U N I V E R S I T Y O F N A I R O B I

ASSESSMENT OF SMALL DAMS AND PANS IN TANATHI WATER SERVICES BOARD

BY

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OCTOBER 2014

DECLARATION:

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

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DEDICATION

I dedicate this work to my wife Lilian, who has put in much effort to ensure the completion of this thesis. May God Almighty bless her abundantly for her resilience, affection, support, and encouragement throughout the period I undertook to prepare this thesis.

I also dedicate the same to my three daughters who missed my company as I struggled to complete the thesis.

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I take this time to express my deep appreciation to the Almighty God who has provided all that I needed throughout my academic program

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ACRONYMS

Ag GDP	Agricultural Gross Domestic Product
ASAL	Arid and Semi-arid Land
BH	Borehole
BoD	Board of Directors
CAAC	Catchment Area Advisory Committee
CBA	Cost-Benefit analysis
CE	Cost-Effective(ness)
DANIDA	Danish International Development Agency
DCU	Dam Construction Unit
EIA	Environmental Impact Assessment
E&M	Evaluation and Monitoring
FAO	Food and Agricultural Organization
FY	Financial Year
GDP	Gross Domestic Product
GoK	Government of Kenya
GWP	Global Water Partnership
ICID	International Commission on Irrigation and Drainage
ICOLD	International Commission on Large Dams
IHA	Integrated Healthcare Association
IDAM	Integrative Dam Assessment Modelling
IWRA	International Water Resources Association
IWRM	Integrated Water Resource Management
JICA	Japan International Cooperation Agency
KEWI	Kenya Water Institute
KWAHO	Kenya Water for Health Organization
LVNWSB	Lake Victoria North Water Services Board
LVSWSB	Lake Victoria South Water Services Board

m^3	cubic meters
m^3/day	cubic meters per day
MWI	Ministry of Water and Irrigation
MEWNR	Ministry of Environment, Water and Natural Resources
NGO	Non-governmental Organization
NIB	National Irrigation Board
NWCPC	National Water Conservation and Pipeline Corporation
NWMP	National Water Management Plan
PC	Performance Contract
RVWSB	Rift Valley Water Services Board
RYI	Return Year Interval
SWS	Structure for Water Storage
UN	United Nations
UNDP	United Nations Development Program
UNEP	United Nations Environmental Program
USA	United States of America
WAB	Water Appeals Board
WRM	Water Resources Management
WRMA	Water Resources Management Authority
WRUA	Water Resources User Association
WSRB	Water Services Regulatory Board
WSB	Water Services Board
WSP	Water Services Provider
WSTF	Water Services Trust Fund
UN	United Nations

ABSTRACT

Water is crucial to sustaining life and many resources are expended in water development and management with the intention of making it accessible so as to improve people's lives and promote civilization. The making of water accessible to people is achieved partly through the development of structures for water storage (SWSs) such as dams and pans worldwide. In Kenya, the National Water Conservation and Pipeline Corporation (NWCPC) is mandated to develop SWSs.

This study examines the cost effectiveness of the implementation of small SWSs in Kenya by NWCPC. The main study was limited to TANATHI Water Services Board. The study looks at various aspects of cost effectiveness such as achievement of project objectives and resource utilization among other aspects. Previous studies were reviewed while various stakeholders were also interviewed during data collection. Field and desk studies were done in Tanathi Water Services Board area using random sampling of the identified population.

The results reveal that NWCPC has been effective in implementation of small SWSs. The main benefit noted was the improved water availability for domestic and livestock uses among several other benefits. Nonetheless NWCPC still has room for improvement such as in the completion of SWSs within the scheduled time, monitoring and evaluation and community involvement.

The study highlights some of the negative issues resulting from the implementation of the SWSs such as conflicts, loss of livestock, diseases and influx of wild animals. It also includes proposals on how NWCPC could be more cost effective in the development of SWSs. These include improving the time taken to implement SWSs, constructing larger reservoirs for longer storage periods and involving the stakeholders.

Finally areas identified for further research are included at the end of the report.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

LIST OF ANNEXES

1 CHAPTER ONE

1. INTRODUCTION

1.1. BACKGROUND TO THE PROBLEM

Water is essential for sustaining life, socio-economic development and for maintaining healthy ecosystems. Although water covers more than seventy percent of the earth's surface, only one percent of the Earth's water is available as a source of drinking (Alphaomega, 2012). Freshwater is a finite and vulnerable resource. There are various sources of water in the world, but generally the main sources are surface water (rivers or lakes, springs, rock catchments, excavated dams, rain water tanks, boreholes (BHs), wells, artesian boreholes among others (Australian Govt., 2010).

There is a growing demand for water, food and energy, which has led International Commission on Large Dams (ICOLD) and other international organizations to make a declaration to the effect that in order to address the issue, solutions for better use of water resources need to be developed, especially for developing countries (ICOLD, ICID, IHA, IWRA, 2012). Despite the growing demand for water, the available water resources are diminishing as a result of several factors such as climate change, man's over-exploitation of the natural resources like forests which help in water conservation. This trend coupled with both population increase and demands from development is putting an ever-increasing strain on these diminishing water resources. Furthermore, many of the man-made water resources are getting de-commissioned since they are gradually running out of their life spans. Pollution of water resources and wastage continues to further lessen the already diminishing available potable water. The resulting intensifying pressure on water resources has in the past led to tensions, conflicts among users, and excessive pressure on the environment (UNEP & DHI, 2009) (UN-Water, 2006).

It has been noted that access to safe drinking water is correlated to Gross Domestic Product (GDP) per capita and that though there is enough water for everyone, access to it is remains a challenge (World Bank, 2004) (Davis & Hirji, 2003). Water scarcity worldwide and especially in developing countries such as Kenya is a challenge which the international community acknowledged by adopting Integrated Water Resources Management (IWRM) strategies (UN-Water, 2006). Throughout history, measures have been taken by various civilizations to try and address these challenges but the challenges still remain.

The harnessing of water for use during the dry seasons is gradually getting more urgent as environmental degradation, especially the continual loss of forest and soil cover which has led to increasingly higher surface runoffs and more damages caused by flooding. This calls for development of structures for water storage in the form of dams, water pans, flood control structures and augmentation of water supplies with boreholes in order to try to harness enough water.

In Africa the water potential is still under-utilised as compared to the rest of the world and in view of the ever rising population, water demand and other factors it begs the question what sustainable measures can be set up in order to address these concerns. Various measures have been taken to address these challenges now and in the past, both in development, management, operation and maintenance. Questions are being raised about how effective these measures are and whether or not there are, or could have been, better ways of addressing them. According to Davis and Hirji access to water is hampered by mismanagement and corruption (Davis & Hirji, 2003). As a result of the mounting need for accountability and effectiveness in all sectors including the water sector both regionally and globally, concerns have been raised regarding the effectiveness of the implementation of water projects.

Due to the low water storage per capita in Kenya the Ministry of Water has recommended that urgent moves be made to maximize investment in storage in

order to capture the substantial annual runoff of 20 billion cubic meters (MWI, 2009). This is one reason why this study is timely.

National Water Conservation and Pipeline Corporation is a state parastatal under the Ministry of Water and irrigation charged with the responsibility of constructing structures for water storage in the whole country of Kenya. It also commands a substantive budget within its parent ministry therefore it has been selected for this study. It undertakes the construction of structures for water storage in Kenya which include large and small dams and pans as part of its mission to enhance water security and storage for multipurpose uses, mitigation of drought and flood effects in a sustainable manner in Kenya (NWCPC, 2010).

This study aims to examine how cost-effective the development of these precious resources has been worldwide but more locally in Kenya and particularly in the development of structures for water storage (SWSs) in Kenya. The history of the use and development of these resources shall be studied briefly considering the worldwide, regional, and Kenyan context. The Government of Kenya has embarked on addressing the water harvesting issue through the Ministry of Water and Irrigation which is leading in these exercises partly through the construction of large and small dams and pans.

NWCPC and other institutions involved in the development of structures for water storage in Kenya were examined and consulted for information on the subject of study either physically or by consulting literature and reports on their involvement in the same. The study is expected to add to the existing knowledge on the cost-effectiveness of the implementation of structures for water storage in Kenya. The results of the study are expected to assist in determining areas where changes could be made in the planning and execution of projects for water storage in order to achieve the intended objectives with regard to the costs incurred. Consequently this is more reason as to why this study is timely.

1.2. PROBLEM STATEMENT

The need to address the ever increasing water demand, which is occasioned by several factors including increased development of industries such as manufacturing and construction, rise in exportation of water-demanding goods and increased population, makes the construction of SWSs and important issue. The resulting competition for water in many areas for instance drinking water and farming water has resulted in a subsequent rise in the value of water (UNEP & DHI, 2009).

Much of the Kenyan rain falls in less than twenty percent of the land in the Central Highlands and Lake Region. Nearly eighty percent of Kenya is arid and semi-arid meaning most of it lacks water/rainfall for the better parts of the year. The rainfall is variable in both space and time. (World Bank, 2004).

The goal of implementing SWSs especially in the arid and semi-arid areas is to tap as much water as possible during the rainy seasons to be utilized during the dry months of no rain. This is intended to assist the residents by lessening the distance they cover from their homes to obtain water for domestic and livestock uses thus freeing up some of their time to engage in other economic pursuits.

In Kenya, NWCPC is one of the key institutions involved in the construction of SWSs. The increasing strain on the government finances calls for the SWSs to be constructed in the most cost effective manner possible in order to optimise the available resources. Such constructions are expected to be done to the best standards possible technologically considering their designs. They are also expected to be constructed efficiently under strict supervision to ensure completion within the time targeted to avoid cost overruns. These measures are expected to enable the SWSs live to their full design lives and achieve their intended purposes.

The above ideal scenario is however not always achieved. The possible reasons could be insufficient budget allocation, inadequate supervisory staff and transport, insufficient time allocated to undertake SWS construction, late availing of design documents among other reasons. This could lead to late, poor or no construction of SWSs, possible SWSs collapse resulting in destruction, loss of investments or even death, continued water scarcity and possible conflicts, including adverse publicity to the Government of Kenya (GoK) and NWCPC amongst other negative results. Bad governance may influence donors to withdraw development funds (KWAHO, 2009).

With proper planning and execution, it is however expected that the SWSs shall be implemented to the satisfaction of all involved stakeholders. There shall be advantages such as positive publicity for the organizations in charge of SWS constructions, increased water availability, fewer conflicts, and enhanced general well-being of the communities utilizing the SWSs. It is also expected that more finances would be availed for implementation of more SWSs as a result of increased donor confidence in the resource utilization by the implementing agencies.

In Kenya the assessment of water resources coverage is inadequate while data collection is irregular and un-coordinated. The data base and information flow in the water sector is characterized by data gaps resulting from disruption in water resource assessment programs. The result is that decisions regarding water utilization, water resource development and protection cannot be properly made. Technology currently in use is old, inadequate and inefficient. (MENR, 2002) Furthermore the effectiveness of implementation of SWSs in the country of Kenya has been put to question in the past but there isn't sufficient information that has been analysed in detail and documented for addressing this effectiveness (MWI, 2009). This study shall therefore assist to fill this knowledge gap and also help improve the implementation of SWS projects in order to uplift the living standards of the target population.

1.3. OBJECTIVES

The purpose of this study was to assess the cost-effectiveness of the implementation of small SWSs by NWCPC in TANATHI Water Services Board and to establish how their implementation could be improved.

Thus the objectives of this study were the following: -

1. To identify the small SWSs constructed by NWCPC in TANATHI Water Services Board area and their intended objectives.
2. To examine the costs of construction and the resources utilized by NWCPC in the construction of small SWSs and ascertain the effectiveness of their utilization.
3. To analyse the cost-effectiveness of small SWS projects in TANATHI Water Services Board area.
4. To propose methods that could improve cost-effective construction of small SWSs.

1.4. RESEARCH QUESTIONS

In order to address the research objectives as highlighted above, the following research questions were to be answered: -

1. What kind of small SWSs does NWCPC construct in Tanathi Water Services Board area?
2. To what extent have the small SWSs constructed by NWCPC achieved their intended purpose?
3. What resources are utilized by NWCPC and what costs are involved in the construction of the small SWSs?
4. How effective is the resource utilization by NWCPC?

5. What is the cost-effectiveness of the small SWSs constructed by NWCPC?
6. How can NWCPC improve the construction of small SWSs?

1.5. STUDY LIMITATIONS

The study was limited by various factors which include time and financial constraints. Budgetary constraints made it difficult to sample as large an area as possible and so the study could only be limited to one Water Services Board (WSB). Time limitations were also encountered as was keeping the finances as much as possible to within the budget. It was therefore decided that the study would only be limited to small dams and pans constructed between the years 2009 and 2012.

Lack of sufficient data especially relevant reports on small SWSs were a challenge especially from other institutions undertaking similar works. The researcher attempted to obtain alternative sources of information so as to obtain sufficient data, otherwise careful projections were made where necessary including reasonable assumptions.

The researcher also came to the realization that it would not be possible to conduct a study on all the small SWSs that NWCPC is involved in, namely small dams, pans, among others. This is because the time involved in such an undertaking would be lengthy. This is one more reason why the study was limited to only one water services board area.

Few studies have been done on NWCPC regarding cost-effective construction of SWSs. This study therefore relied heavily on raw information from the institution, study questionnaires that were administered and the relevant reports available within and without the institution.

The study also heavily relied on information published on the internet from reliable sources due to the foregoing reasons. This method assisted greatly as less time and resources were spent in obtaining the information, not to mention the fact that the information was both fairly current and from relevant situations encountered all over the globe.

1.6. SELECTION OF NWCPC

The reasons for selecting NWCPC as the subject of this study are that NWCPC is one of the key institutions mandated to undertake the development of SWSs in Kenya as discussed in the literature review. Its operations have considerable effect on the water resources development and eventually on the lives of those affected.

NWCPC headquarters is essentially centrally placed within the country of Kenya that is at the capital city of Nairobi thus making it easy for the researcher to access both the information required for this study and nearby areas that NWCPC undertakes its activities.

Since NWCPC's operations are countrywide various areas have different challenges and experiences to learn from and this was expected to add value to the research. Its activities span from the Coastal Region through the South East Arid and Semi-arid Land (ASAL) areas to the highlands of Western Kenya and the Lake Victoria region. It spans also the Rift Valley with its Lake Turkana and the vast ASAL North Eastern region. This wide scope entails various challenges in the implementation of SWSs from which the researcher hoped to gain understanding.

NWCPC also commands a large budget within its parent ministry which is the Ministry of Environment Water and Natural Resources (MEWNR) making it a significant player in the water sector. Therefore its achievements can affect the

sector profoundly. The study conclusions are expected to help improve the effectiveness of the utilization of the funds allocated to NWCPC. This makes the study timely and practically applicable.

Part of the reason for selection of the study of small dams and pans is that the researcher has dealt with them and was acquainted with some of the possible areas that needed studying. Also the fact that small dams and pans are many and widely distributed all over the country and more particularly within the study area provided an abundant source of data from which to carry out the study.

1.7. ETHICAL CONSIDERATIONS

The following are the ethical considerations that were to be adhered to during the research.

1. The research shall comply with any regulations that are in existence and shall supply copies of the research findings to the institutions that are entitled to obtain the same.
2. The study considered all information to be confidential and shall ensure it remains well kept from any unauthorised persons even after the research is concluded. The study shall protect the identity of any informants.
3. The study encouraged honesty and complete information was provided to the respondents so they could make proper decisions on whether to participate in the study or not. The respondents were guaranteed anonymity and confidentiality, and were informed that the study was mainly an academic exercise and so there were no benefits/compensations arising from taking part in the administration of the questionnaires.
4. The study has endeavoured to acknowledge all the sources of intellectual information that not the author's.

2 CHAPTER TWO

2. LITERATURE REVIEW

2.1. INTRODUCTION

This chapter looks at what has already been done in the past in relation to the research problem and reviews relevant aspects noted in relation to the needs of the present study. Study of past literature is intended to identify gaps, which this study may fill or propose for further research. The literature review shall look at aspects such as water resources, their development and management strategies worldwide and in Kenya, costs involved in implementing SWSs in Kenya and other countries, trends and “best methods” practised in the cost-effective implementation of SWSs.

2.2. WATER AS A NATURAL RESOURCE

Water is vital for life and good health. It is fundamental for human, domestic, livestock, wildlife, agricultural and industrial uses amongst many others, and therefore a critical natural resource. Water resources contribute a great deal towards economic productivity and the social well-being of the human population. Fresh water is required for agriculture, industrial, household, recreation and environmental activities. Safe drinking water is essential for humans and other forms of life. (Alphaomega, 2012).

A “Water Resource” is described as a source of water that is useful or potentially useful. Although water covers more than 70% of the Earth/s surface, only 1% of the Earth's water is available as a source of drinking. Water is known as a natural solvent for many substances and so it is prone to contamination. Treatment is

done using disinfectants such as chlorine to reduce health risks that result from use of contaminated water (Alphaomega, 2012).

The main water resources are surface water (water directly from rain on the land's surface such as rivers, lakes, rock catchments, excavated dams, rain water tanks, icecaps, snow packs and glaciers) ground water (such as springs, hot springs and geysers) and rain water. These are the main fresh water resources. Water may be extracted artificially from the ground water resource through methods such as normal boreholes, artesian boreholes and wells. Sea or ocean water is a salty water resource (Australian Govt., 2010).

Currently only 3% of earth's water is fresh water while the rest is salty. Out of this, 2% is ice and the remaining 1% is mostly underground water.

Water is a strategic resource and a potential source of conflicts and therefore its proper management is very important. Davis and Hirji argued that there is enough water for everyone, but that access to it is hampered by mismanagement and corruption (Davis & Hirji, 2003).

2.2.1. Water Situation in the World

The population of the world grew from 1.75 billion in 1910 to 3.7 billion in 1970 and was about 6.8 billion in the year 2010 as shown in Figure 2-1.

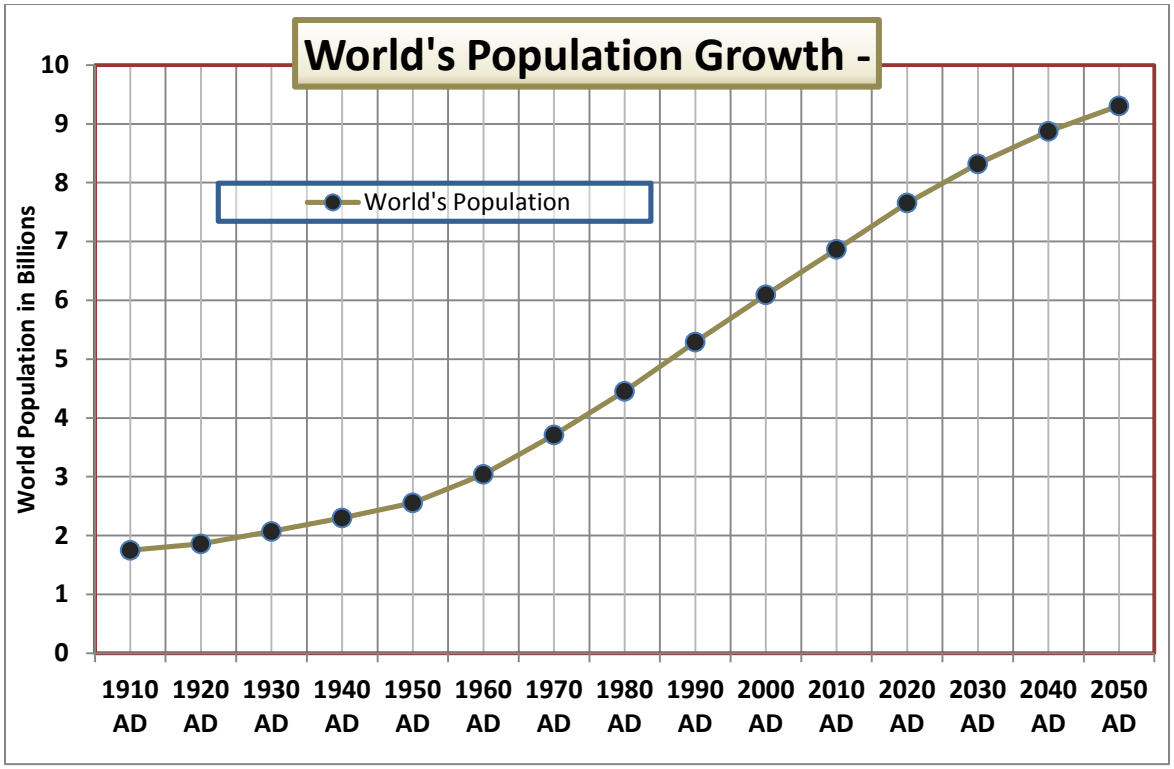

Figure 2-1: World's Population Growth

Source (Ecology Communications Group, 2014)

Currently, over one half of the world's population already live within urban centres while over one billion of the world's people remain without access to safe drinking water. (UN-Habitat, 2008). In order to address this situation it is essential to put into place effective monitoring mechanisms to track the progress towards safe drinking water, globally and at the local level. Strong political leadership support from national governments will be needed to turn things around for the better. This basically implies that good management of water resources is required to address the situation (UN-Habitat, 2003).

Today, the competition for water resources is much more intense. This is because there are now approximately seven billion people on the planet, their consumption of water-thirsty meat and vegetables is rising, and there is increasing competition for water from industry, urbanization, bio fuel crops, and water reliant food items.

In future, even more water will be needed to produce food because the Earth's population is forecast to rise to 9 billion by 2050. Molden (2007) noted that dietary habits impact significantly on the usage of water, for instance cereals require less water than meat and vegetables (UN, 2007).

The United Nations (UN) has noted that much water is lost or wasted and so there is need to improve water management to address this situation (UN Water, 2011).

2.2.2. Water Resources in Kenya

It is estimated that surface waters cover about two percent of Kenya and supply 20.2 billion m^3 of the country's estimated 30.7 billion m^3 of renewable water per year. The rest comes from groundwater and trans-boundary rivers. Natural Renewable Water Resource is defined as the total amount of a country's water resources both internal and external, both surface water and ground water generated through the hydrological cycle. This amount is calculated on a yearly basis. (FAO, 2013)

The majority of Kenya's lakes are in the Great East African Rift Valley and include closed and open-basin systems. Most of the lakes are saline with the exception of Victoria, Naivasha, and Baringo. Kenya's surface waters are fed by five "water towers" representing the country's major drainage areas in the forested catchments. Kenya's water resources include its important wetlands, which cover about 3 to 4 per cent of the land and include coral reefs, marine inshore waters, mangroves, deltas, creeks, lake shores, rivers, marshes, ponds, dams, and mountain bogs. Many communities rely on wetlands for food, medicinal plants, firewood, and many other materials. Wetlands also provide ecosystem services such as filtering and storing water, protecting coastlines from erosion, and as wildlife habitats (UNEP, 2009).

2.2.3. Water demand

Kenya's domestic water demand is ever increasing as shown in Figure 2-2. The figure shows the projected water demand for Kenya up to the year 2030. The projected total water demand for the country (inclusive of domestic, livestock, irrigation and industrial) was estimated at 2,640,340 m^3/day as at 2005 and is expected to rise to over 6,729,377 m^3/day by the year 2030 according to JICA (JICA, 1992). The population growth corresponds to the rise in water demand as indicated by the graphs. From the foregoing data it may be concluded that management of water in Kenya is a vital issue that needs thorough attention and any steps made towards addressing this situation shall be valuable.

