MINISTRY OF AGRICULTURE , LIVESTOCK, FISHERIES AND IRRIGATION

The Principal Secretary, State Department for Crop Development,
Ministry Of Agriculture, Livestock, Fisheries and Irrigation
Kilimo House, Cathedral Road,
P.O. Box 30028 00100
Nairobi KENYA

AGENN ASSOCIATES LTD

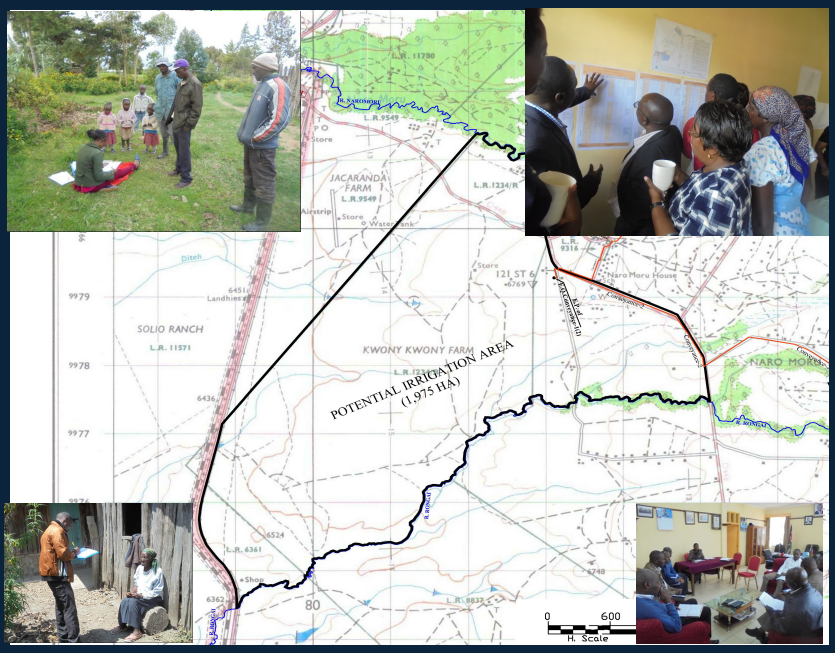
P.O. BOX 30197-00100 NAIROBI
TEL: +254 722 878 029

WEBSITE: www.agenn.co.ke
EMAIL: agennassociates@gmail.com

FINAL DRAFT ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) REPORT FOR:

CONSULTANCY SERVICES ON FEASIBILITY STUDY, DESIGN AND SUPERVISION OF NDIRITI AGUTHI IRRIGATION SCHEME **IN KIENI EAST DIVISION,** NYERI COUNTY.

TENDER NUMBER: **MOALF/SIVAP/T002/2017-2018**



DECEMBER 2018

P. O. Box 30197 - 00100 Nairobi, Kenya.

Tel.:+254-722878029, Email:agennassociates@gmail.com, Or gitauan@yahoo.co.uk

10th December, 2018

The Project Coordinator,
State Department for Crop Development,
Small-Scale Irrigation and Value Addition Project (SIVAP)
Ministry of Agriculture, Livestock, Fisheries and Irrigation
P.O. Box 30028 00100
Nairobi Kenya

Dear Sir/Madam,

Re: SUBMISSION OF FINAL DRAFT ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) REPORT FOR: CONSULTANCY ON FEASIBILITY STUDY, DESIGN, TENDER DOCUMENT PREPARATION AND SUPERVISION OF NDIRITI AGUTHI IRRIGATION SCHEME IN KIENI EAST DIVISION, NYERI COUNTY. CONTRACT NO.: MOALF/SIVAP/T002/2017-2018

Please receive the Final Draft Environmental and Social Impact Assessment (ESIA) Report for ***Consulting services for Feasibility Study, Design, Tender Document Preparation and Supervision of Ndiriti Aguthi Irrigation Scheme in Kieni East Division, Nyeri County.*** The comments received from the County and sub county staff and zone leaders in the during the dissemination workshop on 28th September 2018 have been incorporated.

We have enclosed as per the Terms of Reference, 2 hard copies and 1 soft copy.

Please find attached the response to comments raised by the client during the dissemination workshop on 23rd November 2018 and the modalities used to address them

We remain,
Yours sincerely,

Eng. Ayub N. Gitau,
Director,
AGENN Associates Limited
P.O. Box 30197 - 00100
gitauan@yahoo.co.uk,agennassociates@gmail.com,
Nairobi, Kenya

Encl (2)

FACT SHEET

Project Name	Ndiriti Aguthi Irrigation Scheme in Nyeri County
Assignment Name	Environmental and Social Impact Assessment (ESIA)
Location	The irrigation scheme is situated in Kieni East division, Nyeri County
Coverage	Project has a command area of 225Ha with 1000 beneficiaries.
Main water source	The scheme will abstract water from River Naromoru sampling points located at 37N 0283384 and UTM 9980718 with elevation asl of 2042 m, and Existing Kabunda Reservoirs located at (coordinates 37N 0285427and UTM 9981196 with elevation asl of 2074 m).
Proponent	The Ministry of Agriculture, Livestock, Fisheries and Irrigation, State Department for Crop Development
Address of the Proponent	State Department for Crop Development, Ministry of Agriculture, Livestock, Fisheries and Irrigation P.O. Box 30028 00100 Nairobi Kenya
Project cost	The estimate project cost is Kshs. 217,548,440.48
Funding Agency	Government of Kenya
Consultant	AGENN Associates Limited (C/o Eng. Ayub N. Gitau) P. O. Box 30197 - 00100 Nairobi, Kenya. Tel.: +254 - 722 878 029 Email: agennassociates@gmail.com, Or gitauan@yahoo.co.uk
Start Date	16th April 2018
Completion Date	16th January 2019
LEAD EXPERT	Eng. Ayub N. Gitau NEMA Registration No. 1773

DECLARATION

This EIA report was prepared by a team of experts in accordance with the Environmental Management and Coordination Act, 1999 and the Environmental (Impact Assessment and Audit) Regulations 2003. We the undersigned, do hereby certify that this report was prepared based on the information provided by the proponent as well as that collected from other primary and secondary sources and on the best understanding and interpretation of the facts by the environment experts.

We are pleased to herewith submit the Environmental and Social Impact Assessment (ESIA) Study Report for the Ndiriti Aguthi Irrigation Scheme.

LEAD EXPERT:

NAME: **Eng. Ayub N. Gitau** **NEMA Reg. No.: 1773**

Sign: ..... Date: .....

PROPONENT:

State Department for Crop Development,

Ministry of Agriculture, Livestock, Fisheries and Irrigation

P.O. Box 30028 00100

Nairobi Kenya

On behalf of the proponent

Name: …….. **Title:** ……

……. ……

Signature Date

Disclaimer

This Environmental Impact Assessment Report is being submitted in accordance with the terms and conditions of contract in respect of provision of consultancy services. It has been carried out in full observance of the EIA regulations and in compliance with the Environmental Management and Coordination Act, 1999 and subject to terms and conditions of the National Environment Management Authority (NEMA).

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LIST OF ABBREVIATIONS

AfDB	African Development Bank
AWBM	Australian Water Balance Model
EMCA	Environmental Management and Coordination Act
ESIA	Environmental snd Social Impact Assessment
ESMP	Environmental and Social Management Plan
FAO	Food and Agriculture Organization
FDC	Flow Duration Curve
GDP	Gross Domestic Product
GHG	Green House Gases
GIR	Gross Irrigation Requirement
GIS	Geographic Information System
GPS	Global Positioning System
Ha	Hectare
HIV	Human Immuno-Deficiency Virus
KEBS	Kenya Bureau of Standards
Kg	Kilogramme
KIPPRA	Kenya Institute of Policy and Public Research
Km	Kilometer
KMS	Kenya Meteorological Service
M asl	Meters Above Sea Level
m	Metre
Mm	millimeter
NASA	National Aeronautics and Space Administration
NEAP	National Environment Action Plan
NECC	National Environmental Complaints Committee
NEMA	National Environment Management Authority
NGO	Non-Governmental Organization
NIR	Net Irrigation Requirement
NPV	Net Present Value
OC	Organic Carbon
PCPB	Pest Control Products Board
PET	Potential Evapotranspiration
pF	Soil Moisture Retention Potential
pH	Degree of Acidity or Alkalinity
ppm	Parts per Million
RAM	Readily Available Soil Moisture
RGS	River Gauging Station
RRL	Rainfall Runoff Library
SERC	Standards and Enforcement Review Committee
SIVAP	Small-scale Irrigation and Value Addition Project
TOR	Terms of Reference
TRAM	Total Readily Available Moisture
UTM	Universal Transverse Mercator
WHO	World Health Organization
WRA	Water Resources Authority
WUA	Water User Associations

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EXECUTIVE SUMMARY

I. Purpose

The Ministry of Agriculture, Livestock, Fisheries and Irrigation, contracted the consultants to undertake the Environmental Impact assessment for the proposed rehabilitation and expansion of Ndiriti Aguthi Irrigation Scheme.

II. Background

Ndiriti Aguthi irrigation scheme is situated in Kieni East division, Nyeri County. The scheme will abstract water from river Naromoru and Kabunda dam have a command area of 225Ha with 1000 beneficiaries. The crops grown are mainly vegetables (kales, tomatoes, onions, carrots cabbage) and beans. The proposed areas of intervention include detailed feasibility study of irrigation infrastructure that include command area layout, abstraction infrastructure, water conveyance and supply pipeline networks. The Ndiriti Aguthi irrigation scheme has its catchment within the Naromoru/ Kiamathaga Ward which has an estimated population of 33,476 persons from 9976 households. The ward covers an area of 243 square kilometers. On itself, the Ndiriti Irrigation scheme is found within Ndiriti Location which has a population of 3833 persons from an estimated 1094 households. The Ndiriti Location covers an area of 16.8 square kilometers.

III. Project components

The proposed irrigation system is composed of the following main infrastructure components:

a) *Head-works/Water source:* The existing Kabunda Dam and Ndiriti Aguthii fixed weir Intake on Naromoru River.
b) *Inland Reservoirs/Water Pan:* This will provide temporary storage for irrigation water during low flows at the existing water sources especially during the dry seasons.
c) *Conveyance Pipeline:* This will convey water from the dam sites to the head of the irrigation scheme area located downstream of the existing water sources.
d) *Main Pipelines:* These will convey water to major irrigation areas as delineated and shown in the plan.
e) *Distribution system:* These will convey water from the main pipelines to the small irrigation units/blocks (Tertiary Pipelines) from which the Feeder Pipelines will supply irrigation water to the plots/to the sprinklers for irrigation.
f) *Infield System:* This consists of the hydrants and sprinklers which conveys water to the crops directly from the distribution system

IV. Environmental Social Impact Assessment (ESIA)

In response to the legal requirements that demand that an Environmental and Social Impact Assessment (ESIA) be carried out on projects that are likely to have negative impacts on the environment, the consultant carried out ESIA study. The assessment was carried out to determine the likely environmental impacts anticipated from implementation of the proposed project and the mitigation measures that can be implemented to address the anticipated negative impacts. The assessment was done in accordance with the Environmental Management and Coordination Act (EMCA) 1999 and Environmental (Impact Assessment and Audit) Regulations 2003, among other national legislations, standards and international protocols. This was done in order to comply with environmental and quality standards, and meet requirements as per the applicable laws and regulations in Kenya.

V. Objectives

The objective of the study was to carry out an Environmental and Social Impact Assessment (ESIA) of the project areas in accordance with the Environmental Impact and Audit Regulations 2003 and the international guidelines for ESIA and submit report to NEMA for approval. On the social impact

assessment, it includes; carrying out a socio-economic and environmental status analysis through a baseline survey and preparation of an Environmental and Social Management Plan (ESMP).

VI. Scope of work

The Environmental and Social Impact Assessment study included:

(a) Analysis of the socio-economic and socio-environmental status of the areas during pre and post construction- and thus justify development of the affected irrigation project.

(a) Assessment of the Community's capacity to implement the proposed mitigation measures, and make appropriate recommendations, including potential capacity building and training needs and their costs.

(b) Preparation of an Environmental and Social Management Plan (ESMP) based on the Environmental baseline survey. The ESMP outlines:

(c) Evaluation of the Social Impact and how the Communities in the area will benefit or lose upon implementation of the project.

(d) Based on the information collected from the Social Economic Baseline Survey, in the report the consultant has shown how the identified adverse effects will be mitigated.

(e) The consultant also consulted key stakeholders through interviews, focus group discussions, and public barazas. Records of public consultations are provided in the appendices.

VII. Approach and Methodology

To meet the objectives of the study, we adopted systematic, integrated, participatory and collaborative approaches. We gathered information through document reviews, field investigations, focus group discussions and key informant interviews. We consulted Key Informants, administrators, scheme leaders, community leaders among others.

