THE ROLE OF RURAL WOMEN IN WATER RESOURCE MANAGEMENT IN SEMI-ARID LANDS: THE CASE OF KAJIADO DISTRICT, OF KENYA.

BY

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A THESIS SUBMITTED IN PARTIAL FULFILMENT FOR THE DEGREE OF MASTER OF ENVIRONMENTAL STUDIES OF KENYATTA UNIVERSITY

October, 2004
DECLARATION

"This Thesis is my original work and has not been presented for a degree in any other University or for any other award"

Signed

Beatrice N. Ghetuba

Dedicated to my dear husband, Mshila, and my son, Max, who have brought such joy and happiness to my life.

This Thesis has been submitted for examination with our approval as university supervisors.

Signed

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This work is affectionately dedicated to my dear husband, Akunga, and son, Max, who have brought such joy and happiness in my life.
ACKNOWLEDGEMENT

I would like to express my deepest love and appreciation to my dear husband Akunga, and son, Max, for their constant love and prayers. I want to thank my supervisors, Dr. Richard Kerich and Dr. Abraham Ndung’u, for their encouraging words and for always being available to offer advice. Much thanks to Wincrock International for giving me a grant to finance this research project. This, I believe, was in recognition of the need to support women in Africa to achieve their dreams. In particular, I would like to express my sincere gratitude to Prof. Julia Gitobu for her inspirational words.

Many thanks to all my dear friends Dr. Mary Getui, Dr. Ombongi, Mackenzie, Flora, Achia, Faith, Sheena (Sardep), Gichimo, Everlyn, Susan, Olive, Daisy, Mativo Judy, Mageria, Mbugua, Betty and Vero. My gratitude also goes to my brother, Charles, and his family and my dear parents who in one way or another made this work come into completion.

Finally, I am grateful to my heavenly Father for his Faithfulness and Compassions that are new everyday.
ABSTRACT

The Thesis highlights the role of rural women in the management of water resources in Kajiado district. The study intended to find out the relationship between the socio-economic status (education, income and family size) of rural women and water management in the semi-arid lands of Kajiado district. The study was also designed to identify the problems rural women face in the process of managing their water resources and the priority they give to water management activities.

Several methods were used in the study to come up with the required data. A household survey was carried out with the use of interview schedules and observation record sheets. Random and cluster sampling were used to come up with the required sample. The type of data collected included water management practices employed. These included the type of storage facilities used, whether the respondents harvested rainwater and whether they recycled their wastewater. Information on the education and income levels, family size, problems faced by rural women in the process of managing their water resources and priority rural women give to water management activities was also collected. Data was analyzed using cross tabulations, logistic regression, log linear modeling, percentages and means. The findings showed that there is a relationship between education level and water management. The data collected did not fully show whether there is a relationship between income level and water management. There is no relationship between water management and family size. The results also showed that rural women experience many problems in the process of managing their water resources and they give water management first priority.

The study focused on rural women because of their direct and constant interaction with the environment. Kajiado district was chosen because of the unreliable and low rainfall, and thus the need to conserve the scarce resource effectively.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>TITLE PAGE</td>
<td>i</td>
</tr>
<tr>
<td>DECLARATION</td>
<td>ii</td>
</tr>
<tr>
<td>DEDICATION</td>
<td>iii</td>
</tr>
<tr>
<td>ACKNOWLEDGEMENT</td>
<td>iv</td>
</tr>
<tr>
<td>ABSTRACT</td>
<td>v</td>
</tr>
<tr>
<td>TABLE OF CONTENTS</td>
<td>vi</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>xi</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>xiii</td>
</tr>
<tr>
<td>LIST OF MAPS</td>
<td>xv</td>
</tr>
<tr>
<td>LIST OF ABBREVIATIONS</td>
<td>xvi</td>
</tr>
</tbody>
</table>

## CHAPTER ONE: INTRODUCTION

1.1 Background to the Problem 1
1.2 Statement of the Problem 4
1.3 Research Questions 7
1.4 Objectives of the Study 7
1.5 Hypotheses 8
1.6 Significance of the Study 8
1.7 Study Area 9
CHAPTER FOUR: RESULTS AND DISCUSSION

4.1 Introduction

4.2 Relationship between Socio-economic Status of Rural Women and Water Management

4.2.1 Relationship between Education Level and Water Management

4.2.1.1 Relationship between Education Level and Water Harvesting

4.2.1.2 Relationship between Education Level and Water Recycling

4.2.1.3 Relationship between Education Level and Water Storage

4.2.2 Relationship between Income Level and
Water Management 50

4.2.2.1 Relationship between Income Level and Water Harvesting 50

4.2.2.2 Relationship between Income Level and Water Recycling 52

4.2.2.3 Relationship between Income Level and Water Storage 54

4.2.3 Relationship between Family Size and Water Management 57

4.2.3.1 Relationship between Family Size and Water Harvesting 58

4.2.3.2 Relationship between Family Size and Water Recycling 60

4.2.3.3 Relationship between Family Size and Water Storage 62

4.3 Hypothesis Testing 65

4.4 Problems Rural Women Face in the Process of Managing their Water Resources 69

4.5 Priority Level of Water Management Activities 70
CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary 72
5.2 Research Conclusion 75
5.3 Research Recommendation 76
5.4 Suggestions for Further Research 78

REFERENCES 76

APPENDICES

Appendix 1 Interview Schedule 79
Appendix 2 Observation Record Sheet 87
<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Area and Administrative Units by Division</td>
<td>12</td>
</tr>
<tr>
<td>2</td>
<td>Water Supplies and Maintenance Agency</td>
<td>16</td>
</tr>
<tr>
<td>3</td>
<td>Relationship between education level and water harvesting</td>
<td>43</td>
</tr>
<tr>
<td>4</td>
<td>Relationship between education level and water recycling</td>
<td>45</td>
</tr>
<tr>
<td>5</td>
<td>Relationship between education level and water storage</td>
<td>48</td>
</tr>
<tr>
<td>6</td>
<td>Relationship between income and water harvesting</td>
<td>51</td>
</tr>
<tr>
<td>7</td>
<td>Relationship between income level and water recycling</td>
<td>53</td>
</tr>
<tr>
<td>8</td>
<td>Relationship between income level and water storage</td>
<td>55</td>
</tr>
<tr>
<td>9</td>
<td>Relationship between family size and water harvesting</td>
<td>58</td>
</tr>
<tr>
<td>10</td>
<td>Relationship between family size and water recycling</td>
<td>60</td>
</tr>
<tr>
<td>11</td>
<td>Relationship between family size and water storage</td>
<td>63</td>
</tr>
</tbody>
</table>
12 Logistic regression showing relationship between education level and water harvesting 66

13 Logistic regression showing relationship between income level and water harvesting 67
# LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Conceptual framework</td>
<td>34</td>
</tr>
<tr>
<td>2</td>
<td>Relationship between education level and water harvesting</td>
<td>43</td>
</tr>
<tr>
<td>3</td>
<td>Relationship between education level and water recycling</td>
<td>46</td>
</tr>
<tr>
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</tr>
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<td>7</td>
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<td>56</td>
</tr>
<tr>
<td>8</td>
<td>Relationship between family size and water harvesting</td>
<td>59</td>
</tr>
<tr>
<td>9</td>
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<td>61</td>
</tr>
<tr>
<td></td>
<td>Title</td>
<td>Page</td>
</tr>
<tr>
<td>---</td>
<td>----------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>10</td>
<td>Relationship between family size and water storage</td>
<td>63</td>
</tr>
<tr>
<td>11</td>
<td>Priority levels rural women give to water management activities</td>
<td>71</td>
</tr>
<tr>
<td>12</td>
<td>Revised conceptual framework</td>
<td>74</td>
</tr>
<tr>
<td>List of Maps</td>
<td>Page</td>
<td></td>
</tr>
<tr>
<td>------------------------------------------------------------------------------</td>
<td>------</td>
<td></td>
</tr>
<tr>
<td>Map</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Map 1 Location of Kajiado District</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Map 2 Kajiado District Administrative Units</td>
<td>11</td>
<td></td>
</tr>
</tbody>
</table>
LIST OF ABBREVIATIONS

ASAL  Arid and Semi Arid Lands
CBS   Central Bureau of Statistics
GOK   Government of Kenya
IBRD  International Bank of Reconstruction and Development
IUCN  International Union of Conservation of Nature
L/Community  Local Community
MPND  Ministry of Planning and National Development
MOWD  Ministry of Water and Development
NWC & PC  National Water Conservation and Pipeline Corporation
SADC  Southern Africa Development Community
SARDC  Southern Africa Research Documentation Centre
UNCED  United Nations Conference on Environment and Development
UNDP  United Nations Development Programme
UNEP  United Nations Environment Programme
WCED  World Commission on Environment and Development
WMS II Welfare Monitoring Survey

xvi
CHAPTER ONE

INTRODUCTION

1.1 Background to the Problem

Water is one of the most important of all natural resources. It is vital for all living organisms and major ecosystems as well as for human health, food production and economic development. In the last half of 20\textsuperscript{th} century, population growth and urbanization together with changes in production and consumption have placed unprecedented demands on water resource (Postel et al., 1996). At the UN Conference on Water and the Environment in Dublin in 1992, it was made very clear that human society is at risk unless water and land resources are managed more effectively.