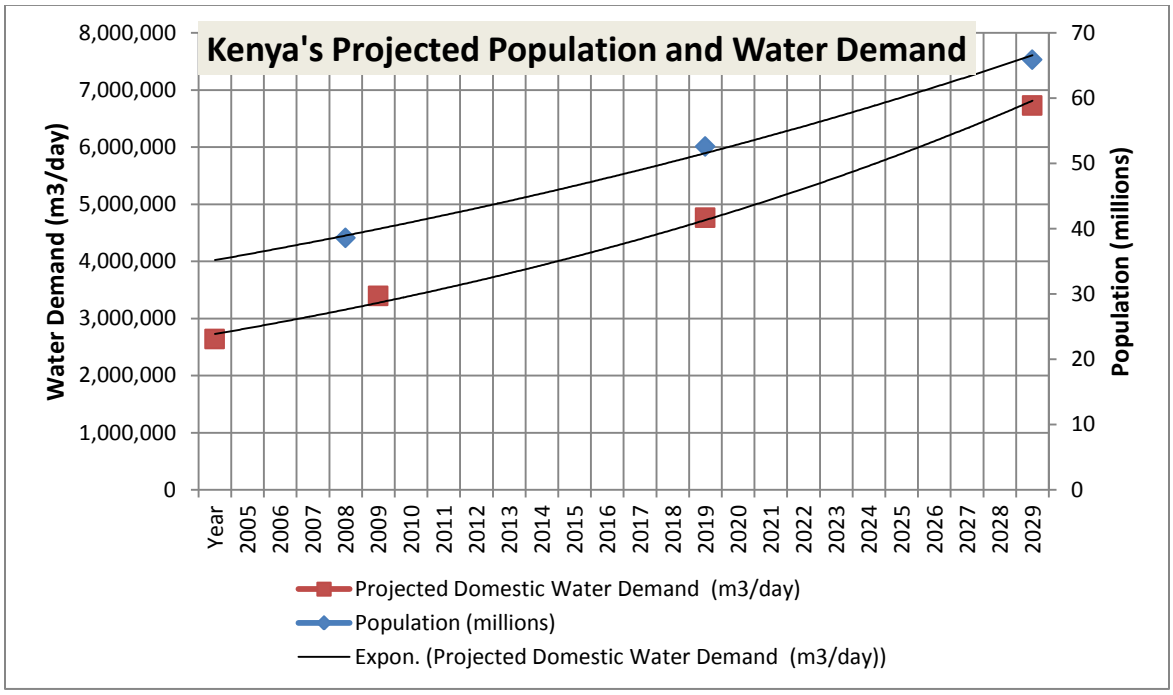

Figure 2-2:Kenya's Projected Population and Water Demand

Source: (JICA, 1992), (Penda Health, 2013)

The chronic water problems in Kenya have been largely attributed to vulnerability of water resources (World Bank, 2004). As Kenya's economy heavily relies on rain-fed agriculture, the variation in rainfall has a significant effect on its Gross

Domestic Product (GDP). Figure 2-3 shows the rainfall variability between 1979 and 2000. During drought years, the Agricultural GDP (Ag GDP) shows a massive deficit while the overall GDP following its deficit trend a little while later.

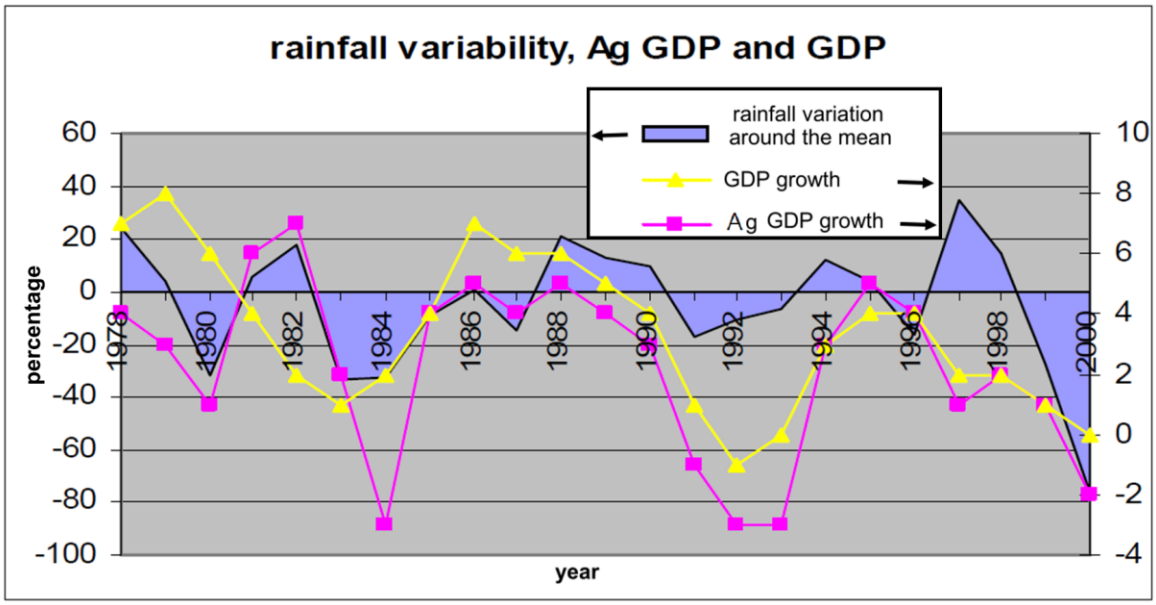

Figure 2-3: Rainfall Variability against Agricultural GDP & GDP

Note: Ag GDP means Agricultural GPD

Source (UNDP & UN-Water, 2013)

According to the Kenya National Water Development Report 2005, Kenya has an annual water runoff of about 20 billion cubic meters. However, in 2003 it had a total storage capacity of only 303 million cubic meters which means the potential of storage capacity in the country is severely underexploited. This level of storage capacity works out to a per capita storage of 9.5 cubic meters. Kenya in comparison with other countries falls far below them in harnessing its potential for water storage. Figure 2-4 shows the water storage per capita in various countries including Kenya.

Simultaneously, the total safe groundwater extraction rate is 193 million cubic meters (5.7 cubic meters per capita). The Ministry of Water recommends that

urgent moves be made to maximize investment in storage in order to capture the substantial annual runoff of 20 billion cubic meters (MWI, 2009).

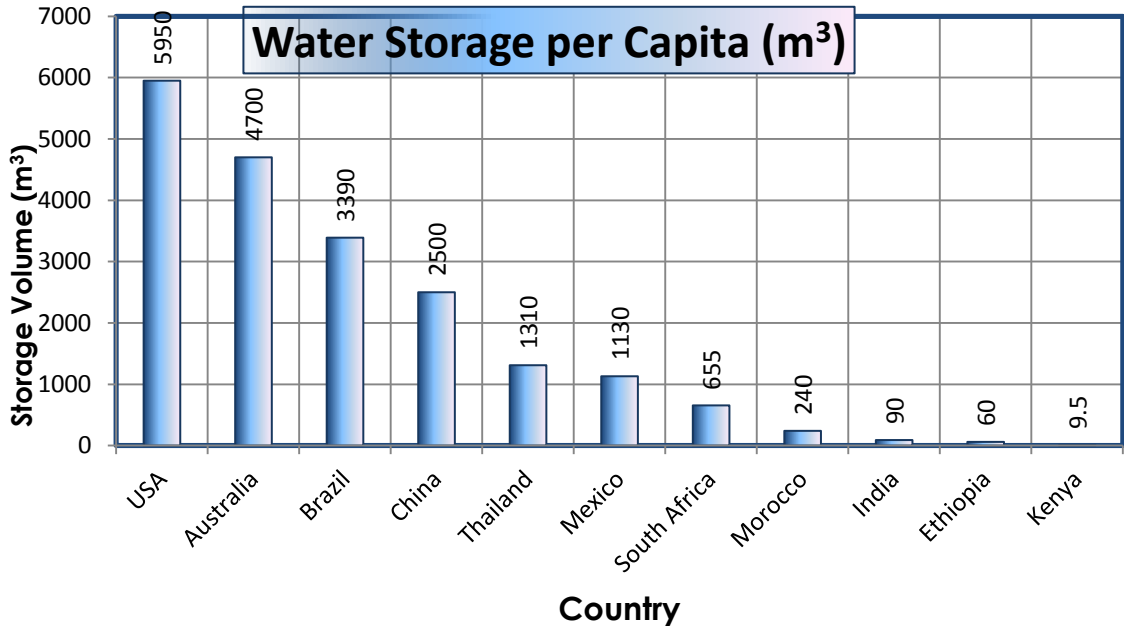

Figure 2-4: Per Capita Water Storage in various Countries

Source: (MWI, 2009)

2.3. DEVELOPMENT OF WATER RESOURCES IN KENYA

2.3.1. Development and Management of Water Resources

It has been indicated by United Nations Environmental Program (UNEP) that many development matters are dependent on water resources management. Over the last 20 years, Chile has successfully incorporated water-related matters into its strategies for sustainable growth. Water has been a key ingredient in fuelling exports and economic growth, and the country has made provisions that

protect the environment and provide affordable water for the poor. Improvements in water-use efficiency have been considerable especially in areas linked to exports, for instance, sophisticated water management systems are now in place in wine production (UNEP & DHI, 2009).

A survey carried out in several continents including Africa showed that countries perform very well in the formulation of policies and the drafting of laws but score very dismally in the cost recovery of water resources management and water demand management. (UNEP & DHI, 2009) The recommendations of the UN-Water survey are that countries lagging behind should prioritize water efficiency measures. (UN-Water, 2008) This indicates that the issue of cost effectiveness is not only a Kenyan problem but one that needs to be addressed nevertheless.

The Fergana Valley was once the most fertile valley in Central Asia but is now subject to high soil salinization and its crops are no longer sufficient to feed its large population. Upon the implementation of Integrated Water Resource Management (IWRM) Actions, there was improved management of water resources, water supply, increased crop yields, and water productivity by up to 30% among other successes (UNEP & DHI, 2009).

Mexico invested heavily in rehabilitation and improvement of water systems and also in operation and maintenance equipment in order to boost agricultural produce and hence the country's economy. National level irrigation reforms employing IWRM principles were undertaken, while decision-making and responsibilities were decentralized, and efficiency was greatly increased. (UNEP & DHI, 2009).

China and the United States of America (USA) have also had similar issues solved by using IWRM techniques.

2.3.2. Comparison of Developed Countries with Other Countries

It has been noted that in the promotion of IWRM, the Developed countries are significantly more advanced on main national instruments, whereas the Asia and the Americas are more advanced on national development plans and national environmental action plans with IWRM components. Of all developing countries, Africa countries are reported to be least advanced with poverty reduction strategies using Water Resources Management (WRM) Components according to UN-Water. As regards the development of water resources, it has been noted that Developed countries are more advanced on most issues, but, not in rain-water harvesting while in developing regions, Asia is more advanced than other developing regions in water resources assessment (UN-Water, 2008).

In water resources management, developed countries are significantly more advanced except in the less relevant areas of combating desertification and irrigated agriculture. Developing regions are very similar though the Americas are more advanced in programs and policies for watershed management, groundwater management and drainage and irrigation; Asia was noted to be more advanced in legislative mechanisms to control pollution of water resources (UN-Water, 2008).

Africa has not developed its water usage techniques as well as the developed countries, thus posing a big challenge to African governments to upscale their activities and plans in this aspect. The recommendations of the UN-Water survey are that countries lagging behind should prioritize water efficiency measures (UN-Water, 2008).

2.3.3. Development of Water Resources in Kenya

In light of the many challenges in WRM facing Africa and especially Kenya in this context, the government of Kenya has been undertaking measures in order to address these challenges. One of the fairly recent steps was the making of the

new Water Act 2002 whereby WRMA was placed as the lead agency in the management of national water resources.

The Water Act 2002 provides for development of new institutions and outlines their roles and responsibilities. One such institution incorporated into the act is National Water Conservation and Pipeline Corporation (NWCPC) with the mandate of managing and developing water projects and for securing an adequate supply of water (NWCPC, 2010).

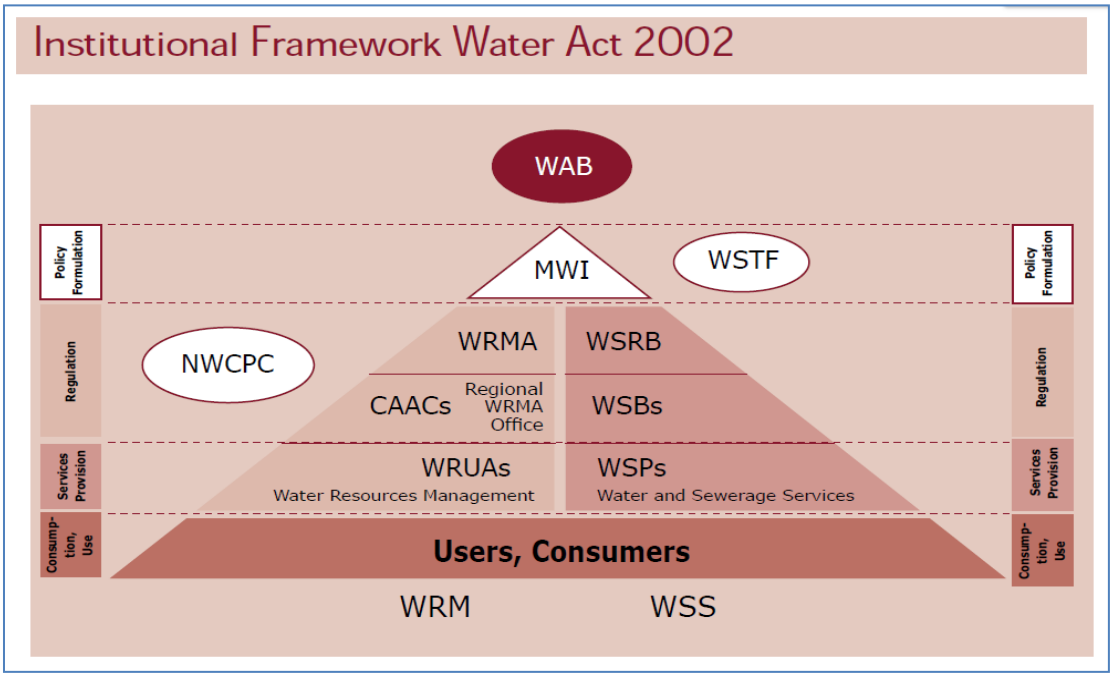

Figure 2-5: Kenyan Water Sector Institutions Setup: (KWAHO, 2009)

The institutions in the water sector are the following in Kenya: Ministry of Water and Irrigation (MWI), Water Resources Management Authority (WRMA), Catchment Area Advisory Committee (CAACs), Water Resources User Association (WRUAs), Water Services Regulatory Board (WSRB), Water Services Board (WSBs), Water Services Providers (WSPs), Water Services Trust Fund (WSTF), Water Appeals Board (WAB), Kenya Water Institute (KEWI), NWCPC

and National Irrigation Board (NIB). Their responsibilities were distributed according to their assigned roles (GDI, 2007).

In 2006 it was reported that there were 26 large dams and about 3,000 small dams and water pans in Kenya with a storage capacity of approximately 124 million cubic meters. The storage capacity had been low attributable to the fact that investment levels in water management infrastructure had been inadequate and had been on a declining trend for many years. Now emphasis is being made towards the development of water resources while further emphasis is being made towards regional cooperation between riparian countries, those that share water resources with Kenya such as rivers and lakes (UN WATER, 2005).

2.3.4. Trends in the effective implementation of SWSs

One of the trends in the development of SWSs has been the preparation of roadmaps for their implementation and this has facilitated the implementation of national plans in the development of SWSs. Another trend in service delivery development for public projects in Kenya has been the introduction of Performance Contracts (PCs), which ensure that top-level managers are accountable for results and that they enhance efficiency and ensure that resources are focused on attainment of key national policy priorities of the government (DANIDA, 2010).

Reforms have also been undertaken in the water sector with positives outcomes such as better sector organization, increased attention and investment in poor and marginalized areas of Kenya, increased investments in the water sector (Kshs. 2 billion 2002 to Kshs. 28 billion in 2009) and improved governance, with corruption in the sector being addressed. As a result of these trends the water sector is now attracting quality professional mix (Ombogo, 2009). Figure 2-6 shows the trend in funding in the water sector as from the year 1998 to 2004.

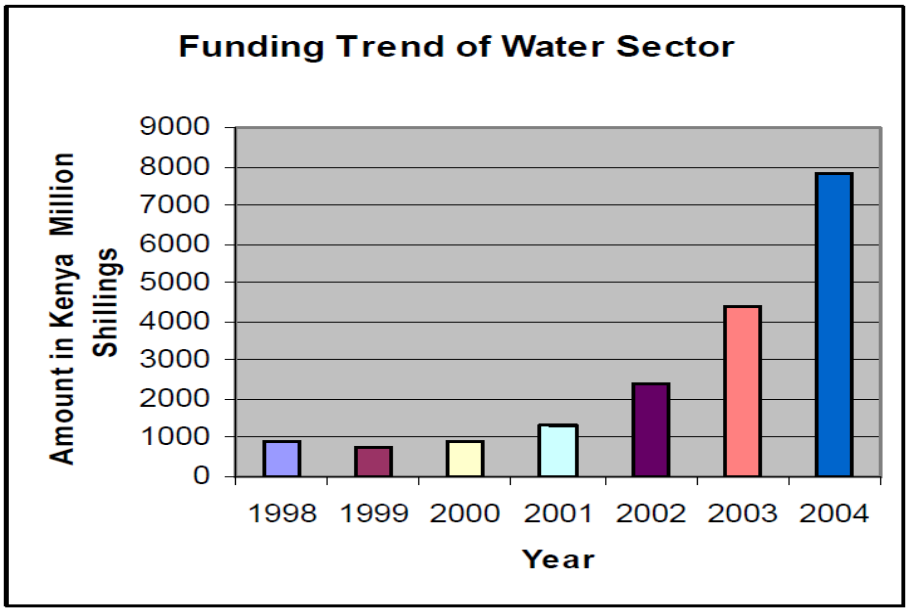

Figure 2-6: Funding Trend in the Water Sector: **(KWAHO, 2009)**

Challenges have also been experienced during the implementation of the reforms. The sector still needs more resources in order to maintain, or better still, improve the trend of ongoing reforms. There is still need to improve sanitation coverage in rural areas and informal settlements and to continue with the mainstreaming of human rights to water and sanitation. Furthermore there is also a lack of critical capacity in the areas of governance, human rights, commercial orientation and regulation including sector monitoring and evaluation. There is also inadequate communication and information management systems, complaint and feedback mechanisms (Ombogo, 2009).

2.4. STRUCTURES FOR WATER STORAGE (SWSs)

2.4.1. Examples of Structures for Water Storage

Structures for water storage (SWSs) are constructed on land for the purpose of storing water for use for various needs. The following are examples of structures for water storage:

(1) **Pan** - Hollowed place in the ground which retains water for a period of time. These are normally made by scooping out soil to make a large shallow hole. In other areas they are known by different names such as ponds and in India nadis or talabs (Australian Government, 2010). Such structures are also called Pan-Dams which are sometimes placed at the bottom of a slope to aid water collection. However, this can only be done in areas where the soil will not allow the water to drain away very easily through the ground, for example, in clay soils. If a community wants a dam in an area where the soil is not impervious this can still be done by digging the hole and lining it with clay or an impervious liner, such as concrete or heavy plastic (Australian Government, 2010).

(2) **Dam** - it is described as a barrier controlling flow of water, or a wall of earth or concrete to keep back water. It also may refer to the water kept back by such a structure (FarlexInc, 2013). It is further described as an artificial barrier that has the ability to impound water, wastewater, or any liquid-borne material, for the purpose of storage or control of water (ICOLD, 2007).

Plate 2-1: Kwa Ngii Dam Reservoir

Plate 2-2: Kwa Ngii Dam Embankment

(3) **Ponds** - These are like water pans on the ground, island bodies of standing water that are smaller than a lake. Natural ponds form in small depressions and are usually shallow enough to support rooted vegetation across most or all of their areas (FarlexInc, 2013)

(4) **Weirs** - A weir is a barrier across a river which causes water to pool behind it yet allows excess water to flow over the top. It is commonly used to alter the flow regime of the river, prevent flooding, measure discharge or help render a river navigable. It is usually smaller than most conventional dams.

(5) **Water tanks** - These are containers for storing water for drinking, irrigation agriculture, fire suppression, agricultural farming of plants and livestock, chemical manufacturing, food preparation as well as many other applications. They are constructed using various materials such as plastic, wood, concrete and metal.

2.4.1.1. Benefits of SWSs

One of the fundamental benefits of dams is the availability of adequate quantities of water with the appropriate quality and an adequate supply of energy. Due to the variations in climate some SWSs are helpful in storing water for providing a consistent discharge to maintain the required water throughout the dry spells.

Dams are needed to supply water for domestic and industrial use, agricultural and industrial use (such as steel production which requires approximately 245m^3 of water to produce 1 ton of steel), flood control, hydro-power generation inland navigation, recreation among others.

How detailed the planning for a dam shall be depends on its size and includes decision on how much public involvement there shall be, addressing of socio-economic issues associated with the dam, and consideration of environmental impact assessments (EIAs). Rigorous economic analyses of the benefits and costs for environmental mitigation and for the whole dam generally need to be addressed more especially for large projects.

Dams have been built with the intention to improve human quality of life by diverting water for power, navigation, and flood control, but have also resulted in human health concerns and environmental problems. Dams benefit people by providing usable, reliable water sources. In the once swampy San Joaquin Valley in California, they have created an area that now provides a quarter of America's food supply.

Hydroelectric dams provide 13% of the total power generation in the United States which prevents over 200 million tons of carbon dioxide emissions. In Latin America they supply 70% of the power generated.

Dam projects can produce greenhouse gases by flooding areas and increasing the rate of decomposition, emitting carbon dioxide and methane. This was considered very important such that a UN commission was set up in 1997 to monitor and evaluate impacts of current, existing and future dams. However the one thing that remains clear is that the need for energy and water will not go away. (EHSO, 2011)

Dams and water resources are important because they provide water for drinking, irrigation, recreational opportunities, hydroelectric power, river navigation, flood control, and many other needs. Dams are built to control water and are usually made from earth, rocks or concrete and are usually constructed on rivers to store water in a reservoir. They store water in the reservoir during times of excess flow, so that water can be released from the reservoir during the times that natural flows are inadequate to meet the needs of water users.

Plate 2-3: Kiserian Dam in Kajiado, Kenya

2.4.2. Development of Dams

The engineering of dams is a vital part of the story of civilization. Reservoirs for water supply were among the earliest structures devised by mankind even as early as 4000BC. More recently however population growth and increased consumption of water has caused the rate of dam construction and water conservation structures to increase. (Pereira, 1973) (Jansen, 1980)

Dams and reservoirs have been used for more than 4000 years, many of which are still in operation today. During the Roman Empire, low dams for water supply were built by the Romans. Later, European engineers refined the design and construction knowledge in the 19th century that gave rise to the capability to construct dams to a height of 45-60 meters (Jansen, 1980), (ICOLD, 2007).

Plate 2-4: Kirandich dam, Kenya

Source: (Italian Development Corporation, 2014)

The increased demand for water has increased the need to build dams for storing large amounts of water. Most dams are between 15 and 29 meters in height, and reservoirs, like the one shown in Plate 2-4, continue to serve the same purposes of meeting the social and economic needs throughout the world (ICOLD, 2007).

A large number of dams have had to be built to satisfy the ever increasing demands for water for various purposes, and also later to generate hydroelectric power. Therefore the construction of SWSs (specifically dams) increased steadily as a solution to such challenges. Both large and small dams have been constructed in more recent times and both of these have their variant positive and negative aspects for both developing and developed nations as they strive to solve the intricate water problems of urban and rural areas. (Biswas & Tortajada, 2001)

2.4.3. Types and Purposes of Dams

Dams are categorized into several types. There are Arch dams, Gravity dams, Barrages, Embankment dams, Earth-fill dams, Rock-fill dams, Concrete face rock-fill and Asphalt-concrete core dams among others. Dams are usually made from earth, rocks or concrete and are usually constructed on rivers to store water in a reservoir.

Dams are used for various purposes such as irrigation, land reclamation, water diversion, recreation, hydro-electric power generation, river navigation, flood control, providing water for drinking and many other needs. A dam is built to control water. They store water in the reservoir during times of excess flow, so that water can be released from the reservoir during the times that natural flows are inadequate to meet the needs of water users.

71.7% of the dams in the International Commission on Large Dams (ICOLD) register are single-purpose dams, but there are a growing number of multipurpose

dams. Today, irrigation is the most common purpose of the dams as noted in the ICOLD register. The distribution for each purpose among the single-purpose dams is such that 48.6% of dams are mainly for irrigation while 17.4 % are for hydropower generation. Another 12.7% of them are for water supply with 10.0% being for flood control while 5.3% are for recreation. 0.6% of the dams are for navigation and fish farming leaving a balance of 5.4% for other uses (ICOLD, 2007).

2.5. NATIONAL WATER CONSERVATION AND PIPELINE CORPORATION

2.5.1. Background

NWCPC headquarters is located in the Industrial area of Nairobi. The functions it undertakes of developing water resources are countrywide. NWCPC commands a significantly large budget within its parent Ministry of Water and Irrigation and its operations have a significant effect on the water sector.

The National Water Conservation and Pipeline Corporation has been operational since 1st July, 1989 after it was established vide a legal notice on 24th June 1988 under the State Corporations Act Chapter 270, as an autonomous agency reporting to the then Ministry of Water Development. The Corporation was created mainly to commercialize and improve the performance of the water sector operations, thereby achieving financial autonomy. Later on, the mandate was expanded to include assisting Government in the formulation and execution of National Water Policy, and developing state schemes in areas where it was appointed water undertaker. NWCPC is currently the construction arm of Kenya's Ministry of Environment, Water and Natural Resources.

As a result of the water sector reforms under Water Act 2002 and later on vide the Cabinet instruction of 21st October 2004 the mandate of the NWCPC became:-

- To develop state schemes, and spearhead dam construction, both large and small dams, for water supplies, flood control and other multipurpose uses, land drainage, construction of dykes and drilling of boreholes;
- To carry out ground water recharge using flood water;
- To develop new water supplies, retain existing ones and expand bulk water supply to Water Services Boards and other service providers (NWCPC, 2010).

