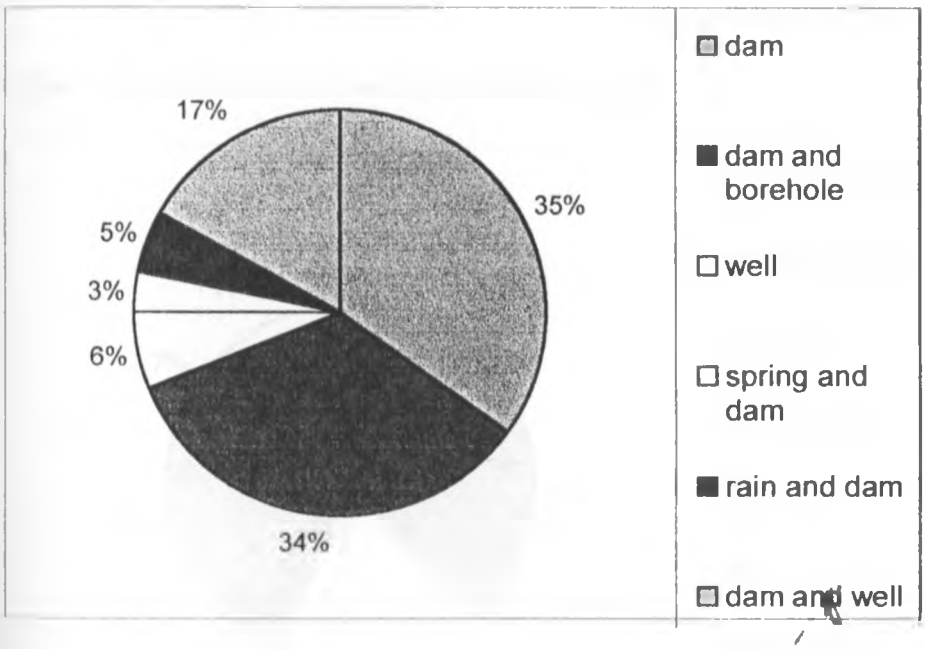
The sources of water available to household interviewed was most critical during the dry season. This was because most of the nearby sources dries up and water has to be fetched from much more distant places. Any improvement in water supply should aim at reducing the distance traveled to fetch water during the dry season. 97 percent of the household interviewed used the dam in combination with others, as the main source of water during the dry season as shown in Table 4.3.

Table 4.3: Sources of Water during the Dry Season.

Sources of water	Percentage of households
Dam	35
Dam and borehole	34
Well	6
Spring and dam	3
Rain and dam	5
Dam and well	17
Total	100

Source: (Researcher 2001)

Figure 4.2: Sources of Water during the dry Season



Source: (Researcher 2001)

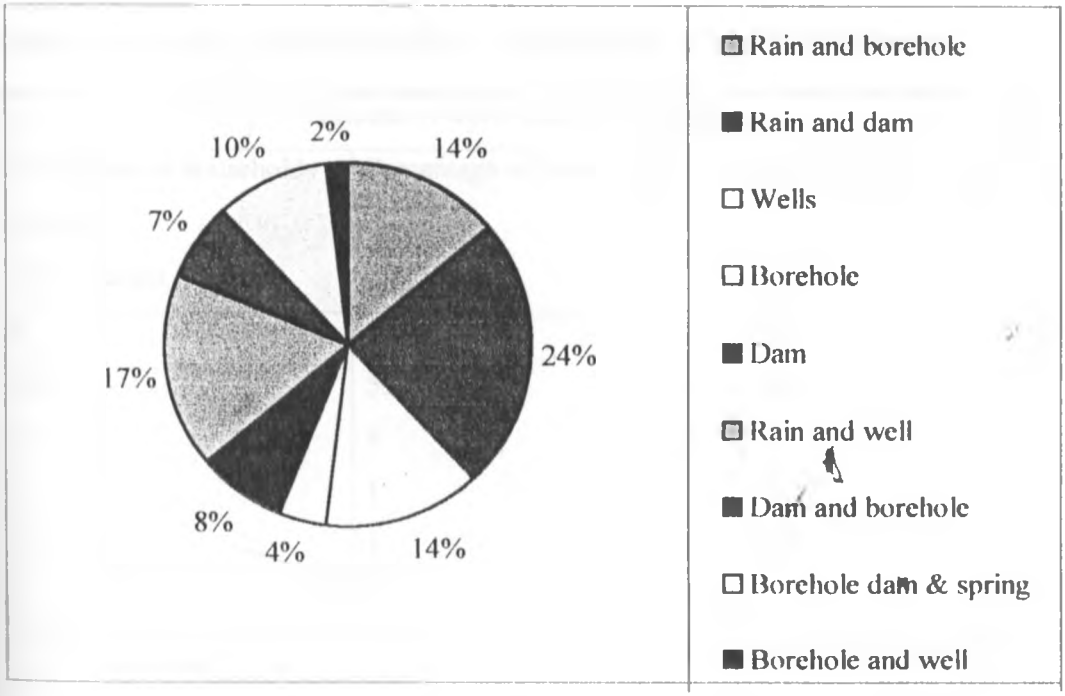
During the rainy season, there were multiplicities of sources of water and no water source was dominant. Rainwater harvesting and dams however were the main sources of water during the rainy season with 24 percentage of the household using them as their main source of water. The sources of water during the rainy season are shown in Table 4.4.

Table 4.4 : Water Sources during the Rainy Season

Source of water during the rainy season	Percentage of household
Rain and borehole	14
Rain and dam	24
Wells	14
Borehole	4
Dam	8
Rain and well	17
Dam and borehole	7
Borehole dam & spring	10
Borehole and well	2
Total	100

Source (Researcher 2001)

Figure 4.3: Water Sources during the Rainy Season



Source:(Researcher 2001)

4.7: Water Uses

4.7.1: Water for Cooking

Water for cooking was not very critical during the rainy season because water was accessible within a short distance. 61 percent of the households interviewed were using 40 litres of water per day for cooking while 32 percent were using 20 litres. 2 percent of the households interviewed were using 10 litres, 3 percent were using 60 litres and 2 percent were using 80 litres of water. Water for cooking drastically reduced during the dry season as nearby sources dries up and water had to be fetched from a longer distance. Those using 40 litres of water for cooking droped from 61 to 41 percent while those using 20 litres of water for cooking increased from 31 percent to 52 percent while 4 percent of the households used 10 litres of water and 1 percent uses 60 and 80 litres of water respectively, as shown in Table 4.5.

Table 4.5 Amount of Water Used for Cooking during dry and rainy Season.

Amount of water used for cooking		
Percentage of households during Rainy season	Percentage of households during Dry season	Litres of water used
61	41	40
32	53	20
2	4	10
3	1	60
2	1	80

Source: (Researcher 2001)

4.7.2: Water for Bathing and Washing

Water available for bathing and washing is a key indicator of socio-economic development of a place. A constant water supply is required for people to improve

their hygiene. During the rainy season, water for bathing and washing was not very critical. The average amount water used for bathing per household was 50 litres per day. This translated to 8 litres per person per day. Washing and bathing becomes rare as dry season advances with only 44 percent of the households using 40 litres of water per day for washing and bathing. Clothes are carried near the water source and then cleaned. The water use for bathing and washing during the dry season is shown in Table 4.6.

Table 4.6 Water for Bathing and Washing During the Dry Season

Water used in litres	Percentage of households
20	37
40	44
70	3
60	8
80	7
120	1
Total	100

Source: (Researcher 2001)

4.8: Sources of Water before Dam Construction and Time Taken to Fetch Water

For sustainability of water to be enhanced it is important to establish the sources of water before any water project is undertaken. Before the construction of the dams 53 percent of the respondents relied on wells mostly on the sand river beds while 8 percent of the households relied on boreholes, 14 percent relied on boreholes and wells, 16 percent relied on another dam while nine percent relied on rivers and springs. Before the construction of the dams the distance traveled to fetch water ranged from half a kilometre to 5 kilometre as shown in Table 4.7 .

Table 4.7: Distance travelled to Water Source before Dam Construction

Distance travelled in kilometres	Percentage of households
½ km	13
1 km	17
2 km	28
3 km	26
4	14
5	2
Total	100

Source: (Researcher 2001)

Table 4.8: The Time Taken to Water Source before the Construction of the Dam.

Time taken to fetch water	Percentage of households
Half an hour	18
1 hour	28
2 hours	38
3 hours	14
4 hours	2
Total	100

Source: (Researcher 2001)

This time reduces drastically with the construction of the dam as shown in Table 4.9.

Table 4.9: Time Taken to Fetch Water after the Construction of the Dam

Time taken to fetch water after dam construction	Percentage of the household
Half an hour	28
1 hour	34
2 hours	38
Total	100

Source: (Researcher 2001)

4.9: Irrigation

Small dams can play an important role in irrigated agriculture if they are well harnessed. The small dams are considered ideal in that they can be easily maintained by the beneficiary community. They can achieve the goal of poverty alleviation through sustenance of food production and income generation. This research established that 55 percent of all households interviewed practiced irrigation while 45 percent did not practice irrigation. The people practice basin irrigation.

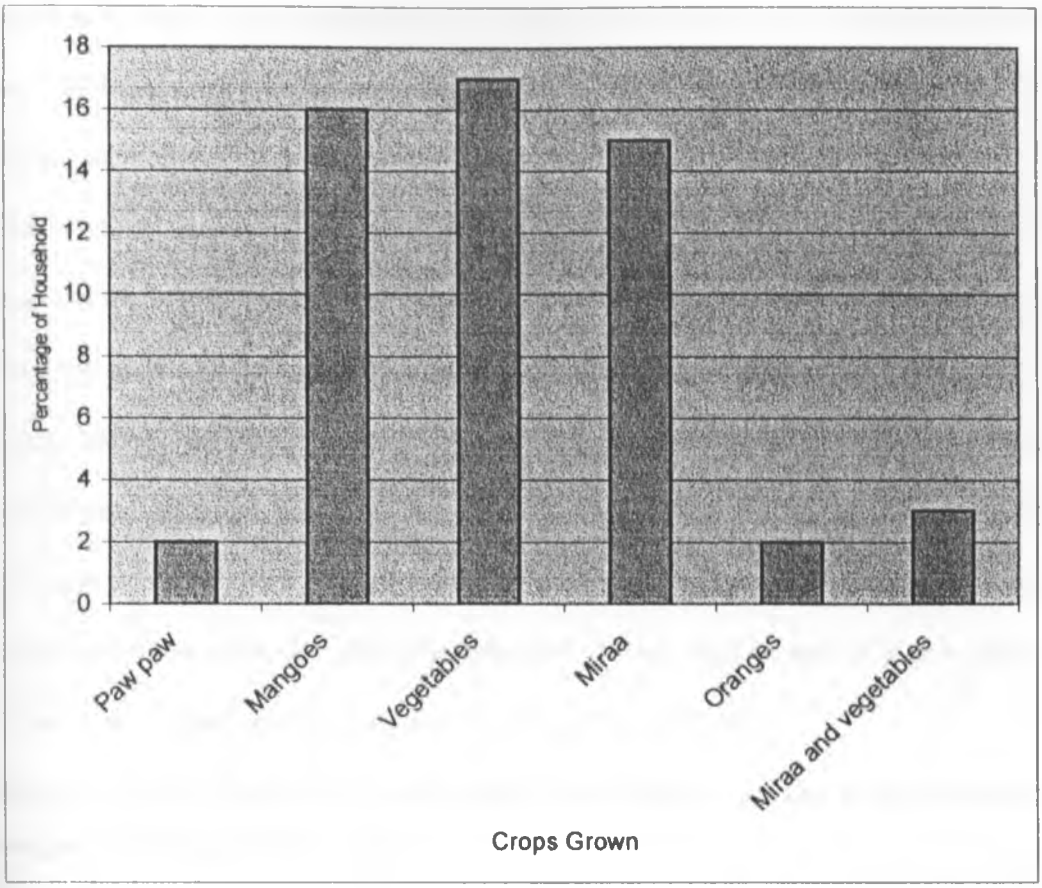
The type of crops grown are shown in Table 4.10