The EIA experts examined all legal and regulatory frameworks, socio-economic profiles in the project area, identified environmental impacts and proposed relevant mitigation measures. The report also provides environmental management framework, monitoring and evaluation mechanisms.

Some of the key components in the ESIA include:

i) **Public Consultations:** Consultations was conducted with the affected persons/communities where issues that may arise during the project life cycle were discussed.

ii) **Project Impacts:** The project traversed a long stretch of land with considerable levels of immitigable impacts to the flora and fauna. Some impacts were socio-economic in nature especially during the construction phase. This would be addressed by interventions suggested in the ESMP section.

iii) **Monitoring and Evaluation:** There will be need for continued monitoring and evaluation. This will ensure that issues that may arise before and after project implementation are properly addressed.

iv) **Community expectations:** All the community expectations and concerns as obtained during the public participation were documented and addressed.

VIII. Legal Framework of the ESIA

Relevant Kenya laws considered include:-

- EMCA 1999
- Water Act, 2012
- Wildlife (Conservation and Management) Cap 376
- Lake and Rivers Act Cap 409
- Occupational Safety and Health Act, 2007
- Irrigation Act 2012
- Land Act, 2012
- Valuers' Act
- The Constitution of Kenya
- Agriculture, fisheries and food Authority Act, No.13, 2013

IX. Social Economic Profile

A household survey for the proposed water project in Kieni East was conducted based on different parameters on socioeconomic and environmental considerations. Demographically, there were 173 female (53%) and 153 (47%) male household heads who respondent during the survey as summarized in Table i.

Table i: Distribution of respondents by Zone based on Gender

	Cross Tabulation of Respondents per Zone						
	Central	**Kabendera**	**Kahuho**	**Lenana**	**Murua**	**Rongai**	**TOTAL**
Female	34	24	43	27	24	21	**173**
Male	19	29	13	31	27	34	**153**
Total	**53**	**53**	**56**	**58**	**51**	**55**	**326**

Majority of households (51%) comprised 4-6 family members. It was also noted that most of the respondents (57%) had immigrated to this area in search for farming land as shown in Figure I here in.

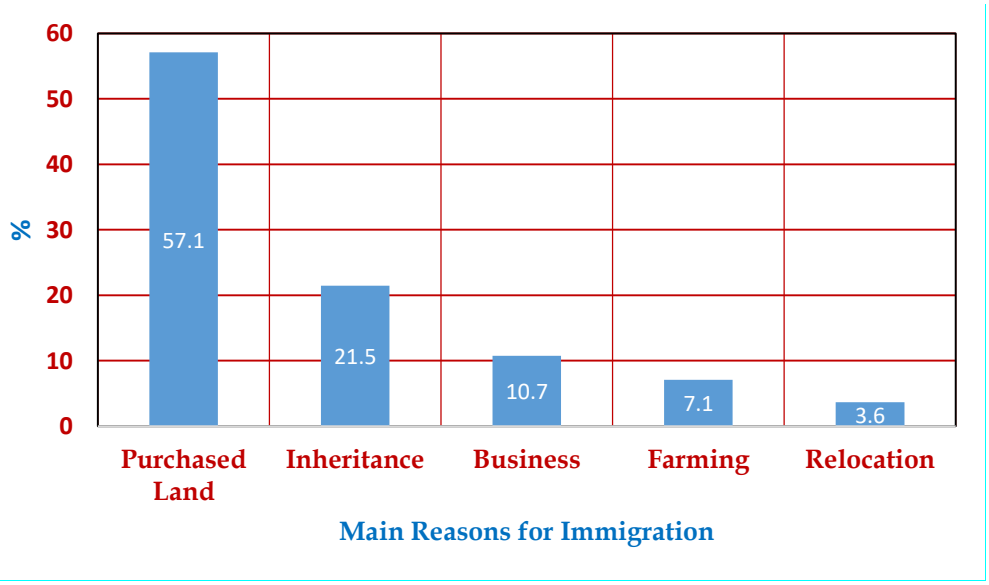


Figure i). : Primary economic activities in Kieni East with mixed-crop farming being most prominent in the area

The main economic activity in Kieni east is mixed farming where approximately 85.5% of farmers grow maize, beans or potatoes as single or mixed crop. The farmers have experienced a number of challenges in crop farming, predominantly crop pests and diseases (63%) and extreme weather conditions of floods and drought (16%). Livestock farmers have faced high costs of veterinary and other extension services (46%) and animal feeds (39%) This is illustrated in Figure ii.

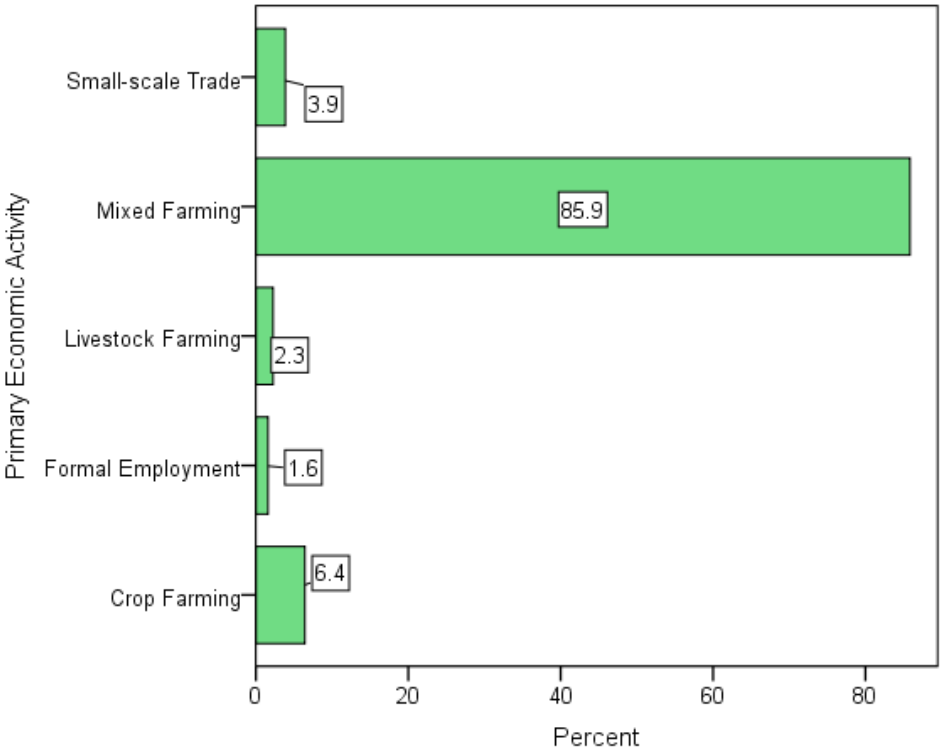
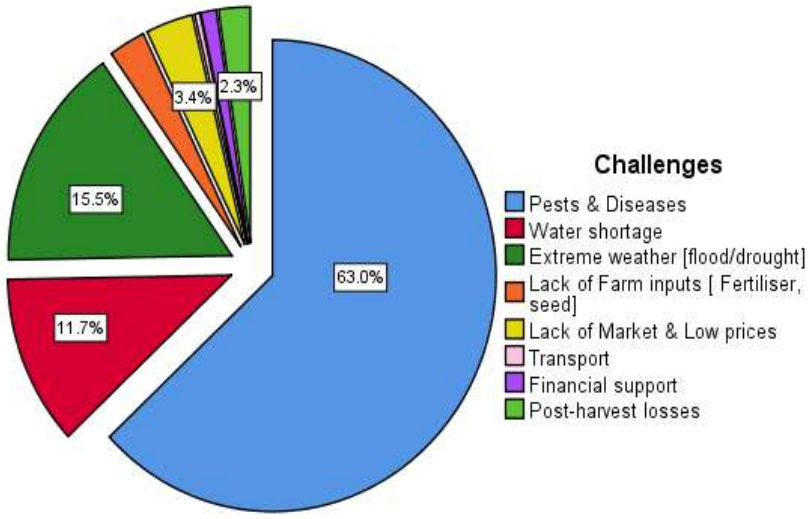


Figure ii). : Primary economic activities in Kieni East with mixed-crop farming being most prominent in the area



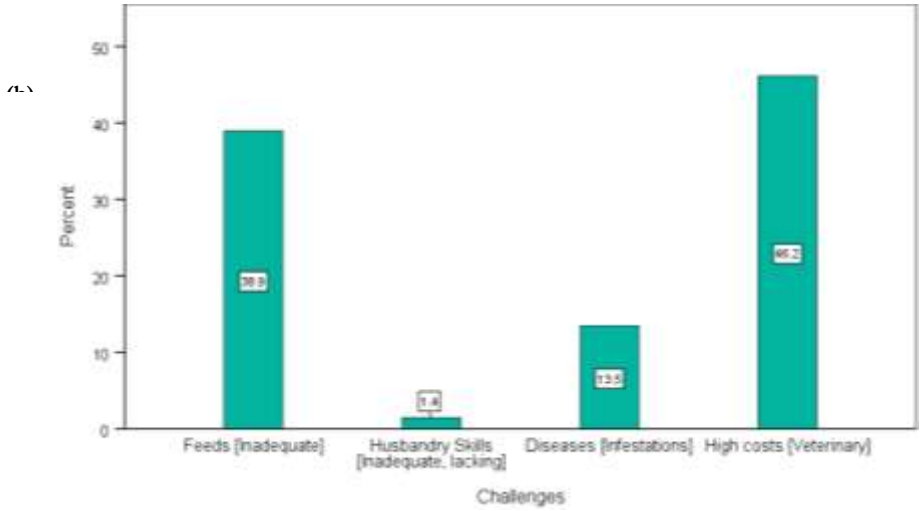


Figure iii). Challenges facing farmers in Kieni East; (a) Crop farming and (b) Livestock keeping

It is noteworthy that the level of farm mechanization among the farmers in Kieni East is moderate at 46%. Most farmers employ manual family (40%) or hired labour (46%) to prepare land during planting and crop husbandry activities (Figure iii). This is a potential determining factor in terms of agricultural productivity in the area and should be prioritized during the design and implementation of development plans for the region.

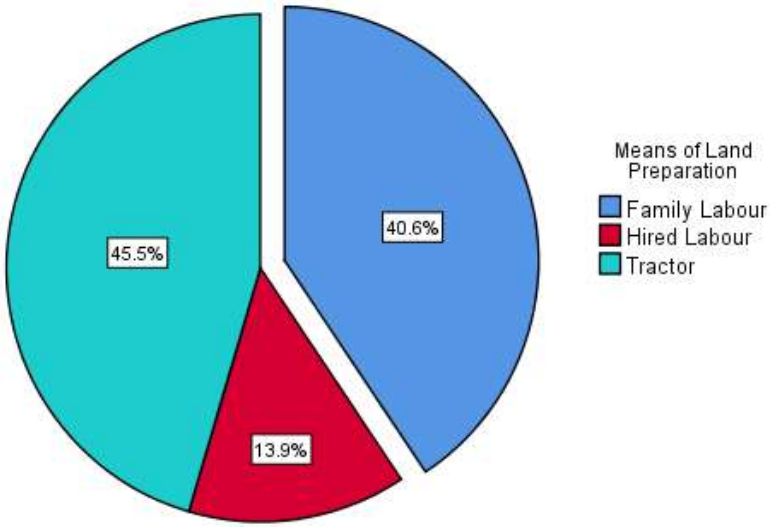


Figure iv).: Level of farm mechanisation during land preparation in Kieni East

The transport network in Kieni East needs improvement since 45% of existing roads are in a very deplorable condition. In addition, nearly 87% of residents in the area move from place to place on foot and mainly for farming activities (Figure v).