NWCPC then set its objectives to increase the storage capacity of water especially in the ASAL areas, improve water security and efficiency in accessing water, reduce risks of floods and drought and create schemes for reliable water supply and strengthening of its own internal capacity to carry out its programmes and projects.

NWCPC has been undertaking these construction projects until 2013. It is organized as shown in the attached Annex 1, with a board of directors, a Managing Director, who leads 5 departments headed by General Managers namely Construction and Electromechanical department, Planning and Design department, Finance department, Human Resource and Administration department and Corporate and Legal Services department.

As part of the measures taken in the development of water resource structures, the strategies proposed included improving the storage capacity of small dams and pans, construction of large dams, development of ground water and water schemes, undertaking flood mitigation measures, identifying and developing potential areas for ground water recharge and carrying out drought mitigation programmes.

NWCPC has been undertaking the construction of the above projects to date. Dams have always included both large and small dams and water pans.

2.5.2. NWCPC's Vision, Mission, Goals and Strategies

NWC's vision is to be the leading organisation in the development and management of water resource structures in Kenya and beyond. Its mission is to ensure enhanced security and availability of adequate and reliable water for multipurpose use and to mitigate the effects of floods and drought. The overall goal of NWCPC is to enhance social and economic well-being of Kenyans through improved access, availability and reliability of water supply (NWCPC, 2005), (NWCPC, 2010)

The approach initially proposed by NWCPC in its strategic plan included: -

- Improving the storage capacity of small dams and pans;
- Construction of large dams identified in strategic locations;
- Development of alternative sources of ground water in all areas of Kenya;
- Development of water schemes in various areas of Kenya;
- Undertaking flood mitigation measures;
- Identifying and developing potential areas for ground water recharge;
- Carrying out drought mitigation programmes.

2.5.3. NWCPC WATER PROJECTS

Since the water sector reforms in 2005, the Corporation has achieved significant progress in design and implementation of water infrastructure projects in line with its formative objectives. Up till 2013, NWCPC has been instrumental in providing water infrastructure solutions. These projects will facilitate in alleviating the perennial water problems experienced especially in the arid and semi-arid areas and provide water for domestic and irrigation uses. (NWCPC, 2012)

2.5.3.1. Large Dams

The Government of Kenya through the Corporation is currently constructing four large dams; Kiserian Dam in Kajiado County, Badasa Dam in Marsabit County, Chemususu Dam in Baringo County and Umaa Dam in Kitui County.

Plate 2-5: Chemususu Dam under Construction

The Corporation has also completed Maruba Dam in Machakos County which is providing water to Machakos Town. It is expected that these large dams will increase water storage in Kenya by 20.94 million cubic meters and provide potable water to over one million people with a water supply of 60,550 cubic meters a day. (NWCPC, 2012).

2.5.3.2. Small Dams and Pans

Between 2005 and 2011 NWCPC constructed over 926 small dams and water pans that have increased the volume of water by over 16 million cubic meters at a total cost of over Kshs 3.4 billion within the arid and semi-arid lands. The water

secured in these dams is adequate to serve approximately 1.8 million livestock and 700,000 people. This therefore increases the overall number of pans and dams in Kenya to over 5,026. This figure does not include those done by the WSBs themselves and other institutions and non-governmental organizations (NGOs) within that period. Some projects so far undertaken are such as sub-surface dams an example being the Libahillow subsurface dam in the former larger Garissa district (NWCPC, 2012).

In order to undertake the supervision of the small dams and pans the NWCPC has one head of department, one Head of Construction division and two deputies all located at the headquarters. Finally for supervising the construction Contractors it has one supervisor assigned to one or more the SWS project sites. This is the general management arrangement for all small SWS projects.

2.6. COST EFFECTIVENESS

2.6.1. Cost-effectiveness Analysis

Cost-effectiveness analysis is a decision-making assistance tool. It identifies the economically most efficient way to fulfil an objective. It presents alternatives in order to identify the most appropriate one to achieve a result at least cost. The comparison of various programmes with similar impacts enables the comparison of the costs of each job and provides useful quantitative indicators for the selection of comparative methodologies (Europeaid, 2012). In other words the effectiveness of a project is the measure of the impacts or outcomes. Moreover in order for a project to be fully effective, the community for which it is being done must be involved in the project right from its inception up till its implementation and handing over. (DANIDA, 2010)

Cost-effectiveness analysis can therefore be defined as a type of analysis ratio where a measure of effectiveness is in the numerator while the cost is in the denominator. (ResearchCORE.org, 2013)

Cost-effectiveness analysis involves an assessment of both cost and effectiveness. A cost-effectiveness analysis is only as valid as its underlying measures of effectiveness and cost. However, the methods to make these assessments vary considerably. There are standards for cost-effectiveness, but at times, perfectly adhering to these standards is not realistic, and scientifically legitimate compromises are often made.

Brown et al calculate Cost-effectiveness as the cost/effect implying that the project with the least resultant figure from the calculations is the most Cost Effective project. (Brown, 2010) Levin outlines the method of calculating the Cost-Effectiveness of a project which is done by the identification of ingredients of the project, then the determination of the value or cost of the ingredients and any interventions and finally determining its cost-effectiveness by combining costs and effectiveness (Levin, 1995).

2.6.2. Determining the Cost-Effective Options for SWSs

In determining cost effectiveness of a project one may start by defining the conditions for its use, then evaluating the total cost of the project, assessing the impact of the project and finally establishing the costs-to-effectiveness ratio (Europeaid, 2012).

Although the benefits of dam construction are numerous, particularly in the context of climate change and growing global demand for electricity, recent experience has shown that many dams have serious negative environmental, human, and political consequences. Despite an extensive literature documenting the benefits and costs of dams from a single disciplinary perspective, few studies

have simultaneously evaluated the distribution of biophysical, socio-economic, and geopolitical implications of dams. To meet the simultaneous demands for water, energy, and environmental protection well into the future, a broader view of dams is needed. A new tool called “The Integrative Dam Assessment Modeling” (IDAM) may be used for evaluating the relative costs and benefits of dam construction based on multi-objective planning techniques. (Brown, 2010)

The Integrative Dam Assessment Modelling (IDAM) tool is designed to integrate biophysical, socioeconomic, and geopolitical perspectives into a single cost/benefit analysis of dam construction. The different impacts of dam construction are evaluated both objectively (for instance, flood protection, as measured by RYI years) and subjectively (that is the valuation of said flood protection) by a team of decision- makers.

By providing a visual representation of the various costs and benefits associated with two or more dams, the IDAM tool allows decision-makers to evaluate alternatives and to articulate priorities associated with a dam project, making the decision process about dams more informed and more transparent. Brown considers it an important evolutionary step in dam evaluation. One of its limitations, however, is that the tool requires considerable up-front data requirements for the objective assessments of dam impacts. Such data may not available. Other limitations are that the various individual impacts may not be appropriate to every setting and also that the tool’s value depends on a balanced treatment of each disciplinary perspective. The tool has been used for assessment of large dams in countries such as China. (Brown, 2010)

It has been noted that if suitable sites exist, the construction of valley dams is much cheaper than the construction of excavated tanks and ponds. This is because a small amount of material needs to be moved for each cubic meter of storage capacity created as compared to the manual excavation of tanks and ponds where only one cubic meter of water storage capacity is created for each cubic meter of soil excavated (DANIDA, 2010).

Other considerations are such as: -

- Will the project have any major impact on the environment?
- What will the impact of the project be on local people and how are they involved in its planning and management?
- Does the project address issues which affect the roles and work of men and women in the community (gender issues)?
- Are there any laws, cultural or ownership issues associated with the project which need to be addressed?

The Table 2-1 summarizes the advantages and disadvantages of the various types of SWSs. (Keller, Sakthivadivel, & Seckler, 2000)

Table 2-1: Comparison between various water reservoirs

	Ground Water Storage	**Small Surface Water Reservoirs**	**Large Dam Reservoirs**
Advantages	• Little evaporation loss • Ubiquitous distribution • Operational efficiency • Available on demand • Water quality	• Ease of operation • Responsive to rainfall • Multiple use • Groundwater recharge	• Large, reliable yield • Carryover capacity • Low cost per m3 water stored • Multipurpose • Flood control and hydropower • Groundwater recharge
Limitations	• Slow recharge rate • Groundwater contamination • Cost of extraction • Recoverable fraction	• High evaporation loss fraction • Relatively high unit cost • Absence of over-year storage	• Complexity of operations • Siting • High initial investment cost • Time needed to plan and construct

	Ground Water Storage	Small Surface Water Reservoirs	Large Dam Reservoirs
Key Issues	• Declining water levels • Rising water levels • Management of access and use • Ground water salinization • Ground water pollution	• Sedimentation • Adequate design • Dam safety • Environmental impacts	• Social and environmental impacts • Sedimentation • Dam safety

2.7. COSTS OF IMPLEMENTING SWSs.

2.7.1. Small Reservoirs

According to ICOLD, a small dam is defined as one with a height of less than 15 meters and with an embankment volume generally less than 0.75 million cubic meters. The following discussion of small SWSs includes small tanks and micro-storage facilities such as dug cisterns and farm ponds. (ICOLD, 2007)

Small reservoirs have the advantage of being operationally efficient. They are flexible, close to the point of use, and require relatively few parties for management. Because of these attributes, they can be responsive to demands, the supply to demand mismatch can be small, and managerial and institutional issues are easier to handle. Because of their limited storage capacity, small reservoirs respond rapidly to precipitation runoff, often refilling several times a year. Thus, the actual amount of water delivery from a small reservoir can be several times its one-time storage capacity. The great operational benefit of small storages is their rapid response times. Like groundwater systems, they can respond to rainfall on fields, thus maximizing effective rainfall and minimizing operational losses. Small reservoirs often serve multiple uses such as bathing, washing, animal husbandry, and aquaculture in addition to irrigation. Small reservoir storage is ideal from the standpoint of operational efficiency, but

generally less effective than groundwater or large dams for water conservation. (Keller, Sakthivadivel, & Seckler, 2000)

The high surface area to volume ratio of small reservoirs leads to high evaporation loss. Micro-storage facilities lose, on average, 50 percent of their impoundments to evaporation in arid and semi-arid areas. Other limitations are that their small storage volume does not allow for seasonal or annual carryover and, in addition, there are the cost and safety problems of handling overflow during extreme storm events. The seepage and percolation “losses” from small tanks (for instance in Sri Lanka) account for 20 percent of reservoir volume against 5 percent of reservoir volume in large dams. Also, small dams often are built without adequate climate and hydrologic analysis which leads to inadequate spillways, which can further lead to dam failure through breaching of the embankment. (Keller, Sakthivadivel, & Seckler, 2000)

Perhaps the greatest threat facing existing reservoirs, both large and small, is sedimentation. While highly variable, it is estimated that 1 percent of the total global freshwater surface storage capacity is lost each year to sediment. This does not seem like much until it is realized that the world needs to increase the amount of storage by 25 percent just to stay where we are over the next 25 years! (Keller, Sakthivadivel, & Seckler, 2000)

Contrary to common opinion, it is very difficult to construct safe small dams. First, in order for them to store as much water as possible, it is desirable to have a large catchment area. But large catchment areas have large runoff, exceeding storage capacity in extreme storm events. The water must therefore be spilled over or around the dam. However, it is very expensive to build concrete and steel spillways, and many small dams, especially in developing countries, do not have them. Consequently, water spillage can breach the dam. In addition, small dams often are constructed in the dry season when there is inadequate soil moisture and water to properly compact soil during construction. Consequently, water

seeps through the dam creating “pipes” that can breach a small dam from within. (Keller, Sakthivadivel, & Seckler, 2000)

2.7.2. Large Reservoirs

By 1997, there were an estimated 800,000 dams in the world, 45,000 of which qualify as large dams. More than half of these large dams were constructed in the past 35 years. In 1997, an estimated additional 1,700 large dams were under construction (WCD 1998). The aggregate design storage capacity of the world’s large dams is about 6,000 km^3. Considering loss of storage due to sedimentation or lack of filling, perhaps one-half of the design storage is actually achieved. (Keller, Sakthivadivel, & Seckler, 2000) It is interesting to note that of all the registered large dams in the world only 5 percent is in Africa where most of the water-scarce countries are located.

Large surface water reservoirs have the advantage of greater yield relative to the available inflow than small reservoirs, and their yield is generally more reliable. This is because of lower evaporation loss fractions in large reservoirs due to their greater depth. Because of their depth, many large reservoirs can store water for multiyear carryover to withstand droughts (Keller, Sakthivadivel, & Seckler, 2000). Other advantages of large surface storage facilities include their relatively low cost per unit of utilizable water (see Table 2-2) and multipurpose qualities for instance, hydropower and irrigation. (Keller, Sakthivadivel, & Seckler, 2000) According to the Secretary General of the International Commission on Large Dams (ICOLD), 30 percent of the world’s registered large dams are multipurpose (LeCornu 1998).

Table 2-2: Water Supply Costs (1998 US Dollars)

Technology	**Storage capital costs (US$/1,000m^3)**			**Lifetime delivery costs (US$/1,000m^3)**		
	Low	Median	High	Low	Median[b]	High
Large storage projects (storage and conveyance costs only)	110	270	1,600	2	5	32
Medium and small storage projects (storage conveyance costs any)	130	320	2,200	7	17	110
Micro-storage projects (storage costs only)	160	390	2,500	7	17	110
Dug storage	500	600	1,200	22	35	60
Artificial ground water recharge				190	210	230
Groundwater development and pumping				20	40	110
Diversion projects (inter-basin)				190	200	400
Conservation practices				40	105	300
Recycling wastewater (secondary treatment)				120	170	220
Reverse osmosis (for brackish water)				160	350	540
Recycling wastewater (advanced water treatment)				260	460	660
Desalinization of seawater				600	1,200	2,000

[b] *Median cost is taken as 2.5 times the low-end cost for large, medium and micro projects.*

Considering the most expensive option worth US$1,200 for dug storage, in USA the equivalent cost in Kshs. is 108/- per m^3. In Kenya the costs is about Kshs.

235/-for the same. This is about twice the cost. The cheap option is only USD 500 which translates to Kshs. 45/- which is less than half the cost in USA. This difference in rates could, among other possible reasons, be partly attributed to higher efficiencies in the construction processes in the developed nation of USA.

2.7.3. NWCPC and the Construction of SWSs

The steps taken by NWCPC when planning for and constructing the SWSs water projects are budgeting, identification, survey, design, preparation of tender documents and the tendering process. This is followed by the construction which may be undertaken in-house, by NWCPC staff or outsourced to a contractor. Supervision is carried out by NWCPC staff during the construction period including monitoring and evaluation. Once the project is completed it is then handed over to the WSB under whose jurisdiction it lies.

2.7.4. Financial Allocation

The initially proposed financial allocation from the Ministry of Water and Irrigation (MWI) to NWCPC as from 2005 was to rise from 1.5 billion to 5.7 billion but the actual allocations were much less than anticipated as highlighted in Table 2-3 for various financial years (FY).

Table 2-3: NWCPC budget allocation for FY 2004/5-2007/8

Financial Year	**2004/5**	**2005/6**	**2006/7**	**2007/8**
Allocation (in Millions)	**142**	**1012**	**1843**	**1830**

Financial Year	2004/5	2005/6	2006/7	2007/8
Total MWI budget (in Millions)	**7,253**	**10,058**	**10,526**	
NWCPC % of MWI Budget	**1.96**	**10.06**	**17.51**	

Source: (Ombogo, 2009)**;** Government Budget Estimates: 2004/5 – 2006/7

The budgetary allocation for NWCPC shot up from 142 million to 1.012 billion from FY2004/5 to FY 2005/6 an increase of over 600%. This was mainly due to the new roles it was given which now included the design and construction of large dams that demand heavy investments.

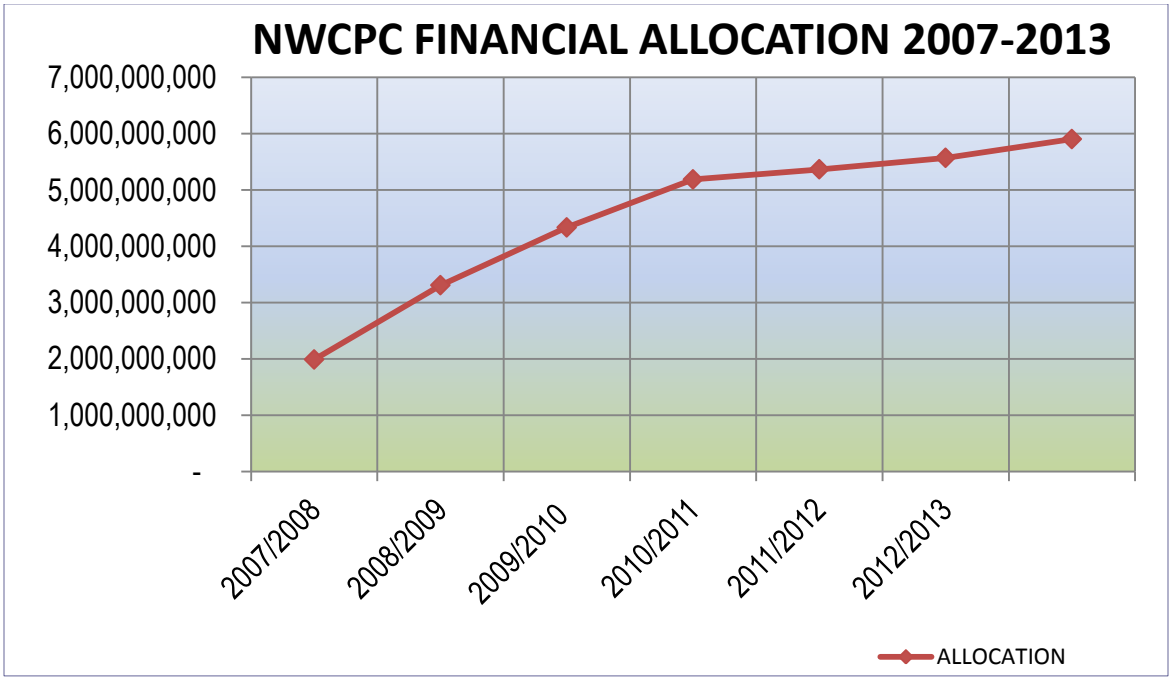

Figure 2-7: Financial Allocation to NWCPC FY2007/8-FY2012/13

NWCPC now receives a budgetary allocation from the GoK of over 5 billion mostly for the construction of large dams. Funding for the small dams and pans and flood control has been on the decline as indicated by the fewer such projects done each year. (NWCPC, 2009)

Water resources remain extremely important even as water conservation through the development of SWSs worldwide is getting progressively crucial owing to factors noted in the above literature review. In Kenya urgent measures are being called for to maximize water storage and NWCPC is a key agent in the construction of SWSs. Therefore in order to improve its efficiency, there is need to ascertain the effectiveness of the implementation of those that have so far been constructed. This study aims at facilitating the realization of this goal.

3 CHAPTER THREE

3. RESEARCH METHODOLOGY

3.1. INTRODUCTION

This chapter describes the procedure that was used in conducting the study. The techniques of data collection, analysis and presentation of the data have been put forth herein. This chapter also discusses the procedures in sampling and the sources of data including the study design, the study variables, research instruments and ethical considerations that were applied in the research.

3.2. BASIC ASSUMPTIONS

The following assumptions have been made with regard to the study

(i) The information supplied by the respondents is a true and accurate presentation of the state of affairs on site.

(ii) That the subjective answers provided were the true feelings of the respondents.

(iii) That the respondents that were sampled represented the general situation in the target population.

(iv) That the data collected from site and NWCPC is both accurate and reliable.

3.3. SCOPE OF STUDY

The scope of the study was limited to Tanathi WSB. The WSB covers four counties sub-divided further into twenty two districts. In particular the study was undertaken in four districts namely Kangundo, Yatta, Matungulu and Mwala Districts. The area is well served by access roads and is therefore reasonably accessible especially during the dry seasons.

The research was further limited to small dams and pans constructed between the years 2010 and 2012 as this is the earliest period when the required NWCPC records were most comprehensive and data could therefore be used for analysis.

It is proposed that the study on the cost-effectiveness of the other types of SWSs could form the subject of further studies and researches.

3.4. RESEARCH TOOLS

Several tools were employed for the study one of which was the research questionnaires that were developed for the study and applied in data collection. Four different questionnaires were developed and used for different classes of respondents that were targeted namely the CBOs and local beneficiaries, local administration, NWCPC staff and government water officers.

Another tool that was employed in the research was data analysis software. Both SPSS and Microsoft Excel software were used as tools for the research. Other computer and software tools used were the Microsoft Office Word 2007 that was used in compiling the report. The integrated dam assessment (IDAM) tool was also used to develop the formula for calculating cost effectiveness analysis of large dams and hence assist to develop analysis for the small SWSs. The tool is explained above in section 2.6.2.

3.5. METHOD OF RESEARCH

The study drew information from various governmental and non-governmental agencies that influence development in the study area. Information and data was collected by use of interviews and questionnaires as this method was deemed appropriate for this study considering the study objectives. Data was collected from NWCPC offices and staff including the CBOs, local residents and Water Services Boards whose District Water Officers (DWOs) helped to guide the researcher in obtaining information from site. The DWOs were interviewed using the questionnaires prepared beforehand. After this they guided the researcher in interviewing the local residents, CBOs, and local administration using other separate sets of questionnaires also prepared beforehand.

The site data was partly obtained by use of questionnaires which entailed visiting the respondents and interviewing them. The questionnaires were prepared with the respondents in mind in that the questions were tailored to suit the different respondents. Members of staff of NWCPC were also interviewed on similar aspects encountered in their circumstances. Four separate sets of questionnaires were prepared for the data collection. One set each was prepared for NWCPC staff, local administration, local residents/CBOs and WSBs staff (DWOs).

There are various types of surveys one can choose from. Collecting information from the respondents at a single period in time uses the cross-sectional type of survey, whereas gathering information over a period of time employs the longitudinal survey. Cross-sectional surveys usually utilize questionnaires to ask about a particular topic at one point in time and this is what has been applied in our study. Therefore this study may be classified as a cross-sectional survey (Sincero, 2012).

The cross sectional survey employed in this study utilized mainly qualitative research designs as opposed to quantitative research designs. The qualitative research designs are usually cheaper and can make use of a smaller sample size

to achieve reasonable results. Qualitative techniques are useful when a subject is too complex be answered by a simple “yes” or “no” hypothesis (Shuttleworth, 2008).

Qualitative data cannot be mathematically analysed in the same comprehensive way as quantitative results and therefore it can only give a guide to general trends and therefore dwells more on observations. This explains why the results of this study do not have the usual statistical analysis outputs such as medians and modes. The Lickert scaling methods were used in preparation of the research questionnaire for the data collection (Shuttleworth, 2008), (Munshi, 2014).

Table 3-1: List of the measures of effectiveness

S/No	Description
1	Construction Method Suitability
2	Meeting of project Objectives
3	Collaboration with other stakeholders
4	General Construction Rate
5	Project Satisfactorily Done
6	Reduced Water Scarcity
7	Timeliness in Dam construction
8	Timeliness in Pans construction
9	Less Time spent Looking for Water
10	Benefits for Domestic Use
11	Benefits for Cattle Watering
12	Benefits for Conflict Resolution
13	Benefits in Time Freed for other activities
14	Benefits in Health
15	Prior Community Awareness
16	Involvement During Construction
17	Supporting Harmony between communities
18	Volume is Adequate
19	Distance to SWS water source

The above Table 3-1 shows a list of the measures of effectiveness. They are not arranged in any order of importance. It is expected that the results of the study shall reveal from the correspondents what they consider as the hierarchy of the measures of effectiveness.

3.6. SAMPLING PROCEDURE

A sample has been defined as “a representative part of a population” (Peter, 1994). As Mugenda and Mugenda (1999) have aptly observed, if the population size is very large, it is difficult to study the whole of the target population as the study would take an exceptionally long time to complete.

Very small sample sizes are prone to sampling errors, hence the sample size selected was just large enough to enable data collection and analysis to be completed within the duration of the study. Simple random sampling was used in the research.

3.6.1. Study Area

In defining and identifying the accessible population from the target population, the researcher used the rationale that the study area, Tanathi WSB, has been one of the areas where the larger numbers of water projects have been undertaken by NWCPC. The area is semi-arid and parts of it are arid lands. The areas under consideration exhibit similar characteristics to other ASAL areas countrywide and hence enable the making of recommendations on SWSs that could be applied to the other ASAL areas. The sample was therefore selected from this accessible

population from the Tanathi WSB districts namely Yatta, Kangundo, Matungulu and Mwala. Figure 3-1 is a map showing the area of administering questionnaires.