Table 4.10: Crops Grown Using Irrigation

Crop grown using irrigation	Percentage of households
Paw paw	2
Mangoes	16
Vegetables	17
Miraa	15
Oranges	2
Miraa and vegetables	3
Total	55

Source: (Researcher 2001)

Figure 4.4: Crops Grown Using Irrigation



Source: (Researcher 2001)

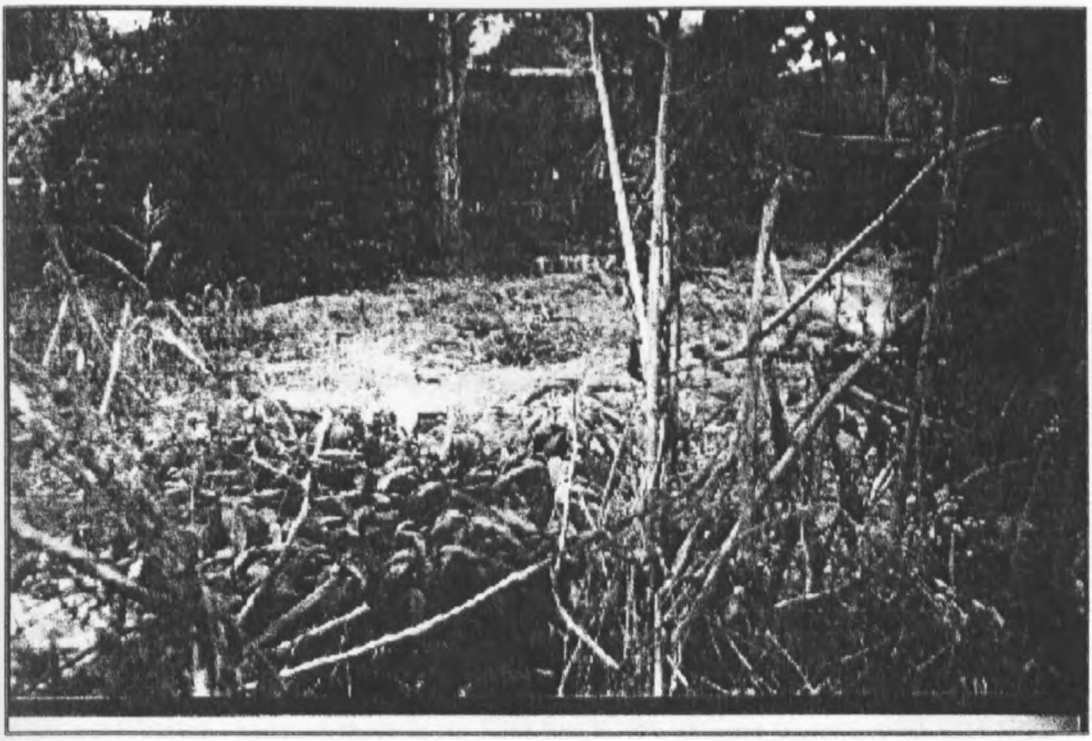
4.10: Miraa Irrigation

For the dams constructed in the Miraa growing zone, that this Kerwa and Mbita dams the biggest impact that has been felt is that of irrigating their miraa plants during the dry season. (Miraa is a plant whose foliage leaves when chewed have stimulant effect). According to the Daily Nation of March 23rd 1985, Miraa contain alkaloid known as Ephedrine which acts as a stimulant. Traditionally miraa used to be chewed by old men and women only, age meant those who had married children or whose who belonged to that age group.

But since 1980's the people started planting miraa for commercial purposes. This was partly as a result of the tarmacking of the Embu Kititiri road in 1987, which made the area easily accessible to the rest of the country. Which ease in transportation people started selling their miraa in Embu, Nairobi, Nyeri Karatina, Mwea, Matuu, Thika and Garrissa town. A demand for miraa meant a demand for water. This is because water is required for watering the plant after planting because the rainy season is followed by a long dry spell which means that if the young plants are not watered they will dry up. Miraa takes three years to mature although harvesting starts early. The Kerwa dams which were constructed hitherto for domestic, livestock and watering a tree nursery are now being used for irrigation especially during the dry season. During the dry season the Miraa plant like other semi-arid plant do not vegetate and for it to vegetate it has to be watered and the dams provide the much needed water.

Plate 4.2: One of the Miraa Farms which Uses Water from the Kerwa Dam for Irrigation during the Dry Season.

Plate 4.3: Mango Tree Nursery That Uses Water from One of the Dams



4.11: Employment in Miraa Growing Zones

The dams have created employment for both miraa growing zones and non growing zones. People travel from as far as 15 kilometres to come and fetch water for irrigation during the month of August, September, October and November. The farmers near the dams have an average of 100 stems of miraa. Each miraa stem requires approximately 80 litres of water per week so as to vegetate. This is the time miraa is in short supply and the market for miraa is quite favourable. The sales from miraa are used to pay for the water used for irrigation. The farmers, near the dam, are paid 5 shillings for every 20 litres jerrican of water.

While those who are more than half a kilometre away from the dams are paid 10 shillings for every 20 litres jerricans of water. Through irrigation farmers are able to harvest more miraa foliage leaves, sell it and then use the money to pay for the water

used in irrigating the miraa plant. During the drought of the year 1999 and year 2000 this was an employment zone, where people used to go in the morning to work. The income from miraa actually trickle down even to those who do not grow miraa through the irrigation process. The respondent interviewed near the dam admitted that were it not for the water from the dam they would have been adversely affected by drought. This according to them has created some dignity because they do not go to took for food or work in the neighbouring Kirinyaga and Embu district as had been the case before, and this has created self esteem because they are not longer down looked by their neighbours as was the case before.

Everything has a price; now that water has become a commercial good this has lead to over exploitation, because there is no limit has to the amount water one should fetch for commercial purposes. This makes the dams, which were perrenial in year 1990; to become seasonal because of problem of over-exploitation, misuse and failure to take care of the catchement area.

Miraa being a drug has increased the rate of deliquences, in the area with men resulting to drinking. This is because money is earned weekly and this creates a tendency of misusing the money because there is surety of earnings. But the earnings are seasonal with high returns during the dry season when miraa is in short supply hence high demand and when water is needed for irrigation and low returns during the wet season when miraa is in high supply hence low demand. But all in all the benefits of the water from the dams have been instrumental in that people are able to earn income by selling miraa or water and hence be able to buy food during the time of drought. This has assisted people when there is no on farm employment which some people resort to

during the planting and wedding time. The water played a very important role in saving people from starvation by creating some form of employment through irrigation.

4.12: Livestock Farming

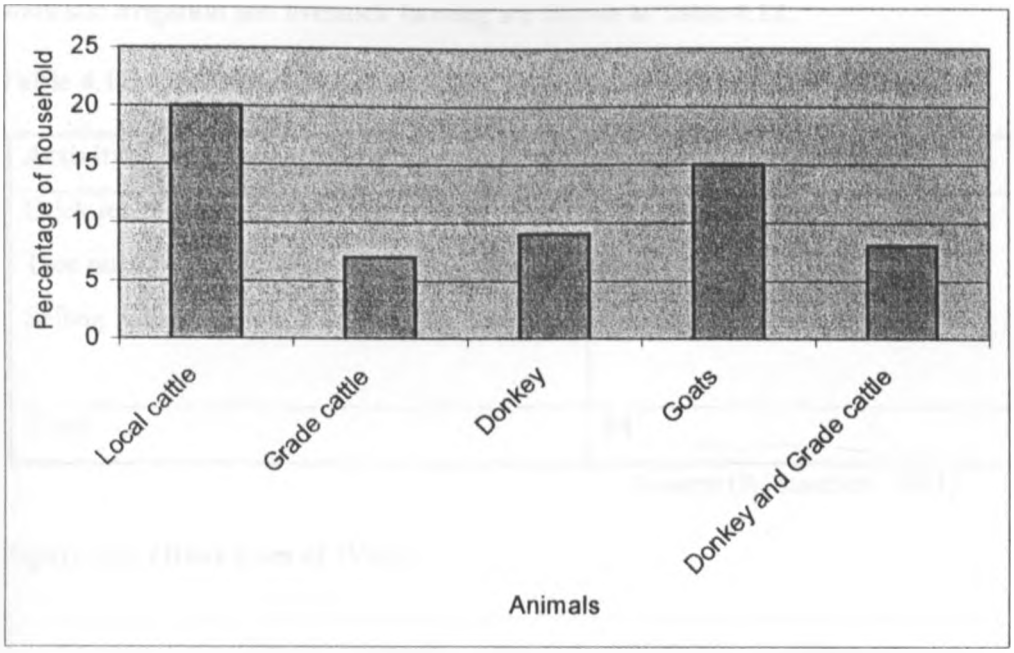
Mbeere people are farmers as well as pastrolists. They keep mostly indigenous type of cattle. In the past it was not possible to rearer exotic or cross breed dairy cows because of the problems of water. Some households have now started rearing exotic and crossbreed dairy cattle through zero grazing. This is because water is available either from the dams or from the boreholes. One exotic cattle consume approximately 50 litres of water and it would have been difficult to rear these animals if a constant supply of water was not assured during the dry season. The availability of water has made this possible and this as introduced a new dimension in the water transport. Farmers have now started keeping draught animals especially donkey which were rare before in the study area. This is an indicator of changes in method of water transport especially for watering dairy cattle and for irrigation. Donkeys are now being auctioned in the Kiritiri livestock market which was not the case before. Type of animals kept are shown in Table 4.11

Table 4.11: Type of Animals Kept

Types of animals kept	Percentage of household
Local cattle	20
Grade cattle	7
Donkey	9
Goats	15
Donkey and grade cattle	8
Total	59

Source: (Researcher 2001)

Figure 4.5: Types of Animals Kept



Source: (Researcher 2001)

4.13 Shelter and Other Uses of Water

The construction of the dams has resulted in creation of water mass which is accessible during the dry season, and this has enabled some people to construct earth bricks and hence put up decent houses. Earth bricks are mostly made during the dry season so as to have time to cure and then have time to construct the house to avoid the bricks from being destroyed by the rain. This has resulted in less deforestation because people do not have to cut poles from the forest to erect houses and this helps in conserving the environmental.

Other than brick making, selling of the water from the dams was also very important. Given that there is no piped water most of the urban centres/markets in the area rely on the water which is hawked from various water points during the dry season. The water sources are mostly dams, springs, boreholes and rivers for those markets near the

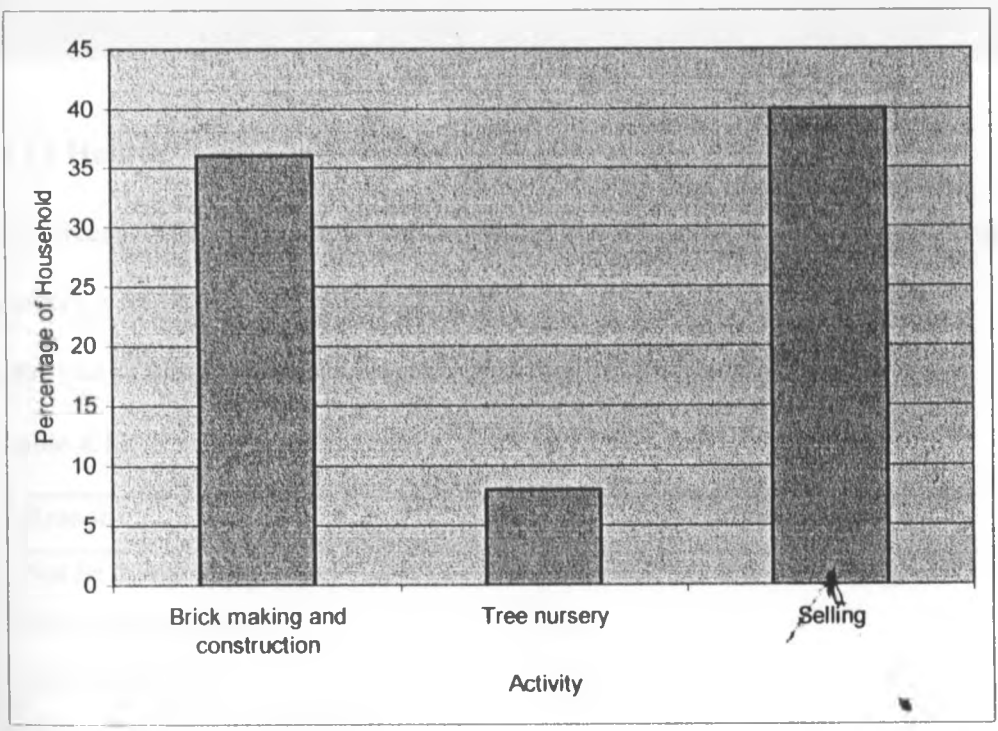
Rupingazi Tana and Thiba rivers. The uses of water from the dam other than for domestic irrigation and livestock farming are shown in Table 4.12.