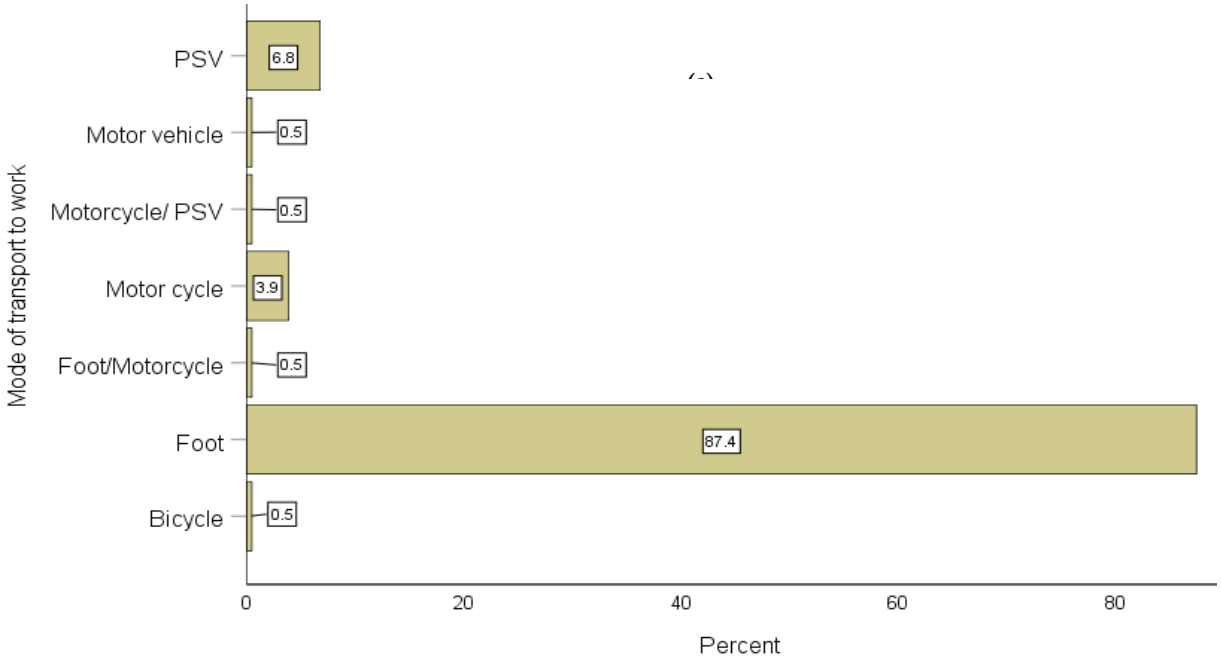


Figure v). : Modes of transport to work/farms.

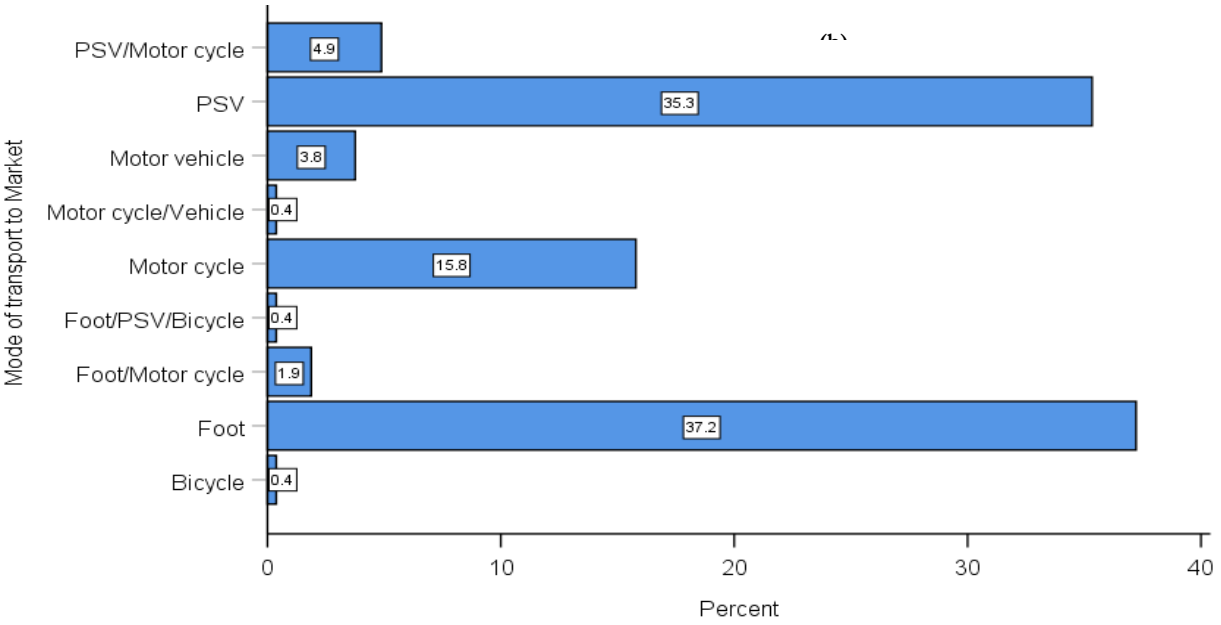


Figure vi).: Modes of transport to the markets

The main source of energy for a variety of uses, such as cooking and heating for most residents is firewood (59%) and charcoal (20%) both of which exert pressure on the forest resources within Kieni and adjacent environments (Figure vii). No wonder in Figure ix, deforestation is the most quoted environmental challenge in Kieni East (58%) followed by pollution of air, water and noise (44%). However, electricity forms the main supply of energy used for lighting in this area with about 64% utilizing this source.

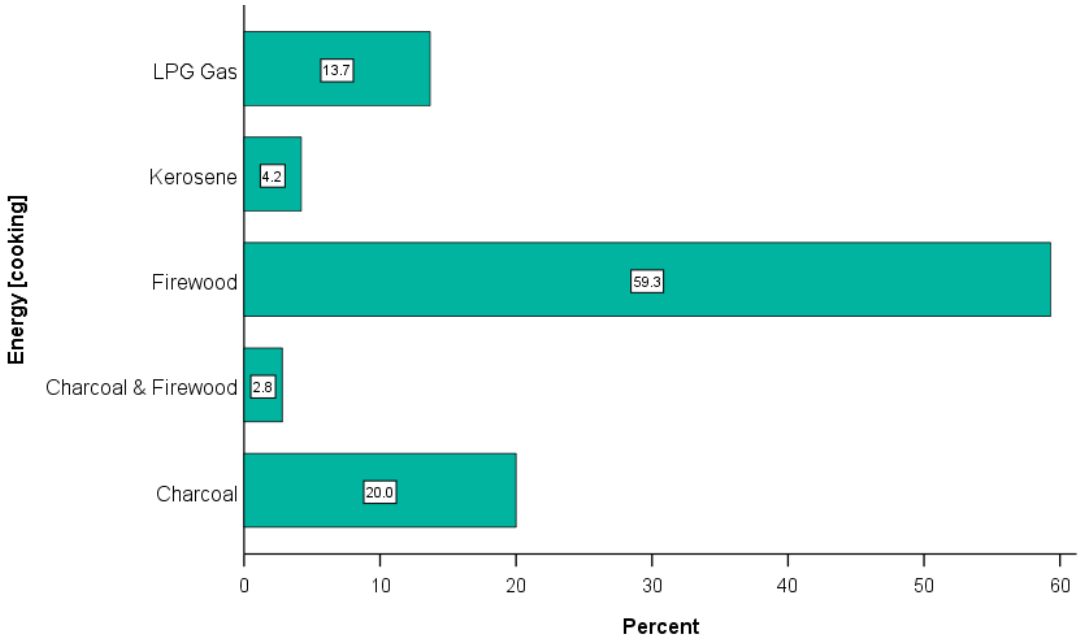


Figure vii). Sources of energy for cooking

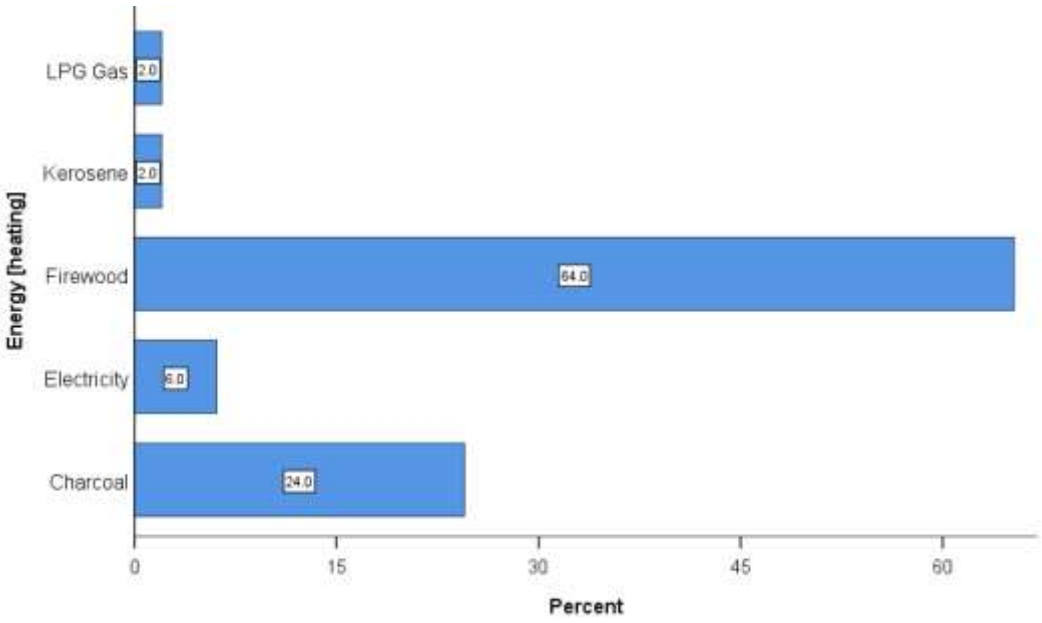


Figure viii). Sources of energy for heating in Kieni East

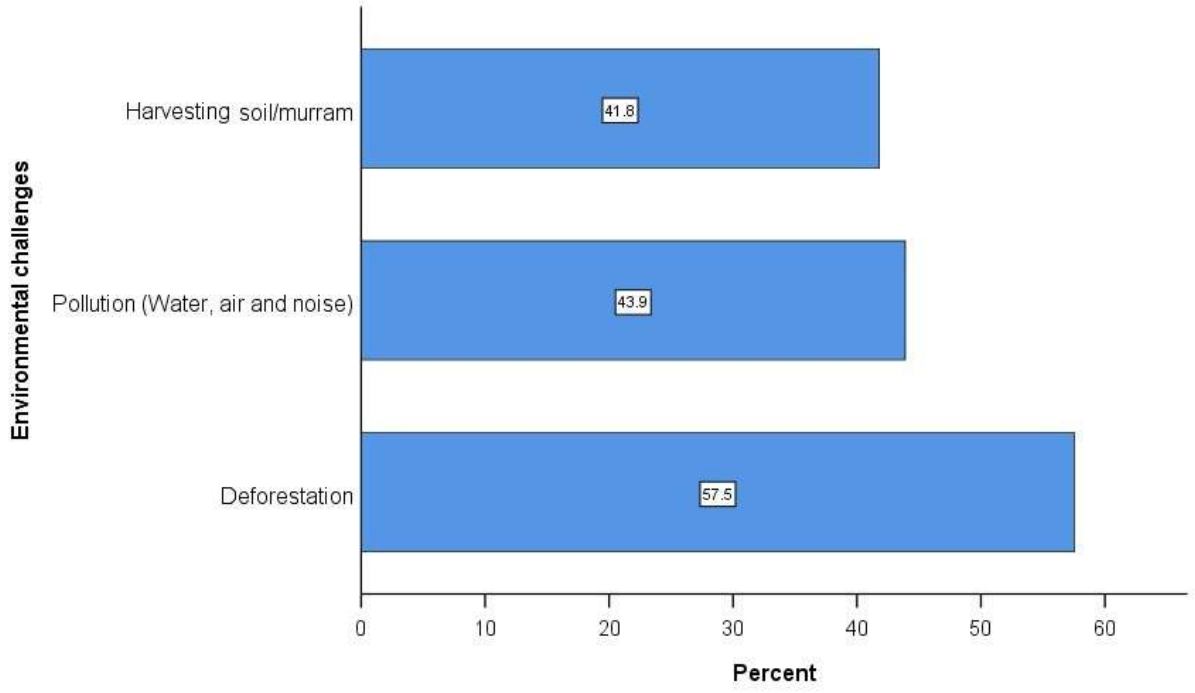


Figure ix). Environmental challenges facing Kieni East community

Given the rising demand for domestic and irrigation water in Kieni, 64% of residents have opted for storage of water in tanks when it is supplied or available while 22% of farmers use modern smart farming technologies such as drip or micro-irrigation, or sub-surface irrigation methods to conserve water.