Widespread public awareness of environmental issues goes back to early times. This awareness has spread to developing countries where it is now appreciated that exploitation of natural resources has resulted in the disruption of crucial ecological processes. The ecology of Kenya is showing degradation resulting from population pressure and desertification as people and their animals are forced further on to marginal lands. The productive capacity of land is falling because of shortened rotational period, soil erosion and overgrazing. Growing
population raises demand for fuel wood and cropland, the resulting
deforestation increases runoff, and soil erosion. This eventually lowers
ground water levels and may further reduce rainfall in arid areas.

The problems of environmental degradation in Kenya are
intertwined with problems of women. The first casualties of environmental
degradation are women whose tasks involve them in continuous
interaction with natural resources (Khasiani, 1992). Throughout the
developing world, the nature of women’s access to natural resources is a
critical factor in determining the potential of rural households’ survival.
Indeed some scholars have argued that the continuing decline in women’s
control of natural resources is one of the many reasons for worldwide
ecological decline (Shiva, 1989; Merchant, 1983). Women, particularly
those living in rural areas of developing countries, play a major role in
managing natural resources such as water, soils and energy. Their daily
tasks in the care of the family and community, women in developing
countries affect and are closely affected by the environment. The World
Commission on Environment and Development (WCED) recognized the
need for environmental protection and man’s right to a healthy
environment. The report of the Commission points out that “All human
beings have the fundamental right to an environment adequate for their
health and well being and states shall conserve and use the environment and natural resources for the benefits of the present and future generations” (WCED, 1987).

Kenya has to grapple with the question of environmental protection. Concern by the Government for the environment has since the early 1970s, been increasing and this is reflected in past Development Plans (GOK, 1983). The theme of the 1979/83 Development Plan, for example, was alleviation of poverty and provision of basic needs. In this Plan, the development of semi-arid lands was described as priority. Having identified the basic problem as increasing population pressure on a fragile ecology and noting the significant degradation and declining income opportunities, the government made it a policy to ‘urgently develop these areas by means and techniques that would preserve and make productive the basic environment’ . If sustainable development, through sound environmental management, is to be achieved there is need to give out most consideration to the experience of those persons directly concerned with the environment in their day to day activities.

This study addressed the role rural women play in the management of water resources in semi arid lands. This was with a view to developing solutions to the pressing questions of water problems in the semi arid
lands of Kenya.

1.2 Statement of the Problem

Kenya's ASAL covers more than 80% of the country's land surface and amount to 473,00Km². The semi-arid region alone accounts for about 60% (342,00Km²) of the surface area of Kenya and so the largest single tract of land in the country (Gwynne, 1991). ASAL areas are not only poorly utilized but their productivity is seriously declining owing to inappropriate technologies which result in degradation and destruction of the natural environment that sustains them (Joint Kenyan –Netherlands Review Report Arid and Semi arid lands). Environmental degradation has already pushed great numbers of women to marginal environments where critically low levels of water supplies, shortage of wood fuel, over utilization of arable and grazing lands, and population density have deprived them of their livelihoods (Kiriro and Juma, 1992). Women not only bear the brunt of environmental degradation but also play a crucial role in environmental management. Their importance as key agents in achieving sustainable development cannot be underestimated (Annabel, 1991).

Formal education is a prerequisite for economic development, for
the effective integration and participation in the national society and economy. Education standards need great attention.

The main constraints with which women are confronted in achieving full integration and participation in natural resource management are: lack of education and training and lack of financial means. Rocheleau (1985) observes that most rural women in developing countries have the least formal power and are the poorest and in most cases illiterate. They are, thus, at times forced by complex cycles of Poverty into ways of living, which induce further destruction of the environment. Poverty, as articulated by governments at the social summit in Copenhagen in 1995 is difficult to eradicate without investment in women. Education for girls must be recognized as the best single investment that most developing countries can make. Education is not a priority in pastoralist society and parents prefer marrying off their girls for dowry to sending them to school. Women in Kajiado, like those from other ASAL districts, have less formal education, lack technical skills and managerial knowledge, have fewer economic resources and are less integrated into the national economy (Naiterra, 1996).

Poverty and environmental degradation are linked in a vicious
cycle, in which people cannot afford to take care of their environment (SARDC, IUCN and SADC, 1994). Poverty has been and remains a major cause and consequence of environmental degradation and resource depletion (UNDP, 1997).

Deterioration of family’s’ income and environment goes hand in hand, each worsening its impact on the other. The vast majority of the 1.3 billion people now living in extreme poverty throughout the world are women and girls, some estimates of the proportion range as high as 70% (Heyzer, 1995).

Population growth is increasingly being seen as the major cause of environmental degradation on a global scale. The most rapid of this population growth is in developing countries (Shiva, 1987). Women, as approximately half of the world’s population, through both action and inaction in environmental management, are critical determinants in advancing a sustainable future. Women as managers, producers, and consumers are managing the ecosystem whether for better or for worse.

This study focused on the relationship between water management and the socio economic status of rural women in semi arid lands. It also sought to find out the problems rural women face in the process of
managing their water resource and the priority they give to water management activities.

1.3 Research Questions

The following questions guided the study

(a) Is there a relationship between the level of socio-economic status (education, income and family size) of rural women in semi arid lands and water management?

(b) What are the water management strategies employed by rural women in semi arid lands?

(c) What are the problems rural women encounter in the process of managing their water resources?

1.4 Objectives

The objectives of the study are to:

(a) determine the relationship between the socio-economic status (education, income and family size) of rural women and water management in the semi arid lands of Kajiado district;

(b) identify the problems rural women face in the process of managing their water resources in the semi arid lands of Kajiado district and

(c) determine the priority rural women give to water management
activities in the semi arid lands of Kajiado district.

1.5 Hypotheses of the Study

The hypotheses for the study were as follows:

(i) Increase in educational level of rural women enhances water management in semi arid lands

(ii) Water management in semi arid lands increases with increasing income level of rural women

(iii) Water management in semi arid lands increases with increased family size.

(iv) Rural women in semi arid lands give water management first priority.

1.6 Significance of the study

The significance of this study is four fold: to policy makers, researchers, and the community specifically rural women. The results of the study will be important in ensuring that policy makers recognize the medium and long-term economic benefits of including women in the search for solutions to water management problems. Researchers will benefit in that they can use the results and compare them with other areas of the same climatic conditions. The community will benefit in that water will properly be managed. The study will improve women’s representation during decision-making.
1.7 Study Area

1.7.1 Location

Kajiado district is one of the eighteen (18) districts in the Rift Valley province and is located at the southern part of the province. The district is situated between longitudes 36° 5′ and 37° 5′ east and between latitudes 1° 0′ and 3° 0′ south. It covers an area of 21,902.9 km² and has 7 divisions namely; Central, Magadi, Loitokitok, Mashuru, Isinya, Namanga and Ngong.

The divisions are further divided into 47 locations and 120 sub-locations (Kajiado District Development Plan 2002-2008) (refer to maps overleaf).
MAP 1: LOCATION OF KAJIADO DISTRICT

SOURCE: Kajiado District Development Plan
SOURCE: Digitized and Compiled by G. Kamula
Developed in 2000
### Table 1  Area and Administrative Units by Division

<table>
<thead>
<tr>
<th>Division</th>
<th>Area km²</th>
<th>No. of Locations</th>
<th>No. of Sub-Locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ngong</td>
<td>3698.1</td>
<td>10</td>
<td>29</td>
</tr>
<tr>
<td>Magadi</td>
<td>2640.3</td>
<td>4</td>
<td>13</td>
</tr>
<tr>
<td>Isinya</td>
<td>1066.3</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Central</td>
<td>2909.7</td>
<td>10</td>
<td>27</td>
</tr>
<tr>
<td>Namanga</td>
<td>2238.0</td>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td>Mashuru</td>
<td>2994.2</td>
<td>9</td>
<td>17</td>
</tr>
<tr>
<td>Loitokitok</td>
<td>6356.3</td>
<td>6</td>
<td>16</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>21,902.9</strong></td>
<td><strong>47</strong></td>
<td><strong>120</strong></td>
</tr>
</tbody>
</table>

**Source:** District Commissioner's office Kajiado, 2001

### 1.7.2 Topography and Climate

Plains and occasional volcanic hills characterize the general topography of the district. Several valleys dissect the plains. The land rises from about 500m above mean sea level around Lake Magadi to about 2500m leveling in Ngong hills area. Topographically, the district can be divided into four different areas namely; The Rift Valley, Athi Kapiti plains, Central broken ground and the Amboseli plains.

The district has a bimodal rainfall pattern. The short rains fall between October and December while the long rains fall between March and May. Annual rainfall in Kajiado is strongly influenced by altitude. Loitokitok, which has a high elevation, has the highest annual rainfall of 1250mm while Magadi and Lake Amboseli, with the lowest elevations have...
the lowest annual average rainfall of about 500 mm.