Table 4.12: Other uses of water

Activity	Percentage of household
Brick making and construction	36
Tree nursery	8
Selling	40
Total	84

Source (Researcher 2001)

Figure 4.6: Other Uses of Water



Source: (Researcher 2001)

Plate 4.4: A House Constructed Using Earth Bricks Made Using Water From one of The Dams

4.14 Health

80 percent of the households interviewed did not boil water for drinking and only 20 percent were boiling water for drinking.

This was as a result of various reasons as shown in Table 4.13

Table 4.13: Reason for Not Boiling Water for Drinking

Reasons	Percentage of households
Not be doing so since ever	17
Don't see the need	32
Not always	24
Water is assumed to be clean	2
Use rain water	5
Total	80

Source: (Researcher 2001)

4.15: People Perception about Quality of Water

The quality of water is very important and this has to start with people's perception about the water supplied. 69 percent of the households interviewed were of the opinion that the water was good for drinking while 31 percent felt that the water was bad. 29 percent of the households complained that the water stains clothes while 71 percent said that the water does not stain clothes. To realize the potential that water supply can have on health, NGOs and the Government must do more than just supply and install hardware. The hardware components of water projects are only one link in a long chain. The other links involves activities ranging from changing hygiene habits to providing and promoting public health education.

4.16: Water Transport

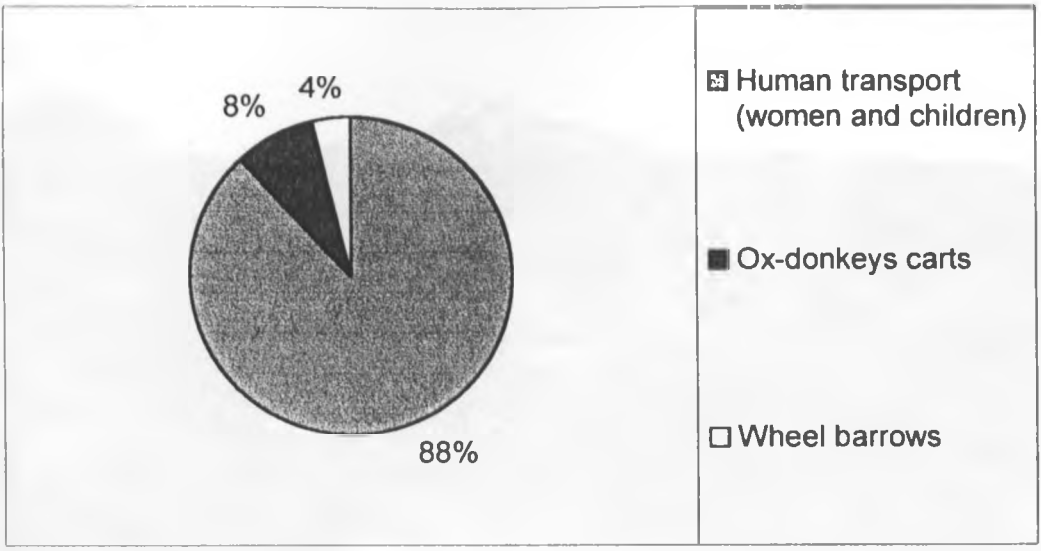
One of the reason advanced in favour of improved water supply is that majority of the household draw water from sources outside their homestead and that this water has to be transported. Since water has to be transported the distance between the water source and the homestead should be preferably short. From the fields this study established that the water transport is a women's role; with men fetching water only, for selling using Ox-or donkey carts and rarely do they fetch water for domestic purposes. Method of water transport is shown in Table 4.14.

Table 4.14: Methods of Water Transport

Method of water tranport	Percentage of households
Human transport (women and children)	88
Ox-Donkey carts	8
Wheel barrows	4
Total	100

(Researcher, 2001)

Figure 4.7: Methods of Water Transport



Source: (Researcher, 2001)

Plate 4.5: Human Water Transport Which is Dominant in the Study Area

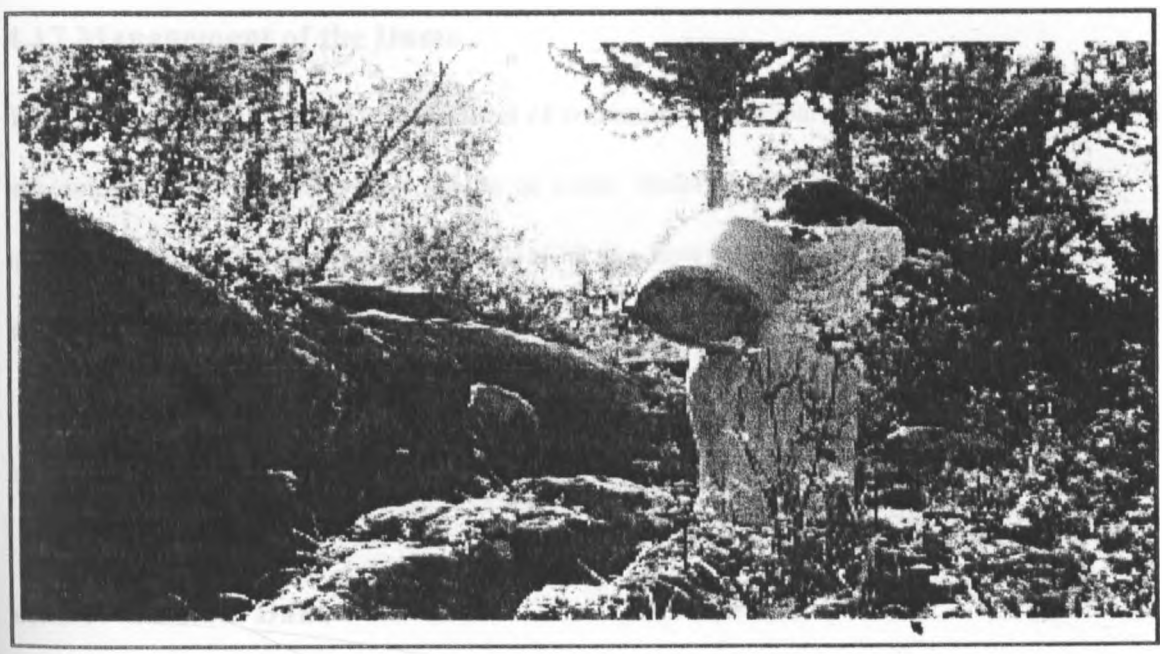
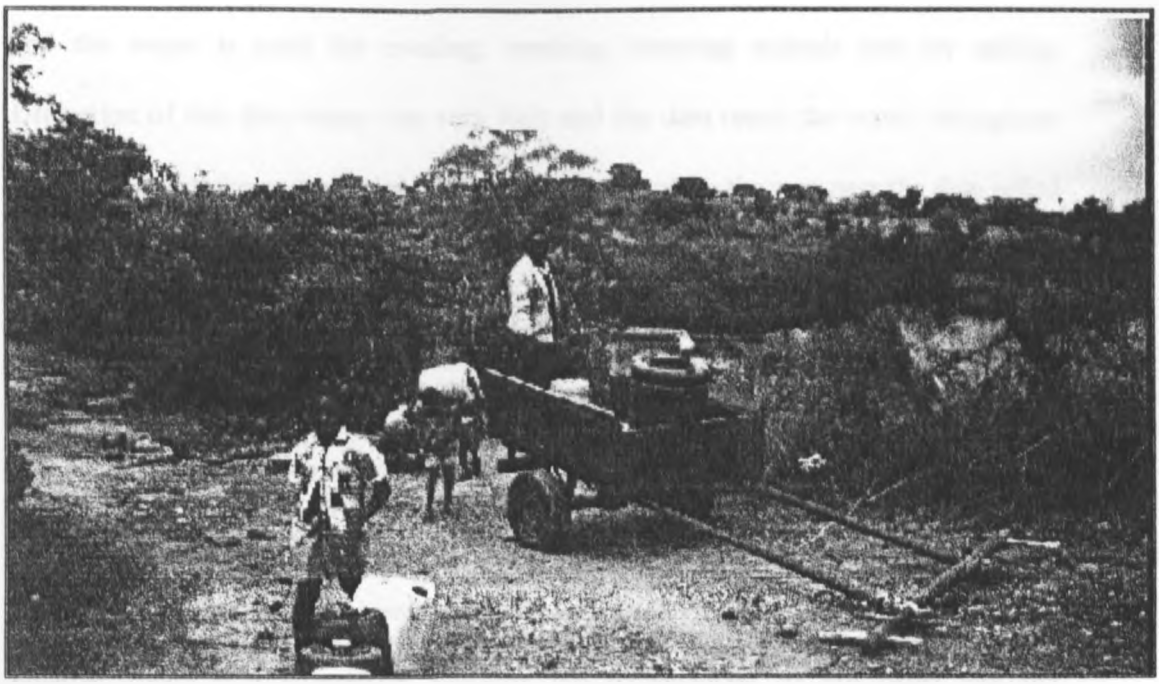


Plate 4.6: Water Awaiting To Be Transported Using Ox-Drawn Cart



4.17 Management of the Dams

This study also sought to assess the level of community participation in planning and implementation of the dams as a source of water. Before analyzing the management aspect of the dams it was necessary to look at the how the dams were constructed, whether the communities were involved or not how they were involved and the current management of the dams. This study would like to highlight how the five dams that were sampled were constructed and how they were being managed.

4.17.1: Gachaki Dam

Gachaki dam is in Mavuria location off the Iriamurai-Ngiori road near Iriamurai Catholic Mission. The dam is 120 metres long, 8 metres high with a crest width of 6 metres the spillway is five metres wide and 40 metres long with a capacity of approximately 150,000 cubic metres of water.

The dam was built in 1996 by the community with assistance from Plan International and the water is used for cooking, washing, watering animals and for selling. Utilization of this dam water was very high and the dam retain the water throughout the year. Before the construction of the dam the people in the area near the dam relied on the borehole and a another dam which was five kilometres away. The soils near the dam are porous and soil had to be transported from elsewhere. Plan International involved the people from the initial stages. They identified the site together with the people and then discussion on the modalities of acquiring the site followed.

Its important to assess the current management aspect of the dams so has to ascertain whether there is a correlation between the management of the dams and the participation of beneficiary communities in the dams construction process. The site on which the dam is constructed falls in two parcels of land because streams act as common land boundaries. The owners of the two parcels of land where the dam was constructed donated the land to the community free of charge. Plan International hired a dam construction expert and beneficiaries provided labour, which involved carrying ballast, removing roots and tree remains from the soil, which was to be compacted to make the dam embankment. Work was organized in villages around the dams. The work was organized communally, taking three days per week from morning to mid-day.