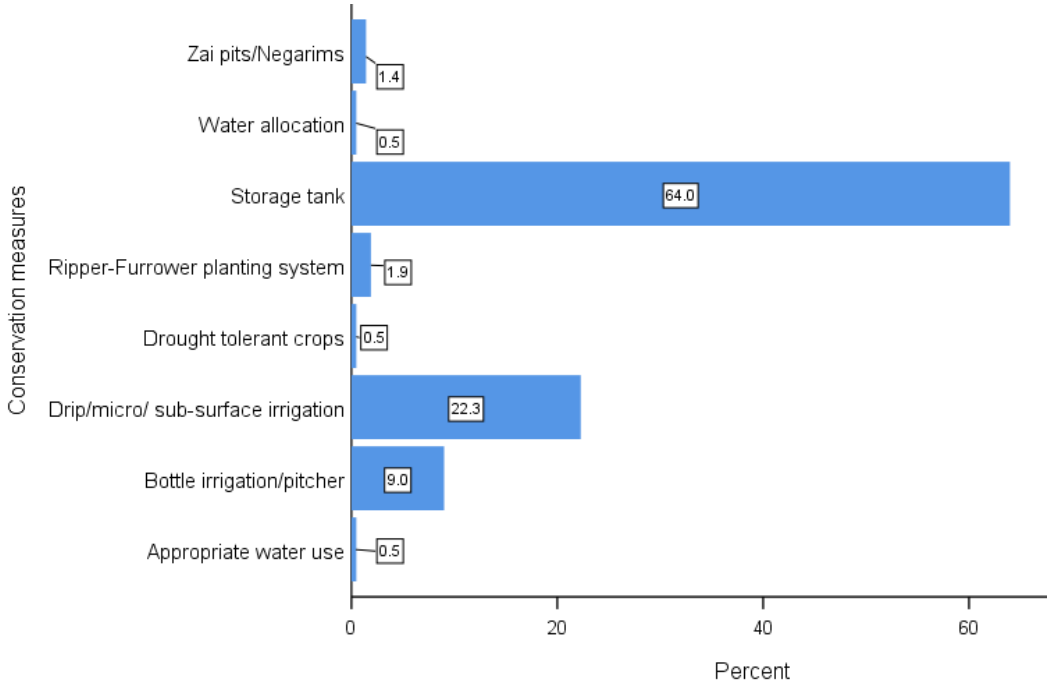


Figure x). : Measures adopted by residents of Kieni East to conserve water

On the same note, 58% of the residents are informed of the proposed water project and 99% also concur that the project would be key in ensuring sufficient supply of irrigation water and therefore to improve crop production. In fact, majority (97.5%) of residents have expressed Willingness To Pay (WTP) for the provision of water supply to the area. However, given this fact, 36% feel that the project will further increase water shortage particularly during the dry season (due to irrigation) while another 30% cited cases of mismanagement of the water project, for instance misuse of funds or unfair allocation of water between or within the zones.

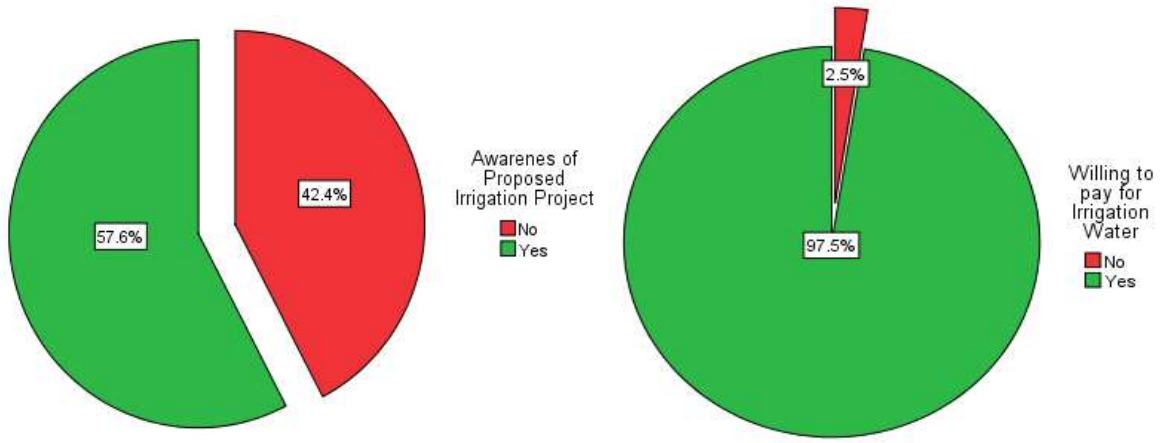


Figure xi).: Level of awareness of the proposed water project (a) and willingness of the residents to pay for water supply services (b)

Among the priority development issues for the Kieni East community, three key areas for development include; water supply for irrigation (33%), lower costs of energy (22%) and improvement of road network (20%).

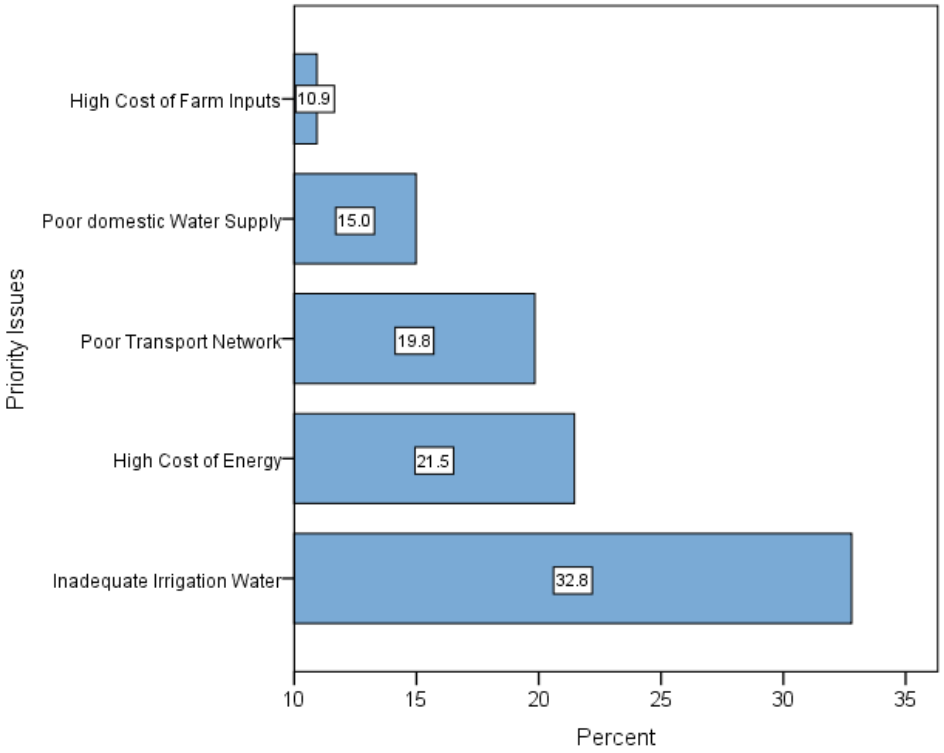


Figure xii). : Priority issues that should be considered in the development plan for Kieni East

Therefore, there is need to develop key infrastructure and utilities, including adequate water supply that will enhance agricultural productivity, socioeconomic development and improved livelihoods in Kieni East. An integrated water resources management approach is also necessary to mitigate the foreseen conflicts and/ or competing interests from utilization of water resources in the region.

X. Environmental and social impacts

The environmental and social impacts are discussed in three phases namely: construction, operational and decommissioning phases. The summary of the positive impacts of the proposed rehabilitation and expansion of irrigation project are as follows:

a) Creation of direct and indirect employment opportunities during the construction and operation phases;
b) Increased agricultural productivity, through the provision of capacity for intensive land use by irrigation;
c) Increase in on-farm revenue;
d) Improved food security;
e) Increased women involvement in irrigation will provide impetus for sustainable development.

XI. Summary of the negative impacts and mitigation measures

Table ii: Summary of the negative impacts and mitigation measures

Potential Impact	Mitigation/ Enhancement Measures
Construction Phase	
Interference with the physical setting	• Adequate survey should be done on the water pipeline route • Anyone, whose property is affected to be compensated for disturbance • Engagement shall be do to assess whether there is grievances.
Noise pollution and vibration	• Noise maintained in accordance to the manufacturer's specification • Operators to put on ear masks to prevent direct noise from the machinery • Machines that are less vibrating to be used • When high vibration needed, to be done during the day
Slope Instability	• Use of manual labour for trenching and backfilling • Avoid utilisation of heavy machinery near steep landscapes • Construction activities to be conducted during dry season
Air Quality Degradation/ Dust Emissions	• Supply and construction vehicles will only use the designated transport routes. The drivers will also be advised to stick to prescribed speed limits • The contractor will ensure proper repair and maintenance of vehicles and equipment to minimize exhaust gases • The contractor shall ensure the appropriate speed limits are observed at along all road sections that will be used by construction vehicles on a needs basis to eliminate the creation of dusts • Construction workers will be provided with dust masks to mitigate
Workers Accidents and Hazards during Construction	• Contractors to adhere to Occupational Health and Safety rules and regulations as stipulated in the Occupational Safety Act of Kenya of 2007 and revised in 2010 • Employers must provide and maintain clothing and appliance that are adequate, effective and suitably protective, including where necessary, suitable gloves, footwear, goggles and head coverings • In case of accidents, injured persons should be given first aid and immediately taken to the hospital • Investigation on the cause of accidents done and adequate conclusion to be arrived at
Extraction and use of Construction Materials	• The construction extraction site should be backfilled to help retain the value of the land resource • Fencing to be done before backfilling to prevent accidents of humans and livestock
Generation of Liquid and Solid Waste	• Provision of solid waste collection facilities (waste bins) • Contracting licensed solid waste handlers • Sensitization of construction workers on proper disposal of solid wastes • The contractor will maintain all site vehicles and equipment is a serviceable state • Temporary latrines will be provided on site to be used by construction workers • Oils and greases emanating from repair and maintenance activities will be collected in containers to avoid entry into local drainage channels • Water from cleaning of equipment will be utilised within the project site and will not be discharged into watercourses.

Potential Impact	Mitigation/ Enhancement Measures
Loss of Flora and Fauna	• The proponent shall ensure that clearing of vegetation clearing is limited to the pipeline trench area (i.e. 0.5 meters width) within the road reserve • Transportation of construction materials to be done through the existing local roads • Avoidance of vegetation clearing along riparian land • Sensitization of construction work-force on environmental conservation and ecological protection • Re-vegetation of completed pipeline route with fibrous rooted indigenous vegetation species
Increased Vehicular and Human Traffic	• Transportation of construction material to specific sites will be done through the existing local roads • The contractor will rehabilitate the local roads that will be damaged during construction activities • Consultation with the local communities on planned road diversions if any • Restriction of Vehicular and Human Traffic to the road reserve where possible • Sensitization of drivers to comply with prescribed speed limits
Occupation Health and Safety	• Continuous supervision of occupational, health and safety management to ensure compliance
	• Occupational Safety and Health Training for contractor's staff
	• Conduct orientation talks and visits
	• Conduct toolbox talks
Operation Phase	
Increase in Waterborne Diseases	• Choice of irrigation system that is efficient in water use • Removal of any stagnant water • Use of nets at homes • Use of gumboots in the irrigation field
Slope-instability	• Repair and maintenance staff shall drain the pipeline sections to be worked on to avoid spillage of water • Pipeline leakages or bursts shall be swiftly attended to
Water use conflicts	• Water abstraction laws followed • Farmers training on water use • Installation of water meters • Enforcement of water Act, 2016 • Establishment of an Irrigation Water User Committee
Pollution of Water	• Machines used during operation maintained in good condition • Oils and greases emanating from repair and maintenance activities will be collected in containers to avoid entry into local drainage channels • All polluted water treated before discharging to water bodies
Soil erosion and Siltation of Surface water resources	• Use excavated earth materials for backfilling • Sprinkling of backfilled trenches with water • Compaction of backfilled trenches • Re-vegetation of excavated areas • Channelling of surface water runoff away from irrigation channels and pipelines
Health and Safety Hazards	• Train all workers on Health, Safety and Environment (HSE) with an aim of improving awareness • The proponent will erect appropriate safety signage during repair and maintenance activities

Potential Impact	Mitigation/ Enhancement Measures
	• The proponent shall provide first-aid facilities for R&M staff • Proponent's staff will be required to use PPEs during R&M work
Decommissioning Phase	
Reduced availability of irrigation water to users	• The proponent shall provide an alternative source of irrigation water to the users of the project
Slope Instability	• Use of manual labour for excavation and backfilling • Avoid utilisation of heavy machinery near steep landscapes • Decommissioning activities to be conducted during dry season
Soil erosion and Siltation of Surface water resources	• Use excavated earth materials for backfilling • Sprinkling of backfilled trenches with water • Compaction of backfilled trenches • Re-vegetation of excavated areas • Channelling of surface water runoff away from the pipeline route
Air Quality Degradation/ Dust Emissions	• Evacuation vehicles will only use the designated transport routes. The drivers will also be advised to stick to prescribed speed limits • The contractor will ensure proper repair and maintenance of vehicles and equipment to minimize exhaust gases • The contractor shall ensure recommended speeds on road sections that will be used by construction vehicles are adhered to on a needs basis to reduce the creation of dusts • Construction workers will be provided with dust masks to mitigate
Interruption of Existing Infrastructure and Socio-Economic Activities	• The proponent will liaise with KURA and KeRRA for authorisation to cut through main roads and feeder roads that fall under their jurisdiction. • The contractor will immediately restore the damaged sections of roads and water supply networks to pre-construction conditions
Impact on Socio-Economic Activities	• Notification to local community members whose farms have encroached on the reserve will be notified of pending decommissioning activities
Loss of Flora and Fauna	• The proponent shall ensure minimal clearing of vegetation • Transportation of decommissioning wastes to be done through the existing local roads • Sensitization of decommissioning work-force on environmental conservation and ecological protection • Re-vegetation of cleared areas with indigenous vegetation species
Increased Vehicular and Human Traffic	• Transportation of decommissioning wastes to specific sites will be done through the existing local roads • The contractor will rehabilitate the local roads that will be damaged during decommissioning activities • Consultation with the local communities on planned road diversions • Restriction of Vehicular and Human Traffic to the road reserve where possible • Sensitization of drivers to comply with prescribed speed limits
Generation of solid and liquid waste	• Provision of solid waste collection facilities (waste bins) • Contracting licensed solid waste handlers • Sensitization of construction workers on proper disposal of solid wastes • The contractor will maintain all site vehicles and equipment to a serviceable state. • Oils and greases emanating from repair and maintenance activities

Potential Impact	Mitigation/ Enhancement Measures
	will be collected in containers to avoid entry into local drainage channels • Water from cleaning of equipment will be utilised within the project site and will not be discharged into water courses.
Health and Safety	Continuous supervision of occupational, health and safety management to ensure compliance
	• Occupational Safety and Health Training for contractor's staff
	• Orientation talks and visits
	• Toolbox talks

XII. Conclusion

Based on the findings, it is evident that rehabilitation, construction and operation of the proposed irrigation project will result in overall economic growth and development as a result of improvement in the availability of water for agricultural use within the project area. As it is indicated in chapter 9, the potential negative impacts can be easily mitigated without any major effect to the environment. However, some important resources may be affected negatively such as flora, fauna and water resources within the project area. These impacts vary from temporary to short term impacts. These impacts can however be mitigated as indicated in the Environmental and Social Management Plan (ESMP) discussed in chapter 10 of this report.