Temperatures in the district also vary with altitude. The highest temperatures of about 30 degrees centigrade are recorded around Lake Magadi. The Lowest mean minimum of 10 degrees Centigrade is experienced at Loitokitok on the eastern slopes of Mt. Kilimanjaro. The temperatures vary with seasons. The coolest period is between July and August while the hottest are from November to April throughout the district (Kajiado District development Plan, 1997-2001).

1.7.3 Soils

There are three broad soil categories in Kajiado district. These are Quarternary volcanic soils, Basement rock soils and the Pleistocene soils. The Quarternary soils are found in the Rift valley floor around Loitokitok and Sultan Humud. These soils are rich and are found where there is adequate rainfall, suitable for a variety of agricultural crops.

The greater part of Kajiado district is covered by Basement rock soils arising from different cycles of erosion. They vary from dark red to reddish brown sandy clay soils. Alluvial soils are found along the river valleys and some parts of the plains. Generally these soils are of low fertility. In addition to this, the limestone content makes them very poor
in water retention and storage of moisture.

Finally, soils comprising of Pleistocene sediments are found in the inland drainage around Lake Magadi, lake Natron and lake Amboseli. The soils found in the northern part of Kajiado division, including the area around Ngong hills, are composed of sediments from the tertiary volcanic rocks washed down from the eastern slopes of the rift valley escarpment while the soils on the Athi Kapiti plains are composed of rocks eroded from Chyulu hills. These soils are dark reddish brown sandy clays. They are of medium potential with respect to crop production but support livestock development in the district. However, where there is adequate rainfall, for example in the Nguruman and Ngong hills, these soils support crop production (Kajiado District Development Plan 1997-2001).

1.7.4 Water Resources and Facilities

The district is faced with severe shortage of surface water due to the fact that most of the rivers and streams in the district are seasonal. This problem is caused by poor precipitation in most parts of the district and frequent drought experienced in nearly all parts of the area. However, the amount of surface water varies from one division to the next.

The southern and central parts of the district are served by a
number of water sources, some of which are seasonal. These rivers include Uaso Nyiro, which enters Kajiado through Mosiro and flows for 128 Km before draining into Engare Nyiro swamp. There are also several steams flowing from the eastern face of the Nguruman Escarpment and Loita Hills. These rivers are the sources of water for domestic and livestock consumption. The other alternative source of water for domestic, livestock and industrial consumption are sub-surface water resources in aquifers that provide water to such as boreholes and springs.

The occurrence of ground water in Kajiado district is mainly influenced by climate and topography, as well as origin of underlying parent rock. The water table is low in most parts of the district as the rocks are generally porous and allow water to percolate to great depth in the ground. The district has 70 rural water supplies, 381 bore holes and numerous dams and springs. Of the 70 rural water supplies 11 are maintained at the Ministry of water, 6 by National Water Conservation and Pipe line Corporation, 41 by the Local Community and 12 by other agencies. Table 2 shows the distribution of water supplies and maintaining agency by division.
Table 2  Water Supplies and Maintenance Agency

<table>
<thead>
<tr>
<th>Division</th>
<th>MOWD</th>
<th>NWC&amp;PC</th>
<th>L/Community</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ngong</td>
<td>6</td>
<td>1</td>
<td>12</td>
<td>-</td>
</tr>
<tr>
<td>Central</td>
<td>0</td>
<td>2</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Loitokitok</td>
<td>-</td>
<td>1</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>Magadi</td>
<td>-</td>
<td>1</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Mashuru</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Namanga</td>
<td>2</td>
<td>0</td>
<td>11</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>11</td>
<td>6</td>
<td>41</td>
<td>12</td>
</tr>
</tbody>
</table>

**Source:** District Water office-Kajiado, 1996

1.7.5 Definition of Terms

**ASAL** – Those regions where the ratio of mean annual precipitation $P$, to mean annual potential evapotraspiration, $PE$, was less than 0.65 for the period 1951-1980 (UNEP 1992; WMO 1993).

**Arid areas** – These are areas without moisture and are excessively dry. They are parched and barren; having insufficient rainfall to support agriculture. They usually have 10-15 inches of rainfall annually.
Agro Pastoral Communities - Those Societies that practice a mixture of animal and crop husbandry activities respectively

Average water managers - For the purpose of these study, average water managers are considered to be all those people who have earth dams and storage containers as water storage facilities.

Average income - For the purpose of this study, average income is defined to be in the range of Ksh. 1,500-10,000. But, The 1994 Welfare Monitoring Survey (WMS II ) conducted by the Central Bureau of Statistics (CBS) defined absolute poverty line for rural and urban areas to be Ksh.978 and Ksh.1,490 per capita per month per Adult Equivalent(AE) respectively (CBS & Human Resources and Social Services Department MNPD,1998).

Conservation - to “preserve” to retain intact over time

Desertification - the reduction or destruction of the lands biological potential finally results in the appearance of desert condition.

Environmental management – a concept of care applied to localities, regions, catchments, natural resources areas of high conservation value. In general, it means the efficient administration of environmental policies and standards. It involves the identification of objectives, the adoption of
appropriate mitigation measures, and the protection of the ecosystem and the enhancement of the quality of life for those affected by the minimization of environmental costs.

**Environmental degradation** - the natural environment’s diminished capacity to satisfy human needs or its increased propensity to cause harms / implies loss of resource potential.

**Formal education** - This entails going to school for the purpose of acquiring knowledge that will assist one in assimilating knowledge in today’s society without being disadvantaged. It involves use of pre-prepared curriculum with definite instructional procedures. For the purpose of my study this is considered in two levels namely primary and post primary.

**Good managers** - In this study good water managers are considered to be all those people who have earth dams, storage containers, water tanks and bore holes as water storage facilities.

**High income** - For the purpose of this study high income is defined to be in the range of Ksh. 10,000 and above.

**Low income** - In this study low income is defined to be in the range of Ksh. 0-1,500.
Poor water managers—For the purpose of these study poor water managers are considered to be all those people who have earth dams as the only means of storing water.

Rainwater harvesting—This is the collection of rainwater from roof surfaces into storage tanks.

Rural—This refers to individuals in communities with less than 150 persons per square Km. This includes individuals living in the countryside, towns and cities inside and outside the communities zone of large urban centers.

Semi-arid—these are areas characterized by light rainfall and high evaporation, the growth of short grasses and dry farming of limited yield; having from about 10-20 inches of annual precipitation.

Sustainable development—current generations meeting their needs without compromising the ability of future generations to do the same (WCED, 1987).

Water Recycling—For the purpose of this study, water recycling is defined as re-use of water for beneficial purposes such as agriculture and house cleaning.

Water Resource Management—For the purpose of this study, water
resource management is defined as the proper utilization of water or rational use of water from various sources. It involves creation of storage facilities, recycling of wastewater and rainwater harvesting.
CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

In developing countries most women's relationship with the environment is vital to their daily lives for example in the provision of water, fuel, food and other basic needs. Their importance as key agents in achieving sustainable development cannot be underestimated (Annabel, 1991). Women are key stakeholders in rural water supply and sanitation projects given their role as users, collectors, and protectors of water. They are, however, often overlooked (Stone and Fyes, Partoni 1995). Women's contribution in semi arid resource management is generally ignored or over looked by researchers and policy makers.

Kenyans' economic growth relies to a large extent on efficient management of resources such as land, water, soils forests and wildlife. Most of these resources are exploited directly by poor people in rural areas in an attempt to meet their basics needs (Chiuru and Nzioki, 1992). Majority of the population in developing countries resides in rural areas and depends directly on the natural resource base for their livelihood. The environment provides inputs for production, amenities and life supporting services such as clean air and water (Dasgupta and Maler, 1995).
Western ignorance of the relevance of women in pastoral and agro-pastoral dry land management continues to contribute to the extraordinary weak performance of rural development interventions among the poor majority in the World’s dry lands (Jowkar et al., 1991). The availability of water is critical to agricultural production and, therefore, to both national and household food security and ultimately to individual nutrition levels. In the arid and semi arid areas of Kenya, women and girls and in some nomadic communities’ men and boys, often have to walk long distances in search for water. Sometimes, the entire community has to keep on moving in search of water (UNICEF, 1992).

A gender sensitive approach to dry land development and management is perhaps even more critical today than it was before. Whether or not dry land environments have continued to deteriorate, it is beyond question that the economic well being of dry land populations have worsened markedly. The great brunt of that worsening is being borne by women, children, and the elderly (Horowitz and Jowkar, 1992).

Among the Maasai, women, who in their roles as daughters, wives and mothers, had some claim over animals and participated in processing and distributing dairy products. They were slowly disenfranchised under
new legal codes and adopted the status of unpaid workers taking care of their husband’s livestock (Kipuri, 1989 and Talle, 1988). The heavy migration of the men out from pastoral regions has found women increasingly assuming the burden of livestock management (Kipuri, 1989).