At the time of this study, the borehole near the dam was not operating and the Gachaki dam was the only source of water. After the dam construction, Plan International left the management of dam under the management of water committee. The water committee comprised of 30 members of which 12 were executive members.

Those who never participated in the dam construction were required to pay 300 shillings as registration fee before they could be allowed to fetch water; and for those fetching water to sell using ox/donkey cart had to pay 500 shillings to be allowed to fetch water. The executive committee at the time of this research comprised of six men and six women. The main duties of the water committee were to register new members, collect money from people fetching water for sale. The water committee had a duty roaster and the member on duty refrained people from watering animals directly in the dam. The committee also supervised how people fetched water so that the taps are not broken or left running to avoid wastage of water. The people were not expected to fetch water directly but to use the taps, which are downstream. The money collected was being used to buy barbed wire to fence the dam.

Plate 4.7: Gachaki Earth Dam

Plate 4.8: Prevention of Soil Erosion by Planting Sisal at the River Bed Downstream Gachaki Earth Dam

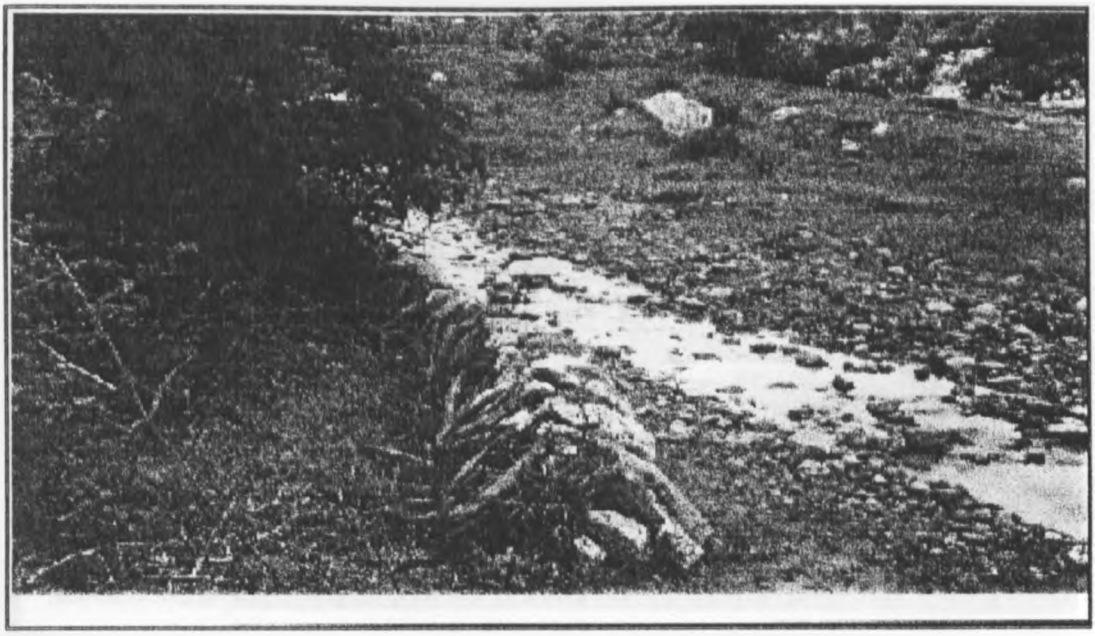


Plate 4.9: Public Taps Used as Water Draw Off from the Dam. They are Located Downstream to Avoid Direct Fetching of Water from the Dam.

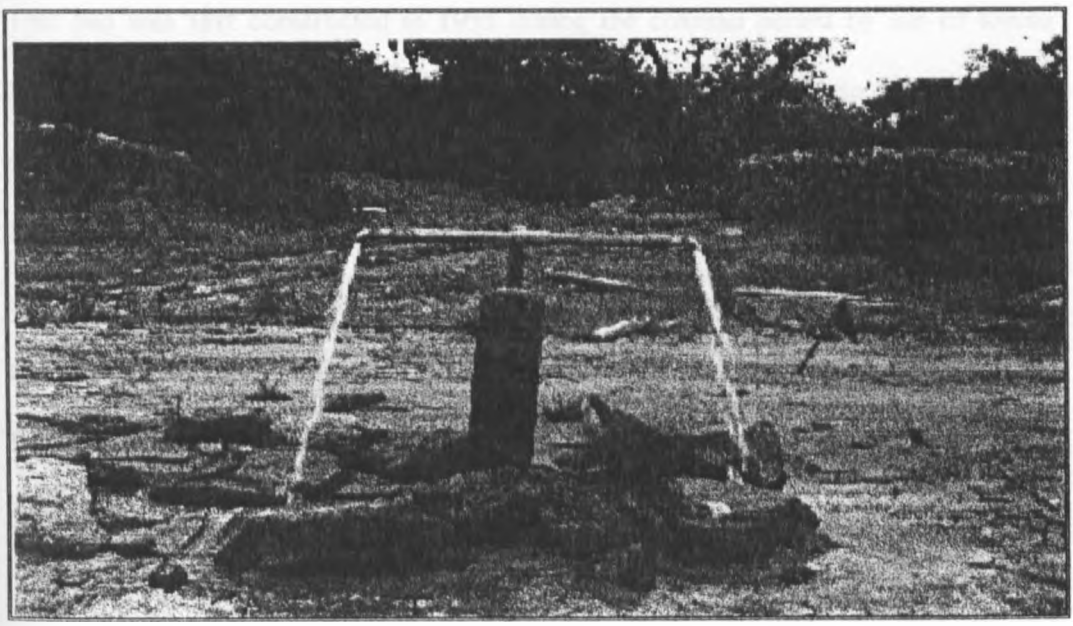
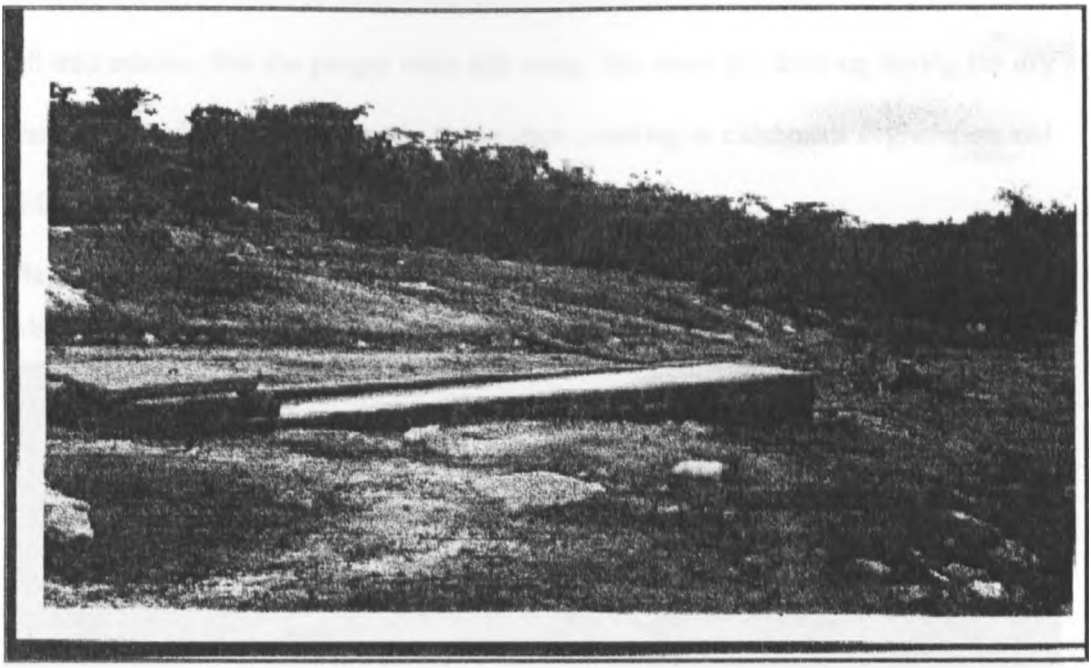


Plate 4.10: Cattle Watering Trough constructed downstream for Watering Animals instead of direct watering



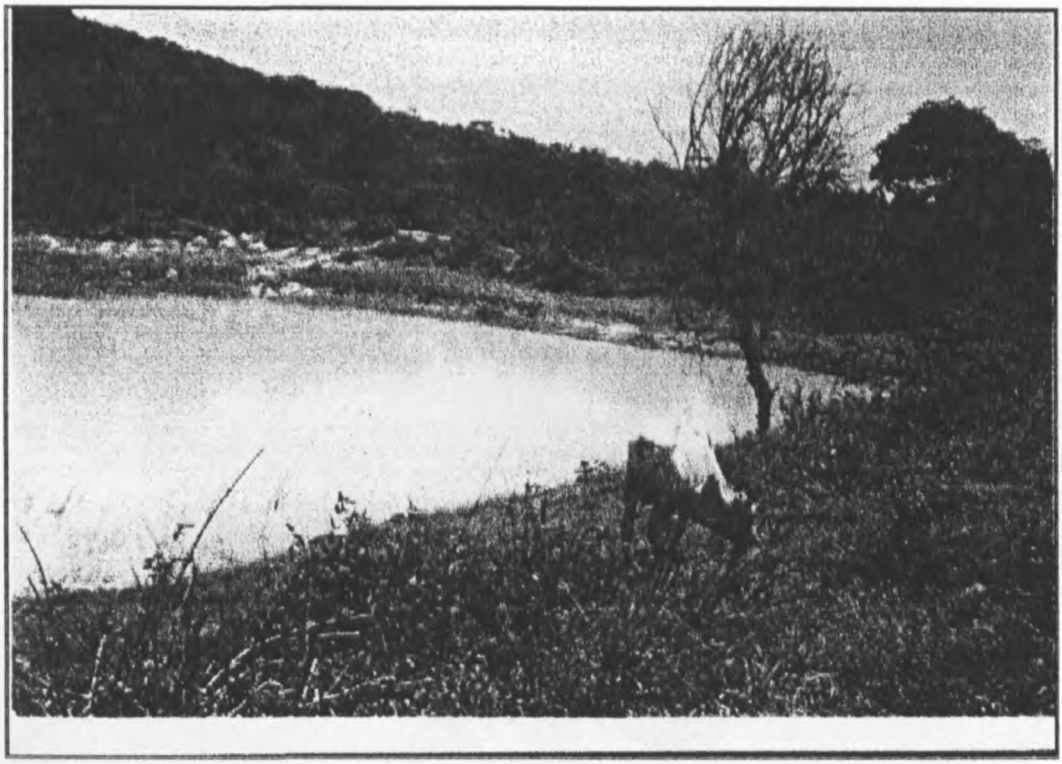
14.17.2: Ithera and Itherero Dam

Ithera Pan

This pan was first constructed in 1955 during the colonial period by use of forced labour. After independence there was no more forced labour and so due to lack of regular maintenance and misuse, the dam was neglected and got silted up. In 1991 Plan International sponsored a group (Kariti group) of 12 men for an organic farming seminar at the University of Nairobi. After the training the people identified water as the major constrain towards the achievements of organic farming. In 1992 Plan International rehabilitated the water pan and the group started using the water for organic farming.

The group did not last long and the people stopped practicing organic farming. The disintegration of the group meant that there was no one to take care of the dam and it fell into misuse. But the people were still using the water for drinking during the dry season and animals water directly in the dam resulting in catchment degradation and pollution.. The water lasts for only 9 months.