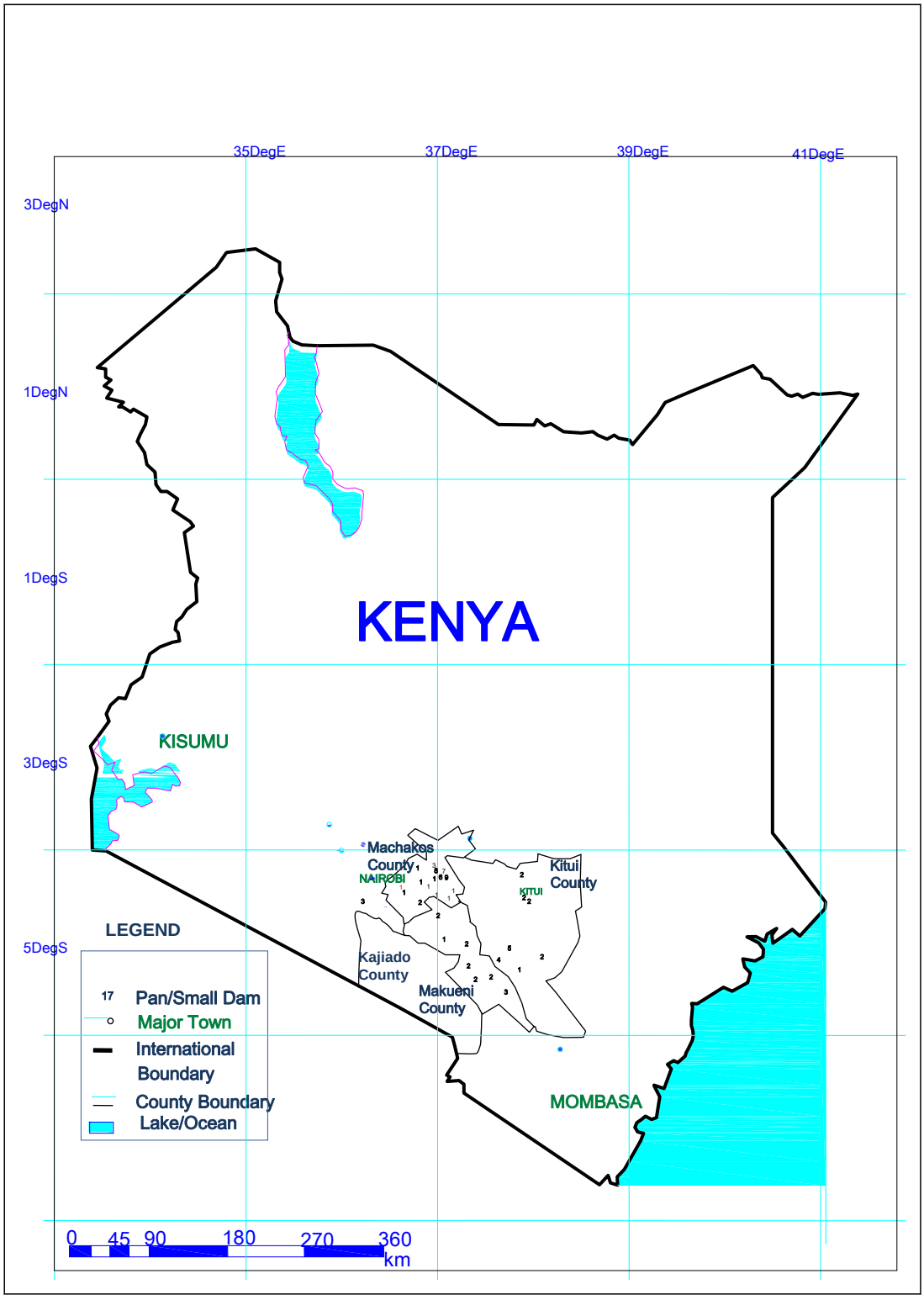

Figure 3-1: Map of Kenya Showing the Study area

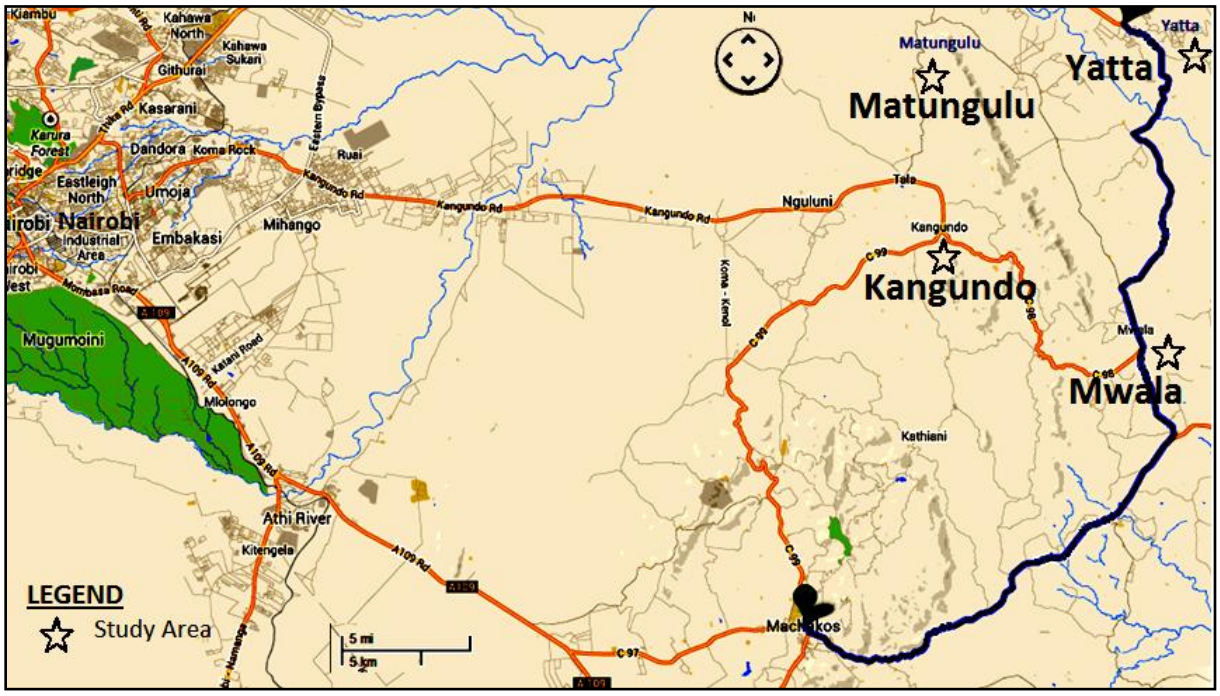

Figure 3-2: Detailed Map Showing Study Area
Source (Google, 2014)

3.6.2. Sample Determination

In preparing a sampling frame, a researcher needs to assess the target population, whether it falls within the category of “Specified Population” or “Unspecified Population” (Peter, 1994). A specified population means that all the members of the population are recorded in some register, such as the national census list, while the reverse is true for unspecified populations. Determination of the nature of the population helps a researcher to select an appropriate method in preparing the sampling frame. In this study, the researcher realized that this was an unspecified population as the targeted population are locals who have benefited from the SWSs implemented by NWCPC and so the specific population could not be determined beforehand.

Samples from unspecified populations are selected using non-probability sampling also called purposive sampling (Peter, 1994) (Mugenda & Mugenda, 2003). In this research the researcher used purposive sampling method which allowed the researcher to interview respondents that had the required information with respect to the objectives of the study. In this case the criterion for the respondents was that they had to be over 20 years old and be beneficiaries of the projects. The researcher then randomly interviewed the respondents selected from the target districts on-site until the required number was obtained including ten technical water officers. Different sets of questionnaires were administered to the non-technical and technical respondents.

3.6.3. Sample Sizing

The target population for the project beneficiaries was estimated at 20,400 persons. This is the number of people who were estimated to have directly benefitted from the SWSs that were surveyed. The figure was derived at from the estimated capacities of the individual SWSs. The formula below was then applied to obtain the sample size needed for the field data collection: -

$$n = p * q * \frac{z^2}{d^2}$$

Where n = desired sample size (if target population is >10,000)

z = the standard normal deviate at the required confidence level (or the z-statistic)

p = the proportion in the target population estimated to have the characteristics being measured

q = 1 - p

d = the level of statistical significance set

In our case the accuracy level was set at 0.1 and p= 50% and the z statistic = 1.96

Using the above formula, the sample size was thus calculated to be 96.04. In this study a total of 118 persons were interviewed including 15 technical staff both from NWCPC and the WSB thus bringing the total number respondents to one hundred and thirty three. The reason for the higher sample number was to obtain better results since as a rule it is always better to acquire as big a sample size as possible. This also helped to cover for any possible erroneous data in order to ensure that the minimum number of samples was achieved (Mugenda & Mugenda, 2003). These were sampled randomly at the points of benefit such as the vicinity of the water projects.

3.7. DATA COLLECTION

In this study primary data was collected through personal observation in the study area, through use of questionnaires, formal and informal interviews.

The questionnaires were prepared in such a way as to enable smooth gathering of information from the respondents. Both structured (close ended) and unstructured (open ended) questions were employed. Nonetheless the former was mainly used as they are easier to administer and analyze. Biased or leading questions were avoided for objectivity of the exercise. The questionnaires were made as brief as possible yet detailed enough to capture the most pertinent issues being sought for in the research.

Four sets of questionnaires were prepared for the data collection. One set each was prepared for NWCPC staff, local administration, local residents/CBOs and WSBs staff (DWOs). The main respondents in the study were the local

residents/CBOs. The information gathered was to help ascertain the effectiveness of the small SWSs that were implemented by NWCPC in Tanathi WSB area.

The Table 3-2 below indicates how the questionnaires were administered: -

Table 3-2: Questionnaire Administration

S/No.	Type of Respondents	Class	No.
1	Local Residents/CBOs	Non-Technical	105
2	Local Administration	Non-Technical	13
3	NWCPC staff,	Technical	10
4	WSBs staff (DWOs).	Technical	5
	Total		***133***

The DWOs were consulted and interviewed because they are the key persons in charge of supervising any water developments and projects that are situated within their districts. They are also the link persons between the local project administration and the government. As such they have valuable experience and information on the water situation on the ground and also on the projects undertaken by NWCPC. Furthermore they have to supervise and approve any project undertaken by NWCPC within their areas of jurisdiction. This makes them able to independently make observations and judgements as to the performance of NWCPC.

The areas of inquiry were the financing of NWCPC operations, implementation plans, SWSs reports and any available material on effective project management and best practices.

Further information was also sought for such as effect on health, social cohesion, time spent in travelling in search of water and agricultural benefits. General information about the respondents was kept confidential with no names included on the analysed data.

The SWSs were classified into categories for example pans or dams, and where possible, by the choice of method used in the implementation if it was contracted out or done in-house by NWCPC.

The respondents were interviewed to ascertain the effectiveness of SWSs implemented by NWCPC and to obtain views on the realization of the objectives and resulting benefits of the SWSs. Data on the resources utilised was collected mainly from NWCPC and also from the field survey. This information was later used to calculate the cost-effectiveness of the projects.

Sample questionnaires that were used to obtain information from site are appended to this report in ANNEXES 2.

3.8. DATA ANALYSIS

The first step after data collection was to verify the data and then code it for ease of analysis and for ensuring its accuracy. For qualitative data, the coding took the form of abbreviations, which enabled the researcher to easily and quickly locate and retrieve the required information. For quantitative data, numerical codes were used to represent attributes.

SPSS and Microsoft Excel data analysis software were employed in the initial compilation of the data obtained and for analysis. Since detailed and vast data was not envisioned in the research, the analysis of the quantitative data was mainly through simple descriptive statistics. Analysis was done to enable the establishing of patterns, trends and relationships from the information gathered. After analysis, the report of field findings was compiled and deductions and generalizations made. Microsoft Excel software was used for the preparation of the presentations.

3.8.1. Calculating Cost-Effectiveness

The civil engineering IDAM tool and the cost -effective calculation concept as used in the medical field aided the researcher to develop the formulae for calculating CE. For purposes of this study, the Cost Effectiveness was calculated as follows. : -

1. The responses were considered as graded by the respondents on a scale of 1-5 [very poor-very good]. The Lickert scaling method was used to determine these scales (Munshi, 2014).
2. The responses were converted then into percentages of the total number of responses
3. The percentages were then weighted by multiplying each one of them with the respective points assigned to the scale [1-5] and dividing them by the sum total of points i.e. 15
4. These weightings were then summed up in order to get a figure for the Effectiveness index (E) for the aspect under consideration.

   The formula below summarizes the calculation for the Effectiveness index (E)

$$E = \left(\frac{1}{15}\right)\sum_{i=1}^{5}\left(i * \left(\frac{R_i}{R_T}\right) * 100\right)$$

Where

E = effectiveness index;

i = grading points assigned on a scale of [1 – 5];

R_i = the number of field responses given to a certain grading point (i) in the scale of 1-5;

R_T = the total number of field responses answered for a particular question;

5. The cost, C of constructing the pans/dams was then ascertained. This was then divided by the volume (V) of the SWS to obtain the cost of construction per unit volume, C' i.e. $C' = C/V$
6. The cost of construction per unit volume, C' was divided by the Effectiveness index (E) in order to obtain the Cost-Effectiveness grade (CE) as shown in the formula hereunder: -

$$CE = \frac{C'}{E}$$

Where CE = cost effectiveness in Kshs/m^3

7. A high CE grade indicates a low cost effectiveness while a low CE grade indicates a better cost effectiveness of the project.

The financial year 2010-2011 was used as the benchmarking year. For ease of comparison and assessment of the Cost effectiveness of the projects, a lower threshold CE figure and an upper threshold CE figure were calculated using the average cost per m^3 of the SWS construction.

In order to get the lower threshold, a theoretically best possible grading of 5points receiving 100% responses was employed. Thus:-

Lower threshold effectiveness, E_L = ([5points] x 100%)/15 = 500/15 = 33.33

Upper threshold effectiveness, E_U = ([1point] x 100%/15 = 100/15 = 6.66

Hence: -

Lower threshold CE, $CE_L = C'_{2010\text{-}11}/E_L = C'_{2010\text{-}11}/33.33$

Upper threshold CE, $CE_U = C'_{2010\text{-}11}/E_U = C'_{2010\text{-}11}/6.66$

Middle threshold CE, $CE_{ave} = 0.5 \times (CE_L + CE_U)$

Where $C'_{2010\text{-}11}$ is the average cost per unit volume for the financial year 2010-11.

8. For ease of appreciation these CE figures are tabulated as percentages using the formula below: -

$$CE_{\%} = \ 100 * {(CE \ \ - CE_U)}/{(CE_L - CE_U)}$$

Which from basic data the following formula may alternatively be used: -

$$CE_{\%} = 18.75\left(\frac{C}{V}\right) * \left[1 - 1/\left(\sum_{i=1}^{5}\left(i * \left(\frac{R_i}{R_T}\right)\right)\right)\right]$$

The threshold gives an indication of how good the calculated CE is and provides a benchmark to gauge the CE calculated for other SWSs and in other years.

A high value of cost per unit volume nearer the upper threshold CE_U indicates a low cost effectiveness while a low value of cost per unit volume towards lower threshold CE_L indicates a high cost effectiveness of the project. The calculations helped gauge the CE index of the projects since there were no previous studies conducted on cost-effectiveness of small SWSs to help provide a standard or benchmark by which to gauge their cost-effectiveness. Nevertheless, these standards and benchmarks may now be developed from the results of this study and from comparative studies in other areas.

3.1 CONCEPTUAL FRAMEWORK FOR STUDY

A Conceptual framework is a theoretical explanation of the research problem (Ngechu, 2006). Normally it is used to outline the possible courses of action or to present a preferred approach to an idea or thought. The conceptual framework for this study is shown as a diagram in Figure 3-3. The diagram highlights the research problem, the approach taken by the study and the study analysis issues as explained in the methodology herein.

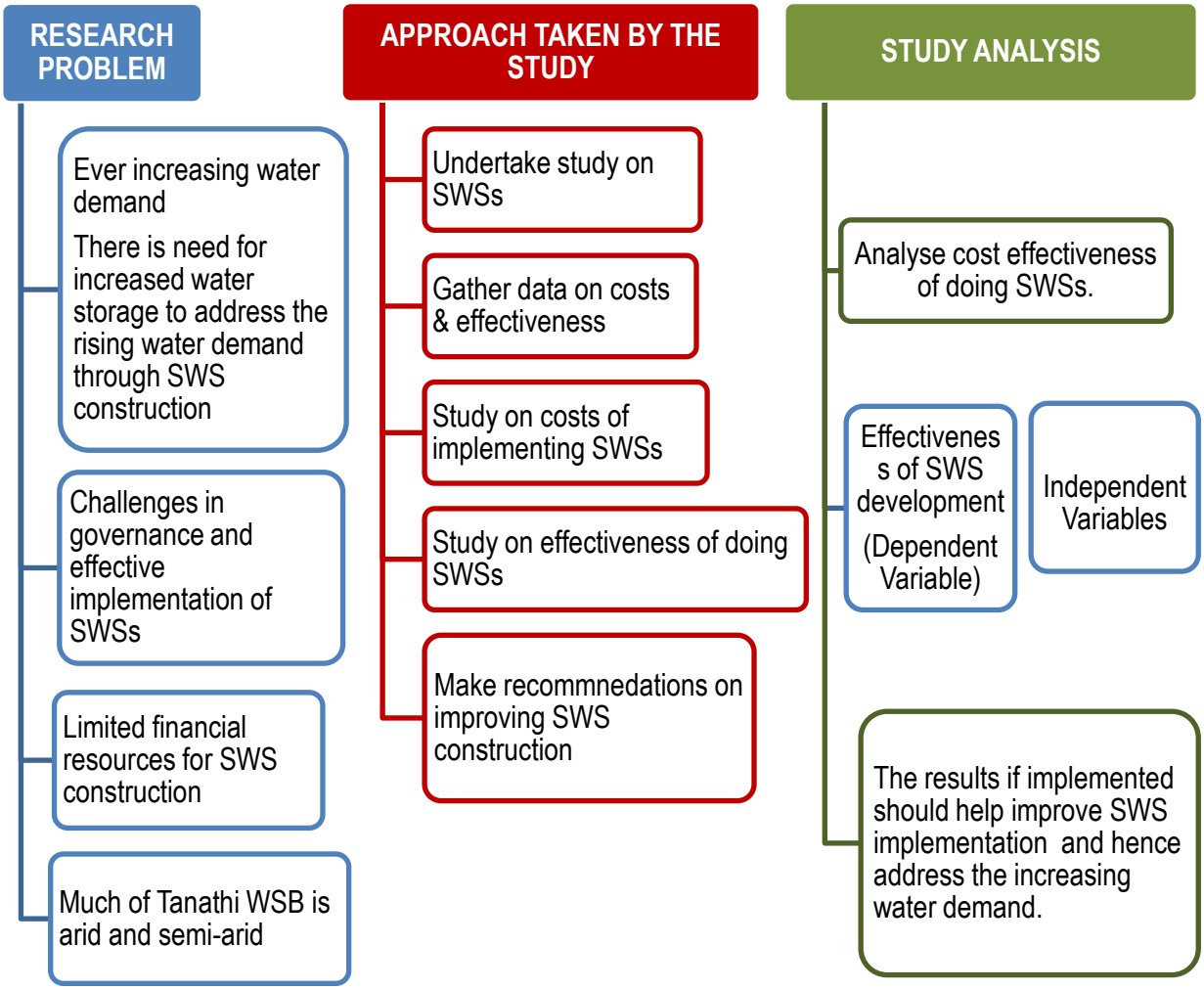

Figure 3-3: Conceptual Framework

The factors that, according to the researcher, could possibly affect the state of implementation of SWSs by NWCPC are discussed hereunder. The independent variables are the presumed causes while the dependent variables are the presumed effects (Escalada, 2009).

The study expects a relation between the independent variables such as “Capacity of staff to manage project in terms of their training and ability” versus the dependent variable of, “Effectiveness of SWSs development by NWCPC”.

In a case where the members of staff are not well trained in modern management techniques they may not deliver projects in good time or as required. This shall affect the effectiveness of the implementations. The manner of managing project funds is also expected to affect the delivery of SWSs positively or negatively.

When appropriate computer software and hardware are obtained for use in SWS project management it is expected that the projects shall be effectively undertaken with better results than if these were not used. Effective planning for SWS development is an independent variable which can affect the SWS implementation since poor planning is often a reason for ineffective delivery of projects.

Regarding staff attitude and legacies in SWSs Development by NWCPC these are variables the researcher believes affect the implementation of projects. Legacies in this case are issues such as the work culture inherited from the previous management and operational manners and attitudes which have been carried along. Bad attitudes and legacies can negatively impact the implementation of the SWSs.

Design methods affect the quality of the SWS designs whereas tendering and selection of contractors will influence the outcome of any relevant undertaking. Actual implementation of the SWSs including the rate of construction is more or less a product of the other issues highlighted above. Inadequate monitoring and evaluation of the SWSs can result in poorly implemented SWSs hence they become ineffective in achieving the targets.

Community influence, administration, local leadership, GoK policies and funding all have an effect on whether the SWSs are effectively implemented. Environmental conditions including the weather also affect SWS implementation positively or negatively.

4 CHAPTER FOUR

4. RESULTS AND ANALYSIS

4.1. INTRODUCTION

This chapter analyzes the research data against the research objectives in order to form a basis for the research conclusions and recommendations to be presented in the subsequent chapters and sections. It also seeks to analyze the data obtained from the study and the field findings in order to come up with proposals on improving the cost effectiveness of SWSs from the lessons learnt from NWCPC's modes of implementing them. This is expected to point out if there are areas NWCPC has succeeded and also highlight areas where NWCPC needs to improve. This process helped to identify areas for further study.

4.2. PROJECT OBJECTIVES ACHIEVEMENT IN TANATHI WSB

As explained earlier, the effectiveness of a project is the measure of the impacts or achievements vis-a-vis its objectives. One of the strategic objectives of NWCPC was to increase water storage capacity. This entailed, among other activities, the construction of small SWSs such as pans and small dams.

Figure 4-1 shows the targeted number of projects versus the actual number of projects constructed by NWCPC between 2005 and 2012. In all the years since 2005 till 2012, NWCPC achieved or surpassed its targets in the construction of small pans and dams except for the financial year 2006-2007. In this aspect, NWCPC was effective in achieving its targeted number of small SWS constructed.

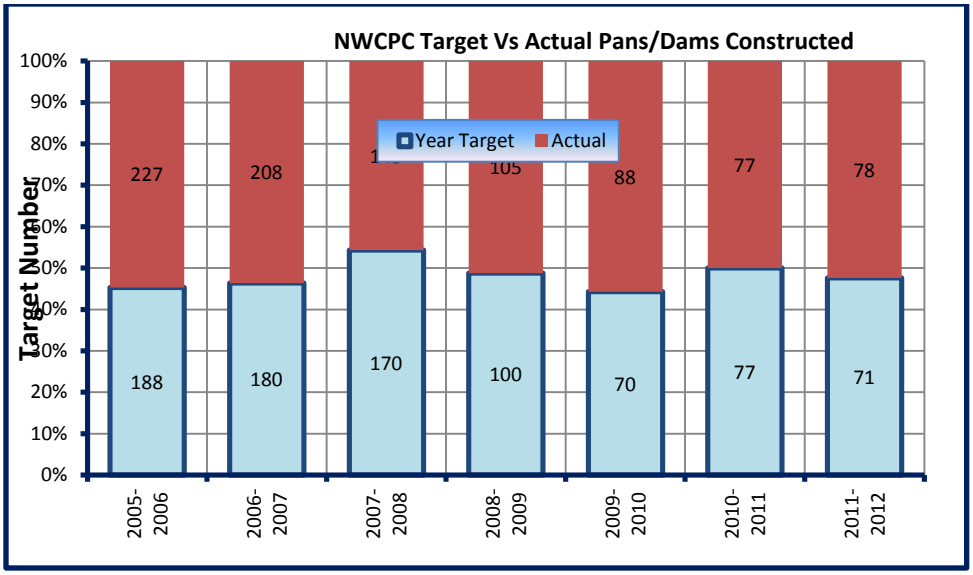

Figure 4-1: NWCPC Target Vs Actual Pans/Dams Constructed FY 2005 to 2012

In the FYs 2010-11 to 2011-12 NWCPC was able to add a total of 1,000,553 m^3 of water storage to the Tanathi WSB area alone. These figures do not include the rehabilitated SWSs which also added some storage volumes but which could not be precisely quantified. The additional volume achieved varies with the "Value for Money" study done (MWI, 2008) which indicated that NWCPC projects had achieved little benefit. The considerable increases in volume of water storage coupled with the on-site research findings indicate that NWCPC projects have benefited many people signifying a positive impact in the communities for which it undertakes projects.