2.2 **Water Resources in Arid and Semi Arid Lands**

Many parts of Africa exist within the Arid and Semi arid area. These areas suffer from water scarcity due to erratic rainfall, which also comes in violent sporadic downpours with a lot of it being lost through runoff (Ominde, 1979). In fact, two thirds of the African population are said to live in severely water stressed countries. This water stress is largely due to rising population growth (Danida, 1989). Most rivers are seasonal due to unfavorable climatic conditions while the few perennial ones have their sources in high potential highlands. A lot of pressure has also been mounted on these water sources due to increasing human and livestock population (Akonga, 1981). ASAL areas that make up to over 80% of Kenya’s total land surface support over 25% of the human population and over half of the livestock production. The majority of the populations of these
areas are pastoralists, although semi-pastoral and farming communities have increased due to migration and sub-division of land (National Development Plan, 1997-2001).

User studies show that women, in arid environments or during dry periods in other climatic situations may spend up to eight hours a day collecting water. In other cases, women spend 15% of their time fetching water, given women's heavy workload, the time spent looking for water keeps them from other productive and household caring activities and impairs their health and well being (A World Bank Policy Paper 1993 IBRD)

2.3 Women, Environmental Degradation and Education

Human beings often of necessity must utilize environmental resources in order to survive. Humanity is becoming increasingly aware of the dangers posed by the erosion of the world’s resources. There is increasing concern, on a global basis, on the potential far-reaching dangers that may occur as a result of imbalance in our ecosystem, which may not only affect the earth but the surrounding atmosphere.

A pervasive barrier to women’s participation in sustainable development has been lack of education. In almost all areas of the world, women’s
literacy rates and levels of education and training are far below men’s (Hill and King, 1991). Rocheleau (1985) observed that most rural women have the least formal power and are the poorest and in most cases illiterate. They are, thus, at times forced by complex cycles of poverty into ways of living, which induce further destruction of the environment. Kenya faces several problems on the education front primarily relating to declines in enrolment and completion rates, financing, and relevance of education. Gender imbalances at secondary and tertiary levels are also an area of critical concern. Indeed, persistent gender imbalances in governance and decision-making are major consequences of historical differences in access to education (National Development Plan, 1997-2001). The role of education in Maasai society has often been misunderstood. Like for most pastoral societies participation in education has been extremely low. This is mainly due to cultural attitudes (Klinken, 1990). Education is not a priority in pastoralist society and parents prefer marrying off their girls for dowry to sending them to school.

A well-educated population is a prerequisite for the development of a modern industrialized nation, which Kenya has set as a goal to be reached by 2020. Education is a fundamental right for all and was first
proposed by the World Summit for Children in 1990, and was reiterated by the World Summit for Social Development in 1995.

It is universally accepted that one of the best ways to improve one’s position in today’s changing and competitive society is through education. For most women in the third world and more so among the Maasai, this is one tool that they greatly lack (Nangurai, 1996).

2.4 Women, Environmental Degradation and Income

Four-fifth of the one billion people who live in poverty are in the rural areas of the developing world, mostly in Asia and the Sub-Saharan Africa. Women comprise a large part of them. The number of rural women living in absolute poverty has risen by 50% over the last two decades, according to the International Fund for Agriculture Development.

The principal victims of environmental degradation are the most underprivileged people and the majority of these are women (Senghor, 1985). In most parts of the world women are the first to notice environmental degradation and the first to suffer from it. As forests disappear and wells dry up, they have to walk further and further to fetch firewood, food and water. Degradation of pastureland increases the amount of time that has to be spent caring for young, sick, and feeble
livestock which are kept at the homestead. It is women who are responsible for collecting water and fodder for these animals. This work is particularly time consuming in the dry season when more animals are in a weakened condition and at the same time, there is scarcity of fodder (Dahl, 1979:64). The unreliable and low rainfall in semi-arid areas means that it is crucial to conserve and use this scarce resource effectively (Lal and Greenland, 1979).

Environmental deterioration in Africa is intricately linked to poor economic performance and poverty. The chain of dependencies is all too familiar; rapid population growth and poverty accelerate deforestation and expansion of agriculture into marginal areas. This in turn leads to land degradation, which exacerbates food insecurity, loss of biodiversity, and decline in water quality and decrease in health status (UNEP, 1995). Poverty and environmental degradation are linked in a vicious cycle in which people cannot afford to take proper care of the environment (SARDC, IUCN, and SADC, 1994). Poverty has been and remains a major cause and consequence of environmental degradation and resource depletion (UNDP, 1997). Marginalisation of women has led to famine and poverty. Consequently the poorest of Kenyan households tend to be
headed by women. Currently more than three quarters of the poor live in rural Kenya and women are a large majority of the rural poor. This face of poverty is especially severe in rural areas where traditional attitudes and divisions of labor are still dominant, particularly, among the pastoralists where men play a dominant role in the management of livestock and pasture (Manifesto for the National Rainbow Coalition (NARC) November 2002).

In Kajiado, women describe poverty as lack of livestock, inability to provide basic needs, lack of water, lack of land, having no source of income and being childless (Poverty Reduction Strategy Paper 2001-2004).

Dankelman and Davidson (1988) point out many of the effects of poverty and environmental degradation are confined to women because of the division of labor by gender in rural and agricultural societies. They are in most cases responsible for providing food for their families, growing food crops, finding water for cooking and sanitation, farming and fuel gathering among other tasks. They, therefore, play a major role in managing natural resources and directly experience environmental degradation because it affects their daily chores.
2.5 Women, Family Size and Environmental Degradation.

Women have been seen as the centre of discussion on population growth. Sharma (1994) observes that often in the past, women have been seen as Statistics. If there are too few people, then, women had to be made to “contribute” by producing more. If there were too many people, then, they had to be made to stop. Women have become the focus of debate, which is intertwined with environment.

As world population grows, so too is pressure growing on our rivers, lakes and ground water aquifers. In many parts of the world, competition is increasingly between users fighting for their share of clean, useable water (Erdelen, 2003). Population growth is increasingly being seen as the major cause of environmental degradation on a global scale. The most rapid of this population growth is in developing countries (Shiva, 1987). Population growth within areas with limited resources has resulted in greater demands being made upon available resources. Farmers migrating into semi-arid areas have brought with them technologies inappropriate to the more variable climate and less fertile soils often characteristic of semi-arid areas (Pratt and Gwynne, 1977). The UNCED (1992) led to the general acceptance that water and other environmental
resources are finite and vulnerable in the light of the exploding population and economic growth.

The ecology of Kenya is showing degradation resulting from population pressure and desertification as people and their livestock are forced further into marginal land. The productive capacity of land is falling because of shortened rotational period, soil erosion, and overgrazing. Growing population raises the demand for fuel wood and cropland; the resulting deforestation increases runoff and erosion, lowers groundwater level and may further reduce rainfall in arid areas. Being aware that Kenya is being threatened by the expansion of desert-like conditions and that desertification come as a result of misuse of land and by indiscriminate cutting of trees, bush clearing and consequent soil erosion by the elements. These actions result in drought, malnutrition and death (Mathai).

It is important to appreciate women’s involvement in environmental management as they are the persons who are directly concerned with their environment in their day-to-day activities.

Some important authors who have done some work on women in semi-arid lands include Ayiemba (1981) who did some work on Human
Ecology: A study of environmental perception and modes among the Samburu. Kipuri (1989) studied Maasai Women in Transformation: Class and Gender Transformation of a Pastoral society. He observed that with the heavy migration of men out from pastoral regions, women are increasingly assuming the burden of livestock management. Stiles (1995), observed that with dry land areas accommodating over 100 countries, there is obviously a problem of increased stress being placed on the natural resources of these areas which ultimately contributes to overall land degradation.

In formal and informal education from the cultural point of view on the improvement of the Maasai woman’s position Nangurai (1996) observed that Maasai women have the informal education but unfortunately it does not enhance the woman’s economic and social status. She noted that women urgently needed formal education. Naiterra (1996) noted that women in Kajiado had less formal education, lacked technical skills and managerial know-how and had fewer economic resources. Klinken (1990) observed that education participation was low among pastoralists due to cultural attitudes.
In all these works, the researchers did not discuss the relationship between the socio-economic status (education, income and family size) of women and management of water resources in semi arid lands. Another shortcoming of the above studies was that they did not discuss the constraints women face in the process of managing water resources and the priority rural women in semi arid lands give to water management activities. This, therefore, left an existing gap that will be filled in by the present study.