Plate 4.11: A Cow Grazing Near Ithera Pan. This Accelerates Soil Erosion and Also Pollutes the Water through Direct Watering of Animals

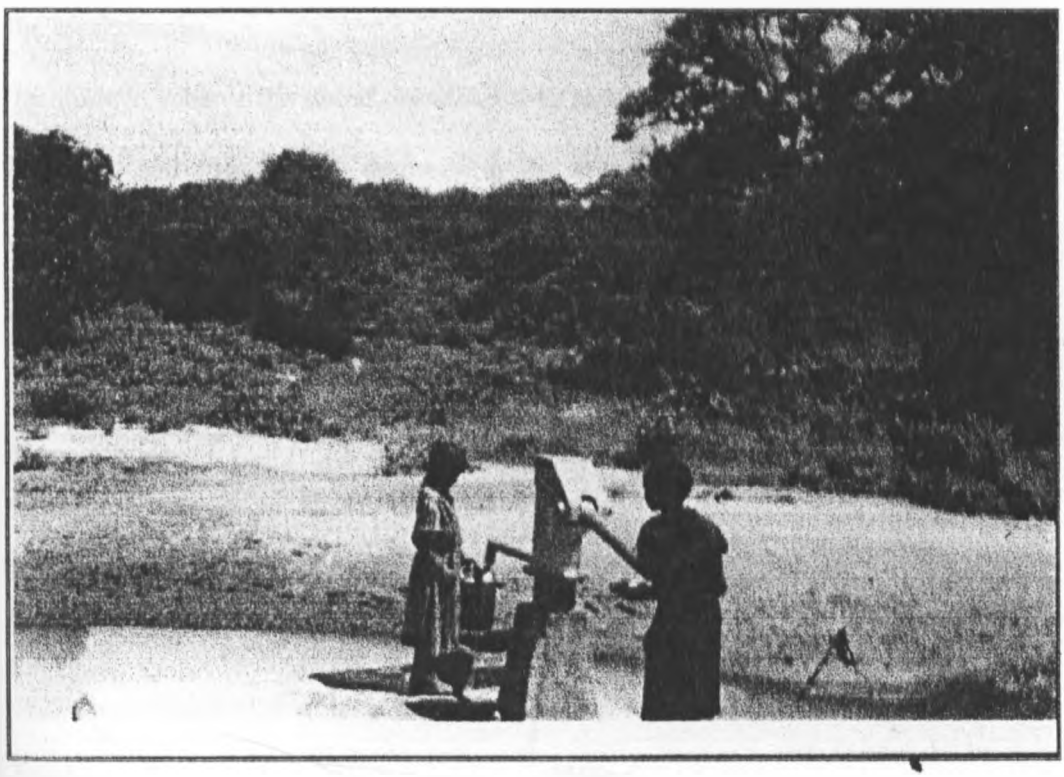


Itherero Sand Dam

Although Ithetero sand dam was not within the sample framework, it because necessary in the field to look at some of its aspect. This was because it was less than 2 kilometres from Ithera dam, which was within the sampling framework and present; a new dimension of dam construction in the area; that of sand storage dam construction, which have not been constructed in the area before.

The people around the area; use the dam as their main source of water. The dam is in Kirima sublocation, Kianjiru location off Kiritiri Embu road. The dam was built in 1999 by the Catholic diocese of Embu together with the local community. The community provided labour and some building materials. The dam costed 449,600 Kenya shillings and the water is drawn using a handpump. Respondent interviewed admitted that it was a useful source of water; and was being used as an alternative to Ithera pan.

Plate 4.12: Itherero Sand Storage Dam with a Handpump



4.17.3: Kerwa Dam

Kerwa dam is formed by a combination of four weir. Three weirs are constructed on one stream within an interval of 100 metres from each other. The fourth one is one kilometer away on a different stream. The dam is situated between Embu town and

Kamburu Hydroelectric Power (H.E.P) dam near Kiritiri market. The weir were constructed in 1980 by the Ministry of Agriculture as a soil and water conservation pilot project.

As stated earlier this was a U.N.D.P/G.O.K Project which was started in 1978 and F.A.O was the executing agency. The main objective of the project was to control soil deposits from reaching the Kindaruma, Gitaru, Kamburu and Kiambere H.E.P dams along the Lower Tana river. To implement a soil and water conservation programme near the dam area and to increase land productivity and raise the standard of living of the local people.

In order to achieve the stated objectives they had to construct artificial reservoirs and introduce soil conservation methods in the area. Kerwa dam was the first to be constructed as a pilot project. The weirs and their water shortage capacities are shown in the Table 4.15

Table 4.15: Weirs and their Water Capacity

Name of weir	Capacity
Mborori	$1500m^3$
Igumori	$1500m^3$
Kagumori	$4000m^3$
Mashiara	$1500m^3$
Total	$8500m^3$

Source: (Researcher 2001)

Plate 4.13: Igumori Weir which Has a Capacity of 1500 cubic metres of Water

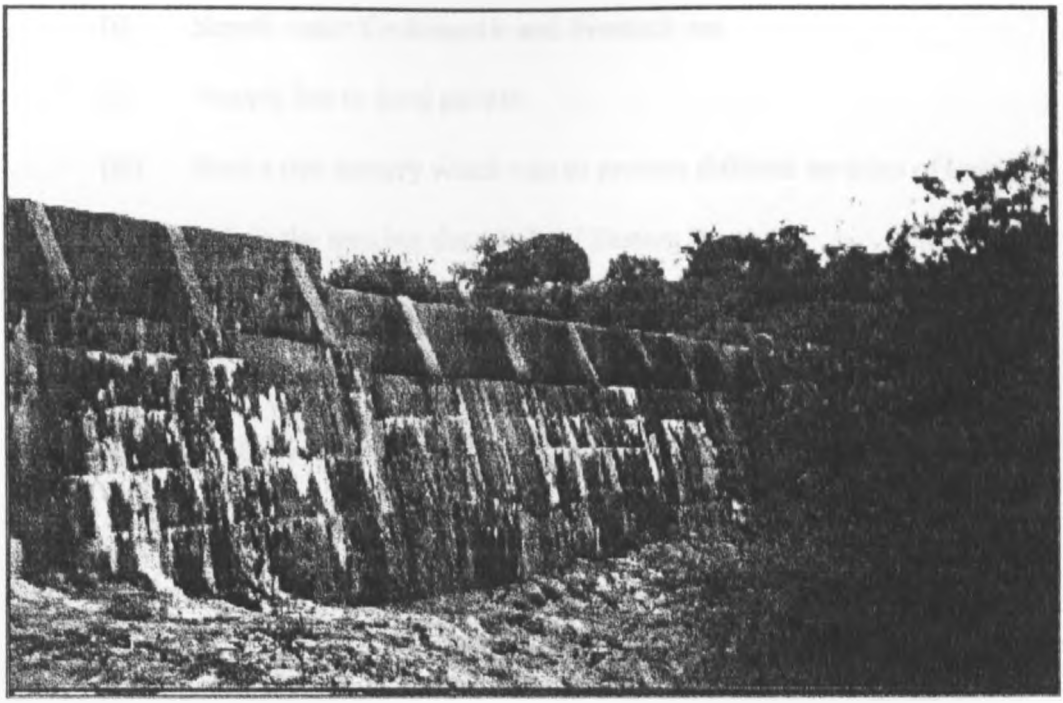


Plate 4.14: Children Fetching Water from Mashiara Weir Dam Which has a Capacity of 1500 cubic metres of Water

The main objectives of constructing the dams was to

(i) Supply water for domestic and livestock use

(ii) Supply fish to local people

(iii) Start a tree nursery which was to provide different varieties of trees not only in the area but the whole of Eastern Province.

After identifying the suitable site for the dam construction land on which the dams were to be constructed had to be acquired from the owners. The streams where the dams were to be constructed formed a common boundary between land that belonged to two different clans. Land adjudication by then was still going in the area. The area Assistant Chief was involved in sensitizing the people about the importance of the project. A meeting between the owners of the parcels and clan elder from the two clans agreed to give out land for dam construction for free.

After acquiring land for the dam construction the people were not involved in any other way expect recruitment in the construction as casual labourers. After the construction of the dams the Ministry of Agriculture established a tree nursery which has been abandoned. The dams on completion were under the care of the local community. As stated earlier, the three weirs dams were constructed in a row. The people started using the dams upstream for watering livestock directly and for other uses other than drinking. The third weir which is the biggest was used for domestic water and for watering animals incase the other two weir dams upstream dried up but direct watering of animals in the third weir dam was not allowed.

Initially the animals were not supposed to be watered directly into the dams. The watering troughs were constructed outside the third weir but were never connected to

the dam. The constructor had installed a manual water pump, which was there by the time of this study, but the pump was never connected to the trough. The contractor because of local politics concerning the location of the dams left without connecting the pump to the trough. Since the community was not involved in the whole process they did not see the need to connect the pump to the trough which only require laying of pipes between the pump and the trough.

Plate 4.15: A Watering Trough that has not been used by the Community since it was Constructed in 1980.

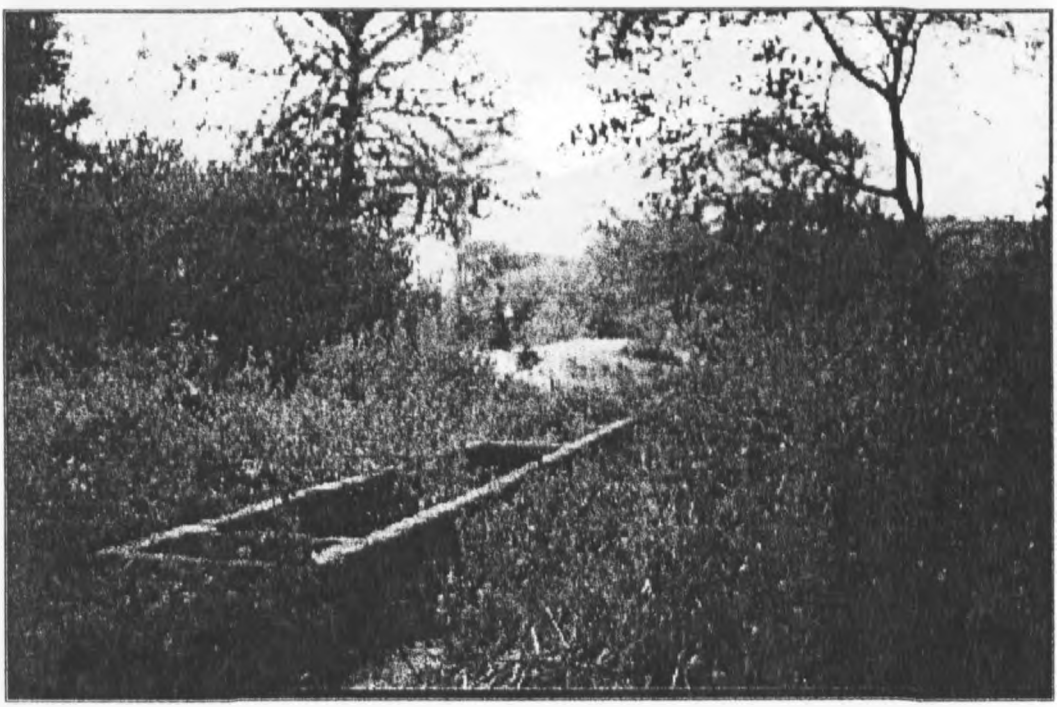
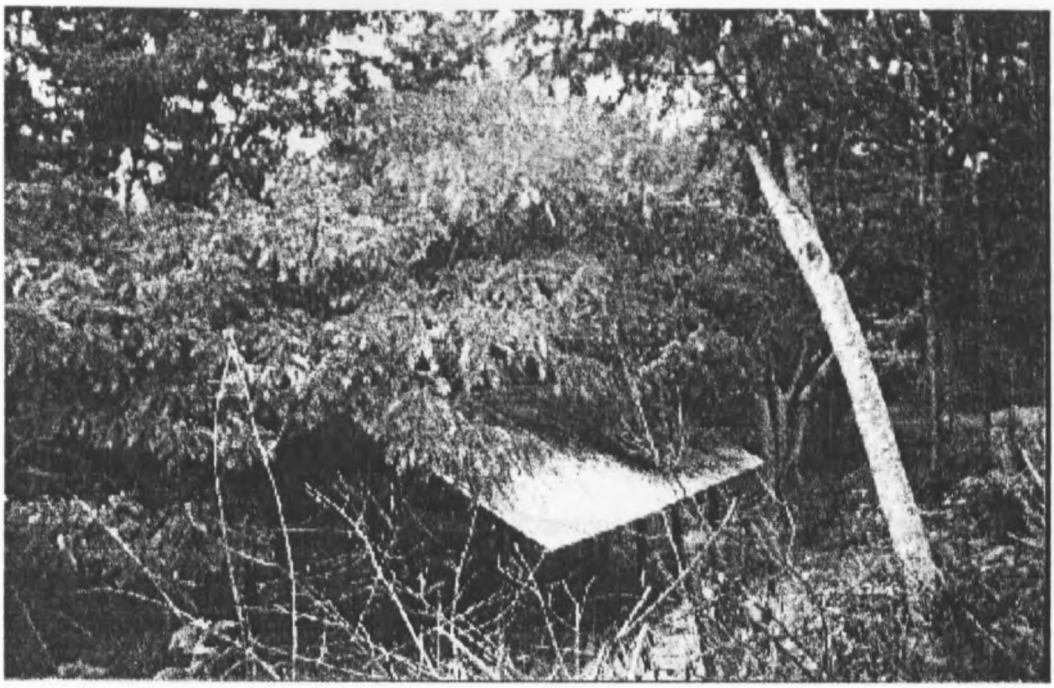


Plate 4.16: A Tree Nursery sheds which was abandoned by the Government in 1986 And Has Not Been In Use since Then. Note that the sheds have not been vandalized.