1 INTRODUCTION

1.1 Preface

The Ministry of Agriculture, Livestock, Fisheries and Irrigation, State Department for Crop Development, engaged the services of the consultant to carry out an Environmental and Social Impact Assessment (ESIA) for Ndiriti Aguthi Irrigation Scheme.

1.2 Project Description

Ndiriti Aguthi irrigation scheme is situated in Kieni East division, Nyeri County. The scheme will abstract water from river Naromoru and Kabunda dam have a command area of 225Ha with 1000 beneficiaries. The crops grown are mainly vegetables (kales, tomatoes, onions, carrots cabbage) and beans. The proposed areas of intervention include detailed feasibility study of irrigation infrastructure that include command area layout, abstraction infrastructure, water conveyance and supply pipeline networks. The Ndiriti Aguthi irrigation scheme has its catchment within the Naromoru/ Kiamathaga Ward which has an estimated population of 33,476 persons from 9976 households. The ward covers an area of 243 square kilometers. On itself, the Ndiriti Irrigation scheme is found within Ndiriti Location which has a population of 3833 persons from an estimated 1094 households. The Ndiriti Location covers an area of 16.8 square kilometers.

1.3 Objectives of the Environmental and Social Impact Assessment (ESIA)

The objective of the study was to carry out an Environmental and Social Impact Assessment (ESIA) of the project areas in accordance with the Environmental Impact and Audit Regulations 2003 and the international guidelines for ESIA and submit report to NEMA for approval. On the social impact assessment, it includes; carrying out a socio-economic and environmental status analysis through a baseline survey and preparation of an Environmental and Social Management Plan (ESMP).

1.4 Scope of work

The Environmental and Social Impact Assessment study included:

(a) Analysis of the socio-economic and socio-environmental status of the areas during pre and post construction- and thus justify development of the affected irrigation project.

(b) Assessment of the Community's capacity to implement the proposed mitigation measures, and make appropriate recommendations, including potential capacity building and training needs and their costs.

(c) Preparation of an Environmental and Social Management Plan (ESMP) based on the Environmental baseline survey. The ESMP outlines:

i) Institutional arrangements, training requirement and responsibilities for monitoring implementation of the mitigation measures and monitoring indicators;

ii) Proposed work program, budget estimates, schedules, staffing and other necessary support services to implement the mitigation measures;

iii) Assessing compensation to affected parties for impacts that cannot be mitigated;

iv) Preparation of emergency response measures to accidents as appropriate e.g., flood damages etc.

v) The proposed concerned parties should agree on the time horizons and mitigation measures for implementing the recommendations in the ESMP.

vi) Potential environmental and social impacts resulting from the activity;

vii) Proposed mitigation measures.

(d) Evaluation of the Social Impact and how the Communities in the area will benefit or lose upon implementation of the project.

(e) Based on the information collected from the Social Economic Baseline Survey, in the report the consultant has shown how the identified adverse effects will be mitigated.

(f) The consultant also consulted key stakeholders through interviews, focus group discussions, and public barazas. Records of public consultations are provided in the appendices.

The consultant also evaluated the social impact and showed how the communities in the area will benefit or lose upon implementation of the project. Based on the information collected from the socio-economic baseline survey, the consultant proposed mitigation measures.

The consultant consulted with stakeholders and the public on the environmental and social aspects of the proposed project. The consultant recorded all public consultations and the issues raised e.g. views of affected stakeholders; date and location of consultation meetings; a list of attendees, their affiliation, contact addresses and a summary.