2.6 Conceptual Framework

In carrying out the study it was conceptualized that: the level of income, education and family size directly determines the way that rural women manage their water resources. Women with a low level of income and education impact water management negatively in that they lead to deteriorated resource management and the outcome is reduced water availability. A large family size is likely to lead to degradation or deterioration of water resources. A high-income level empowers women economically and thus leads to improved water resource management. The resultant outcome is i
increased water availability. Women with a high level of formal education impact resource management positively in that they understand environmental matters better and, therefore, are better managers of water resources. A small family size impact resource management positively. There’s less resource deterioration when the family size is small due to the fact that there is less stress on the water resources.
Fig. 1  Conceptual Framework

AGENTS' CHARACTERISTICS

SOCIO-ECONOMIC STATUS

- Income
- Education
- Family Size

EFFECT OF AGENTS' CHARACTERISTICS ON RESOURCE MANAGEMENT

Water Management

ENVIRONMENTAL RESOURCE STATUS (OUTCOME)

- Water Availability
CHAPTER THREE
METHODOLOGY

3.1 Introduction

In this Chapter, the following has been considered: study design, sample and sampling procedures, nature and sources of data, instruments and instrumentation, methods of data collection and analysis of data. Data collected was subjected to various methods of analysis. These included cross tabulations strategies, log linear modeling and logistic progression. In the process, percentages and means were computed.

3.2 Study Design

In this study, a survey was carried out. The purpose of the survey was to obtain characteristics of the sample so as to generalize for the population so that inferences could be made about certain characteristics.

3.3 Sample and Sampling Procedures

The study used random sampling and cluster sampling. Kajiado District has 7 divisions namely, Central, Magadi, Loitokitok, Isinya, Mashuru, Namanga and Ngong. Annual rainfall in Kajiado district is strongly influenced by altitude. Loitokitok and Ngong have high annual rainfall (1250-mm) relative to the other divisions of the district. In addition, due to its proximity to Nairobi, Ngong is also served with water
from Nairobi town. Hence, for the purpose of this study these two divisions were deliberately excluded from sampling.

The remaining five divisions all have rainfall below 500mm, hence, the need to manage their water resources properly. Out of these five marginalized divisions, Central division was randomly selected. Out of the selected Central division, half the total numbers of locations in that division were randomly selected.

Out of the 10 locations in Central division, five locations were randomly selected. These locations included Engorika, Lodikilani, Enkaronil, Township and Sajiloni. Out of the five locations selected, a total of fourteen sub locations were considered. Cluster sampling was used to select 150 households from the selected sub locations. Every 5th household in the cluster was considered. In the cases where there were less than five households, any one household was considered. Counting of households began from the Sub-chief’s office eastwards. The mother of the home or if unavailable, the oldest member of the household was taken as the respondent for the household. It was assumed that information received would approximately be the same.
3.4 **Instruments and Instrumentation**

(a) **Observation Record Sheet**

This was a special sheet form, which was useful when quick recording was needed. In its structure it had the name of the Division, Location and Sub-location, household number and the water management practices employed that is whether the household had a water tank, storage containers, earth dams and boreholes. It was important because it increased precision and ensured reliability of information given. It was important in collecting data related to visible water management attributes. (See appendix 2)

b) **Interview Schedule**

This is an oral questionnaire. However, instead of writing the response, the subject or interviewee gave the needed information verbally in face-to-face relationship. This type of informal talk created more congenial atmosphere for effective communication. The interviewer explained the purpose of her study and the information she wanted.

3.5 **Methods of Data Collection**

3.5.1 **Direct Interviewing**

This was the main method of data collection and the tool, which
was used, was an interview schedule. The same questions were used for all respondents. The data that was collected included data on educational level, income level and number of children, priority that women gave to water management and problems women faced in the process of managing their water resources.

3.5.2 Direct Observation

This included observing and recording the type of storage facilities in the compound, whether they were tanks, storage containers, earth dams or boreholes.

3.5.3 Focused Group Discussions

Group interviews to find out the problems rural women face in the process of managing their water resources were done. The groups considered included two women groups and one youth groups. Open-ended type questions were used in the discussions. The size of the focus groups was between 5-10 people. It was visualized that this number of people would give sufficient information.

3.5.4 Key Informant Interviews

This included interviewing the community's resource persons
including elders, chiefs and selected leaders of local women groups. They were also interviewed on the problems rural women face in the process of managing their water resources.

3.6 Type of Data Collected

3.6.1 Primary Data

These data were obtained from various resource persons visited such as chiefs, women groups, District officer, and officers from NGO’s. The instruments used to obtain primary data included interview schedules and observation record sheets.

3.6.2 Secondary Data

Secondary data were collected from relevant sources. This included review of past literature on women and water management from various institutions visited. Information was got from journals, magazines and books. The information included water resources in semi arid lands, aspects on the relationship between women, poverty and environmental degradation, women, education and environmental degradation and women, population size and environmental degradation.

3.7 Data Analysis

The data collected were subjected to various methods of analysis.
cross tabulation was used to compare the relationship between the levels of education, level of income and level of family size of rural women with water management. In the process, percentages were computed. Log linear modeling was used to prioritize the problems rural women face in the process of managing their water resources. Logistic regression was used to establish whether an increase in education, income and family size enhanced water management. Percentages were used to determine the priority rural women give to water management activities in semi arid lands of Kajiado district.
CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Introduction

This Chapter presents the results of the relationship between water management and the level of education of rural women, income and family size. It also points out problems rural women experience in the process of managing their water resources and the priority rural women give to water management practices in the semi-arid lands of Kajiado district.

Data collected for each item will be presented in the following paragraphs together with their mode of analysis and an interpretation thereof.

4.2 The Relationship between the Socio-economic Status of Rural Women and Water Management in Semi Arid Lands.

Water management was considered in three aspects. These included: water harvesting, water recycling and water storage. Data on the level of education, level of income and family size was collected from 150 respondents. Data on the type of storage facilities used, and the various water management practices employed by each respondent was also collected. To be able to have a comprehensive report, each one of
the socio-economic parameters were considered separately and the individual results were presented in the sections that follow.

4.2.1 Relationship between Education Level and Water Management

In trying to assess the relationship between water management and education level, three areas were visualized independent of each other. These areas included: relationship between education level and water harvesting, education level and water recycling, and education level and water storage. Three cross tabulations were run to find out whether there exists a relationship between education level and water management.

4.2.1.1 Relationship between Education Level and Water Harvesting

In trying to find out whether there was a relationship between education level and water harvesting a cross tabulation was done. Table 3 and figure 2 show the relationship between education level and water harvesting.

The results indicate that of the 150 respondents 59 % harvest rainwater while 41 % do not harvest. Of the 89 respondents who harvest
rainwater, 30 % have no education, 34 % have primary education and 36 % have post-primary education.

Table 3  Relationship between education level and water harvesting

<table>
<thead>
<tr>
<th>Education Level</th>
<th>Frequency</th>
<th>% in water harvesting</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>27</td>
<td>30 %</td>
</tr>
<tr>
<td>Primary</td>
<td>30</td>
<td>34 %</td>
</tr>
<tr>
<td>Post-Primary</td>
<td>32</td>
<td>36 %</td>
</tr>
<tr>
<td>Total</td>
<td>89</td>
<td>100 %</td>
</tr>
</tbody>
</table>

Figure 2  Relationship between education level and water harvesting
Chi-Square Tests

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson Chi-square</td>
<td>30.557</td>
<td>.000</td>
</tr>
<tr>
<td>Likelihood Ratio</td>
<td>34.542</td>
<td>.000</td>
</tr>
<tr>
<td>No. of valid cases</td>
<td>150</td>
<td></td>
</tr>
</tbody>
</table>

Where Chi-square values were computed, the P value was taken to be 0.010.

Based on the Pearson chi-square value of 30.557, P=0.000 indicating that there is an association between education level and water harvesting. Individuals who had some education did more water harvesting than those who had no education.

4.2.1.2 Relationship between Education Level and Water Recycling

In trying to find out whether there was a relationship between education level and water recycling a cross tabulation was done. Table 4 and figure 3 show the relationship between education level and water recycling.

The results indicate that of the 150 respondents 34 % recycle their water while 66 % do not recycle. Of the 51 respondents who recycle
24% have no education, 43% have primary education and 33% have post primary education.

**Table 4  Relationship between education level and water recycling**

<table>
<thead>
<tr>
<th>Education Level</th>
<th>Frequency</th>
<th>% in water recycling</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>12</td>
<td>24%</td>
</tr>
<tr>
<td>Primary</td>
<td>22</td>
<td>43%</td>
</tr>
<tr>
<td>Post-Primary</td>
<td>17</td>
<td>33%</td>
</tr>
<tr>
<td>Total</td>
<td>51</td>
<td>100%</td>
</tr>
</tbody>
</table>
Figure 3  Relationship between education level and water recycling

Chi-Square Tests

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson Chi-square</td>
<td>26.569</td>
<td>.000</td>
</tr>
<tr>
<td>Likelihood Ratio</td>
<td>26.535</td>
<td>.000</td>
</tr>
<tr>
<td>No. of valid cases</td>
<td>150</td>
<td></td>
</tr>
</tbody>
</table>

Based on the Pearson chi-square value of 26.569, P=0 .000 indicating that there is an association between education level and water
recycling. Individuals who had some education recycled their water much more than those who had no education.

4.2.1.3 Relationship between Education Level and Water Storage

In trying to find out whether there was a relationship between education level and water storage a cross tabulation was done. The results are presented in table 5 and figure 4.