Participation is a long term process that cannot be effective if it is restricted to certain stages of a project for example handing over the water systems to communities after completion. The constructor did not bother to understand the traditional methods of watering animals. The people were used to traditional methods of watering animals in wells that were dug in seasonal well, and were well fenced. But traditionally the wells for livestock were never dug near those for drinking water.

Wells for watering cattle were dug downstream while those for domestic purpose were dug upstream. These people had never watered their animal in trough. The troughs that were constructed for watering animals are still intact and have never been used since 1980 (see plate 15) when the dams were constructed. The dams did not have a

management committee; and the way the people have been using the water creates a problem because the dam upstream are polluted by livestock watering directly into the dam and people also wash their clothes in the stream between the first and the second dam. The water in the two dams upstreams overflows during the rainy season onto the third weir, which is downstream. But from the interviews in the field it was realized that people do not recognize livestock as a major agent of pollutant water. This may be because of the value the local people attach to livestock. Before 1987, when the water from the dams started being used for irrigation, one of the weir Kagumori with a capacity of 4000 cubic metres of water was perennial.

But with introduction of commercial miraa farming in the area which require irrigation during the dry spell, all the dams dries up and the water lasts for only ten months; forcing people to result to their traditional sources of water. Because of misuse the dams are now threatened by siltation and require to be desilted in order to increase their water holding capacities. The dams were desilting in 1993 by the local community in partnership with Plan International an NGO working in the area and Machanga Agricultural Mechanization Station. The entire catchment's area was terraced and checks dams and gabions constructed to prevent silt from going to the dam. The local community was involved through food for work programme. The check dams were filled with sand and the sand has not be collected by the local people as envisaged by the NGO. There is no borehole nearby and the dams are the main source of water.

Plate 4.17: A Checkdam Constructed to Prevent Silt from Entering The Dam

4.17.4: Muiru Dam

The dam was constructed by the government in 1980 with the aim of providing with water for domestic and livestock use. After the completion of the dam the government handed over the dam to the community for use and management. The people were not involved in the planning and the implementation of the dam. The people were only involved in the acquisition of the site on which the dam was constructed. The site was donated by the owner of the land on which the dam was constructed free of charge. The dam does not have a management committee and the dam has since silted up completed. The Ministry of Water constructed a well in August 2000 on the side of the silted dam. The well was installed with a handpump which is used for domestic water. The construction of the well was sponsored by Plan International. Another dam is under construction in the area by the same NGO.

4.17.5: Mbita Earth Dam

The dam was constructed in 1998 and the initiative to construct the dam was started by the local people themselves who organized themselves into a self help group called Kamwirutiri self help group. The dam is in Kianjiru location off Embu Kiritini road near Mbita Primary School. The dam is 60 metres long, 8 metres high with a crest width of 5 metres. The spillway is 2 metres wide and 30 metres long. The reservoir has a capacity of approximately 3000 cubic metres of water. The objective of starting the group was to construct a small earth dam which could be used as a source of water by the community and the nearby primary and secondary school. The site was donated by one of the members and they started clearing the site in readiness for construction of the dam while at the same time sourcing for a donor to fund the project since they did not have funds.

The officials of the committee approached Rwika Technical Institute where they were advised to write a proposal requesting for funding from Danida International Development Agency (Danida). Danida financed the project and the construction of the dam was started and completed in 1998. The dam had a management committee of 15 members whose responsibility was to regulate the amount of water to be fetched during the dry season especially those fetching water to sell. Those who did not participate during construction of the dam were required to pay 250 shilling per year to be allowed to be members. The dam dried once in 1998 for only 2 weeks before the rain. The same help group has started constructing a community dispensary in the same area.

4.18: Participation in Dams Construction

Field survey revealed that in all the five dams sampled only 40 percent of the households were involved in one way or another in the dams construction. Out of the 40 percent; 34 percent of the households contributed labour while 6 percent contributed money in substitute for labour. Out of the 5 dams sampled only two had management committee and the beneficiaries were involved in all the stages of dams construction from site identification to implementation. The other three dams the users were not fully involved and the dams were only handed over to them after completion. They are not fenced and animals water directly in the dams. All the dams were constructed on sites that were donated free of charge by the beneficiaries; and they were all constructed with outside assistance.

Its not a coincidence that it is only the two dams where the beneficiaries were involved fully that had water managements committees. This is because through the process of community participation, a sense of ownership is instilled in the community. It is natural that people will take care of the things that they are associated with. Through participation people will take care of their project even after the donors have left. The role of the donor should be that of assisting the people to assist themselves. Donors should involve the beneficiaries as this is one way of bringing knowledge of past development experience to bear on new initiatives. The local people know what if anything had been tried before and what if any worked. The area near all the dams that were sampled has piped water supplies, which no longer works; and so harvesting the runoff water during the rainy season is an appropriate way of making sure that the runoff is stored before it disappears into the Indian Ocean.

Local knowledge and expertise are there in the community but have not often been tapped. Even poor people can provide considerable amount of money or labour when they want service provided. In this period of rising demands and shrinking resources cost can be reduced through community taking responsibility of sharing costs by voluntary labour and payment for charges. The communities should only be assisted where they are unable. Community participation reduces dependency syndrome since it lays down the ground for communities to take their own development forward; like the case of construction of Mbita dam, people had identified water as their felt need and went further ahead to solicit for a donor.

4.19: Summary of Findings

From the foregoing analysis it has been established that the small community dams have played a role in rural development. Going by the definition of rural development as the improvement of the standard of living in rural areas on a self sustaining basis through the transformation of their social spatial structures of their productive activities. Where the dams have been constructed, they have benefited the local communities in a number of ways.

4.19.1: Accessibility of Water

From the analysis, it has been found that with the construction of the dams; the distance and time taken to fetch water has decreased. Before the construction of the dams the average distance to the nearest water source was 2.2 kilometres and the average time that was taken to fetch one load of water was one hour and 40 minutes.

With the construction of dams the average distance traveled to fetch water now was 1.2 kilometres and the average time taken was one hour and 20 minutes. This represents a reduction of 20 minutes. Pearson correlation done between distance and time taken before and after dam construction indicates that with the construction of the dams time taken to fetch water has decreased. Before the construction of the dams, the correlation coefficient (r) between distance traveled and time taken to fetch water was 0.84 and then it reduced to 0.78 after the dam construction. This means that before the construction of the dams the variation in distance explained 84 percent variation in time. This reduced to 78 percent with the construction of the dams.

The construction of the dams has been a relief to women who bore the burden of fetching water. The time saved was used in leisure and preparing the farms during the dry period in readiness for planting. They do not queue for water and they travel short distances to fetch water and hence they are less tired. The dams are accessible by road and so children assist in fetching water during the weekend and school holidays.

4.19.2: Irrigation

The biggest impact that arose from the construction of dams is that of irrigation. The area under study experienced severed drought during the year 1999 and 2000. The prolonged drought had impact on crop yield; resulting in acute shortage of food. The four weir dams in Kerwa acted as an employment zone where people used to go and work. The people used to sell water for irrigation in the miraa farms and the money they earned was used to buy food.

The people were able to survive locally without having go to look for employment in neigbouring Embu and Kirinyaga district and this has created dignity in that they can now avoid the humiliating effect of looking for food from their neighbours. The people practice bucket type of irrigation which consumes a lot of water. This results in over exploitation of the water from the dams which has made the dams to dry earlier than was the case before they started being used for irrigation. From the analysis, it has been established that there is over dependency on external donors. All the five dams sampled were constructed with assistance from outside. In all the five dams the land was voluntary donated free of charge by the people on whose land the dams were constructed which was a major contribution which reduced the construction cost if the land had to be bought or owners compensated.

Only communities in two dams were involved in planning and construction of the dams. These dams were fenced, had a water management committee, there was no direct watering of animals and instead the animals were watered in the troughs. Those who were not involved in construction were required to pay. In the three other dams the communities were not involved in the planning and construction of the dams and they were only handled over to them after completion. The dams had no water user committees; were not fenced and livestock watered directly in the dam. There was also the problem of paying for the water since the people claim that the dams were constructed by the government. This has created the problems of sustainability because in future these dams will require rehabilitation, and this will require money.

Traditionally the communities never used trough to water their animals and used to water them directly in wells. So there was no offence when they refuse to use the

watering troughs constructed for the livestock since they were not involved when they were being constructed. On water transport human transport was still the dominant form of water transport and women are the ones responsible for transporting water for domestic use. However, there was an increased use of donkeys and ox/drawn carts as a means of water transport mostly for selling in the market centres or in the miraa farms.

There was also problem of siltation occurring in the earth and weir surface dams where 42 percent of all the dam in the study area required desilting. It should be noted that the siltation problem was arising from degradation of catchment areas.

CHAPTER FIVE

5.0: RECOMMENDATIONS AND CONCLUSION

From the literature reviewed in this study it becomes necessary to emphasize recommendation given by various scholars and give additional recommendation that are implicated by the findings. There has been various argument in favour of the small community dams as form of water conservation in the ASALs. From this study and other related study the following recommendations could help in enhancing sustainability of community small dams.

From literature review it is evident that the availability of perrenial water sources may simply not be enough to provide centralized water supply schemes which have to use pumps and piping system in ASALs. The Kenya government in its strategic poverty eradication plan of 1999 recognized that it may not be economically viable to plan and implement large piped water supply in ASALs; and that small dams, water pans and boreholes would be the most appropriate technology to apply in providing water. In these area water conservation must be developed as community based water supplies. The most fundamental aspect of water development lies not only with the technical aspect but with the management and the ownership.

The small dams are probably the most common form of water conservation. There is need to conserve water resources through technologies that can easily be managed by the rural community. Small dams are ideal in that they are cheap to construct compared with piped water supply and can be maintained by the beneficiaries communities without necessary hiring dam engineers.

The construction and rehabilitation of small dams must be undertaken within the broader framework of regional or district planning. At the very early stage of planning process, the linkages between agencies should be established. This will allow for the input by other agencies which can contribute to project sustainability. The agencies and department which should be included are, Ministry of Agriculture and Rural Development, Ministry of Water ,NGOs involved in water provision in rural areas and the provincial administration to sensitize the people and help in resolving land issues.

5.1: Partnership

As the government shifts from being a provider of water to being a facilitator of rural water supply there is need also for a shift from mere participation where communities have only been providing land for dam construction and unskilled labour. The government, NGOs and communities should form partnership where neither party should attempt to dominate each other and should endeavor to understand and accept its role. The community will require a variety of supportive function, which the government has to act as promoter and educator. The government should provide training, disseminate information and offer technical and managerial assistance and for communities having difficulties in raising funds required for dam construction and rehabilitation the government should act as an intermediary between community and credit institution whenever possible.