The reducing targets with each subsequent year is directly related to reduced funding budget with time which caused the number of pans/small dams to be decreased with each year. It could also indicate a policy change regarding NWCPC's role in implementing the small SWSs coupled with the proposed changing roles made necessary by the new constitution. Also other government bodies and NGOs are undertaking the construction of small SWSs thereby reducing the number of SWSs done by NWCPC.

4.2.1. Increasing Accessibility to Water

From the responses of the NWCPC staff interviewed in the field study it was noted that the Corporation has achieved the objectives of increasing accessibility to water through the construction of SWS projects. Figure 4-2 shows the responses given by the respondents which indicate that the NWCPC staffs are very confident about the performance of the organization as all of them rated it above average.

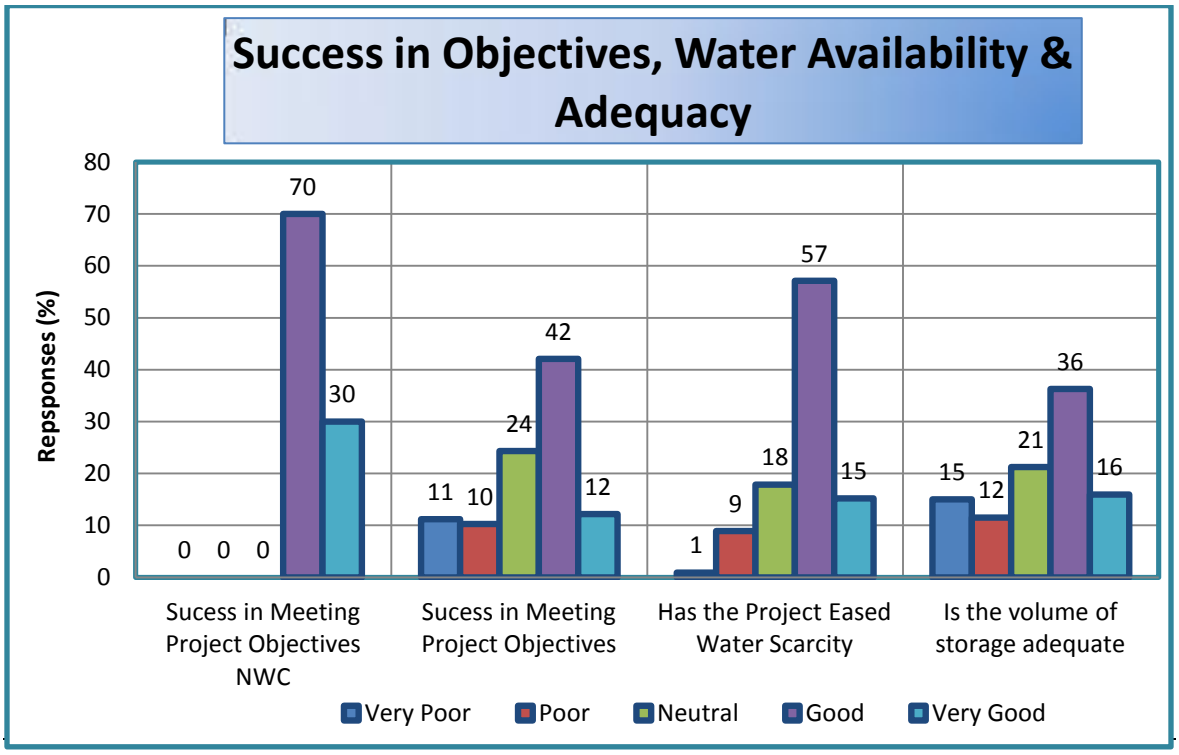

Figure 4-2: Success in Objectives, Water Availability & Adequacy

All of the NWCPC respondents interviewed stated that NWCPC had met its objectives for the projects. On the other hand 54.2% of the local respondents interviewed considered NWCPC to have met its project objectives. The rest were either unsure or did not agree at all that NCWPC had met its objectives.

As regards the objective of easing water scarcity (through increasing accessibility and availability of water), there was an high positive response for NWCPC with 72% of the respondents stating that NWCPC had eased the problem of water scarcity through SWS construction as indicated in the same Figure 4-2. These results suggest that NWCPC is deemed to have achieved its goal of enhancing social and economic well being of Kenyans through improved access, and availability of water.

4.2.2. Water Storage Capacity

As regards the objective of increasing water storage capacity, about 52% of the respondents interviewed agreed that the volume of storage was adequate for their usage (Figure 4-3). However it was noted that in some areas the volume of storage was inadequate since the water did not last them from one rainy season to the next. The DWOs and local residents suggested that the volume of the reservoirs be increased so as to meet the water demand.

From design calculations most of the SWSs are usually inadequate to supply water for the dry duration of about 5 months. Many are only able to supply about 2-3 months of water before they run dry. Take for instance the water demand for Kwa-Kiloo area is 433m^3/day meaning the SWS storage of 10,000m^3 can only supply the residents for 1 month of full dependence on it for consumption.

The photos below show the SWSs to be found within the study area.

Plate 4-1: Typical Dam in the Research area

Plate 4-2: Matungulu Dam in the Research area

Plate 4-3: Typical Dam Embankment in the Research area

Plate 4-4: Typical Reservoir in the Research area

About 60% of the respondents noted that the water in their reservoirs lasted for four months as indicated in the Figure 4-3. As there are normally two rainy seasons annually within the area selected for study, the longest period from one rainy season to the next is about six to seven months long. This indicates that NWCPC needs to construct SWSs that provide water for these lengths of time, so as to provide continuous sources of water.

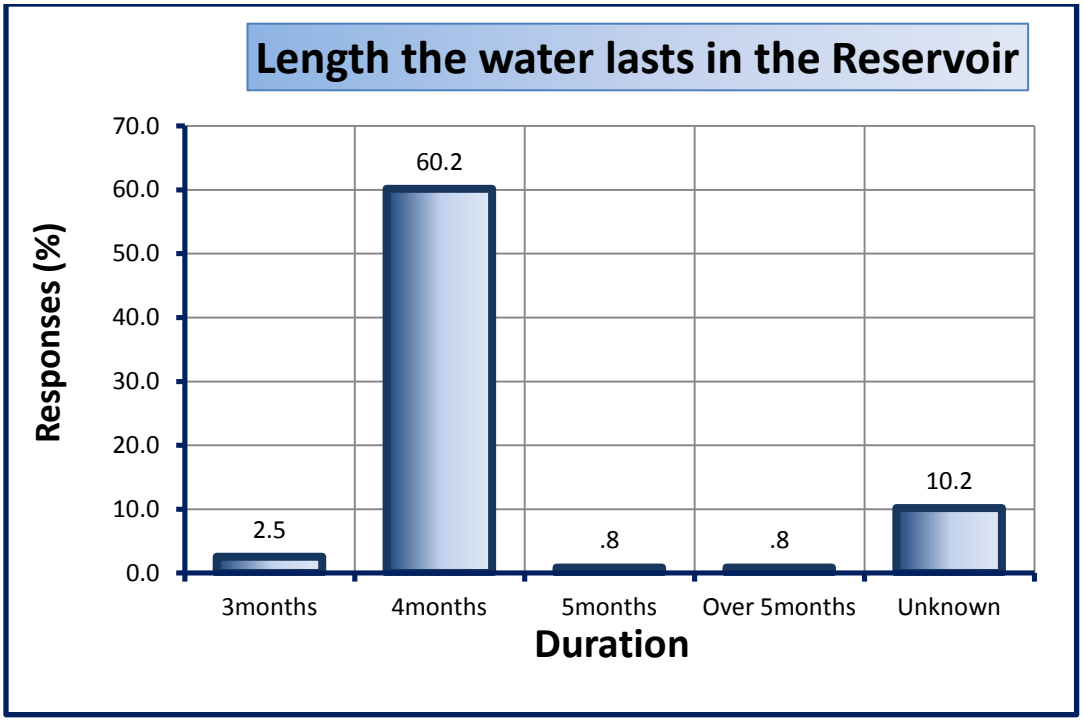

Figure 4-3: Period Water Lasts in Reservoir

4.2.3. Availability of water

To address the objective of water availability, the distance travelled to the water sources developed by NWCPC and time spent in search of water were investigated.

78 percent of the respondents travelled less than one km to obtain water. However, some three percent of the respondents travelled over three kilometres in search water with some one percent travelling over 5 kilometres as shown in Figure 4-4. This indicates that most of the SWSs done by NWCPC are within one kilometre distance to the users. However this situation may be improved by constructing more SWSs nearer to the users.

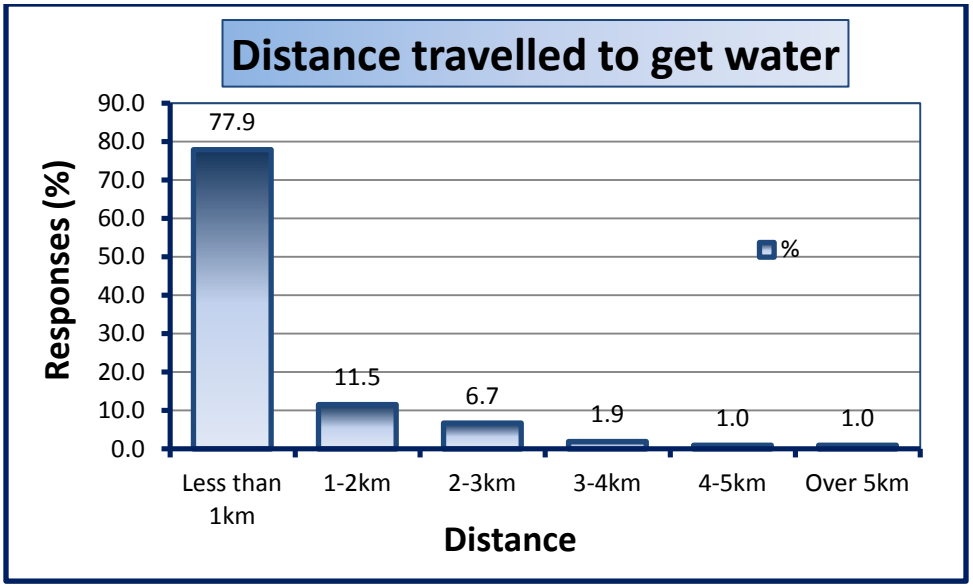

Figure 4-4: Distance to Water Source

Figure 4-5 indicates that 73% of the respondents benefiting from water projects undertaken by NWCPC are within one hour's reach to the water sources. This is a positive achievement that can, and should be improved upon by NWCPC in collaboration with other stakeholders. That there are some 5.8% of locals travelling over 3 hours to get water is an issue that requires critical addressing. The challenge to NWCPC may be in balancing between addressing the needs of these few who are located far away and the many that are near located close the water sources.

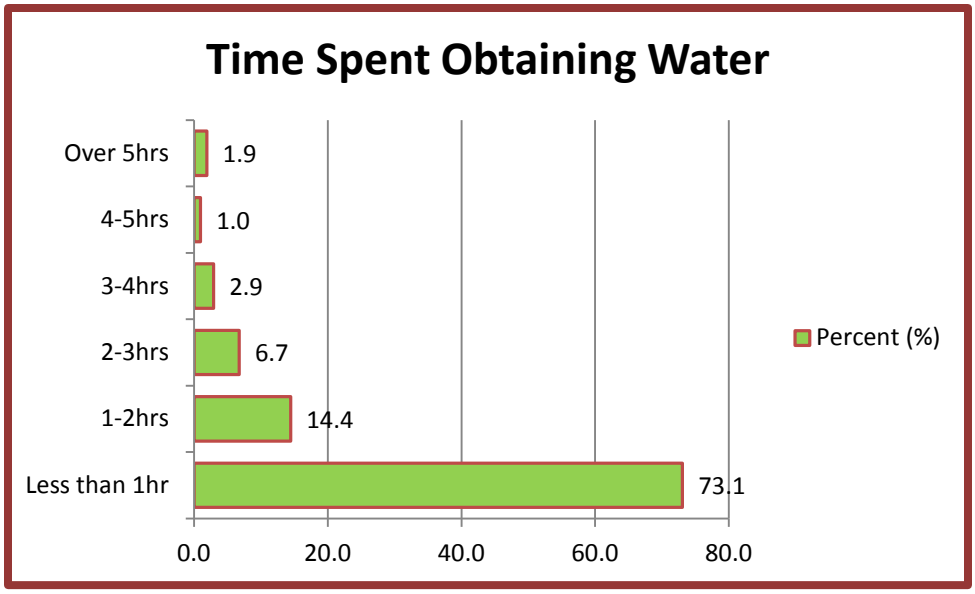

Figure 4-5: Time Spent Getting Water

4.3. NWCPC RESOURCE UTILIZATION

Efficient utilization of staff and other resources results in better cost effectiveness as compared to inefficient utilization of the same. Hence resource utilization has been included in the study.

The following discussion is a detailing of the results obtained in the field investigations on the effectiveness of the resource utilization in implementing SWS's.

Resources are vital in the effective realization of the goals of implementing SWSs. Some of the resources used by NWCPC and are currently employed in SWS implementation, are the following: -

- Staff – currently NWCPC has a staff number of about 390 persons.
- Money – NWCPC receives about Kshs. 4 billion per year for the construction of SWSs and for its overheads.

- Machinery and equipment (bulldozers, excavators, drilling rigs, test-pumping units, vehicles, trucks, software etc.)

4.3.1. Staff and Machinery

The next aspect to be studied on resource utilization was resources of staff and machinery. The Figure 4-6 highlights the responses obtained from the survey of NWCPC staff. All the responses in the figure were provided by technical persons.

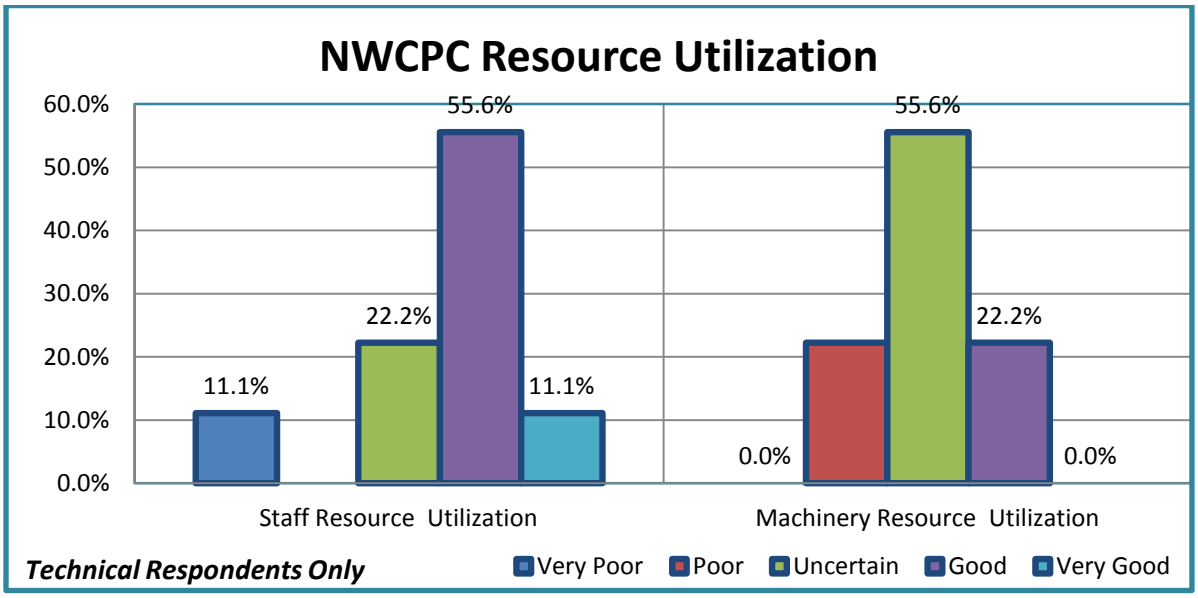

Figure 4-6: NWCPC use of Resources

The utilization of staff as a resource by NWCPC was well rated as good or very good by 67% of the respondents, though some 11% of them gave it a very poor grading as shown on the Figure 4-6. The rest were unsure of the matter. These findings denote that NWCPC is to a larger extent considered effective in utilization of its staff. As explained in the methodology above, the ratings were developed from the Lickert scale.

As regards the use of machinery resources, 56% of the NWCPC respondents were uncertain. The ratings mainly lay in the mid categories meaning 50-50 or balanced between good and poor as is evident in the Figure 4-6.

4.3.2. Financial Utilization

The study sought to establish whether the use of funds has been effective in realising the objectives of SWS construction. Generally, the end results of the use of these resources are an indication of their effectiveness. The costs of construction are a very significant aspect as this is the fiscal amount used in implementing the SWSs and is a key component in calculating the cost-effectiveness of the SWSs. In Tanathi WSB these were the amounts of monies used up by the NWCPC itself or contractors it engaged on its behalf to undertake the projects to completion and handing over.

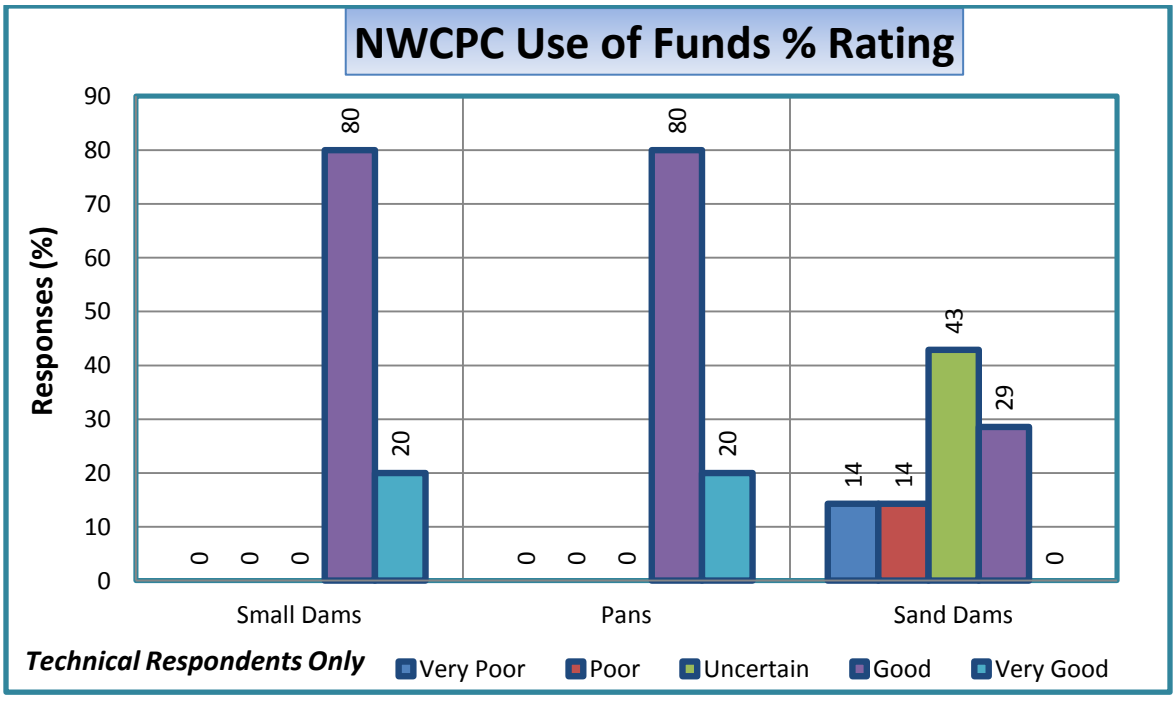

Figure 4-7: NWCPC Use of Funds for SWSs

Figure 4-7 indicates the response by the NWCPC staff on how they rate monetary utilization in SWS construction.

All the NWCPC staff interviewed stated that NWCPC has used its financial resources for implementing of small dams and pans effectively. All the responses in the figure were provided by technical persons.

As regards sand dams 43% of the respondents were mainly uncertain as to whether the use of funds has been effective. Of the rest 28% were negative while 29% rated NWCPC as having used funds well for sand dams' construction.

4.3.3. Timeliness in SWS Construction

Timeliness in the construction of SWSs is key to attaining a better measure of cost-effectiveness since the costs involved are directly or indirectly affected with the time taken to complete the projects. Timely implementation of SWSs was considered a factor in cost–effectiveness since delays in project commencement and completion leave the project prone to changes in costs, interest rates, political influence among other negative factors. Hence the value of the project tends to rise with passage of time. Therefore it may be deduced that the shorter the implementation time, the more cost-effective it is expected to be.

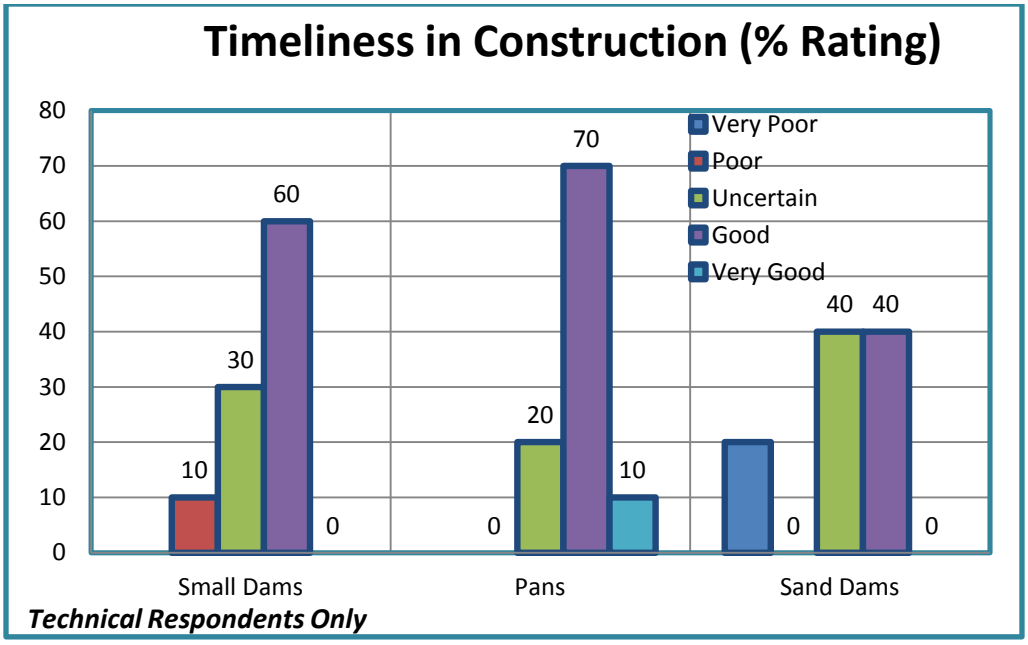

Figure 4-8**:**Timeliness in Constructing SWSs

Figure 4-8 indicates the responses regarding timeliness of NWCPC in the construction of SWSs. All the responses in the figure were provided by technical persons.

As concerns timeliness in finishing small dams 60% of the NWCPC respondents stated that NWCPC was timely in its execution of projects, 30% were uncertain and 10% stated that it was not timely.

As concerns timeliness in finishing pans, 80% of the NWCPC respondents stated that NWCPC was timely in its execution of projects. Nonetheless, from the respondents comments some SWSs were noted to have taken twice the time expected to complete.

Regarding timeliness in Sand dam construction, 40% of the respondents gave NWCPC a rating of “good” while 20% were dissatisfied and gave it a rating of “very poor”.

Considering the results of the survey, NWCPC did not, in the aspect of timeliness, perform as well as in other aspects surveyed.

4.3.4. Effectiveness of Methods Used

The effectiveness of methods used will determine the success in meeting project objectives, thereby impacting on the overall cost effectiveness index of an organization.