The results show that of the sample size of 150 respondents, 13 % of the respondents are poor water managers, 55 % are average water managers and 32 % are good water managers. Of the individuals with no education, 47 % are poor water managers, 57 % are average water managers and 31 % are good water managers. Of the individuals with primary education, 21 % are poor water managers, 18 % are average water managers and 27 % are good water managers. Of the individuals with post primary education, 32 % are poor water managers, 25 % are average water managers and 42% are good water managers.
Table 5  Relationship between education level and water storage

<table>
<thead>
<tr>
<th>Education level</th>
<th>Frequency</th>
<th>% in water storage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Poor</td>
<td>Average</td>
</tr>
<tr>
<td>None</td>
<td>9</td>
<td>47</td>
</tr>
<tr>
<td>Primary</td>
<td>4</td>
<td>15</td>
</tr>
<tr>
<td>Post-primary</td>
<td>6</td>
<td>21</td>
</tr>
<tr>
<td>Total</td>
<td>19</td>
<td>83</td>
</tr>
</tbody>
</table>

Figure 4  Relationship between education level and water storage

Chi-Square Tests

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson Chi-square</td>
<td>7.896</td>
<td>.095</td>
</tr>
<tr>
<td>Likelihood Ratio</td>
<td>8.044</td>
<td>.090</td>
</tr>
<tr>
<td>No. of valid cases</td>
<td>150</td>
<td></td>
</tr>
</tbody>
</table>
The results show that based on Pearson's chi-square value of 7.896, $P=0.095$ indicating that there is an association between water storage and education.

**Discussion**

The results indicate that based on the Pearson chi-square value of 30.557, $P=0.000$ showing that there is an association between education level and water harvesting. Based on the Pearson chi-square value of 26.569, $P=0.000$ showing that there is an association between education level and water recycling.

Based on Pearson's chi-square value of 7.896, $P=0.095$; indicating that there is an association between water storage and education level. It can thus be concluded that there is a relationship between education level and water management.

The results show that a large number of women do not have formal education. This is in line with other studies that have shown the literacy level among women to be very low. Hill and King (1991), writing on Women's Education in the Third World: An overview, in Women's education in developing countries observed that an estimated 601.6
million women (33.6% of women) compared with 346.5 million men (19.4% of men) were still illiterate.

4.2.2 Relationship between Income Level and Water Management

In trying to assess the relationship between water management and income three areas were considered independently of each other. These included: income level and water harvesting, income level and water recycling and income level and water storage.

4.2.2.1 Relationship between Income Level and Water Harvesting

In trying to find out whether there was a relationship between income level and water harvesting a cross tabulation was done. Table 6 and figure 5 show the relationship between income level and water harvesting.

The results indicate that of the 150 respondents 59% harvest while 41% do not harvest. Of the 89 respondents who harvest 23% have low incomes, 55% have average incomes and 22% have high incomes.
Table 6  Relationship between income level and water harvesting

<table>
<thead>
<tr>
<th>Income level</th>
<th>Frequency</th>
<th>% in water harvesting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>20</td>
<td>23 %</td>
</tr>
<tr>
<td>Average</td>
<td>49</td>
<td>55 %</td>
</tr>
<tr>
<td>High</td>
<td>20</td>
<td>22 %</td>
</tr>
<tr>
<td>Total</td>
<td>89</td>
<td>100 %</td>
</tr>
</tbody>
</table>

Figure 5  Relationship between income level and water harvesting

[Graph showing the relationship between income level and water harvesting]
Chi-Square Tests

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson Chi-Square</td>
<td>9.312</td>
<td>.010</td>
</tr>
<tr>
<td>Likelihood ratio</td>
<td>9.264</td>
<td>.010</td>
</tr>
<tr>
<td>No. of valid cases</td>
<td>150</td>
<td></td>
</tr>
</tbody>
</table>

Based on the Pearson Chi-Square value of 9.312, \( P = 0.010 \), indicating that there is an association between income level and water harvesting. Individuals with average incomes did the most water harvesting, followed by those with low incomes individuals with high incomes did the least water harvesting.

4.2.2.2 Relationship between Income Level and Water Recycling

In trying to assess whether there is a relationship between income level and water recycling a cross tabulation was done. Table 7 and figure 6 show the relationship between income level and water recycling.

The results indicate that 34 % of the respondents’ recycle their water while 66 % does not recycle. Of the 51 respondents who recycle 26 % have low incomes, 51 % have average incomes and 23 % have high incomes.
Table 7: Relationship between income level and water recycling

<table>
<thead>
<tr>
<th>Income level</th>
<th>Frequency</th>
<th>% in water recycling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>13</td>
<td>26%</td>
</tr>
<tr>
<td>Average</td>
<td>26</td>
<td>51%</td>
</tr>
<tr>
<td>High</td>
<td>12</td>
<td>23%</td>
</tr>
<tr>
<td>Total</td>
<td>51</td>
<td>100%</td>
</tr>
</tbody>
</table>

Figure 6: Relationship between income level and water recycling
Chi-Square Tests

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson Chi-Square</td>
<td>1.547</td>
<td>.461</td>
</tr>
<tr>
<td>Likelihood ratio</td>
<td>1.578</td>
<td>.454</td>
</tr>
<tr>
<td>No. of valid cases</td>
<td>150</td>
<td></td>
</tr>
</tbody>
</table>

Based on the Pearson Chi-Square value of 1.547, P=0.461 indicating that there is no association between income level and water recycling.

4.2.2.3 Relationship between Income Level and Water Storage

In trying to find out whether there is a relationship between income level and water storage a cross tabulation was done. Table 8 and figure 7 show the relationship between income level and water storage.

The results show that of the sample size of 150, 32 % have low income, 47 % have average income and 21 % have high incomes. Of the 48 respondents who have low incomes, 13 % are poor water managers, 60 % are average water managers and 27 % are good water managers.

Of the 71 respondents with average incomes 11 % are poor water managers, 54 % are average water managers and 35 % are good water managers.
managers. Of the 31 respondents who have high incomes 16% are poor water managers 52% are average water managers and 32% are good water managers.

Table 8  Relationship between income level and water storage

<table>
<thead>
<tr>
<th>Income level</th>
<th>Frequency</th>
<th>% in water Storage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Poor</td>
<td>Average</td>
</tr>
<tr>
<td>Low</td>
<td>6</td>
<td>29</td>
</tr>
<tr>
<td>Average</td>
<td>8</td>
<td>38</td>
</tr>
<tr>
<td>High</td>
<td>5</td>
<td>16</td>
</tr>
<tr>
<td>Total</td>
<td>19</td>
<td>83</td>
</tr>
</tbody>
</table>
Figure 7  Relationship between income level and water storage

Chi-Square Tests

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson Chi-Square</td>
<td>1.340</td>
<td>.855</td>
</tr>
<tr>
<td>Likelihood ratio</td>
<td>1.329</td>
<td>.855</td>
</tr>
<tr>
<td>No. of valid cases</td>
<td>150</td>
<td></td>
</tr>
</tbody>
</table>

Based on the Pearson Chi-Square value of 1.34, P=0. 855,
indicating that there is no association between income level and water storage.

Discussion

It was established that based on the Pearson Chi-Square value of 9.312, $P = 0.010$, showing that there is an association between water harvesting and income level. Based on the Pearson Chi-Square value of 1.547, $P = 0.461$, showing that there is no association between income level and water recycling. Based on the Pearson Chi-Square value of 1.34, $P = 0.855$, indicating that there is no association between water storage and income level. It was therefore not fully established whether there exists a relationship between water management and income level since there exists an association between water harvesting and income level only and not the others.

4.2.3 Relationship between Family Size and Water Management

In trying to assess the relationship between water management and family size three areas were considered independently of each other. These areas included: family size and water harvesting, family size and
4.2.3.1 Relationship between family size and water harvesting

In trying to establish the relationship between family size and water harvesting a cross tabulation was done. Table 9 and figure 8 show the relationship between family size and water harvesting.

The results show that of the 150 respondents 59 % harvest their water and 41 % do not harvest. Of the 89 who harvest, 1 % has no dependants 15 % have family members in the range of 1-5 members, 46 % have family members in the range of 6-10 members, 29 % have family members in the range of 11-15 members while 9 % have family members in the category of others.

<table>
<thead>
<tr>
<th>Family size</th>
<th>Frequency</th>
<th>% in water harvesting</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>1</td>
<td>1 %</td>
</tr>
<tr>
<td>1-5</td>
<td>13</td>
<td>15 %</td>
</tr>
<tr>
<td>6-10</td>
<td>41</td>
<td>46 %</td>
</tr>
<tr>
<td>11-15</td>
<td>26</td>
<td>29 %</td>
</tr>
<tr>
<td>Others</td>
<td>8</td>
<td>9 %</td>
</tr>
<tr>
<td>Total</td>
<td>89</td>
<td>100 %</td>
</tr>
</tbody>
</table>
Figure 8  Relationship between family size and water harvesting

Chi-Square Tests

<table>
<thead>
<tr>
<th>Family size</th>
<th>Value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson Chi-Square</td>
<td>4.761</td>
<td>.313</td>
</tr>
<tr>
<td>Likelihood ratio</td>
<td>4.735</td>
<td>.316</td>
</tr>
<tr>
<td>No. of valid cases</td>
<td>150</td>
<td></td>
</tr>
</tbody>
</table>

Based on the chi-square value of 4.761, P=0.313, indicating that there is no association between water harvesting and family size.
4.2.3.2 Relationship between family size and water recycling

In trying to find out the relationship between family size and water recycling a cross tabulation was done. Table 10 and figure 9 show the relationship between family size and water recycling.