To be able to solve the problem of management of the dams the community should be involved at all the stages of dam construction. The communities should own their water projects and the governments and NGOs should only assist the people where

they are unable to assist themselves. There should be commitment to community based approach to planning by providing legitimacy and assistance where needed. The responsibility of making and executing decision should be left on the hands of community. The relationship between community willingness to pay and perceived benefits should be identified and brought to attention of the users during the planning stage. This is because if the idea of financial sustainability is not discussed at the planning study it may become difficult to rehabilitate or repair the dams when need arise.

In partnership formation different agencies should agree on how to optimize their comparative advantages since different partners have different strengths and weaknesses. No single partner is strong in all aspects. Making use of comparative advantages in partnership formation would have remarkable effect in terms of sustaining water project as shown in Table 5.1.

Table 5.1 Comparative Advantages of Different Partners Involved in Small Community Dam Construction

	Local knowledge	Research	Planning	Funding	Implementation	Sustaining	Evaluation	Monitoring
Beneficiary communities	X		X	X	X	X		
District development committee	X		X	X	X	X		X
NGOs		X	X	X	X			X
Central government agencies		X		X			X	X
Donors		X		X				X

Source: (After Mbugua G.K *et al* 1992)

From the table it is evident that different partners have different strengths, which should be taken advantage of when forming partnership. For example, the table reveals that the local communities are good in local knowledge and are also good at funding, planning, implementation and sustaining projects. But if they are only involved in some aspect of the project; the advantages that community has will be missed. Over and above, they are the ones who will use the water and so their stake in the water project is the highest.

Experience has taught the government to abandon the top-bottom approach, which before has been the normal procedure for project implementation. In demand driven or bottom up approach the communities should be given the responsibility of implementing project activities while the government acts as facilitator providing the necessary guidance in the implementation stages. This approach is valuable in that it creates an ownership spirit among the local communities for the projects. As a result, they take up full responsibility for ensuring that facilities are protected from vandalism and misuse.

The donors are good at research, funding and monitoring. If they construct a water supply facility without involving the community the likelihood of project sustainability is minimal. In assessing the capacity of communities to manage water projects its necessary to know traditionally how they managed their traditional source of water. This is because these management practices were evolved over thousands of years. Communities have always managed their traditional sources of water so when they are provided with new water supply facility efforts should be made to change management and use practices. For example, the Mbeere people never used to water their animals in

a trough. It may appear like it is simple but it will require a change of the animal watering method by involving them in the construction process so that the issue of cattle watering can be addressed during this stage.

It has also been established that the study area is in the Tana river drainage basin and the water from the area is drained into the dams at the lower Tana. These dams, are Kamburu, Gitaru, Kindaruma and Kiambere which are used for generating electricity. One of the objective of starting Agricultural Mechanization Station in the region was to control soil deposit from reaching the dams at lower Tana river. But due to lack of funds the unit has been unable to construct more small dams and initiate soil and water conservation in this region to help reduce the siltation of the H.E.P dams. Its for this reason that this study recommends that the Tana and Athi River Development Authority (T.A.R.D.A) and the Kenya Power Generating Company (KenGen) should be involved in the construction of small dams together with the community. If the construction of these dams is integrated together with soil conservation measures both at the catchment and household level; the community would benefit by having access to more water and the country will benefit in that the capacity of the H.E.P dams would be enhanced by reducing siltation.

This study has established that human transport is still the common method of water transport. There is however, an increased use of ox-donkeys carts to transport water which requires to be encouraged so as to reduce the burden of carrying water on women. Mass poverty in Kenya is the source of many problems facing the country. Arresting the rising unemployment levels and poverty is therefore of priority. According to Kenya times newspaper of 13th March 2000 drip irrigation was

recognized as the answer to hunger that ravages the country whenever the rainfall falls. The drip irrigation which was being demonstrated in Nairobi proved it is possible to grow maize, potatoes, carrot cabbages all popular crops in Kenya using only small amount of water. The demonstration plots in Kenya Agricultural Research Institute (K.A.R.I) headquarters in Nairobi have proved popular with women groups from various parts of the country. Those who have visited the plots have come out highly impressed. As the main focus now is on poverty alleviation K.AR.I should establish demonstration sites in a number of the small dams in the area so that the people can take advantage of this technology which uses little water. The communities can use drip irrigation to grow fruits like passion fruits and grafted mangoes, which they can sell and earn some income.

From the analysis, it has been realized that majority of the people do not boil or treat water for drinking. The water from the dams cannot be assumed to be clean for drinking. In cases where domestic water supply is to be the main purpose of dam construction then public education should be part and parcel of the dam construction process. The quality of water intended for water supply should be improved as much as possible. Simple methods of improving the quality of water from the dams and pans will be limited to reducing the turbidity of water by use of gravel and sand filters and boiling the water for drinking.

Rainwater harvesting should be encouraged. Although 45 percent of the total households interviewed practiced roof catchment, the reservoir were to small to sustain them for long after the rain. Local groups can act as catalysts for development at the grassroot level. These self-help groups in collaboration with NGOs can be very

helpful in assisting each other to construct big reservoirs which can sustain the whole household throughout the dry season.

With an average household of six members and a mean water demand of 10 litres a day a reservoir with a capacity of 12,000 litres would be enough for the household throughout the dry season of six months. This water from the rain should only be used for cooking and drinking; and then water from the dams can be used for bathing, watering livestock and small scale irrigation.

There is also need to combine underground water with surface water. Water from boreholes where there is less fluoride content should be used in combination with water from the dams. In the study area, the emphasizes has been to construct surface earth and weir dams as a soil and water conservation measures since 1979. The construction of sand storage dams was started in 1996 by the Catholic Diocese of Embu. Geologically most of the area are suitable for the construction of sand storage dams. The runoff in seasonal streams in the study area carries a lot of sand and gravel, which can be utilized by constructing weirs across these rivers to trap the sand.

Construction of sand dam is appropriate in that they are comparatively simple and inexpensive to construct and has potential of using self-help labour. Water stored in the sand is not exposed to pollution and evaporation is reduced because one metre below the sand evaporation is not significant. Sand stored in the dam should be prevented from being scooped by sand harvesters. This is because when the surface layer of sand is continually scooped out much of the stored water will be lost through surface evaporation. The rate of sand harvesting is higher than the rate of replenishing of the

sand in the dam. But sand has to be harvested because of it is in high demand in the construction industries in the neighbouring towns like Embu and Kerugoya. Therefore, there should be specific sites for sand harvesting and for water storage inorder to avoid conflict.

Indeed the Ministry of Water Development should identify all the suitable site; for the construction of small dams. If water from the small dams is combined with roof water catchment this can form an effective way of solving chronic water shortage in ASALs.

5.2: Conclusion

This study had a broad objective of examining the impact of using the water from the small dams on the recipient communities. It has been revealed that indeed small community dams are ideal for conservation water during the rainy season for use in the dry season. Indeed, the government has identified dams, pans and borehole as the most appropriate technology for supplying water which has been the main constrain to development in these areas. The development of small dams has both positive and negative impacts but in most of the cases the benefits outweighs the adverse effects. Positive impacts include the conservation of water, which is used for irrigation, which in the process has created some form of employment. The water is also used for domestic purpose and for watering livestock. This has lead to an increased in the number of exotic cattle because water is readily available. The surface dams are exposed to agents of pollution and given that majority of people do not boil the water for drinking, public education should be incorporated in construction and management

of the dams. There is also problem of siltation and loss of farmland, which was impounded by the reservoir.

There are also problems of mismanagement and misuse of the dams; resulting in reduced capacity of the reservoirs. Mitigating measures to some of these problem may include, improvement in public health education, community management of the dams should be improved through empowering the communities. Indeed the small community dams can be an entry point of establishment of strong local based institutions which can be used to support other development project. The community should be incorporated in environmental conservation, since they have knowledge of local flora and fauna, a knowledge that has been borne out of centuries of constant interaction with the environment. The communities together with government, NGOs and private sector should devise local policies of resource conservation. The dam catchment should protected through afforestation programmes, good land husbandry practice and use of check dams to trap sediments and adhering to engineering standards to curb collapse of structures.

Bibliography

Agarwal, A. et al (1981): **Water Sanitation; Health – for All?** Prospects for the International Drinking Water Supply and Sanitation. Published by International Institute for Environment and Development. Russel Press Limited, Nottingham.

Bear, L.M (1952): **A Geological Reconnaissance of the Area South East of Embu.** Government printers Nairobi.

Biwas, A.K. (1978): **The Social and Ecological Effects of Water Development in Developing Countries.** Printed in Great Britain by A. Wheaton and company Ltd. Exeter Devon.

Biwas, A. K (1992): **Water Resources Development** Butter worth – Heinemann Limited. Linancre House Jordan Hill Oxford.

Carruthers, I.D. (1973): **Impact and Economics of Community Water Supply. A study of rural water investment in Kenya**. School of rural Economics and Related Studies. Wye College.

Castelino, J.B. et al (1977): **Role of Water in Development.** Proceeding of the 13th annual symposium of East African Academy. Kenya National Academy for Advancement of Arts and sciences.

Catholic Diocese of Embu (1996): **Iriamurai Sand Storage Dams Project.** Unpublished report, Kaburu Orina and Partners Consulting Engineers.

Catholic Diocese of Embu (2000): **Existing Water Supply Schemes in Embu and Mbeere district** . Unpublished Report. Kaburu Orina and Partners Consulting Engineers.

Catholic Diocese of Embu (2000): **Water Resources Survey Report.** Unpublished Report Kaburu Orina and Partners Consulting Engineers.

Clarke, R. (1991): **Water: The International Crisis** Earthscan Publication Limited, London Published in Association with the Swedish Red Cross.

Curtis V. (1994): **Women and the Transport of Water.** Intermediate Technology Publication.

Deborah, E. (1997): **Capacity Building: An Approach to People Centred Development** .Published by Ox Farm (U.K and Ireland).

Feachem, R. (1978): **Water, Health and Development**. An Interdisciplinary Evaluation. Trimmed Books Limited London.

Fox, F.W. (1994): **Urban Management and Infrastructure Strategies Options for Urban Infrastructure Management**. Published for The Urban Management Programme by World Bank. Washington D.C, U.S.A.

Gamba , A.P. (1994): **The Impact Of Rural Water Supply Programme on Receipient Communities**. A Case Study of Kenya – Finland Water Supply Programme in Western Kenya. Unpublished M.A. Thesis University of Nairobi.

Gezahegne, W. (1986): **Subsurface Flow Dams for Rural Water Supply in Arid and Semi Arid Regions of Developing Countries**. Unpublished Master of Science (M.S.C) Thesis in Engineering Tempere University of Technology.

Gichuki, F.N. *et al* (1993): **Land and Water Management in Kenya: Towards Sustainable Land Use.** Department of Agricultural Engineering University of Nairobi Soil and Water Conservation Branch, Ministry of Agriculture and Rural development, Nairobi Kenya. Printed by English Press, Nairobi Kenya.

Hai, M. T (1998): **Water Harvesting. An Illustrative Manual for the Development of Micro Catchment Techniques for Crop Production in Dry Areas.** Regional Land Development Unit Sewish Internal Development Authority.

Hudson; W.M. (1987): **Soil and Water Conservation in Semi Arid Areas.** Food and Agricultural Organization (F.A.O) Rome.

Iherkildsen (1988): **Watering White Elephants: Lessons from Donor Funded Planning and Implementation of Rural Water Supplies in Tanzania.** Scandinavian Institute of African Studies Uppsala

Jaetzold, R. (1983): **Farm Management Handbook of Kenya Volume II.** Natural Conditions and Farm Management Information Part C Eastern Kenya (Eastern And Coast Province) Printed by Typo-Duck Rossdorf W. Germany.