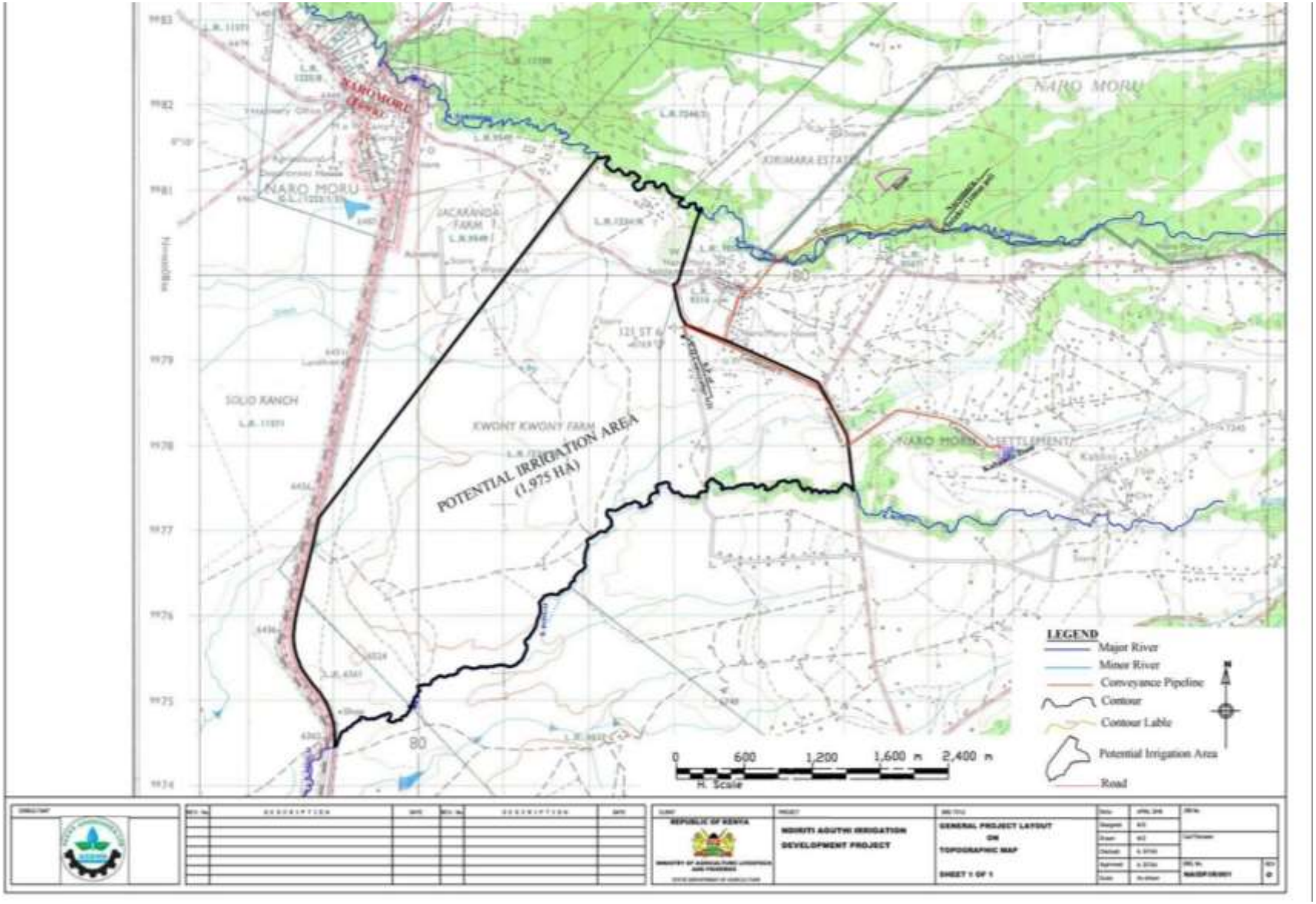


Figure 1.1: General Project Layout map on topographic Map

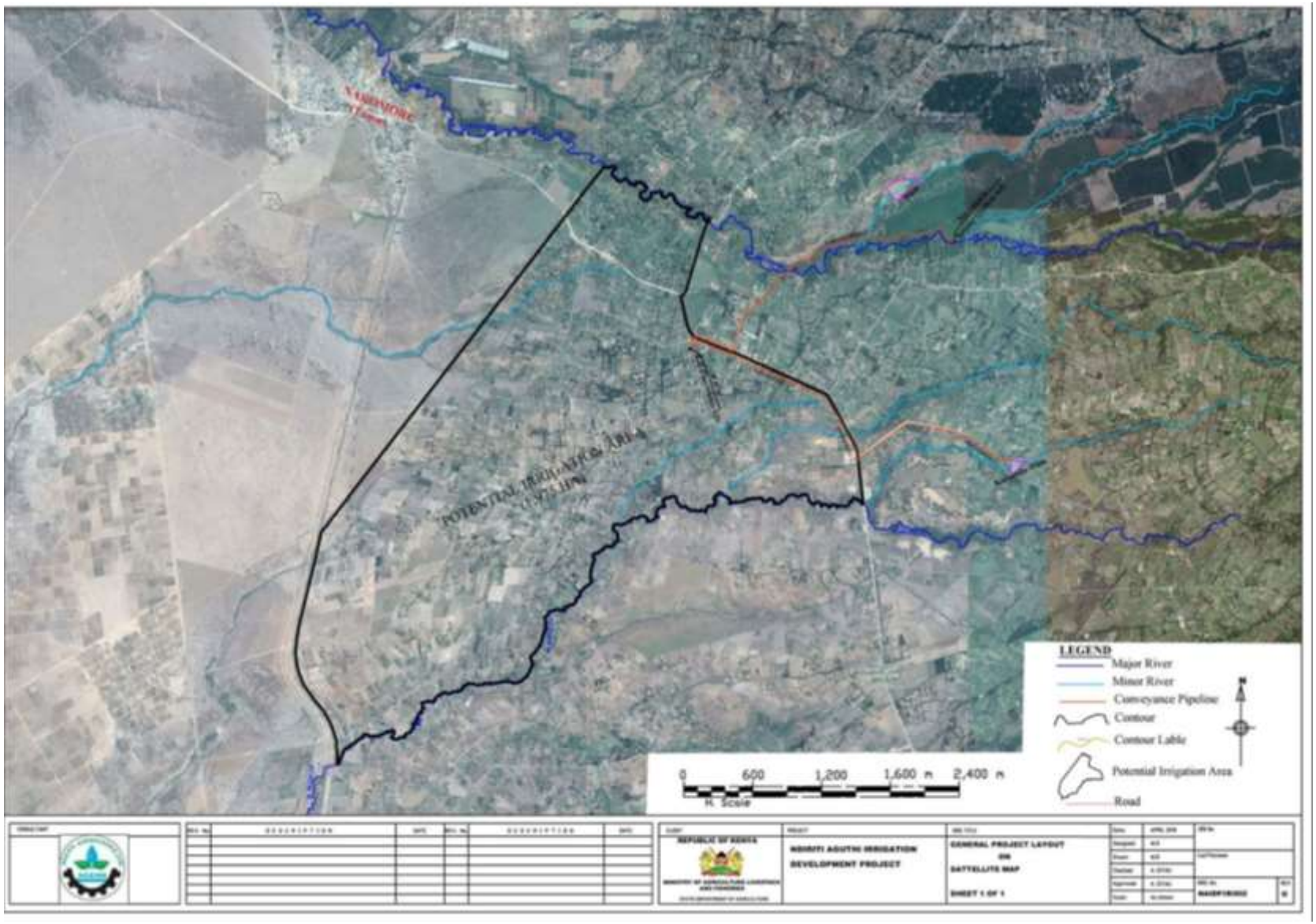


Figure 1.2: General Project Layout map on Satellite Map

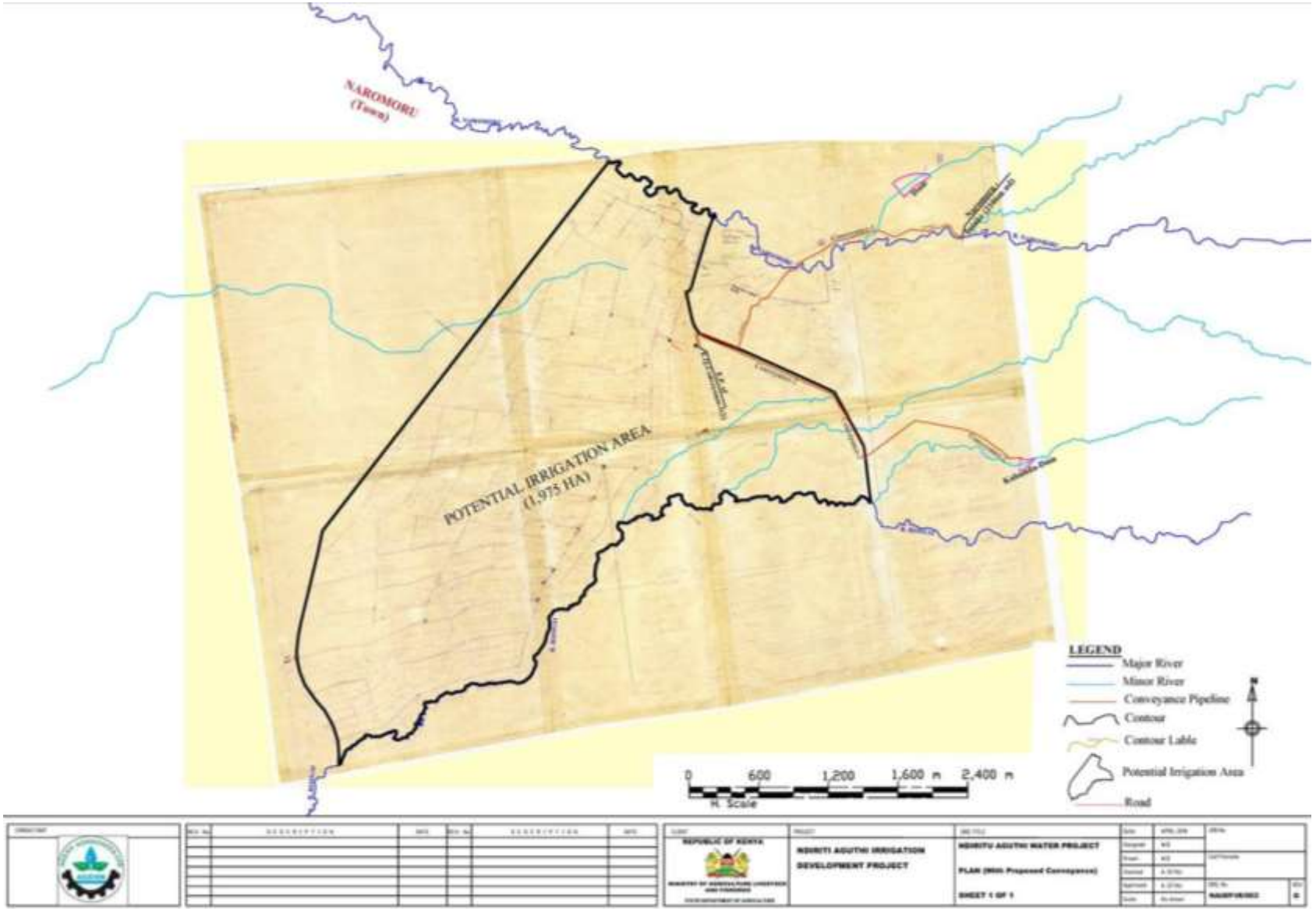


Figure 1.3: Ndiriti Aguthi Master Plan Project Layout Map

1.5 Methodology of ESIA Study

1.5.1 The Approach of ESIA Study

This EIA study was based on the available baseline information and reports on the irrigation project. An irrigation scheme exists and the aim was to rehabilitate and upscale it. Among the sectoral issues addressed by the study were: irrigation systems design, technologies and water management; socio-economic, gender and socio-cultural issues; environmental conservation, bio-diversity, wildlife and resource use and occupational health and safety. The latter aspect was considered as cross cutting and therefore was captured in pertinent sectoral issues. This ESIA Study Report was prepared in accordance with "*The Environmental (Impact Assessment and Audit) Regulations, 2003*" for submission to the National Environmental Management Authority (NEMA).

Preparatory meetings were held with key stakeholders at various stages of the assignment. The ESIA Consultancy Team was expected to review existing related legislation and regulations in Kenya and all documents on the proposed Irrigation Project. Review of literature was to compliment field survey data. During the site visits, comprehensive field survey data on the Irrigation Project and its environs was collected. The field survey was based on pre-determined parameters and acceptable methodologies used in environmental and social impact assessment. Field surveys methods included observations, focus group discussions and interviews with key informants, assessment of extent of environmental degradation and conservation in Kieni Sub County. The data collected was processed to establish the existing and expected environmental impacts.

The socio-economic, gender and socio-cultural component of this study was designed to assess the impact of the proposed Irrigation Project on the socio-economic, gender and cultural environment of the people who will be affected by the project. The assessment involved an investigation of the current living conditions in sampled households in order to determine the nature and extent of poverty.

The overall objective of the assessment was to get the views of local community members on the positive and negative impacts of the project as well as giving them a chance to suggest possible mitigation measures. The key issues addressed in the assessment include; changing social networks, economic opportunities, cultural beliefs and practices, irrigation infrastructural development, emerging scenarios with project and community consultation and participation.

Socio-economic, gender and socio-cultural impacts on the people who will be affected by the proposed Irrigation Project were assessed through carrying out key informant interviews, focus group discussions, direct observation and public meetings with the local community.

The consultant was accompanied for the interviews by the representative of the Department of Agriculture who introduced them to the project members.

1.5.2 Mobilization and Planning

At the commencement of the study, the consultants met with personnel from the State Department for Crop Development, to discuss and agree on the scope of work, confirm the consultancy team understanding of the TOR and agree on the proposed methodology. During this meeting, the consultancy team were briefed by the client on their policy and philosophical viewpoint of the project as a whole. The consultancy team presented their detailed program of work in order to agree on specific timing for various inputs, progress meetings and reporting dates. The consultancy team also discussed and finalized the modalities of the logistics and staff who the client provided to the team during the assignment period.

1.5.3 Desk Review of Documents

The consultancy team reviewed all the relevant available documents on project activities and components from the client. The team also reviewed all the available and relevant internal environmental guidelines put in place by the proposed project and recognized guidelines and standards on ESIA.

1.5.4 Field Data Collection

The consultancy team conducted field visits to the proposed project site and consulted the stakeholders to obtain further information. The team established the nature of the surroundings including: existing infrastructure, economic and social set up of the local communities whose normal daily activities will be and/or likely to be affected by the implementation of the proposed irrigation project.

During the field study, the consultancy team collected existing information and administered interviews with a view to predicting the potential environmental impacts on the day to day activities of the community due to the implementation of the proposed irrigation project.

1.5.5 Project Data Synthesis

The consultancy team thereafter interpreted and used the data collected to prepare a comprehensive environmental and social management plan (ESMP) encompassing the potential negative environmental impacts, mitigation measures and monitoring indicators. The ESMP is incorporated in the ESIA report.

1.5.6 Public Consultation

The consultancy team organized and convened public consultation meetings for all stakeholders. The team used the local administration leaders and scheme leadership to convey the consultation theme and appropriate public consultation venues. During these forums, the consultancy team in close consultation with the client shared the project information in terms of its implementation and predicted impacts.

2 PROJECT DESCRIPTION

2.1 Project Location, Area and Beneficiaries

The proposed Irrigation Project area is located 4km downstream of the Kabunda Dam Site and is bounded by coordinates Latt -0.170372°,37.043135°; Long -0.223659°,36.999826°; Latt -0.235268° Long 37.029851° and Latt -0.182167° Long 37.071022°. The area is accessible from Naromoru Town located along the Nairobi-Nyeri Road and all-weather road to Mount Kenya National Park-Naromoru Gate as shown in Fig.7.1 below. Administratively the irrigation area is located in Ndiriti Location, Naromoru/ Kiamathaga Ward in Nyeri County.

2.2 Administration

The sub-location is administered by the Assistant Chief whose office is in Naromoru town. The Naromoru Location Chief is also in Naromoru town.

Plate 2-1: The scheme offices in two locations

2.3 Population

Table 2.1 shows the area, population and number of households in Kieni Sub County, Naromoru/Kiamathaga Ward and Ndiriti location.

Table 2.1:Area and Population of the Project Area

Parameters	Kieni Sub County	Naromoru / Kiamathaga Ward	Ndiriti Location
Area in Km²	817.1	243.3	16.8
Population	96,500	33476	3833
Households	29012	9976	1094

(***Source***: *Kenya National Bureau of Statistics 2009 Census Study)*

2.4 Social-Economic Activities

The main economic activity in Kieni east is mixed farming where approximately 85.5% of farmers grow maize, beans or potatoes as single or mixed crop The farmers have experienced a number of challenges in crop farming, predominantly crop pests and diseases (63%) and extreme weather conditions of floods and drought (16%). Livestock farmers have faced high costs of veterinary and other extension services (46%) and animal feeds (39%)

2.5 Transport and Communication

Access to the area is through the Naromoru - Munyu road sections that have been tarmacked. The feeder roads connecting the interior of the region are mainly earth roads, though motorable. During the rainy season the roads are almost impassable.

2.6 Irrigation System Layout and Development Options

2.6.1 Introduction

The proposed irrigation system is composed of the following main infrastructure components:

a) *Head-works/Water source:* The existing Kabunda Dam and Ndiriti Aguthi fixed weir Intake on Naromoru River.
b) *Inland Reservoirs/Water Pan:* This will provide temporary storage for irrigation water during low flows at the existing water sources especially during the dry seasons.
c) *Conveyance Pipeline:* This will convey water from the dam sites to the head of the irrigation scheme area located downstream of the existing water sources.
d) *Main Pipelines:* These will convey water to major irrigation areas as delineated and shown in the plan.
e) *Distribution system:* These will convey water from the main pipelines to the small irrigation units/blocks (Tertiary Pipelines) from which the Feeder Pipelines will supply irrigation water to the plots/to the sprinklers for irrigation.
f) *Infield System:* This consists of the hydrants and sprinklers which conveys water to the crops directly from the distribution system

2.6.2 Delineation of the Irrigation Areas

The general layouts for the potential irrigation areas have been prepared taking into consideration the following factors:

a) Available water for irrigation development
b) Minimum Potential head to operate the selected sprinklers (15m) at the head of scheme from the existing intake sites.
c) Topography – blocking of areas with similar topographical features such as same ridge and slope class.
d) Existing drainage system (natural waterways/depressions) – used to form boundary between tertiary blocks.
e) Soil types – stony / rocky areas left out;
f) Minimum interference on the Existing infrastructure in the project area e.g Schools, market centres, settlement, and cattle holding grounds, roads, power lines etc;
g) Existing farm/plot boundaries and access roads in the project area.
h) Existing layout for water supply of the project area.

Based on the above considerations, and using the topographical maps from the Survey of Kenya, Contour

maps from the topographic surveys of the project area, high resolution satellite image, detailed layout has been prepared and presented in the sections here-in.

2.6.3 Irrigation Development Options

Three irrigation development options have been proposed for consideration, taking into consideration the following factors among others;

a) Water source location with respect to the irrigation area
b) Quality and Quantity of the water sources to meet the irrigation water demand
c) Cropping pattern and calendar (seasons)
d) Hydrological data for the project area
e) Views/Local knowledge of the existing water users in the project area

The main water source for irrigation is from the existing Kabunda Dam with current capacity of 244,675m3. With dam improvement works on the embankment as illustrated in the above chapters, the new storage will be 294,675m^3 while available storage is 270,000m^3 by allowing 10% for dead storage. The project water requirement for 225 Ha required in the ToR is 1.42mmc. This implies that water from the dam improvement works can irrigate 32.4% of the targeted area i.e. 181 acres (73ha) and for only one season annually. This has been considered as Irrigation Development Option No.1. Table 2-2 shows the Monthly Water requirements for this development Option.