The results show that of the 150 respondents, 34 % recycle their water while 66 % do not recycle. Of the 51 who recycle 2 % have no dependants, 14 % have family members in the range of 1-5 members, 45 % have family members in the range of 6-10 members, 27 % have family members in the range of 11-15 members and 12 % have family members in the category of others.

Table 10 Relationship between family size and water recycling

<table>
<thead>
<tr>
<th>Family size</th>
<th>Frequency</th>
<th>% in water recycling</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>1</td>
<td>2 %</td>
</tr>
<tr>
<td>1-5</td>
<td>7</td>
<td>14 %</td>
</tr>
<tr>
<td>6-10</td>
<td>23</td>
<td>45 %</td>
</tr>
<tr>
<td>11-15</td>
<td>14</td>
<td>27%</td>
</tr>
<tr>
<td>Others</td>
<td>6</td>
<td>12%</td>
</tr>
<tr>
<td>Total</td>
<td>51</td>
<td>100%</td>
</tr>
</tbody>
</table>
Figure 9   Relationship between family size and water recycling

Chi-Square Tests

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson Chi-Square</td>
<td>.237</td>
<td>.994</td>
</tr>
<tr>
<td>Likelihood ratio</td>
<td>.236</td>
<td>.994</td>
</tr>
<tr>
<td>No. of valid cases</td>
<td>150</td>
<td></td>
</tr>
</tbody>
</table>

Based on the chi-square value of 0.237, P=0.994 indicating that there is no association between water recycling and family size.
4.2.3.3 Relationship between Family Size and Water Storage

In trying to assess whether there is a relationship between family size and water storage a cross tabulation was done. Table 11 and figure 10 show the relationship between family and water storage.

The results indicate that of the 150 respondents 13% are poor water managers, 55% are average water managers and 32% are good water managers. Of the 3 respondents who have no family 33% are poor water managers, 33% are average water managers and 33% are good water managers. Of the 20 respondents who have family members in the range of 1-5 members 15% are poor water managers 50% are average water managers and 35% are good water managers. Of the 70 respondents who have family members in the range of 6-10 members, 14% are poor water managers 54% are average water managers and 31% are good water managers. Of the 38 respondents in the family range of 11-15 members, 11% are poor water managers, 63% are average water managers and 26% are good water managers. Of the 19 respondents who are in the category of others, 5% are poor managers 53% are average water managers and 42% are good water managers.
### Table 11  Relationship between family size and water storage

<table>
<thead>
<tr>
<th>Family size</th>
<th>Frequency</th>
<th>% in water Storage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Poor</td>
<td>Average</td>
</tr>
<tr>
<td>None</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1-5</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>6-10</td>
<td>10</td>
<td>38</td>
</tr>
<tr>
<td>11-15</td>
<td>4</td>
<td>24</td>
</tr>
<tr>
<td>Others</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td>19</td>
<td>83</td>
</tr>
</tbody>
</table>

### Figure 10  Relationship between family size and water storage
Chi-Square Tests

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson Chi-Square</td>
<td>4.082</td>
<td>.850</td>
</tr>
<tr>
<td>Likelihood ratio</td>
<td>3.995</td>
<td>.858</td>
</tr>
<tr>
<td>No. of Valid cases</td>
<td>150</td>
<td></td>
</tr>
</tbody>
</table>

Based on the chi-square value of 4.082, P=0.850 indicating that there is no association between water storage and family size.

Discussion

Based on the chi-square value of 4.761, P=0.313 indicating that there is no association between water harvesting and family size. Based on the chi-square value of 0.237, P=0.994 indicating that there is no association between water recycling and family size. Based on the chi-square value of 4.082, P=0.850 indicating that there is no association between water storage and family size. It was therefore established that there is no relationship between water management and family size.

The results show that the water per capita for personal use (drinking, cooking and bathing) and for watering animals is 153 litres per day. This figure is below the required minimum standards considering that this people are pastoralists with very big numbers of livestock, which require lots of water. Several different amounts have been proposed as
minimum standards. Falkenmark uses the figure of 100 litres of fresh water per capita per day for personal use as a rough estimate of the amount needed for a minimally acceptable standard of living in developing countries, not including uses for agriculture and industry (Falkenmark and Widstrand, 1992).

4.3 Hypothesis Testing

This section deals with hypothesis testing. Logistic regression was used to find out whether an increase in education level, income level and family size increased or enhanced water management activities. The first hypothesis was testing the influence of levels of education on water management. The null hypothesis of no relationship is tested against the research hypothesis as follows: - The dependent variable is water management while the independent variables are education, income and family size.

H₀ there is no correlation between the level of education and water management activities in semi arid lands.

H₁ Increase in education level increases water management activities in semi arid lands.
Observation

Table 12  Logistic regressions showing the relationship between water harvesting and education

<table>
<thead>
<tr>
<th></th>
<th>B</th>
<th>S.E</th>
<th>Sig</th>
<th>Exp (B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary</td>
<td>3.196</td>
<td>.770</td>
<td>.000</td>
<td>24</td>
</tr>
<tr>
<td>Post-Primary</td>
<td>1.246</td>
<td>.397</td>
<td>.002</td>
<td>3</td>
</tr>
<tr>
<td>Constant</td>
<td>-3.954</td>
<td>.831</td>
<td>.000</td>
<td>.019</td>
</tr>
</tbody>
</table>

The Model chi-square is 34.542, which indicates association between harvesting and education (p=0.000). The chances of individuals with primary education harvesting are 24 times those of individuals with no education. The chances of individuals with post-primary education harvesting are 3 times those of individuals with no education. Individuals with some education are more likely to harvest than those with no education. However, the individuals with primary education are more likely to harvest than those with post primary education.

Discussion

There is an association between water harvesting, water recycling,
and water storage and education level. It was though not fully established that an increase in education level increases water management activities. Therefore, the null hypothesis of no correlation between the level of education and water management is true.

The second hypothesis was testing the influence of levels of income on water management. The null hypothesis of no correlation is tested against the research hypothesis as follows. The dependant variable is water management while the independent variable is income.

H₀ there is no correlation between income level and water management activities in semi arid lands.

H₂ Increase in income level increase water management activities in semi arid lands.

**Table 13** Logistic regressions showing the relationship between water harvesting and income

<table>
<thead>
<tr>
<th></th>
<th>B</th>
<th>S.E</th>
<th>Sig</th>
<th>Exp (B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average income</td>
<td>1.137</td>
<td>.389</td>
<td>.003</td>
<td>3</td>
</tr>
<tr>
<td>High income</td>
<td>.934</td>
<td>.476</td>
<td>.050</td>
<td>2</td>
</tr>
<tr>
<td>Constant</td>
<td>-1.735</td>
<td>.541</td>
<td>.001</td>
<td>.176</td>
</tr>
</tbody>
</table>
Discussion

The Model chi-square is 9.312, which indicates association between water harvesting and income (p=0.010).

The chances of individuals with high income harvesting are 2 times those of individuals with no income. The chances of individuals with average income harvesting are 3 times those of individuals with no income. Individuals with average income did more harvesting than those with high income. The individuals with a low income did the least water harvesting.

The results showed that there is a relationship between water harvesting and income. There is no relationship between income and water recycling and income and water storage. The data could not fully show that an increase in income increased water management activities.

The third hypothesis was testing the influence of levels of family size on water management activities. The null hypothesis is tested against the research hypothesis as follows. The dependant variable is water management while the independent variable is family size.

H₀ there is no correlation between the level of family size and water management in semi arid lands

H₃ Increase in family size increases water management activities in
Discussion

There is no relationship between water management activities and family size. The null hypothesis of no correlation between the level of family size and water management is true.

4.4 Problems Rural Women Face in the Process of Managing their Water Resources.

It was found from the focused group discussions and individual households interviewed that rural women experience different problems in the process of managing their water resources. Both the individual households and focused groups gave similar problems. Log linear modeling was used to prioritize these problems. They included in order of priority;

(i) Distance to water source;
(ii) Drying up of the water sources;
(iii) Conflict between women and men with regard to watering their animals versus women drawing up water for domestic purposes;
(iv) Maintenance of the water source;
(v) Demand of water versus supply of water;
(vi) Flooding of the water sources during wet season; and

(vii) Contamination

4.5 Priority Level of Water Management Activities.

<table>
<thead>
<tr>
<th>Priority ranking</th>
<th>Frequency</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&lt;sup&gt;st&lt;/sup&gt;</td>
<td>149</td>
<td>99%</td>
</tr>
<tr>
<td>2&lt;sup&gt;nd&lt;/sup&gt;</td>
<td>1</td>
<td>1%</td>
</tr>
<tr>
<td>3&lt;sup&gt;rd&lt;/sup&gt;</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Difficult to prioritize</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Out of the 150 people who were interviewed 149 (99%) of them said that they gave water management first priority. One person took water management as a second priority.
Figure 11  Priority level of water management activities

Priority levels rural women give to water management activities

- 1st priority: 99%
- 2nd priority: 1%

The results showed that there was no relation between the availability of water resources and the priority level of water management.
CHAPTER FIVE
CONCLUSION AND RECOMMENDATIONS.