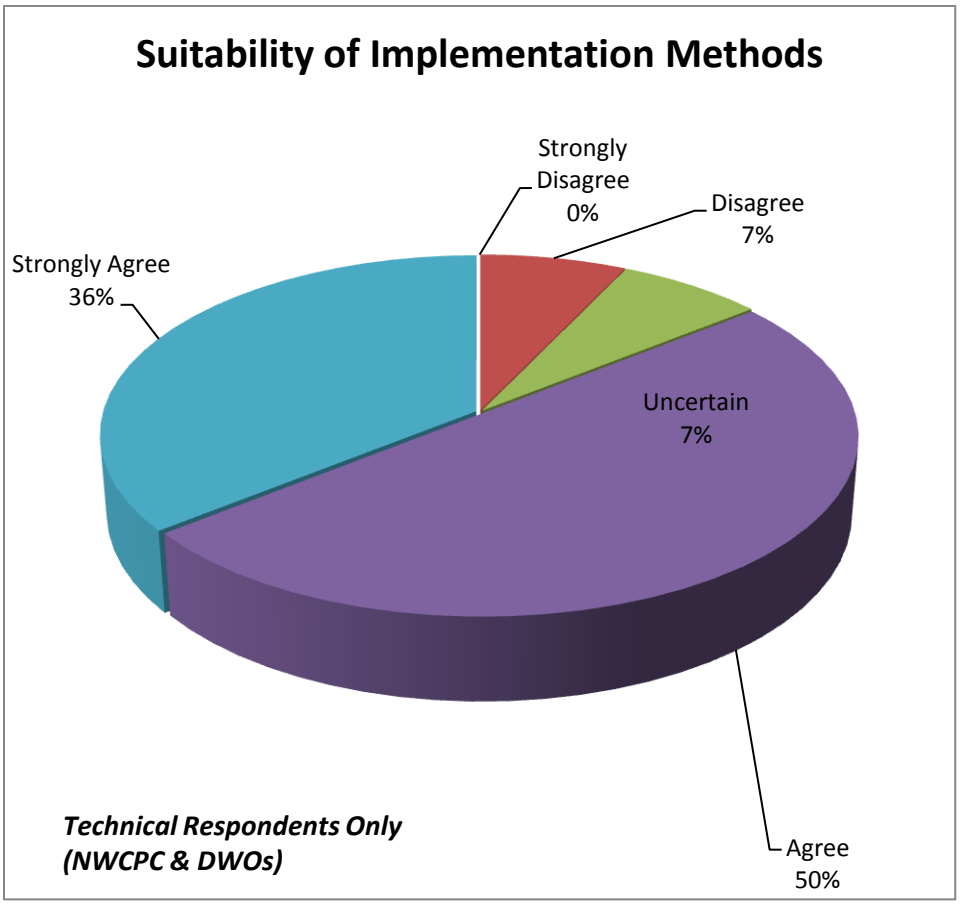

Figure 4-9: NWCPC Suitability of Implementation Methods

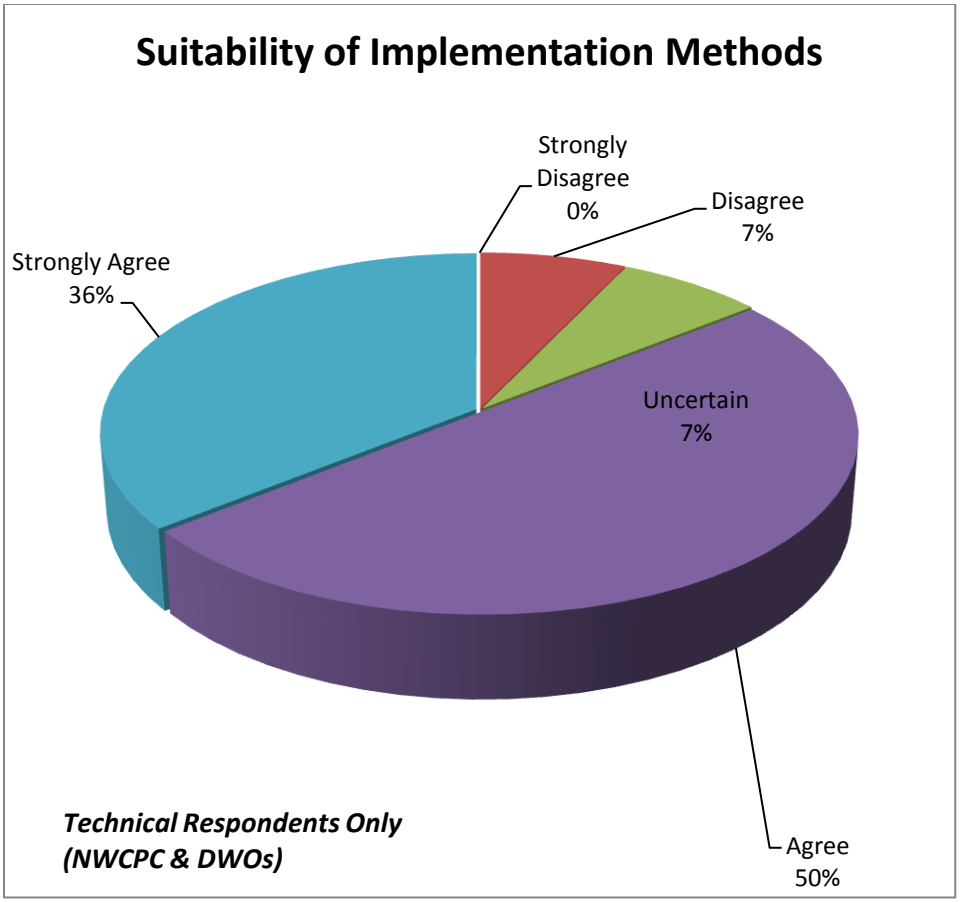

Figure 4-9Figure 4-9 indicates the responses regarding the suitability of implementation methods adopted by NWCPC whereby 86% of them (50% agree and 36% strongly agree) were positive that the methods used by NWCPC in the SWS construction were suitable.

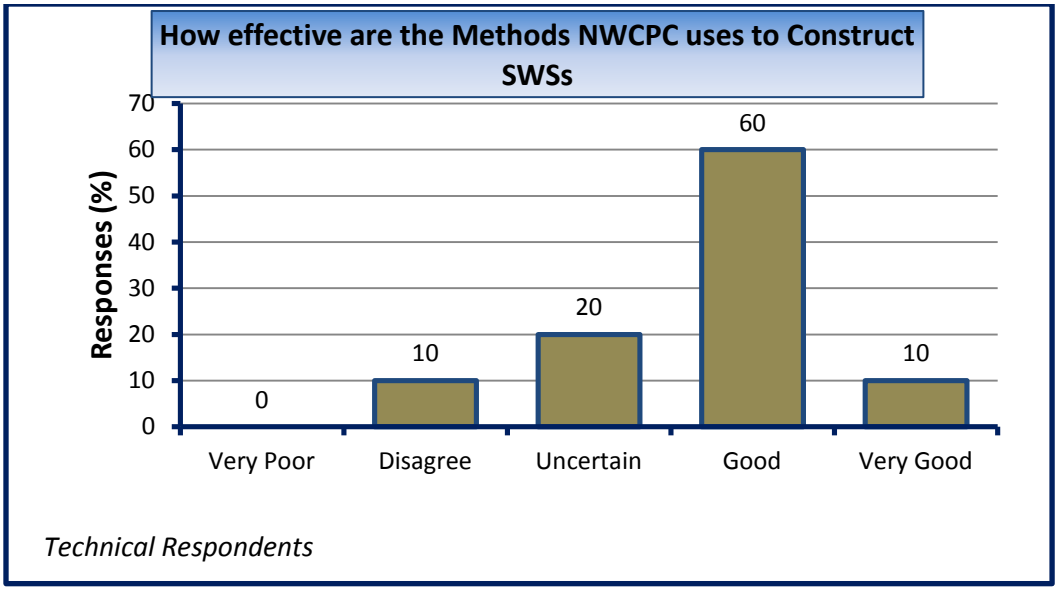

Figure 4-10: Effectiveness of Methods NWCPC uses

For purposes of the study, the methods investigated by the interviews herein were taken to be inclusive of planning, survey, design, tendering, supervision and construction. The responses by NWCPC staff are as indicated in Figure 4-10. The respondents' answers were based on what they had noted regarding the supervision and construction techniques employed on site. This time 60% and 10% of the NWCPC respondents noted that the methods used by NWCPC were good and very good respectively hence 70% of the NWCPC staff surveyed considered the methods used by NWCPC in constructing SWSs to be effective.

The NWCPC staff responses indicate that NWCPC's methods of implementing the SWSs are considered effective in achieving the results that are intended on site. It is worth noting that there is room for improvement in resource utilization by NWCPC as indicated by the 10% of them that disagreed.

4.3.5. Community Involvement

In order for a project to be fully effective, the community for which it is being done must be involved in the project right from its inception up till its implementation, and handing over (DANIDA, 2010). This helps to ensure that the community owns the project and are made aware of the project objectives. When this is done they can also offer useful advice on how best to implement the project. This issue has been witnessed in the past on several NWCPC projects.

During the field survey, the respondents were asked whether they were aware of the project in advance, whether they had been involved in the project implementation and how they were involved.

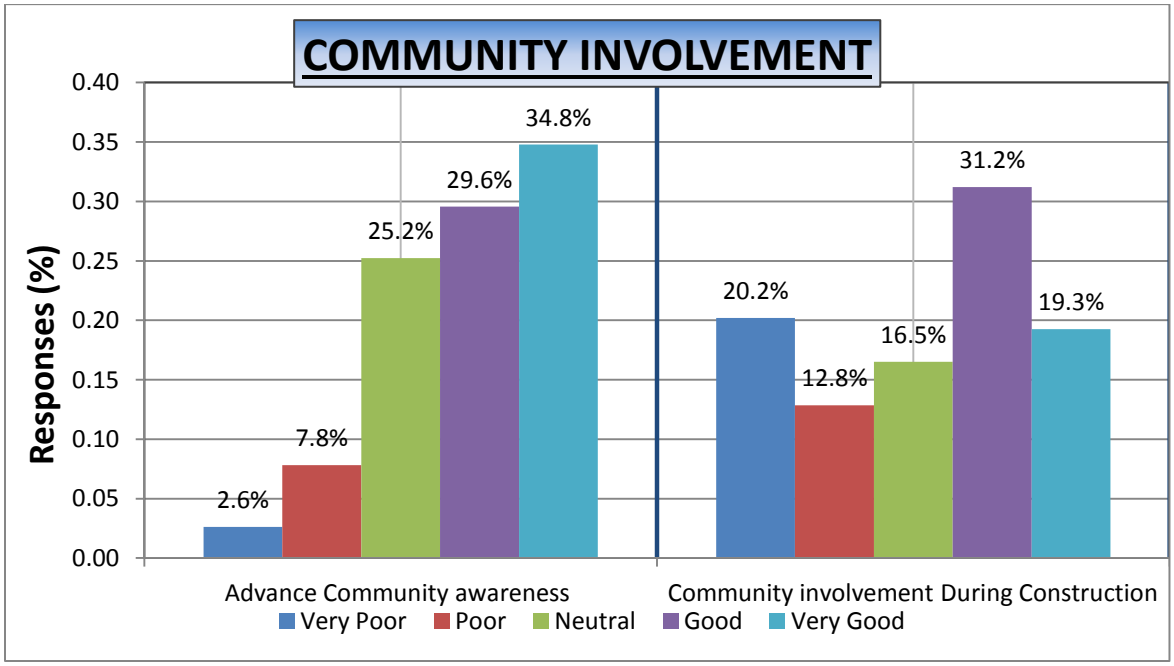

Figure 4-11: Community involvement and awareness

Figure 4-11 shows what the respondents experienced during the project development stages regarding community involvement. 64.4% of the respondents positively stated that they were aware of the projects in advance. Here NWCPC

fared quite well in making the communities aware of the project in advance of the construction. Nevertheless some 10.4% of the respondents noted that they had not been made aware of the project beforehand

Some of the ways in which the respondents were involved included the providing of casual labour to the project during site clearance and implementation stages. At times the locals were also asked to form committees manage the final projects. Furthermore in some areas they were also consulted on the availing of, or preparation of land and where to locate the projects or even simply about their acceptance of the same. The locals also sold food to the labourers which also gave them business opportunities that were mutually beneficial to both parties.

Some 19.3% of the respondents were very positive about NWCPC's involving of the community during construction whereas 31.2% gave NWCPC a rating of "good". 33 % of the respondents rated NWCPC poor or very poor in community involvement during construction. It was noted that local leaders usually informed the locals about the projects and consulted them regarding the areas to be supplied, sizing of the projects and at times involved them in fund raising for the projects. For some, involvement was through provision of construction materials.

4.4. COSTS OF CONSTRUCTION.

A comparison of the costs incurred by NWCPC in constructing SWSs in other WSBs was done as shown in the Table 4-1below.

Table 4-1: Cost of De-silting/Constructing dams FY 2010-2011

Water Service Board	Dam De-silting Est. cost per m^3	New Dam Est. Construction. cost per m^3
Coast		230.05
Lake Victoria North	129.82	376.35
Lake Victoria South	177.07	200.75
Northern	110.17	242.17
Tanathi	334.03	277.39
Rift Valley	433.26	
Grand Average	236.87	265.34

From NWCPC records for the financial year 2010-2011, the average cost of de-silting an existing pan/small dam country wide was Kshs. 236.87 per m^3 versus Kshs 265.34 per m^3 for the cost of constructing a new pan as shown in Table 4-1. It seemed to be cheaper to de-silt an existing dam than construct a new one though there were variations for Tanathi WSB.

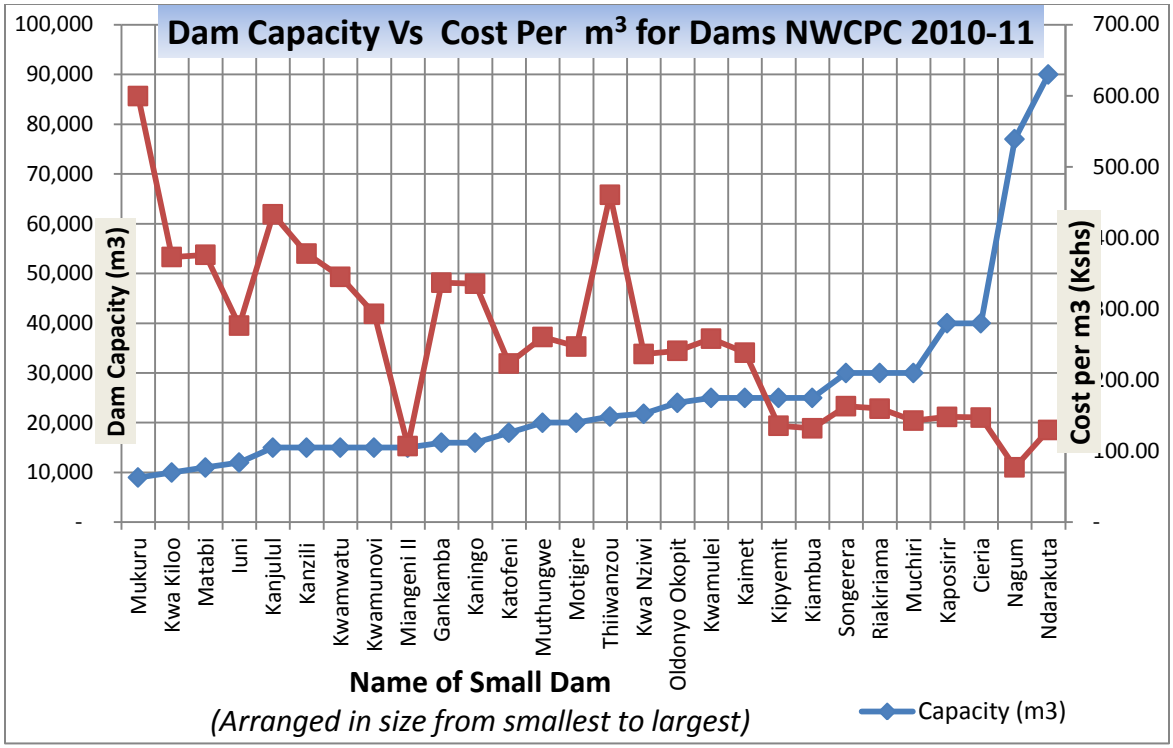

Figure 4-12: Dam Capacity Vs Cost Per m^3 2010-11

Figure 4-12 shows the data obtained relating to the dam capacity and the cost of construction per cubic meter of water for the same year 2010/2011.

A general trend may be noted that with an increase in the dam capacity, there is a corresponding decrease in the cost per cubic meter of water it holds. In order to confirm this trend, a similar comparison was done for pans and the results proved to be similar. This seems to suggest that it is more economical to construct a larger capacity small SWS than it is to construct a smaller capacity one.

The Table 4-2 and Table 4-3 indicate the details of the SWSs undertaken within the area that was selected for the detailed study under the Tanathi Water Services Board between the financial years 2010-2011 and 2011-12.

Table 4-2: Details of Pans and Small Dams 2010-11 Tanathi WSB

S/no.	Name of Project	Pan (P)/ Dam (D)	New/ Desilt	Capacity (m^3)	Cost (Kshs.)	District	Est. cost per m^3
1	Kwa Kiloo	D	De-silting	10,000	3,731,850	Kangundo	373.19
2	Kaningo	D	De-silting	16,000	5,370,200	Kyuso	335.64
3	Kambi ya mawe	P	New	143,000	9,200,490	Makueni	64.34
4	Thiiwanzou	D	New	21,250	9,790,425	Makueni (Kathonzweni)	460.73
5	Muthungwe	D	New	20,000	5,212,800	Mutomo	260.64
6	Kiambua	D	New	25,000	3,305,100	Mwala	132.2
7	Kwamulei	D	New	25,000	6,458,025	Mwala	258.32
8	Iuni	D	New	12,000	3,320,500	Mwala	276.71
9	Kyamboo	P	De-silting	15,000	2,440,200	Mwala	162.68
10	Kanzili	D	New	15,000	5,670,250	Nzaui	378.02
11	Miangeni II	D	New	15,000	1,608,000	Yatta	107.2
12	Kwamunovi	D	De-silting	15,000	4,398,850	Yatta	293.26
13	Kwamwatu	D	New	15,000	5,179,597	Yatta (Masinga)	345.31
	Total			**347,250**	**67,118,077**		

Key

IWSC - Increase Water Storage Capacity.

Table 4-3: Details of Pans and Small Dams 2011-12 Tanathi WSB

S/no.	Name of Project	Pan (P)/ Dam (D)	New/ Desilt	Capacity (m^3)	Cost(Kshs.)	District	Est. cost per m^3
1	Mbuini	D	Desilting	20,000	4,907,600	Yatta	245.38
2	Kwa Kyeti	D	Desilting	25,000	4,999,890	Kangundo	200.00
3	Kwa Kamelo	D	Desilting	30,000	4,000,000	Mwala	133.33
4	Kwa Luvai	D	Desilting	35,000	4,500,000	Mwala	128.57
5	Kwamunovi Phase II	D	Desilting	25,000	3,347,700	Yatta	133.91
6	Kwasika	D	Desilting	15,000	3,090,500	Yatta	206.03
7	Kwandumbi	D	New	24,000	5,160,290	Nzaui	215.01
8	Masongaleni	D	Desilting	15,000	4,976,350	Kibwezi	331.76
9	Muungamo	P	New	15,000	6,000,000	Mbooni East	400.00
10	Kathamboni	D	New	69,303	5,760,850	Makueni	83.13
11	Kwa Kisina	D	Desilting	35,000	5,659,000	Kibwezi/ Makindu	161.69
12	Kwa Mukai	D	Desilting	10,000	1,500,000	Kitui Central	150.00
13	Mimindi (Katuka)	D	New	20,000	5,804,050	Kyuso	290.20
14	Kitenzele	P	New	13,000	5,993,750	Mutomo	461.06
15	Kalundu	D	Desilting	260,000	184,475,822	Kitui Central	709.52
16	Serashe	P	New	17,000	5,500,000	Kajiado North	323.53
17	Kavumbu	D	Desilting	25,000	5,932,966	Mwala	237.32
	Total			**653,303**	**261,608,768**		

Key

IWS - Increase Water Storage Capacity.

Table 4-4: Small SWS Construction Costs 2010-12 Tanathi WSB

District	Cost(Kshs.)	Est. cost per m^3
Kajiado North Average	5,500,000	323.53
Kangundo Average	4,365,870	286.59
Kibwezi Average	5,317,675	246.72
Kitui Central Average	92,987,911	429.76
Kyuso Average	5,587,125	312.92
Makueni Average	8,250,588	202.73
Mbooni East Average	6,000,000	400.00
Mutomo Average	5,603,275	360.85
Mwala Average	4,279,542	189.87
Nzaui Average	5,415,270	296.51
Yatta Average	3,755,375	221.84
Grand Average	**10,909,835**	**261.95**

The Table 4-4 highlights the various costs of constructing SWSs in the whole of Tanathi WSB from 2010 to 2012. Mwala district had the least cost per unit volume (189.87) followed by Makueni district (202.73). The districts with the highest costs per m^3 were Kitui Central and Mbooni east.

4.4.1. Cost-Effective Analysis of NWCPC Projects

In order to calculate the cost effectiveness one has to consider the cost of a project and also the benefits/effects thereof. As earlier mentioned the method of calculating the Cost-Effectiveness of a project may be done by the identification of ingredients of the project, determination of the value or cost of the ingredients and any interventions and finally its cost-effectiveness by combining costs and effectiveness (Levin, 1995).

For purposes of this study, in calculating the cost effectiveness the researcher followed the method as outlined hereinabove.

The year 2010-11 was taken as a representative year. The average cost of the pans/dams construction for Tanathi WSB during this year was 265.25/= per m^3 ($C'_{2010-11}$)

The lower threshold CE was therefore calculated to be

E_L = 33.33

$C'_{2010-11}/E_L$ = 265.25/33.33 = 7.95 Kshs/m^3 (this is taken as 100%)

The upper threshold CE was therefore calculated to be

E_U = 6.66

$C'_{2010-11}/E_U$ = 265.25/6.66 = 39.82 Kshs/m^3(this is taken as 0%)

The middle threshold CE, CE_{ave} was therefore calculated to be

CE_{ave} = 0.5 x (CE_L + CE_U) = 0.5*(7.95 + 39.82) = 23.885 Kshs/m^3 (this is taken as 50%)

In order to determine the effectiveness of a project, one has to look at the benefits accruing from the project. In this case we were able to measure cost-effectiveness by considering both the costs and benefits gained from the project. A high value of cost per unit volume indicates a low cost effectiveness while a low value of cost per unit volume indicates a high cost effectiveness of the project. The resulting ratios for the individual projects that were assessed for the various aspects are as shown in Figure 4-13. These figures are the averaged values of Cost-effectiveness calculated for each aspect such as is the ones shown in Table 4-5 such as Construction Method Suitability, Meeting Objectives, Collaboration, General Construction Rate.

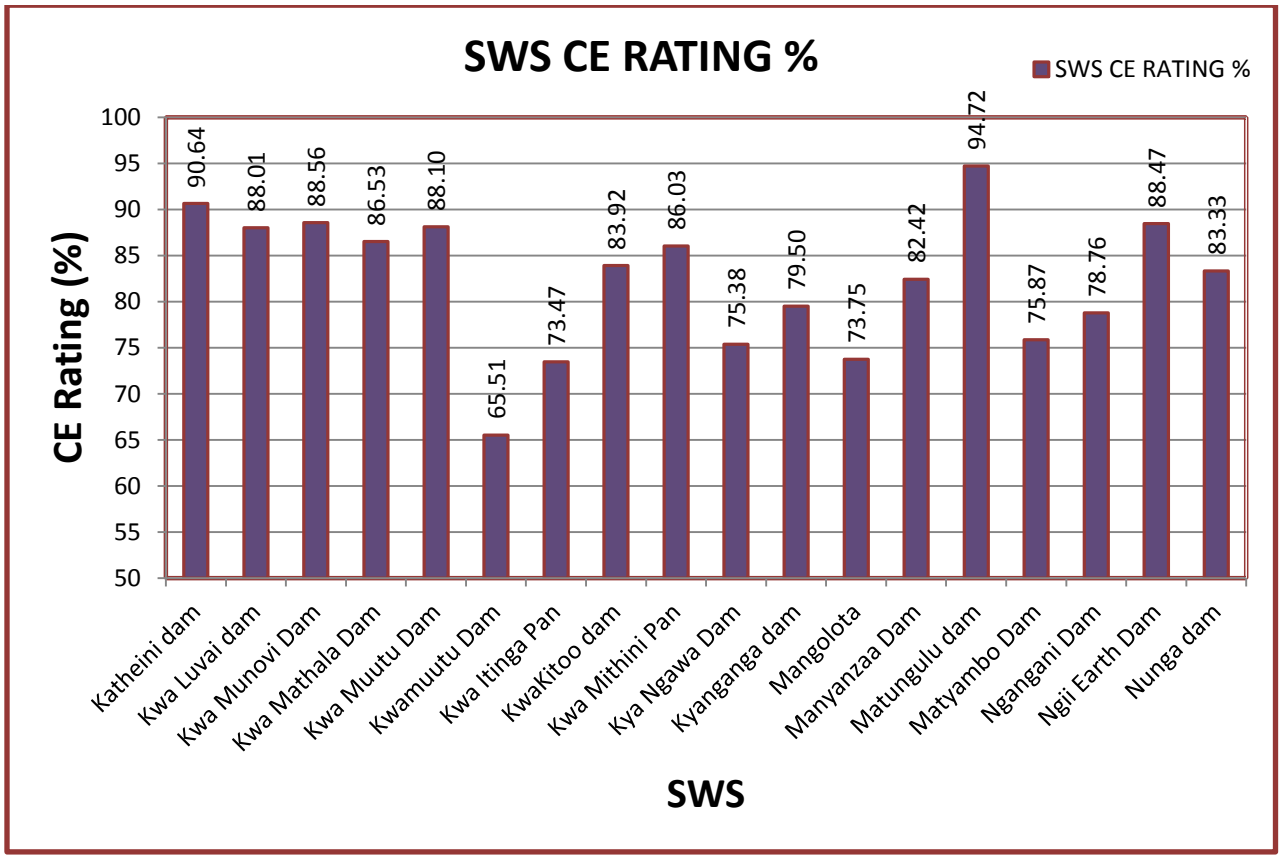

Figure 4-13: Cost – Effective Rating per SWS Projects

From Figure 4-13 it may be deduced that the most cost effective dam project was the Matungulu dam with a grading of 94.72% (9.64 Kshs/m^3. This is closely followed by Katheini dam at 90.64% (10.94 Kshs/m^3). The Kwamuutu Dam had the poorest CE rating at 65.51% (18.94 Kshs/m^3), meaning that the project was least cost-effective.