Table 2-2 Monthly Water Requirements for Development Option-1

Month	Option-1 Dam
Jan	67,511
Feb	60,977
Mar	67,511
Apr	0
May	0
Jun	0
Jul	67,511
Aug	67,511
Sep	65,333
Oct	67,511
Nov	0
Dec	0

NB: Only Season two will be irrigated by water from the Dam for the months of July to October

In order to irrigate 225Ha for two seasons, Irrigation Development Option-2 has been formulated and it has been proposed to utilize the flood flows of the Naromoru River for irrigation development by method of abstraction from the existing Aguthi Fixed weir intake located 6km above the head of the scheme. The excess flood flows will be conveyed and stored in a water pan/on-farm reservoir for use during the dry seasons. Table 2-3 shows the monthly irrigation water demand compared to the river flood flows.

Table 2-3 Water Balance for irrigating 225 ha (Irrigation Development Option-2)

Month	Available Flood Flows at Aguthi Intake				Irrigation water demand, m^3	Monthly Deficit/Surplus (M^3)
	m^3/day	m^3/s	Lit/s	Monthly (m^3)		
Jan	3,882	0.044931	44.93056	120,342	207287.5	-86,945
Feb	1,910	0.022106	22.10648	53,480	187227.4	-133,747
Mar	4,980	0.057639	57.63889	154,380	207287.5	-52,907
Apr	15,700	0.181713	181.71300	471,000	0.0	471,000
May	11,197	0.129595	129.59490	347,107	0.0	347,107
Jun	4,212	0.048750	48.75000	126,360	0.0	126,360
Jul	2,415	0.027951	27.95139	74,865	207287.5	-132,422
Aug	4,815	0.055729	55.72917	149,265	207287.5	-58,022
Sep	8,640	0.100000	100.00000	259,200	200600.8	58,599
Oct	9,827	0.113738	113.73840	304,637	207287.5	97,350
Nov	12,636	0.146250	146.25000	379,080	0.0	379,080
Dec	12,120	0.140278	140.27780	375,720	0.0	375,720

From Table 2-3, it is evident that there is insufficient flood water to irrigate the proposed 225 ha for the months of January, February March and July and August spreading across the two seasons. Table 2-4 summarizes the volume of water-deficit per season.

Table 2-4 Seasonal Water Deficit for irrigating 225Ha

Season	Deficit (m^3)
Season-1 (Jan, Feb Mar)	273,599
Season-2 (Jul, Aug)	190,444

From Table 2-4 above, Onfarm storage/Water pan of 275,000m^3 was proposed as shown in the drawings.

Maximum daily flow rate for this option is = 0.391*3600*5 = 7,038m^3/day

Irrigation development Option No.3 will consist of irrigation of the infrastructure in Development Option No.1 and an additional abstraction of flood waters from the Existing Aguthi Intake to irrigate the lower part of the scheme comprising of 67.6%. On-Farm reservoir has been proposed and storage capacity determined as shown in Table 2-5.

Table 2-5 Water Balance for Irrigation Development Option No.3

Month	AIW (Q50-Q80), (m^3)	Option-1 WRQ (m^3)	225ha-ToR (m^3)	Option-3 Lower Part (m^3)	Deficit-Option-3 Lower Part, (m^3)
Jan	120,342	0	207,287	0	0
Feb	53,480	0	187,227	0	0
Mar	154,380	0	207,287	0	0
Apr	471,000	0	0	0	0
May	347,107	0	0	0	0
Jun	126,360	0	0	0	0
Jul	74,865	67,511	207,287	139,776	-64,911
Aug	149,265	67,511	207,287	139,776	9,489
Sep	259,200	65,333	200,601	135,268	123,932
Oct	304,637	67,511	207,287	139,776	164,861
Nov	379,080	0	0	0	0
Dec	375,720	0	0	0	0

From Table 2-5, monthly water deficit of 64,911m^3 occurs in the month of July. On-farm storage has been proposed with a max capacity of 68,000m^3.

Table 2-6: Water Balance for Irrigation Development Option No.4

Month	AIW (Q50-Q80), (m^3)	Option-1 WRQ (m^3)	225ha-ToR (m^3)	Option-4 Lower Part (m^3)	Deficit-Option-4 Lower Part, (m^3)
Jan	120,342	67,511	207,287	139,776	-19,434
Feb	53,480	67,511	187,227	119,716	-66,236
Mar	154,380	65,333	207,287	141,954	12,426
Apr	471,000	0	0	0	0
May	347,107	0	0	0	0
Jun	126,360	0	0	0	0
Jul	74,865	67,511	207,287	139,776	-64,911
Aug	149,265	67,511	207,287	139,776	9,489
Sep	259,200	65,333	200,601	135,268	123,932
Oct	304,637	67,511	207,287	139,776	164,861
Nov	379,080	0	0	0	0
Dec	375,720	0	0	0	0

From Table 2-6, In-field storage/Water ponds of 90,000m^3 capacity is proposed in individual farms.

2.7 Irrigation Method

2.7.1 Recommended Irrigation Methods

Based on the availability of potential head, soil conditions and the ease of operation for the proposed system, sprinkler and drip Irrigation systems are feasible. Due to the high technical know-how in operation and maintenance of the drip system, it is recommended that the Sprinkler system be considered at the first

implementation of the project and after the farmers have obtained adequate training and knowledge on irrigation, the drip system can be introduced to replace the sprinkler system and subsequently will result in increased irrigation area and efficient use of irrigation water

Table 2-7: Irrigation Method Selection Criteria

	Decision Criteria	Irrigation Method Suitability Criteria		
		Surface Irrigation	Sprinkler Irrigation	Drip Irrigation
1	Natural Conditions			
	Slope (%)	0 – 2 %	0 – 8 %	0 – 16 %
	Soil type	Clay loam	Most soil types	
	Soil infiltration rate	medium to low(<30 mm/hour)	Higher infiltration rate (Higher than water application rate)	
	Climate	-	Low wind speed(< 5m/s)	-
	Water quality	Free from sediments and dissolved salts		
	Water availability and supply method	Sufficient supply at low head (Gravity open)	Sufficient supply at a higher head (15-50 m) (piped)	Scarce supply (piped)
2	Social Aspects			
	Experience required	Limited experience	Moderate experienced	Experienced
	Labour requirements	High – (O&M, land levelling)	Moderate (sprinkler moving)	Low (filters replacement)
3	Type of Crops	All crops	Crops with no effect of wetting foliage leaves	High Value crops and crops with wide spacing
4	Level of technology	Less sophisticated	Moderate sophistication (O&M)	Highly sophisticated (O&M)
5	Cost and benefits in water use efficiency	Low investment cost per Ha but limited in water use efficiency (50%)	Relatively high investment cost per Ha but more benefits in water use efficiency (70%)	Highest investment cost per Ha but most benefits in water use efficiency (90%)

From Table 2-7 above, the suitable irrigation method for the project area is mainly the sprinkler system. Surface system has not been considered as suitable due to the undulating terrain and limited water availability. Drip system has also not been recommended as a result of high operation and maintenance costs as well as high technical know-how which is not with the intended beneficiaries.

The irrigation water requirements have been determined for the sprinkler irrigation system.

2.7.2 Proposed Cropping Pattern & Calendar

The cropping pattern for the proposed crops is as shown in Table 2.8.The annual cropped areas will gradually increase from the current 100% until a cropping intensity of 200% is achieved in the third year. Cropping intensities in the first year are estimated at 140%, 170% in the second year and 200% from the third year

Table 2.8: Proposed cropping pattern and Calendar

	Area (%)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Season 1													
Snow Peas	40												
Carrots	55												
Capsicum	5												
Total	100												
Season 2													
Irish Potatoes	50												
Cabbage	30												
Cauliflower	10												
Brocolli	10												
Total	100												
Total Monthly Crop Areas, %	**100**	**100**	**100**	**10**	**30**	**0**	**100**	**100**	**100**	**100**	**5**	**100**	**100**

From Table 2.8 above the maximum irrigation area for season 1 occurs in the months of July to October and December to April in Season 2.

2.8 Irrigation Requirement

2.8.1 Net Irrigation Requirement

The Net Irrigation Requirement (NIR) has been determined as follows

NIR = ET crop - P e- Ge – Wb (mm/day)
Where, Pe - Effective rainfall (mm)
Ge - Ground water contribution (mm)
Wb - Stored water contribution (mm)

Since, Ge and Wb are assumed to be negligible,

Therefore,

NIR = ETcrop - Pe

NIR at various months were calculated and presented in Table 7-10 below.

Irrigation Efficiencies

The project irrigation efficiency (Ep) has been estimated using the following criteria:-

Ep = Ec x Ea x Ed

Where;
Ec is conveyance efficiency, 95% for piped system

Ea is application efficiency, assumed 80% for sprinkler irrigation, 90% for drip system and 50% for surface system

Ed Distribution efficiency, assumed 95% for piped system

The overall irrigation efficiency is therefore:

Sprinkler: 0.95 x 0.95 x 0.83 =0.75 (75%);

Drip: 0.95 x 0.95 x 0.89 =0.82(82%);

Surface: 0.95 x0.95 x0.5=0.45(45%);

Since the proposed system for the irrigation method for the project area is by Sprinkler method, the overall efficiency of 75% has been adopted as shown in table 2.9 below.

Table 2.9: Climatic Data for project area

Irrigation Efficiencies	
Conveyance	95%
Distribution	95%
Application	83%
Overall	75%

2.8.2 Gross Irrigation Requirement

The Gross Irrigation Requirement is determined by,

GIR = NIR /Ep

Where;

GIR: Gross Irrigation Requirement

NIR: Net Irrigation Requirement

Ep: Overall Irrigation efficiency

GIR for different months are therefore then calculated as shown in Table 8-12 below.

NB: Minimum net irrigation area of 225ha has been considered for the calculation of irrigation water requirements.

Readily Available Soil Moisture, (RAM)

Available soil moisture content in the root zone is the total amount of water that the crop can use for plant growth and is the difference between the water content at field capacity and the water content at permanent wilting point. It is also a factor of the plant root zone depth and is expressed as:

RAM = (Fc – Wp) x Zr x p

Where;

Fc = water content at field capacity;

Wp = water content at permanent wilting point

Zr = rooting depth

P =average fraction that can be depleted by the crop and varies from crop to crop

According to the information obtained from the review of various reports coupled with reconnaissance field visits in the proposed irrigation area, the soils are predominantly Clay Loam soils. From the soils investigations, the minimum readily available soil moisture (RAM) is 35mm/m depth of soil. (Soil Study Report, 2018).The selected crops have rooting depths ranging from 300mm to 1000mm. For purpose of irrigation scheduling, shallow rooting depth is normally used.

Total Readily Available Moisture, (TRAM)

The total readily available moisture, TRAM = Average Rooting Depth x RAM x P

The fraction p varies from one crop to another, ranging from 0.3 to 0.7 depending on the ETc rates. For most crops 0.5 is commonly used. (FAO 1998). Therefore 0.5 was adapted for purpose of water requirements estimation

Therefore,

TRAM = RAM * DRZ * P

For shallow rooted Crops, TRAM = 35 x 0.3 x 0.5

= 5.2 mm.

For deep rooted crop, TRAM = 35 x 1.0 x 0.5

= 17.5 mm

Thus

TRAM Lies between 5.2mm to 17.5mm

Maximum Irrigation Interval, IImax

II Max is determined using the equation below,

$$II_{max} = \frac{TRAM}{ETcrop}$$

Where **ETcrop = ETo * Kc**

The table 2.10 below shows the resultant ETcrop based on the cropping pattern.

Table 2.10: Monthly Crop Water Need

No.	Design Parameters	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	ETo (mm/day)	3.07	3.33	3.13	2.72	2.52	2.51	2.41	2.37	2.73	2.68	2.42	2.55
2	Days in month	31	28	31	30	31	30	31	31	30	31	30	31
4	Kc per month, Snowpeas							0.44	0.62	0.70	0.99		
5	Kc per month, Carrots							0.89	0.54	0.89	0.38		
6	Kc per month, Capsicum							0.61	0.43	0.42	0.99	0.54	
7	Kc per month, Irish potatoes	0.48	0.43	0.68	0.23								0.59
8	Kc per month, Cabbages	0.37	0.27	0.30	0.34	0.89							0.54
9	Kc per month, Cauliflower	0.40	0.33	0.36	1.00								0.62
10	Kc per month, Broccoli	0.41	0.35	0.38	1.00								0.62
11	Max Crop water need (ETo*Kc) mm/day	1.46	1.43	2.12	2.72	2.23	0.00	2.15	1.47	2.41	2.66	1.31	1.58

From the table above, the maximum ETcrop occurs in April where Maximum ETo = 2.72mm/day and Max Kc = 1 and is used for the proposed crops.

Therefore, ETcrop=2.72*1 = 2.72

From the TRAM calculated above, for shallow rooted crops;
IImax = TRAM / ETcrop = 5.2/2.72 = 2 Days
And for deep rooted crops,

IImax = TRAM / ETcrop = 17.5/2.72 = 6.4 Days

For shallow and deep-rooted crops, the field capacity can be filled within 2 and 6.4days respectively. The adopted irrigation interval is 4 days and has been used in the determination crop/project water requirements.