Katko, P.S. (1992): **The Development of Water Supply Association in Finland and Its Significance for Developing Countries.** UNDP – World Bank Washington , D.C. U.S.A.

Kenya Republic of (1970): **National Development Plan, 1970-74** Government Printer Nairobi.

Kenya, Republic of (1972): **The Water Act Chapter 372.** Government Printer, Nairobi.

Kenya , Republic of (1974): **National Development Plan 1974-79** Government Printer, Nairobi.

Kenya, Republic of (1979): **National Development Plan 1979-83** Government Printer, Nairobi.

Kenya, Republic of: (1986): **Sessional paper No. 1 on Economic Management for Renewed Growth.** Government Printer, Nairobi.

Kenya, Republic of (1992): **Guidelines for the Design Construction and Rehabilitation of Small Dams and Pans in Kenya.** Kenya Belgium, Water Development Programme Nairobi.

Kenya, Republic of (1992): **The Study on National Water Master Plan. Sectoral Report. Ministry of Water Development.** Japanese International Cooperation Agency.(J.I.C.A)

Kenya, Republic of (1997): **Mbeere District Development Plan 1997-2001** Government Printer, Nairobi.

Kenya, Republic of (1997): **National Development Plan 1997-2001** Government Printer, Nairobi.

Kenya, Republic of (1999): **Poverty Eradication Plan by the Year 2015** Government Printer, Nairobi.

Kenya, Republic of (1999): **Sessional Paper No. 1 on National Policy on Water Resource Management and Development;** Government Printer, Nairobi.

Kenya, Republic of (2000): **Interim Poverty Reduction Strategy Paper for Period 2000- 2003.** Government Printer, Nairobi.

Kimuyu, P. (1998): **Water Sources and Use in Semi Arid Africa Insights From Machakos District Kenya**. Institute Of Policy Analysis and Research.

Uma, L. (1975): **The Design of Rural Development: Lessons From Africa.** International Bank for Reconstruction and Development Washington D.C.

Mabogunje, A.L. (1984): **The Development Process: A spatial perspective**; Hutchinson, University Library for Africa, London, Melbourne Sydney, Auckland, Johannesburg.

Malawi, Government of (1981): **Rural Water Supply in Developing Countries Proceeding of a Workshop on Training Held in Zomba.** Malawi International Development Research Center (IDRC).

Mugenda, O. M. and Mugenda, A. G. (1999): **Research Methods.** Quantitative and Qualitative Approaches. African Centre for Technology Studies (ACTS) Nairobi Kenya

Mundlak, Y. and Singer, F. (1977): **Arid Zone Development; potentials And Problems.** Ballinger Publishing Company. Cambridge, Massachusetts.

Ngethe N. *et al* (1982): **Asals Pre-Investment Study: Kitui, Embu and Meru**, Vol. 1. Institute of Development Studies; University of Nairobi.

Nilson , A. (1988): **Ground Water Dam for Small Scale Water Supply.** Intermediate Publication Printed by Russel Press Limited Gamble Street: Nottingham.

Nir, D. (1974): **The Semi Arid World: Man on the Fringe of the Desert.** Published By Bialik Institute. Jerusalem, Israel.

Norcliffe, E. *et al* (1981): **Planning African Development** Published by West View Press, U.S.A.

Ondigo, R.S. (1979): **An African Dam: Ecological Survey of the Kamburu, Gitaru Hydro Electric Dam Area; Kenya.** Swedish Natural Science Research Council; Stockholm.

Oywa, S.K. (1989): **Increasing Food Production in Marginal Areas of Kenya** Unpublished M.A. Thesis. University of Nairobi.

Ornas, A.H. (1996): **Dryland Management for Food Production a Shift in Paradigms.** African Arid Lands Working Paper No. 1. Scandinavia I.A.S Uppsala.

Pickford, J. (1976): **Planning For Water and Waste in Hot Countries.** Loughborough University of Technology.

Safier, M. (1970): **Role of Urban and Regional Planning in Nation Development of East African.** Milton Obote Foundation.

Sherbinin (1997): **Water and Population Dynamics. Local Approaches to a Global Challenge.** Report on a Collaborative Initiative and Workshop on IUCN World Conservation Congress Montreal Canada 1996

Tim, S. (1991): **Handbook on Small Earth Dams and Weir.** Cranfied Press, Bedford.

Uma, L. (1975): **The Design of Rural Development Lessons from Africa**. International Bank of Reconstruction and Development Washington D.C U.S.A.

UNCHS (Habitat) (1991): **Human Settlement Development Through Community Participation.** Nairobi, Kenya.

UNCHS (Habitat) (1991): **Infrastructure, Environment, Water and People**, Nairobi, Kenya.

UNCHS (Habitat) (1995): **Guideline for Assessing Effective Demands of Communities for Environment Infrastructure.** Nairobi, Kenya.

UNCHS (Habitat) (1997): **Partnership in the Water Sector for Cities in Africa; Report of Cape Town Consultation.** Nairobi, Kenya.

Warner, D. (1970): **A Preliminary Assessment of the Impact of Rural Water Supply upon Households and Villagers.** Economic Research Bureau University College, Dar-Es-Salaam.

Warner; D. et al (1990): **Community Management of Rural Water Supply and Sanitation Services.** UNDP – World Bank Water and Sanitation Program. Washington D.C U.S.A.

APPENDIX 1

UNIVERSITY OF NAIROBI

DEPARTMENT OF URBAN AND REGIONAL PLANNING

Impact of small community dams on arid and semi-arid lands development

A case study of Gachoka Division in Mbeere District.

HOUSE HOLD QUESTIONNAIRE

Declaration: *The information given here is for academic purposes only and shall not be used for any other purpose.*

Questionnaire No. _____

Date of interview _____ Location: _____

Personal Details

1. Name of respondent _____
2. Age _____
3. Sex _____ (1) male (2) female
4. Education level _____ None (1) primary (2) secondary (3) post secondary
5. Occupation _____
6. Household size _____
7. Land size _____ acre
8. Type of house _____ (1) permanent (2) semi permanent
9. Land tenure _____ (1) freehold _____ (2) lease hold _____ (3) communal

10. House hold members characteristic

Name	Sex	H/hold status	Age	Marital status	Education	Occupation

11. Where do you get water from during the dry season?

_____

12. Where do you get water during the rainy season _____

13. Do you practice rain water harvesting (1) Yes (2) No _____

14. If yes how big is your reservoir _____

15. How much water do you use during the rainy season per day on

i) Cooking _____ Jerrican

ii) Bathing and washing _____ Jerrican

16. How much water do you use per day during the dry season on

i) Cooking _____ Jerrican

ii) Bathing and washing _____ Jerrican

17. Do you use the water from the dam Yes (1) No (2)

18. If yes when was the dam constructed? _____

19. Were you involved in the construction of the dam? Yes (1) No (2)

20. If yes how are you involved _____

21. Before the dams were constructed what was your source of water

_____

22. How far was the source?

(a) Half a kilometre (1) (b) 1 km (2) (c) 2 km (3) (d) 3 km (4) (e) 4 km (5)

(f) 5 km (6) (g) over 5 km (7)

23. How long did you used to take to fetch water?

(a) Half an hour (1) (b) 1 hr (2) (c) 2 hrs (3) (d) 3 hrs (4) (e) 4 hrs (f) 5 hrs (6)

24. How many times did you fetch water per day? _____

25. How much money do you use in following per month?

(a) Food

(b) Water

(c) Kerosene

(d) Transport

(e) Health

26. What time of the day did you fetch water before the dams are constructed?

(a) Morning (1) (b) Afternoon (2) (c) At dawn (3)

27. Who used to fetch water then?

(a) Men (1) (b) Children (2) (c) Women (3)

28. How far is the dam from your home?

(a) half km (1) (b) 1 km (2) (c) one and a half km (3) (d) 2 km (4)

29. How long do you take to fetch water now?

(a) Less than 1 hr (1) (b) 1 hr (2) (c) 2 hrs (3) (d) 3 hrs (4) (e) 4 hrs (f)over 4 km (6)

30. How many times per day, do you now fetch water? _____

31. Do you take more or less time now if less _____

32. How do you use the time saved? _____

33. Is the quality of water good ( ) or bad ( )

34. Is the water for drinking treated/boiling Yes/No _____

35. If no why _____

36. Does the water stain clothes Yes (1) No (2) _____

37. Does the water from the dam last throughout the dry season Yes (1) No (2)

_____

38. If no how long does it last? _____ (months)

39. Is there any siltation-taking place on the dams? Yes (1) No (2) _____

40. If yes what measures are the people take to control the situation

_____

41. Do you use the water from the dams for irrigation? Yes (1) No (2)

_____

42. If yes what type of crops do you grow and how much water do you require per day/week

Crop	Water required (in jerrican) per day/week

43. What types of animals do you keep in and what are their daily water requirement.

Type of animals	Water required	Source

44. Do you use fertilizer in your farm? Yes (1) No (2) _____

45. If no, what do you use _____

46. Do you pay for the water from the dam? Yes (1) No (20 _____

47. If yes how much do you pay _____

48. Do you experience any food shortages Yes (1) No (20 _____

49. If yes, do you receive any relief food when there is food shortage

_____

50. List the other uses of water from the dam

51. Method of water transport

(a) Human

(b) Animal

(c) Others

52. Who own the land on which the dam is built? Private (1) communal (2)

_____

53. If communal, does the land have a title deed? _____

54. Who manages the dam? _____

55. What do you consider to be the most important need for the community at the moment.

(a) Electricity (1)

(b) A road (2)

(c) A dispensary (3)

(d) A water source (4)

56. Arrange them in order of priority.

57. What according to you do you think should be done to improve the water from the dam _____

APPENDIX 2

Impact of Small Community Dams on Arid and Semi-Arid Lands Development.

A Case Study of Gachoka Division in Mbeere District.

MACHANGA AGRICULTURE MECHANISATION STATION (AMS)

OFFICIALS

Checklist

1. When was this station started

2. How many dams have you constructed in this district in order of division

3. Who finances the construction of the dams

4. What factors do you consider in construction of
   (a) Weir dams
   (b) Earth dams

5. Who are the main stakeholder in the dam construction

6. What are the cost of construction a weir dam (according to size)

7. Do you involve the community in the constructions of the dams.

8. What is the future of dam in this area?

APPENDIX 3

Checklist for Plan International

Impact of Small Community Dams on Arid and Semi-Arid Lands Development.

A Case Study of Gachoka Division in Mbeere District.

1. For how long have you been operation in the district?
2. How many water projects have you been involved in since you started operating in district?
3. How many dams have you been involved in
   (a) Construction
   (b) Rehabilitation
4. Do you involve the community in the planning design and implementation of the water project Yes/No
5. If yes how do you involve the community
6. Do you incorporate is public health and environmental issues in water projects?
7. Have you carried any evaluation of the water projects that you have helped install?
8. Are you involved in water harvesting initiatives in the division Yes/No?
9. If yes, how
10. What is the attitude of the people towards improved water supply in Gachoka Division?
11. According to you, how can the problem of water shortage be alleviated in Gachoka division?
12. What is the organizations future water plans for the area.

APPENDIX 4

Checklist: District Water Offices

Impact of Small Community Dams on Arid and Semi-Arid Lands Development

A Case Study of Gachoka Division in Mbeere District.

1. As the office in charge of water in the district, what is the situation of water problem in the district?
2. Given that Mbeere is a semi-arid district, what appropriate measure has your office identified in solving the water problems in the district.
3. How many dams (earth, weir, pans) are in the district (in order of division their capacity and year of construction).
4. Is the ministry involved in dam construction in the district Yes/No?
5. If yes, are there any legal requirements in the construction of dams?
6. Do you involve the community?
7. What is the quality of the water from the dam? (Does the ministry conduct water quality tests to ascertain whether the water is suitable for human consumption?
8. Has the ministry identified sites for future construction of earth/weir dams?
9. What is the future water plans for the district?