5.1 Summary

From the literature review it was apparent that studies on women and water management in semi arid lands have not been given much attention. And studies on the relationship between socio economic status of rural women and water management have not been done in Kajiado district.

The results showed that there is a relationship between income level and water harvesting but there is no relationship between income level and water recycling and income level and water storage. The data did not fully show whether there exists a relationship between income and water management.

The results showed that there was no relationship between family size and water management.

A revised conceptual framework is represented below

Individuals with average incomes were the best water managers followed by those with high incomes. Those with low incomes were poor water managers. Individuals with average and high incomes had increased water availability as compared to those with low incomes who had reduced water availability.
Those individuals with primary education are better water managers as compared to those with post primary education and those with no education. Individuals with primary and post primary education had increased water availability as compared to those with no education.

Family size did not play any role in the management of water resources.
Fig 12  Revised conceptual framework

Socio-Economic status

Income

High
Average
Low

Education

Post primary
Primary
None

Water Management

Water Availability

Family size

Others
11-15
5-10
1-4
Rural women in semi-arid lands face many problems in the process of managing their water resource they included in order of priority:

- distance to water source;
- drying up of the water sources;
- conflict between women and men with regard to watering their animals versus women drawing up water for domestic purposes;
- maintenance of the water source;
- demand of water versus supply of water and
- flooding of the water sources during wet season.
- contamination

It was also seen that women in semi arid lands give water management first priority.

5.2 Conclusion

The following conclusions have been drawn from this study:

a) The study showed that there is increased water shortage in the study area as indicated in the per capita for personal use.

b) Education of rural women played a significant role in the management of water resources in semi arid lands.

c) It was not categorically established whether income played a significant

75
role in the management of water resources in semi arid lands.

d) It was established that family size did not play a significant role in the way rural women manage their water resources.

e) It was also established that rural women face various problems in the process of managing their water resources and they give water management first priority.

5.3 Recommendations

a) The pastoralists derive a meager livelihood from the care of livestock in dry areas. The Government, through the Ministry of Water Development should increase the number of water points so as to improve their income earning opportunities and reduce the distance women have to walk to water points. This will be in line with the long term objectives of the Government to ensure the supply of water of good quality, in sufficient quantity and in close proximity to the population as was indicated in the Government Development Plan of 1984-88.

b) The NGOs should also help the local communities by drilling more boreholes, building of large storage tanks and earth dams to store rainwater to be used during the dry seasons. They should ensure that they give a specific group to maintain these water points for example
women groups, for purposes of better accountability. They can also charge a small fee from the community to be able to meet operational and maintenance costs.

c) There is need to develop separate water points for watering livestock and for domestic use. This will reduce pressure on a single water point and reduce conflicts between men and women.

d) Earth dams should properly be designed to prevent collapse during rainy seasons.

e) The Government, through the Ministry of Education, should sensitize communities against cultural practices that impact negatively on enrolment, and completion rates. Women in Kajiado district should be encouraged to have formal education especially now that the Government is offering free primary education since it is seen that those women with an education are better water managers than those with no education.

f) Women should be consulted on their own water needs as custodians of large groups of users, but they have on the other hand to enter into both policy and decision making processes.

g) Stakeholder involvement and participatory processes. should be encouraged as women participation and their contribution in transforming the decision making process by more focus on water resources as
something to share and care about rather than to fight about.

i) Community based organizations and other stakeholders should facilitate better water harvesting techniques; and construct appropriate dams to conserve water caused by the erratic rainfall patterns and lack of adequate storage facilities. These steps will be important in improving food security and poverty eradication.

5.4 Suggestions for Further Research

a) More studies on education level and income level and how they relate to water management should be carried out.

b) Studies on the role of rural men on water resource management in semi-arid lands should also be carried out.
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APPENDICES

APPENDIX I

INTERVIEW SCHEDULE

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<tr>
<th>CODE</th>
<th>DATE</th>
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</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>INTERVIEWER</th>
<th>LOCATION</th>
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<table>
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</table>

<table>
<thead>
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<th>SUB-LOCATION</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Personal information

1. What is your name?

2. What is your marital status?
   (a) Single  (b) Married  (c) Divorced  (d) Separated  (e) Widower  (f) Widow

3. How many dependants do you have?
   (a) 0-5  (b) 6-10  (c) 11-15  (d) others  (e) none

4. What is your education level?
   (a) Primary  (b) Secondary  (c) tertiary  (d) none

5. What is your occupation?
   (a) Agro pastoral  (b) pastoral  (c) others

6. What is your family source of income per month?
   (a) Selling agricultural produce  (b) selling animal products
   (c) Selling firewood  (d) others
7. What is the range of your income per month?
   (a) Ksh.0-500 (b) Ksh.500-1000 (c) Ksh.1000-1500 (d) Ksh.1500-2000

Management Issues

8. What are your sources of water for domestic use?
   (a) Rain       (b) stream/wells       (c) River       (d) tanks
   (e) earth dams (f) boreholes

9. How far are the sources of water?
   (a) 0-4        (b) 5-10           (c) 11-15       (d) more than 15

10. What do you use your water for?
    (a) Cooking   (b) washing         (c) watering the kitchen garden
     (d) Watering Livestock

11. Are the sources of water adequate?
    (A) Yes       (B) No

12. If No, what have you done to eliminate this problem?
    (a) Constructed a water tank       (b) have storage containers
    (c) have enough water              (d) nothing               (e) digging holes
    (f) bore holes

13. How much of your income do you contribute towards the construction of water tanks or buying water storage facilities?
    (a) Ksh 0-500   (b) Ksh 500-1000   (c) Ksh 1000-1500
    (d) less than 500  (e) None
14. How many streams or rivers pass near your homestead?
(a) 1  (b) 2  (c) none  (d) more than 2

15. Are these rivers seasonal?

16. If they are seasonal how do you conserve the water?
(a) Construction of a water tank  (b) storage containers  (c) earth dam
(d) Do not store

17. How many boreholes are there in your homestead?
(a) 1  (b) 2  (c) none  (d) more than 2

18. Are they all operational?
(a) Yes  (b) No

19. If No, how many are operational?

20. How many are not operational?

21. Do you store rainwater?
(a) Yes  (b) No

22. If yes how do you store it?
(a) Storage tanks  (b) storage containers  (c) earth dams

23. If no why don’t you store?

24. Is there any Government or private water projects in your area?
(a) Yes  (b) No

25. How many times do you water your livestock?
(a) once a day  (b) twice a day  (c) once in two days
(d) once in three days  (e) others
26. Are you aware of any problems facing the water sources you have?

27. List the problems related to the water sources

28. How much water do you use?
   (a) 0-100 ltrs  (b) 101-200 ltrs  (c) 201-300 ltrs
   (d) more than 300
   (e) hard to say

29. Do you use (recycle) it again?

30. How do use the recycled water?

31. Are their changes in water levels in your rivers nowadays as compared to the olden days?

32. What are the causes of these changes in water levels?

33. What do you think you can do to alleviate this problem of water level?

34. Does the family size affect the management of water resources?
   (a) Yes  (b) No

35. If yes, what role does it play?
   (a) the more the family members the more difficult it is to manage the water
   (b) the less the family members the more difficult it is to manage water resources
   (c) no difference whether large or small
   (d) the less the family members the better the management of water resources
36. What priority do you give to the management of water resources?

<table>
<thead>
<tr>
<th>Priority ranking</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Priority</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2nd Priority</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3rd Priority</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Difficult to prioritize</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

37. Factors that limit water management

- (a) None so far
- (b) Ignorance
- (c) Financial constraints
- (d) Climatic condition
- (e) Others

38. Ranking of water management

<table>
<thead>
<tr>
<th>Value</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No effort done in managing water resources</td>
</tr>
<tr>
<td>1</td>
<td>Little effort done in managing water resources</td>
</tr>
<tr>
<td>2</td>
<td>Some effort done in managing water resources</td>
</tr>
<tr>
<td>3</td>
<td>Average</td>
</tr>
</tbody>
</table>

91
4. Much effort done in managing water resources

39. Are there disputes as far as water sources are concerned?

40. How do solve them?

41. Do you think the way you solve them is efficient?
## APPENDIX 2

### OBSERVATION RECORD SHEET

<table>
<thead>
<tr>
<th>DIVISION</th>
<th>LOCATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUB-LOCATION</td>
<td>HOUSEHOLD No.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>No. of earth dams visible</th>
<th>No. of Containers</th>
<th>No. of Tanks visible</th>
<th>No. of bore holes visible</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

93