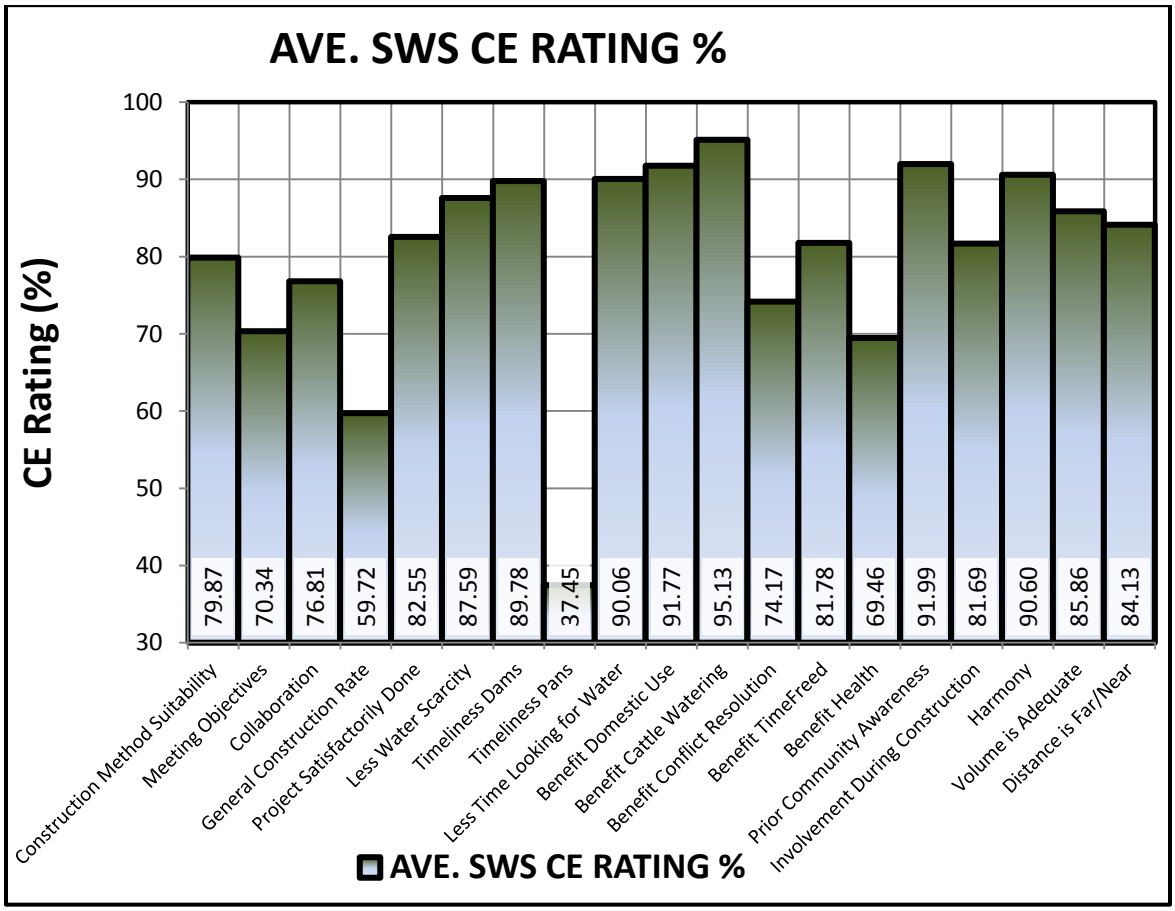

Figure 4-14: Average Cost – Effective Analysis for Various Aspects

From Figure 4-14 it can be deduced how cost effective the various aspects of the SWSs undertaken by NWCPC are (see Annex 3 for the data). The small SWSs undertaken by NWCPC were found to be most cost-effective in the aspects of cattle watering at 95.13% (or 9.51 Kshs/m^3), prior community awareness of the project at 91.99% and water for domestic use at 91.77%. The SWSs undertaken

by NWCPC were least cost-effective in the aspects of timeliness in construction of pans at 37.45% (or 27.87 Kshs/m^3) and in the general rate of construction at 59.72%.

The overall grading for NWCPC has been taken as the average of all the individual grading considering the crucial objectives of NWCPC as given in the performance contracts and the strategic plans.

Table 4-5: Average Cost Effectiveness

S/No	Project Name	AVE. SWS CE RATING %	AVE CE PER ASPECT, Kshs/m^3	POSITION
11	Cattle Watering	95.13	9.51	1
15	Prior Community Awareness	91.99	10.51	2
10	Domestic Use	91.77	10.58	3
17	Harmony	90.60	10.95	4
9	Less Time Looking for Water	90.06	11.12	5
7	Timeliness Dams	89.78	11.21	6
6	Less Water Scarcity	87.59	11.91	7
18	Volume is Adequate	85.86	12.46	8
19	Distance is Far/Near	84.13	13.01	9
5	Project Satisfactorily Done	82.55	13.51	10
13	Time Freed	81.78	13.76	11
16	Involvement During Construction	81.69	13.79	12
1	Construction Method Suitability	79.87	14.36	13
3	Collaboration	76.81	15.34	14
12	Conflict Resolution	74.17	16.18	15
2	Meeting Objectives	70.34	17.40	16
14	Health	69.46	17.68	17
4	General Construction Rate	59.72	20.78	18
8	Timeliness Pans	37.45	27.87	19
	General Average CE	**80.04**	**14.31**	

Using the following formula

$$CEave = \frac{\sum_{i=1}^{n} CE_i}{n}$$

The average CE comes to 80.04% (14.31 Kshs/m^3). (See Table 4-5)

The average CE value of **80.04%** indicates that NWCPC is noted to be cost-effective in its small SWS undertakings in the Tanathi WSB area that was surveyed. Nevertheless it still has room for improvement especially in the areas with unsatisfactory CE rating such as the timeliness in construction of pans and general construction rate for small SWSs.

In summary, NWCPC has been found to be cost-effective in its undertakings in small SWS development in the Tanathi WSB area which was the study area. The overall Cost-Effective rating of NWCPC projects in the Tanathi WSB area that was surveyed, as calculated herein is **80.04%**.

4.5. IMPROVING IMPLEMENTATION OF SWSs

4.5.1. Adverse Effects from SWS Implementation

As expected from any significant undertaking, there are both positive and negative effects that arise from the same. In order for one to improve effectiveness of any project one must first analyse the adverse effects so as to come up with measures to address these effects and improve the project.

During the field study 72% of the respondents stated that there were negative effects that resulted from the implementation of the projects. Highlighted hereunder is a summary of the main adverse effects that the respondents noted which arose from the construction of the SWSs.

One of the negative effects was that the SWSs led to in-fighting among the communities and conflicts over the use of water. Furthermore the construction of the SWSs also led to drowning by people trying to access the dams or swim in them. This was attributed to lack of proper fencing and lack of draw off points situated well away from the reservoirs created.

Another negative effect was that the implementation of the SWSs gave rise to land conflicts among the residents resulting in the displacement of people.

Environmental degradation was another negative effect raised by the respondents. This was attributed to overgrazing due to the influx of many animals coming to these new watering points. The area most affected was about 100 m radius from the project sites.

Cattle death was cited as another negative effect possibly due to drowning or poor water quality. It was also reported that solid waste in the vicinity of the projects increased owing to the SWS developments as a result of more people and animals visiting the area after the implementation leading to dumping of waste.

Diseases were noted to be another negative effect as was effluent from nearby institutions and dwellings. The water that now collected in the pans and dams was a source of water-borne diseases and mosquitoes and hence malaria.

Wild animals that started frequenting some of the new watering points posed danger to the locals whom the project was otherwise meant to benefit.

The respondents interviewed also gave their views as to why some of the projects undertaken by NWCPC failed. They cited reasons such as conflict over land which caused the project to stall, shallow dams which did not hold water for long, breakdown of installed equipment. Poor workmanship and incomplete structures have also led to failed projects.

4.5.2. Proposals on Effective SWS Implementation

The comments from the respondents on how NWCPC can improve its operations were that NWCPC should undertake the following: -

1. Hasten procurement and funding processes so as to reduce delays on project implementation.

2. Take advantage of dry seasons to implement SWSs since rainy seasons hamper such undertakings.

3. Involve communities in the conception and construction of SWSs and also train the locals on the operation and maintenance of the same for promoting a sense of project ownership and hence project sustainability.

4. Ensure that supervision of the projects is done strictly and ensure specifications for the same are followed.

5. Engage experienced and reliable contractors as these shall assist to ensure it achieves its targets.

6. Undertake thorough feasibility studies, planning and proper SWS designs in order to avoid problems associated with poor identification of sites and inadequate designs.

7. Strive to do more projects in-house than rely mainly on outsourcing of contractors as it then can have more control over the results. In this regard, NWCPC may opt to create several well managed Dam Construction Units (DCUs) by purchasing adequate equipment and machinery such as bulldozers and upgrade its transport system for timelier implementation.

8. Request for an increased budget for building larger water projects for more water storage and thus achieve greater impacts.

9. Train its staff on project management to boost their management skills and also consider the issue of capacity building.

10. Undertake post-construction evaluation and get end-user feedback which would help improve future projects using the lessons learnt from those already implemented.

11. Revamp and boost its Monitoring and Evaluation team for more effective monitoring and evaluation. The management should take the teams' observations and recommendations seriously and act on them.

The Figure 4-15 indicates proposals from the respondents on how NWCPC could improve their projects.

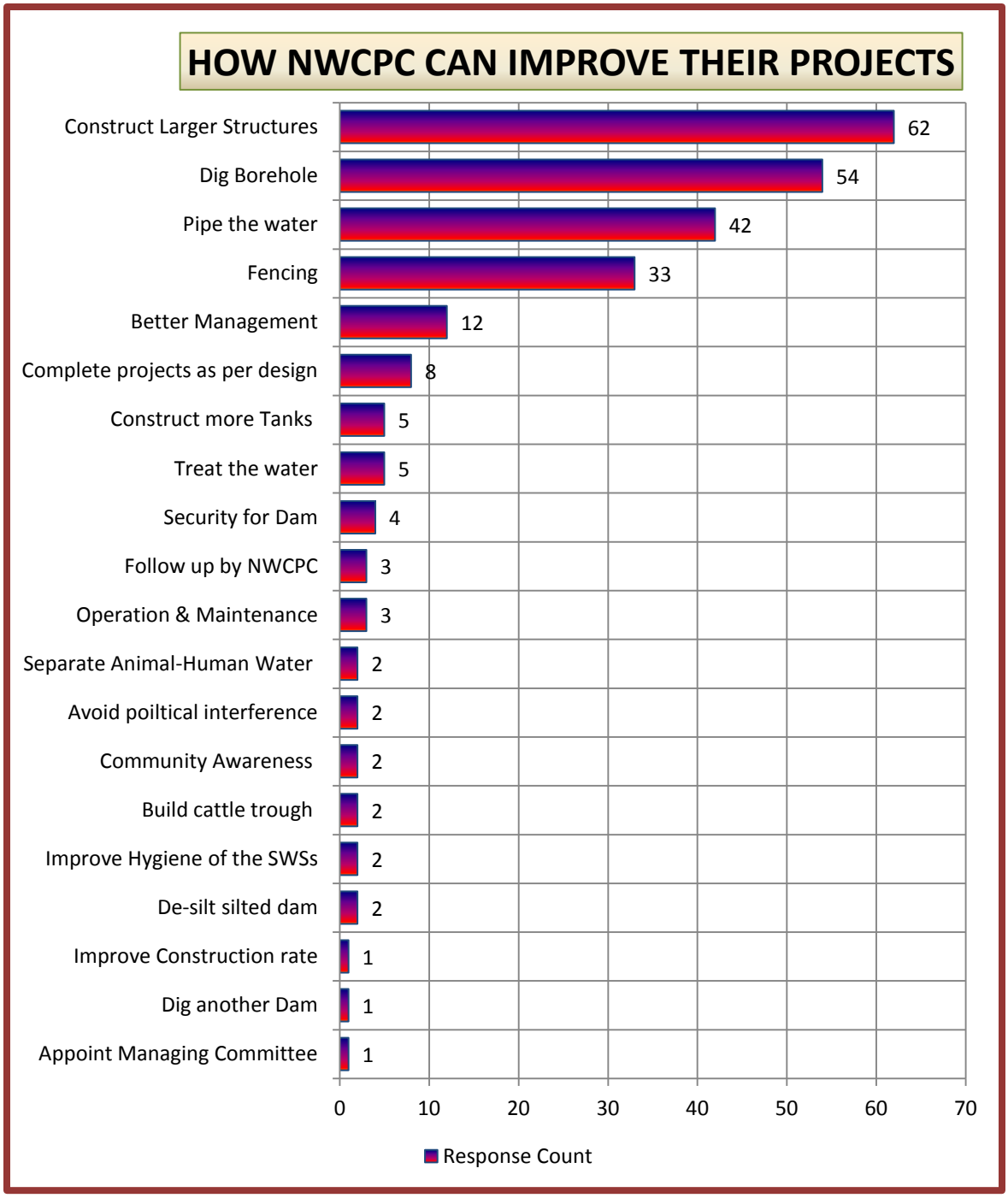

Figure 4-15: How NWCPC Can Improve their Projects

From Figure 4-15 the suggestion with the highest number of responses (62no.) was regarding construction of larger SWSs. This corresponds very well with the

results of the analysis on cost effectiveness on the sizes of SWSs whereby it was deduced that it was more cost effective to construct larger ones.

The need for more water was noted by the suggestion on drilling more boreholes as was stated by 54 responses. This was followed by 42 of them suggesting that water be brought nearer to the users through pipelines.

33 of the responses indicated that fencing was a key aspect in enhancing proper management of the SWSs in terms of safety, hygiene, security, revenue collection and preventing land encroachment.

Managerial issues were also noted by 12 of the respondents as requiring improvement. Other suggestions given were as shown in the same Figure 4-15. Though NWCPC does not manage these projects after construction, it can come up with methods of handling some of the concerns that do not lie directly in NWCPC's mandate. In future the issues that have been noted and that are directly NWCPC's responsibility should be taken up seriously and addressed by NWCPC for an enhanced and more cost effective implementation of the SWSs.

5 CHAPTER FIVE

5. CONCLUSIONS AND RECOMMENDATIONS

5.1. CONCLUSIONS

The purpose of this study was to ascertain the cost-effectiveness of the implementation of small SWSs by NWCPC in Tanathi WSB and to establish how their implementation could be improved. The study has revealed that NWCPC has performed well in the implementation of SWSs in the Tanathi WSB despite various setbacks and challenges. The following statements summarise the key aspects of the findings of this study.

NWCPC has achieved over 100% of its targets in numbers and volumes for small SWSs as per its records for pans and small dams, thereby achieving the objectives set out by the Corporation in the Tanathi WSB area. 54.2% of the beneficiaries there indicated that the SWSs have successfully achieved their intended purpose.

The overall Cost-Effective rating of NWCPC for the Tanathi WSB small SWSs as calculated herein is 80.04% (14.31 Kshs/m^3). This rating closely approaches 100%. It however still needs to improve on the general rate of construction and especially timeliness in the construction of water pans in order to attain greater overall cost-effectiveness. The rate of construction may be improved by accelerating the pace of its operations and making them more efficient while addressing other factors that will make the projects to be of greater assistance to the beneficiaries.

The small SWSs undertaken by NWCPC in Tanathi WSB were found to be most cost-effective in the aspects of cattle watering at 95.13% (or 9.51 Kshs/m^3), prior community awareness at 91.99% and water supply for domestic use at 91.77%.

Resource utilisation was rated by over 60% of the NWCPC respondents as good or very good. NWCPC shall have to use these resources more efficiently in order to achieve higher cost-effectiveness than has been achieved so far.

Considering NWCPC's mandate, one of the main checks as to whether it has been effective is the increase in volume impounded by the SWSs it constructs. Within the Tanathi area, considering that the volume of water impounded has been substantial, NWCPC has hence made an impact in the communities dwelling there as indicated by the study. Some 1,000,553 m^3 of water was developed in between the FY 2010-11 and FY 2011-12 in Tanathi WSB area. This increased water has helped ease water scarcity in the areas studied. However there is still room for even greater impact in this aspect by exploiting the various recommendations as highlighted in this report such as construction of larger SWSs, drilling of boreholes and other methods.

A general trend was noted during the study that with an increase in the capacity small SWS constructed, there was a corresponding decrease in the cost per unit volume of water. This suggests that it is more economical to construct larger capacity SWSs than it is to construct smaller capacity ones. Therefore policies should be made towards making use of this finding.

Various suggestions for improved cost effectiveness have been put forth as a result of this study. These need to be considered when constructing SWSs and developing water policies. These measures such as treatment of water for reduced risk to health of the users, better and more interaction with the communities, greater community awareness before and during implementation, fencing among other proposed measures will undoubtedly go a long way in improving the cost-effectiveness of constructing SWSs.

The results of the study can assist in policy development by making it mandatory that high volume SWSs be considered for construction always as a first priority unless it is not feasible. Policy makers should also consider the increased funding

for SWSs to ensure adequate funds are availed for large capacity SWSs. Furthermore more studies can be undertaken using the methodology highlighted herein to study cost -effectiveness of projects undertaken.

It should further be the policy that every project that is implemented should be assessed for its cost-effectiveness. The methodology used herein could guide the process and be developed further with increased time and experience.

5.2. RECOMMENDATIONS

The following are various recommendations that if implemented are expected to assist in achieving a greater impact in the cost-effective implementation of SWSs. The main recommendations are the following: -

1. There should be should hastened procurement and funding processes as a means to reduce delays on project implementation. Dry seasons should be taken advantage of to implement SWSs as rainy seasons hamper such undertakings thereby reducing cost effectiveness.

2. The body mandated to develop SWSs should endeavour to construct as large SWSs as is possible so as to achieve maximum impacts and hence greater cost effectiveness.

3. Involve communities in the conception and construction of SWSs and also train the locals on the operation and maintenance of the same for promoting a sense of project ownership and hence project sustainability.

Other recommendations are that: -

1. Staff to be trained on project management to boost their management skills and undertake the necessary capacity building.

2. Post-construction evaluation should be undertaken to get end-user feedback which would help improve future projects using the lessons learnt from those already implemented.

3. NWCPC should undertake more effective monitoring and evaluation.

5.2.1. Recommendations for Further Study

In this study the researcher was only able to undertake the study of cost-effectiveness of small dams and pans yet NWCPC undertakes the construction of large dams and boreholes too. Furthermore the researcher was only able to undertake studies on a small area in comparison to the large coverage undertaken by NWCPC. In view of this I hereby would suggest the following areas for further study.

1. A study on the cost-effectiveness of the construction of large dams and/or boreholes in comparison with the smaller SWSs.

2. A study on the cost-effectiveness of the other areas having SWSs other than the TANATHI WSB for a more country-wide perspective.

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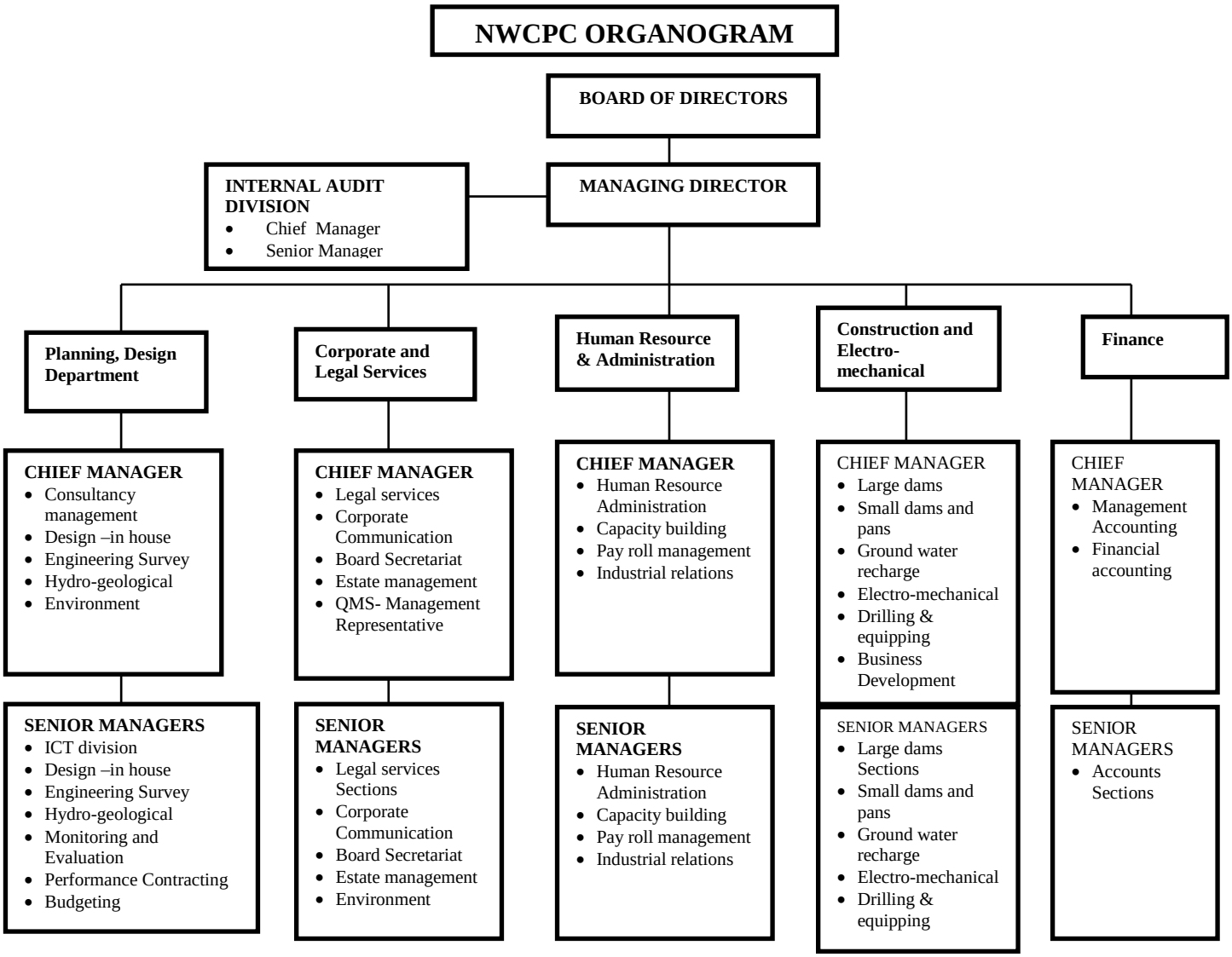
7 ANNEXES

Annex 1: NWCPC Organogram



Annex 2: Questionnaires

INTERVIEW SCHEDULE FOR CBOs/LOCAL RESIDENTS

This questionnaire is divided into several sections to ease the filling in of the required information.

Section 1: General Information on the respondent

1. Name_____(Optional)

Tick the appropriate response from the alternatives provided hereunder: -

2. Gender: M [ ] F [ ]
3. Age: (years): 20-30 [ ] 31-40 [ ] 41-50 [ ] above 51
4. Designation (Optional) _____
5. Institution (Optional) _____
6. Job title (Optional) _____
7. Locality (nearest City /Town/village) _____

Section 2: Effectiveness of NWCPC Projects & Implementation

The section is intended to gather information on the effectiveness of the implementation of NWCPC projects and the achievement of the project objectives.

8. Which are the water projects undertaken by NWCPC within your area? (you may tick one or more of the following and give their names where possible)
   [ ] Small dams [ ] Pans [ ] Boreholes [ ] Sand dams
   Names:
   ……
   [ ] Flood control works [ ] Other (name it) _____

   Names:
   ……

For the following questions please tick the appropriate answer from the alternatives using a scale of **[1] (least) to [5] (Best)** as shown hereunder **to rate NWCPC: -**

KEY:

[1]	Strongly disagree	- (very bad)
[2]	Disagree	- (bad)
[3]	Uncertain	- (neutral)
[4]	Agree	- (good)

[5] Strongly agree - (very good)

9. How suitable have been the methods employed by NWCPC in the implementation of these projects? 1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

How successful generally have been the NWCPC projects that have been implemented in the following areas: -

10. In meeting their objectives (such as water provision, flood control, reducing distance to assessing water) 1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

Tick only for those that are applicable in your area

11. Timeliness (finishing of projects in shortest time)

11.1. Small dams	1[ ]	2[ ]	3[ ]	4[ ]	5[ ]
Pans	1[ ]	2[ ]	3[ ]	4[ ]	5[ ]
Boreholes	1[ ]	2[ ]	3[ ]	4[ ]	5[ ]
Sand dams	1[ ]	2[ ]	3[ ]	4[ ]	5[ ]
11.2. Flood control works	1[ ]	2[ ]	3[ ]	4[ ]	5[ ]
11.3. Other (name it)……					
	1[ ]	2[ ]	3[ ]	4[ ]	5[ ]

Section 3: Comparison of NWCPC with other institutions undertaking similar work

KEY:

[1] - (worst)
[2] - (worse)
[3] - (neutral)
[4] - (good)
[5] - (best)

12. How long has NWCPC been working in your area?

13. Do you pay for the water? Y[ ], N[ ]

13.1. If so how much per jerry-can?

14. Do you have any other water source?

14.1. If yes Which one is it?.....

15. Are there any other organizations within your area that do work that is similar to what NWCPC does? Yes [ ] No [ ]

16. If your answer is yes to the above question, which organizations are they (State their Names)?

_____

17. In your opinion was the rate of construction satisfactory?

1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

18. Has the project helped ease the problem of water scarcity?

1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

19. How does this project benefit the community and meet your needs?

19.1. Irrigation.

1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

19.2. Farming.

1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

19.3. Reduced time spent in searching for water.

1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

19.4. Water supply.

1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

19.5. Domestic use.

1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

19.6. Cattle watering.

1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

19.7. Employment.

19.7.1. Casual labor.

1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

19.7.2. Skilled labor (local).

1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

19.8. Food kiosks.

1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

19.9. Lifestyle, business and other benefits through items purchased by implementers during construction such as sell of food, clothing, renting of houses etc.

1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

19.10. Social interaction with other communities who come to work on the project.

1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

19.11. Sharing of ideas and technologies used.

1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

19.12. Soil/minerals obtained (such as murram, stones, and any other).

1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

19.13. Political benefits.

1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

19.14. Conflict resolution.

1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

19.15. Time freed for other economic activities.
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

19.16. Improved health.
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

20. Other Socio-economic benefits.
……

21. Were the community made aware of the project in advance?
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]
……
….

22. Was the community involved during project construction?
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]
……
.

23. Was the community involved or consulted about the project at the beginning?
Yes [ ] No [ ]

23.1. If yes to the above question, how were they consulted?
……

If No to the above question, why do you think they were not consulted?
……

24. Are there any negative/adverse effects arising from this water project? Yes [ ] No [ ]

24.1. If yes to the above question, which are some of the problems?

……

25. Has the finished project been constructed to your satisfaction?
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]
……

26. Has the method/manner in which project was constructed satisfactory?
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]
……

27. Has the project helped bring the community (or communities) together?
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]
……

28. Does the project cross any administration or political boundaries?
    1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

    ……

29. Have there been water related conflicts in your area in the past? Yes [ ] No [ ]

    29.1. If yes to the above question, has the project helped reduce conflicts in the area especially over water?
    1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

    ……..

30. What are the costs involved in the implementation of the SWSs? [NGOs, WSBs, etc.]

31. Name them and give approximate figures in Kenyan Shillings (Kshs)
    ……

32. How long does the water last in the structure?
    State the number of months……..

    32.1. Is this period of storage adequate? Y[ ] N[ ]

    ……..
    32.2. Is the Volume of the reservoir adequate?
    . 1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

33. How far do you go in search of water?
    ……..

    33.1. Is this distance okay for you? Y[ ] N[ ]
    33.2. Explain……
    33.3. How much of your time do you spend obtaining water?
    ……
    …

34. Are there any environmental issues arising from the project? If so which ones are they?

    ……

35. Has any NWCPC project failed in the past i.e. in terms of completion, collapsing etc.?
    Y[ ] N[ ]
    35.1. If so what was the cause?

……

36. How do you think NWCPC can improve their projects in order to serve the residents better?

_____

37. Any Other comments or suggestions?

_____

Thank you very much for sparing your time to answer this questionnaire.

INTERVIEW SCHEDULE FOR GOVERNMENT REPRESENTATIVES

This questionnaire is divided into several sections to ease the filling in of the required information

Section 1: General Information on the respondent

1. Name_____(Optional)

   Tick the appropriate response from the alternatives provided hereunder: -

2. Gender: M [ ] F [ ]

3. Age: (years): 20-30 [ ] 31-40 [ ] 41-50 [ ] above 51

4. Designation (Optional) _____

5. Institution (Optional) _____

6. Job title (Optional) _____

7. Locality (nearest City /Town/village) _____

Section 2: Effectiveness of NWCPC Projects & Implementation

The section is intended to gather information on the effectiveness of the implementation of NWCPC projects and the achievement of the project objectives.

8. Which are the surface water structures undertaken by NWCPC within your area? (you may tick one or more of the following and give their names where possible)
   [ ] Small dams [ ] Pans [ ] Boreholes [ ] Sand dams

   Names:
   ……
   [ ] Flood control works [ ] Other (name it) _____

   Names:
   ……

9. What methods are employed by NWCPC in the construction of surface water structures?

[ ] Self implementation (NWCPC) [ ] Contracting out

[ ] Manual labor [ ] Machinery

[ ] Others (name them)
……..

For the following questions please tick the appropriate answer from the alternatives using a scale of **[1] (least) to [5] (Best)** as shown hereunder **to rate NWCPC: -**

KEY:

[6]	Strongly disagree	- (very bad)
[7]	Disagree	- (bad)
[8]	Uncertain	- (neutral)
[9]	Agree	- (good)
[10]	Strongly agree	- (very good)

10. How suitable have been the methods employed by NWCPC in the implementation of these projects? 1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

How successful generally have been the NWCPC projects that have been implemented in the following areas: -

11. In meeting their objectives (such as water provision, flood control, reducing distance to assessing water) 1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

Tick only for those that are applicable in your area

12. In the use of funds for the implementation of
    - 12.1. Small dams 1[ ] 2[ ] 3[ ] 4[ ] 5[ ]
    - 12.2. Pans 1[ ] 2[ ] 3[ ] 4[ ] 5[ ]
    - 12.3. Boreholes 1[ ] 2[ ] 3[ ] 4[ ] 5[ ]
    - 12.4. Sand dams 1[ ] 2[ ] 3[ ] 4[ ] 5[ ]
    - 12.5. Flood control works 1[ ] 2[ ] 3[ ] 4[ ] 5[ ]
    - 12.6. Other (name it)…… 1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

13. Resource utilization
    - 13.1. Staff 1[ ] 2[ ] 3[ ] 4[ ] 5[ ]
    - 13.2. Machinery 1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

14. Timeliness (delivery of projects in allocated time)

14.1.	Small dams	1[ ]	2[ ]	3[ ]	4[ ]	5[ ]
14.2.	Pans	1[ ]	2[ ]	3[ ]	4[ ]	5[ ]
14.3.	Boreholes	1[ ]	2[ ]	3[ ]	4[ ]	5[ ]
14.4.	Sand dams	1[ ]	2[ ]	3[ ]	4[ ]	5[ ]
14.5.	Flood control works	1[ ]	2[ ]	3[ ]	4[ ]	5[ ]
14.6.	Other (name it)……	1[ ]	2[ ]	3[ ]	4[ ]	5[ ]

Section 3: Comparison of NWCPC with other institutions undertaking similar work

KEY:

[6] - (worst)
[7] - (worse)
[8] - (neutral)
[9] - (good)
[10] - (best)

15. How would you rate NWCPC's general coordination and collaboration with stakeholders

1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

16. Are there any other organizations within your area that do work that is similar to what NWCPC does? Yes [ ] No [ ]

17. If your answer is yes to the above question, which organizations are they (State their Names)?

_____

18. When implementing similar projects are these organizations doing a better job than NWCPC in the following: -

18.1.	In meeting the project objectives	1[ ]	2[ ]	3[ ]	4[ ]	5[ ]
18.2.	In the use of funds for the implementation of projects	1[ ]	2[ ]	3[ ]	4[ ]	5[ ]
18.3.	Resource utilization					

18.3.1. Staff 1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

18.3.2. Machinery 1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

18.4. Timeliness (delivery of projects in allocated time)
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

18.5. Efficiency 1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

19. In your opinion was the rate of construction satisfactory?
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

20. Has the project helped ease the problem of water scarcity?
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

21. How does this project benefit the community and meet your needs?

21.1. Irrigation.
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

21.2. Farming.
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

21.3. Reduced time spent in searching for water.
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

21.4. Water supply.
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

21.5. Domestic use.
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

21.6. Cattle watering.
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

21.7. Employment.

21.7.1. Casual labor.
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

21.7.2. Skilled labor (local).
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

21.8. Food kiosks.
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

21.9. Lifestyle, business and other benefits through items purchased by implementers during construction such as sell of food, clothing, renting of houses etc.
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

21.10. Social interaction with other communities who come to work on the project.
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

21.11. Sharing of ideas and technologies used.
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

21.12. Soil/minerals obtained (such as murram, stones, and any other).
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

21.13. Political benefits.
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

21.14. Conflict resolution.
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

21.15. Time freed for other economic activities.
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

21.16. Improved health.
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

22. Other Socio-economic benefits.
……

23. Were the community made aware of the project in advance?
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]
……

24. Was the community involved during project construction?
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]
……
….

25. Was the community involved or consulted in deciding whether the project should be constructed?
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

……
…..

26. Are there any negative/adverse effects arising from this water project? Yes [ ] No [ ]

26.1. If yes to the above question, which are some of the problems?
……
…..

27. Are you happy with the finished project or could it have been done better?
Y [ ] N [ ]

Explain your answer
……

28. Has the project helped bring the community (or communities) together?
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

29. Does the project cross any administration or political boundaries?
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

30. Have there been water related conflicts in your area in the past? Yes [ ] No [ ]

31. If yes to the above question, has the project helped reduce conflicts in the area especially over water?

1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

……

32. What are the costs involved in the implementation of the SWSs? [NGOs, WSBs, etc.]

33. Name them and give approximate figures in Kenyan Shillings (Kshs)

……

34. How long does the water last in the structure?

State the number of months……..

34.1. Is this period of storage adequate? Y[ ] N[ ]

……..

34.2. Is the Volume of the reservoir adequate?

. 1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

35. Was a social impact assessment study done on the project?

36. How do you think NWCPC can improve their projects in order to serve the residents better?

_____

37. Any Other comments or suggestions?

_____

Thank you very much for sparing your time to answer this questionnaire.

INTERVIEW SCHEDULE FOR LOCAL AREA ADMINISTRATION

This questionnaire is divided into several sections to ease the filling in of the required information

Section 1: General Information on the respondent

1. Name_____(Optional)

Tick the appropriate response from the alternatives provided hereunder: -

2. Gender: M [ ] F [ ]
3. Age: (years): 20-30 [ ] 31-40 [ ] 41-50 [ ] above 51
4. Designation (Optional) _____
5. Institution (Optional) _____
6. Job title (Optional) _____
7. Locality (nearest City /Town/village) _____

Section 2: Effectiveness of NWCPC Projects & Implementation

The section is intended to gather information on the effectiveness of the implementation of NWCPC projects and the achievement of the project objectives.

8. Which are the surface water structures undertaken by NWCPC within your area? (you may tick one or more of the following and give their names where possible)
   [ ] Small dams [ ] Pans [ ] Boreholes [ ] Sand dams

   Names:
   ……
   [ ] Flood control works [ ] Other (name it) _____

   Names:
   ……

For the following questions please tick the appropriate answer from the alternatives using a scale of **[1] (least) to [5] (Best)** as shown hereunder **to rate NWCPC: -**

KEY:

[11]	Strongly disagree	- (very bad)
[12]	Disagree	- (bad)
[13]	Uncertain	- (neutral)
[14]	Agree	- (good)
[15]	Strongly agree	- (very good)

9. How suitable have been the methods employed by NWCPC in the implementation of these projects? 1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

How successful generally have been the NWCPC projects that have been implemented in the following areas: -

10. In meeting their objectives (such as water provision, flood control, reducing distance to assessing water) 1[ ] 2[ ] 3[ ] 4[ ] 5[ ]
Tick only for those that are applicable in your area

Section 3: Comparison of NWCPC with other institutions undertaking similar work

KEY:

[11] - (worst)
[12] - (worse)
[13] - (neutral)
[14] - (good)
[15] - (best)

11. How would you rate NWCPC's general coordination and collaboration with stakeholders
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]
……
12. Are there any other organizations within your area that do work that is similar to what NWCPC does? Yes [ ] No [ ]
13. If your answer is yes to the above question, which organizations are they (State their Names)?
_____
14. When implementing similar projects are these organizations doing a better job than NWCPC in the project implementation?
……
15. In your opinion was the rate of construction satisfactory?
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]
……
16. Has the project helped ease the problem of water scarcity?
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]
……
17. How does this project benefit the community?
17.1. Irrigation.
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]
17.2. Farming.
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]
17.3. Reduced time spent in searching for water.
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

17.4. Water supply.
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

17.5. Domestic use.
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

17.6. Cattle watering.
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

17.7. Employment.

17.7.1. Casual labor.
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

17.7.2. Skilled labor (local).
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

17.8. Food kiosks.
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

17.9. Lifestyle, business and other benefits through items purchased by implementers during construction such as sell of food, clothing, renting of houses etc.
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

17.10. Social interaction with other communities who come to work on the project.
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

17.11. Sharing of ideas and technologies used.
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

17.12. Soil/minerals obtained (such as murram, stones, and any other).
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

17.13. Political benefits.
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

17.14. Conflict resolution.
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

17.15. Time freed for other economic activities.
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

17.16. Improved health.
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

18. Other Socio-economic benefits.
……

19. Were the community made aware of the project in advance?
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]
……

20. Was the community involved during project construction?
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]
……

21. Was the community involved or consulted in deciding whether the project should be constructed?
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

……

22. Are there any negative/adverse effects arising from this water project? Yes [ ] No [ ]

23. If yes to the above question, which are some of the problems?
……

24. Has the finished project been constructed to your satisfaction?
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]
……

25. Has the method/manner in which project was constructed satisfactory?
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]
……

26. Has the project helped bring the community (or communities) together?
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]
……
Does the project cross any administration or political boundaries?
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]
……
Have there been water related conflicts in your area in the past? Yes [ ] No [ ]

27. If yes to the above question, has the project helped reduce conflicts in the area especially over water?
1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

28. How long does the water last in the structure?
State the number of months……..

28.1. Is this period of storage adequate? Y[ ] N[ ]

……..

28.2. Is the Volume of the reservoir adequate?
. 1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

29. How do you think NWCPC can improve their projects in order to serve the residents better?
_____

30. Any Other comments or suggestions?
_____

Thank you very much for sparing your time to answer this questionnaire.

INTERVIEW SCHEDULE FOR NWCPC STAFF

This questionnaire is divided into several sections to ease the filling in of the required information

Section 1: General Information on the respondent

1. Name_____(Optional)

   Tick the appropriate response from the alternatives provided hereunder: -

2. Gender: M [ ] F [ ]

3. Age: (years): 20-30 [ ] 31-40 [ ] 41-50 [ ] above 51

4. Designation (Optional) _____

5. Level /position in the organization
   - [ ] Lower management
   - [ ] Middle level Management
   - [ ] Divisional head
   - [ ] Top management
   - [ ] Other (State it) _____

6. Job title (Optional) _____

7. Department
   - [ ] Construction & electromechanical
   - [ ] Planning & design
   - [ ] Finance
   - [ ] Human resource and administration
   - [ ] Corporate and legal services
   - [ ] Other (State it) _____

Section 2: Effectiveness of NWCPC Projects & Implementation

The section is intended to gather information on the effectiveness of the implementation of NWCPC projects and the achievement of the project objectives.

For the following questions please tick the appropriate answer from the alternatives using a scale of **[1] (least) to [5] (Best)** as shown hereunder **to rate NWCPC: -**

KEY:

[16]	Strongly disagree	- (very bad)
[17]	Disagree	- (bad)
[18]	Uncertain	- (neutral)
[19]	Agree	- (good)
[20]	Strongly agree	- (very good)

8. How effective have been the methods (employed by NWCPC in the implementation of projects (Dams, pans, boreholes, etc?
   1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

How successful generally have been the NWCPC projects that have been implemented in the following areas: -

9. In meeting their objectives (such as water provision, flood control, reducing distance to assessing water) 1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

Tick only for those that are applicable in your area

10. In the use of funds for the implementation of

10.1.	Small dams	1[ ]	2[ ]	3[ ]	4[ ]	5[ ]
10.2.	Pans	1[ ]	2[ ]	3[ ]	4[ ]	5[ ]
10.3.	Boreholes	1[ ]	2[ ]	3[ ]	4[ ]	5[ ]
10.4.	Sand dams	1[ ]	2[ ]	3[ ]	4[ ]	5[ ]
10.5.	Flood control works	1[ ]	2[ ]	3[ ]	4[ ]	5[ ]
10.6.	Other (name it)……	1[ ]	2[ ]	3[ ]	4[ ]	5[ ]

11. Resource utilization

11.1.	Staff	1[ ]	2[ ]	3[ ]	4[ ]	5[ ]
11.2.	Machinery	1[ ]	2[ ]	3[ ]	4[ ]	5[ ]

12. Timeliness (delivery of projects in allocated time)

12.1.	Small dams	1[ ]	2[ ]	3[ ]	4[ ]	5[ ]
	Pans	1[ ]	2[ ]	3[ ]	4[ ]	5[ ]
12.2.	Boreholes	1[ ]	2[ ]	3[ ]	4[ ]	5[ ]
12.3.	Sand dams	1[ ]	2[ ]	3[ ]	4[ ]	5[ ]
12.4.	Flood control works	1[ ]	2[ ]	3[ ]	4[ ]	5[ ]
12.5.	Other (name it)……	1[ ]	2[ ]	3[ ]	4[ ]	5[ ]

Section 3: Comparison of NWCPC with other institutions undertaking similar work

KEY: **(**Tick the box that best indicates your answer.)

[16] - (worst)
[17] - (worse)
[18] - (neutral)
[19] - (good)
[20] - (best)

13. How would you rate NWCPC's general coordination and collaboration with stakeholders

    1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

14. Are there any other organizations you are aware of that do work that is similar to what NWCPC does? Yes [ ] No [ ]

15. If your answer is yes to the above question, which organizations are they (State their Names where possible)?

    _____
    _

16. When implementing similar projects are these organizations doing a better job than NWCPC in the following: -

    16.1. In meeting the project objectives

    1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

    16.2. In the use of funds for the implementation of projects

    1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

    16.3. Resource utilization

    16.3.1. Staff 1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

    16.3.2. Machinery 1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

    16.4. Timeliness (delivery of projects in allocated time)

    1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

    16.5. Efficiency 1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

17. In your opinion is the general rate of construction of projects satisfactory?

    1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

    ……

18. Have the projects helped ease the problem of water scarcity?
    1[ ] 2[ ] 3[ ] 4[ ] 5[ ] Don't Know [ ]

    ……

19. How would you rate NWCPC in the involving of communities during project inception or formulation?
    1[ ] 2[ ] 3[ ] 4[ ] 5[ ] Unsure [ ]

20. How would you rate NWCPC in the involving of communities during project construction?
    1[ ] 2[ ] 3[ ] 4[ ] 5[ ] Unsure [ ]

21. Are there any negative/adverse effects arising from the water projects? Yes [ ] No [ ] Don't know [ ]

22. If yes to the above question, which are some of these effects?

    ……

23. Generally are the finished projects constructed to the required standards?
    1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

    ……

24. Are the methods/means used in the project construction satisfactory?
    1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

    ……

25. How do you think NWCPC can improve the implementation of such projects in future in order to serve the residents better?
    _____

26. Any Other comments or suggestions?

Thank you very much for sparing your time to answer this questionnaire.

Annex 3: Average CE Per Aspect of Project

Project Name / Project Aspect	Katheini dam	Kwa Luvai dam	Kwa Munovi Dam	Kwa Mathala Dam	Kwa Muutu Dam	Kwamuutu Dam	Kwa Itinga Pan	KwaKitoo dam	Kwa Mithini Pan	Kya Ngawa Dam	Kyanganga dam	Mangolota	Manyanzaa Dam	Matungulu dam	Matyambo Dam	Ngangani Dam	Ngii Earth Dam	Nunga dam	**AVE CE PER ASPECT**	NWCPC AVERAGE CE
Construction Method Suitability	9.95	5.51	11.94	12.24	12.03	17.27	9.95	12.66	13.26	19.89	13.26	9.95	39.79		13.26	13.26	10.85	13.26	**14.02**	13.82
Meeting Objectives	9.95	6.43	10.67	11.6	12.93	14.54	39.79	13.93	9.95	13.26	13.26	39.79	39.79		13.26	9.95	19.89	9.95	**17**	13.82
Collaboration		4.82	13.26	15.91		27.63										9.95			**14.31**	13.82
General Construction Rate		6.43	9.95	13.26		27.63										39.79			**19.41**	13.82
Less Water Scarcity		6.43	9.95	9.95		18.42										7.96			**10.54**	13.82
Timeliness Dams	9.95		9.95	13.26	9.95					13.26			9.95		13.26	11.37	9.95		**11.21**	13.82
Timeliness Pans		11.57	23.87	18.57	19.89	31.58	39.79	30.95	39.79		39.79					13.26	13.26	39.79	**26.84**	13.82
Less Time Looking for Water	9.95	6.43	10.32	9.65	10.13	15.35	9.95	14.66	9.95	13.26	13.26	9.95	9.95	9.95	11.37	9.95	9.36	9.95	**10.74**	13.82
Benefit Domestic Use	9.95	4.82	10.51	12.24	10.92	17.27	7.96	9.6	7.96	13.26	9.95	7.96	8.84	9.95	11.37	8.84	10.61	13.26	**10.29**	13.82
Benefit Cattle Watering	7.96	4.29	9.13	9.36	9.6	12.56	7.96	9.6	7.96	11.37	9.95	7.96	8.84	9.95	11.37	9.95	8.84	9.95	**9.25**	13.82
Benefit Conflict Resolution	19.89	5.14	17.41	18.72	13.59	25.12	7.96	13.26	9.95	13.26	13.26	13.26	13.26	13.26	39.79	17.68	17.68	13.26	**15.88**	13.82
Benefit TimeFreed	9.95	5.51	12.66	11.37	11.14	17.27	9.95	12.66	9.95	26.52	19.89	13.26	11.37	9.95	19.89	19.89	10.61	9.95	**13.43**	13.82
Benefit Health	15.91	4.82	12.11	12.24	14.66	15.35	9.95	12.66	9.95	39.79	9.95	39.79	9.95	9.95	39.79	31.83	14.47	9.95	**17.39**	13.82

Project Name / Project Aspect	Katheini dam	Kwa Luvai dam	Kwa Munovi Dam	Kwa Mathala Dam	Kwa Muutu Dam	Kwamuutu Dam	Kwa Itinga Pan	KwaKitoo dam	Kwa Mithini Pan	Kya Ngawa Dam	Kyanganga dam	Mangolota	Manyanzaa Dam	Matungulu dam	Matyambo Dam	Ngangani Dam	Ngii Earth Dam	Nunga dam	**AVE CE PER ASPECT**	NWCPC AVERAGE CE
Prior Community Awareness	8.84	4.82	9.44	11.14	11.37	19.73	7.96	10.71	7.96	11.37	13.26	9.95	7.96	7.96	8.84	10.61	8.84	13.26	**10.22**	13.82
Involvement During Construction	8.84	5.26	12.95	12.11	12.56	17	9.95	11.14		11.37	9.95		7.96	7.96	26.52	39.79	8.38	13.26	**13.44**	13.82
Project Satisfactorily Done	9.95	5.14	10.71	12.24	11.37	23.02	39.79	13.26	13.26	13.26	13.26	9.95	9.95	9.95	9.95	11.37	11.37	9.95	**13.21**	13.82
Harmony	15.91	5.14	9.77	9.95	10.51	13.16	7.96	10.71	7.96	19.89	13.26	9.95	8.84	9.95	9.95	9.95	8.84	9.95	**10.65**	13.82
Volume is Adequate	9.95	5.14	10.51	10.61	11.14	21.25	9.95	12.11		13.26	13.26		13.26		9.95	13.26	14.47	13.26	**12.09**	13.82
Distance is Far/Near	8.84	6.43	10.14	11.37	9.77	13.81	19.89	15.47	19.89	15.91	19.89		13.26	7.96	9.95	8.53	13.26	9.95	**12.61**	13.82

Notes:
-The blank spaces are those that received no response from the respondents.