3 POLICY, LEGAL AND INSTITUTIONAL FRAMEWORK

3.1 Policy Framework

The Kenya Government's environmental policy seeks to achieve sound environmental management through sustainable development that ensures that the needs of the future generations are not compromised as a result of current use. This subsection details the various policy provisions pertinent to environmental management:

3.1.1 Constitution of Kenya, 2010

The constitution of Kenya spells out the fundamental rights of every Kenyan citizen. Article 42 of the bill of rights of the Constitution provides that 'every Kenyan has the right to a clean and healthy environment, which includes the right to have the environment protected for the benefit of present and future generations through legislative and other measures' The Constitution goes further ahead and stipulates under article 69 of part II, chapter 5 (environmental and Natural Resources) that the State shall;

a) Ensure sustainable exploitation, utilization, management and conservation of the environment and natural resources and ensure the equitable sharing of the accruing benefits;
b) Work to achieve and maintain a tree cover of at least ten per cent of the land area of Kenya;
c) Protect and enhance intellectual property in, and indigenous knowledge of, biodiversity and the genetic resources of the communities;
d) Encourage public participation in the management, protection and conservation of the environment; protect genetic resources and biological diversity;
e) Establish systems of environmental impact assessment, environmental audit and monitoring of the environment;
f) Eliminate processes and activities that are likely to endanger the environment; and Moreover, every person has been mandated to cooperate with the State organs and other persons to protect and conserve the environment and ensure ecologically sustainable development and use of natural resources.

In addition to the environmental and natural resources provision, part 1 of the same chapter emphasizes the following;

- Land use and management shall by law, benefit local communities;
- Community land is protected from encroachment by State;
- Law shall protect Rivers, forests and water bodies;
- Equitable access to land;
- All lawful land rights are secured; only someone who has stolen land needs to worry;
- County governments will manage land in trust of the people in accordance with the constitution.

In addition to these provisions, article 70 provides that if a person alleges that their right to a clean and healthy environment recognized and protected under article 42, is being or is likely to be, denied, violated, infringed or threatened, the person may apply to a court for redress.

The Constitution of Kenya stipulates for sustainable and sound management of the environment in relation to development projects. Article 69, the project proponent is mandated to cooperate with State organs and other persons to protect and conserve the environment. Ministry of Agriculture, Livestock, Fisheries and Irrigation, State Department for Crop Development, through Small-scale Irrigation and Value Addition Project (SIVAP) should therefore ensure compliance with the constitution in so far as ensuring sustainable development. Moreover, the project should aim at ensuring sustainability of the livelihoods and biological resources within the project area while taking cognizance to the powers given under the constitution to communities and individuals to enforce their rights through legal redress.

3.1.2 Kenya Vision 2030

The Kenya Vision 2030 provides the National development blueprint for the period 2008 to 2030 emanating from the Economic Recovery Strategy for Wealth and Employment Creation. Following the post-election violence in 2007/2008, the GDP growth rate that had rose to 7% in 2007 dipped to 1.7% in 2008. The Visions objective is to transform the Country into a middle-income economy with a consistent annual growth of 10% by year 2030.

The Vision outlines the 2030 goal for urban areas as to achieve a "well housed population living in an environmentally-secure urban development" The vision envisages to achieve this by bringing basic infrastructure and services including roads, street lights, water and sanitation facilities, storm water drains, footpaths and others to the people. In achieving these, the vision emphasizes on the need to promoting environmental conservation to better support the economic pillar.

The proposed project intends to improve water supply and service delivery in Ndiriti Aguthi (Nyeri County) through the designs and rehabilitation of the irrigation scheme. This initiative is part of the process in achieving the goals of Vision 2030 for residents within these locations. The proponent should also endeavor to protect the environment in supporting the economic pillar of the vision.

3.1.3 National Environment Policy, 2013

This Policy sets out important provisions relating to the management of ecosystems and the sustainable use of natural resources. The policy further acknowledges that natural resources are under immense pressure from human activities particularly for critical ecosystems including forest, grasslands and arid and semi-arid lands.

The policy seeks to develop an integrated approach to environmental management, strengthening the legal and institutional framework for effective coordination, promoting environmental management tools.

This ESIA study will develop an environmental and social management and monitoring plan to mitigate the impacts that may result during the construction and operation phases of the project. This tool is aimed at promoting coordination of environmental management of the project such that sensitive ecosystems are not destabilized by the subsequent project activities

3.1.4 National Policy on Water Resources Management and Development (1999)

The Sessional Paper No. 1 of 1999 was established with the objective of preserving, conserving and protecting available water resources and to ensure that water is allocated in a sustainable, rational and economic way. The policy further desires to provide water of good quality and in sufficient quantities that meets the various water needs while ensuring safe disposal of waste water and environmental protection. To achieve these goals, water provision through increased household connections and developing other resources and improved sanitation is required.

While the National Policy on Water Resources Management and Development (1999) enhances a systematic development of water facilities in all sectors of socio-economic progress, it recognizes the by-products of this process as waste water. The proposed project is towards providing sufficient and good quality water supply to the residents of Ndiriti Aguthi (Nyeri County). As an ongoing process, it is important for the proponent to put in place strategies and plans for waste water management having in mind that the project area lacks a sewerage system

3.1.5 National Environment Action Plan (NEAP) 1994 (revised 2007)

This plan indicates that the Government recognized the negative impacts on ecosystems that come about as a result of economic and social development programmes that disregard environmental sustainability. In addressing this, establishment of appropriate policies and legal guidelines as well as harmonization of the existing ones have been accomplished or are in the process of development.

The ESIA process came about as part of the NEAP process and among the important participants identified were the then *District Development Committees*. This implies that a multi-sectoral approach is desired in identifying and solving environmental problems. The proponent should therefore strive to engage partners and stakeholders in identifying and solving environmental issues.

3.1.6 The National Land Policy, 2009

In chapter 4 of the land policy under Environmental Management Principles, the policy provides actions for addressing the environmental problems such as the degradation of natural resources, soil erosion and pollution. The policy also recommends for appropriate waste management systems and procedures, including waste and waste water treatment, reuse and recycling.

The policy goes further to advocate for environmental assessment and audit as a land management tool to ensure environmental impact assessments and audits are carried out on all land developments that may degrade the environment and take appropriate actions to correct the situation. Public participation has been indicated as key in the monitoring and protection of the environment.

Chapter 4 further advocates for the implementation of the 'polluter pays principle' which ensures that polluters meet the cost of cleaning up the pollution they cause, and encourage industries to use cleaner production technologies.

During water abstraction for the scheme, the project shall pass through the existing public road reserves and private land and as such, the proponent is required to ensure environmental protection of the subject land. Moreover, this study is what is advocated for in the policy on top of the public consultations conducted.

3.1.7 Gender Policy, 2011

This Policy Framework aims at mainstreaming gender concerns in the National development process in order to improve the social, legal/civic, economic and cultural conditions of women, men, girls and boys in Kenya. The policy provides direction for setting priorities to ensure that all ministerial strategies and their performance frameworks integrate gender equality objectives and indicators and identify actions for tackling inequality. In addition, each program will develop integrated gender equality strategies at the initiative level in priority areas. Within selected interventions, the policy will also scale-up specific initiatives to advance gender equality.

This policy will be referred to during project implementation especially during hiring of staff to be involved in the implementation of the project. Moreover, the project will be of benefit to women and girls by providing opportunities to reduce poverty and food insecurity among the rural poor households by improving the performance of irrigation and marketing infrastructure, as well as enhanced methods of post-harvest management of the produce.

3.2 Legal Framework

Applications of National statutes and regulations on environmental conservation suggest that the proposed project management institutions will have a legal and social responsibilities to ensure the proposed development is carried out without compromising the status of the natural resources, health and safety in the area. The key National laws that have a direct relevance to the proposed project are briefly discussed here in.

3.2.1 Environmental Management and Coordination Act, 1999 (Amended 2015)

The Environmental Management and Coordination Act (EMCA), 1999 coupled with the Environmental Management and Coordination (Amendment) Act, 2015 provide legal and institutional framework for environment management in Kenya. EMCA as such supersedes all environmental regulations that may be contrary to the provisions therein owing to its comprehensive coverage of environment management and judicial enforcement Part II of the Act confers to every person the right to clean and healthy environment and to its judicial enforcement. Every citizen is also charged with the duty to safeguard and enhance the environment. In achieving this provision, part VI of the Act directs that any new programme, activity or operation should undergo environmental impact assessment and a report prepared for submission to the National Environment Management Authority (NEMA), who in turn may issue a license as appropriate. As per Environmental Management and Coordination Act, 1999, Legal Notice 150 (2016) - Replacement of the Second Schedule - Water resources infrastructure is listed as one of the activities that must undergo environmental impact assessment. Section 42 of the Act deals specifically with the protection of rivers, lakes and wetlands. The Act forbids interference with water bodies without the express permission from the Director General of NEMA. The permission can be granted subject to the findings of an Environmental and Social Impact Assessment. The Act also empowers the Minister of Environment to declare a lakeshore, wetland, coastal zone or riverbank as protected area and impose such restrictions, as it considers necessary to protect the lakeshore, wetland, coastal zone and riverbank from environmental degradation. The Environmental (Impact Assessment and Audit) regulations, 2003, provide the basis and procedure of carrying out EIAs and EAs.

The *Second Schedule* to the *Act* specifies the projects for which an EIA or environmental audit must be carried out. According to the Act, Section 58, all projects listed in the Second Schedule of the Act must submit a study report to NEMA. The proposed Irrigation Project is classified under Item 8 (e) Irrigation, in the Second Schedule of EMCA 1999.

EMCA and the other National laws that govern environmental, health and safety issues, in relation to agricultural and irrigation activities, are briefly discussed in the following sections. Wherever any of these laws contradict each other, the Act should prevail.

3.2.2 Agriculture, Fisheries and Food Authority Act, 2013

Agriculture, Fisheries and Food Authority Act (No.13, 2013) is an Act of Parliament to provide for the consolidation of the laws on the regulation and promotion of agriculture generally, to provide for the establishment of Agriculture, Fisheries and Food Authority. The Act tend to protect Agriculture and fisheries excluding livestock for the purpose of food security in the country.

The Act addresses the following activities:

a) Administer the crops Act and the fisheries Act in accordance with provision of these Act.
b) Promote best practices and regulate, the production, procesing and marketing of agricultural and acquatic products.
c) Collect, collate data and maintain a database on agricultural and acquatic products.
d) Deteremines the research priorities in agriculture and acquaculture.

3.2.3 Water Act, 2016

The Water Act of 2016 was assented to on 20th September 2016 and repealed the water Act 2002. The enactment of this law aimed at aligning National water management and water services provision with the requirements of the Constitution of Kenya 2010 particularly on the clauses devolving water and sanitation services to the County governments.

The Act provides for National monitoring and information systems on water resources. The Act regulates abstraction and storage of water from water courses depressions or channels. Section 36 on water rights and works and Section 37 permit not required for certain activities. To formalize the project, the proponent should notify the sub County water officer on the project and its components.

Part IX section 105 of the Act states that no person/institution shall cause nuisance or condition liable to be injurious or dangerous to human health. Section 106 requires Local Authorities to take all lawful, necessary and reasonably practicable measures to maintain their jurisdiction clean and sanitary to prevent occurrence of nuisance or condition liable for injurious or dangerous to human health. The key areas of the Act related to irrigation activities include:

a) Obtaining water permits for irrigation (application and issuance procedures and attached conditions);
b) Provision of sufficient drainage works for delivery of used or unused water to a water course or body from irrigated lands;
c) Revision or variation and cancellation of water permits;
d) Penalty for waste;
e) Penalty for polluting water used for human consumption.

3.2.4 Public Health Act, 1986 (Revised 2012)

The Public Health Act (Cap. 242), in Part IX Section 8 & 9 states that no person/institution shall cause nuisance or condition liable to be injurious or dangerous to human health. Any noxious matter or waste water flowing or discharged into a water course is deemed as a nuisance. Part Xll Section 136 states that all collections of water, sewage, rubbish, refuse and other fluids which permits or facilitates the breeding or multiplication of pests shall be deemed nuisances The Act addresses matters of sanitation, hygiene and general environmental health and safety. Whereas the contractor must comply with the Act during construction, the proposed project will be required to comply with the provisions of this Act during the operation phase.

3.2.5 The Wildlife Conservation and Management Act; 2013

This is an Act that provides for the protection, conservation, sustainable use and management of wildlife in Kenya and for related purposes.

Section 39 provides for the establishment of conservancy or sanctuary, whereby any person or community who own land on which wildlife inhibits may individually or collectively establish a wildlife conservancy or sanctuary in accordance with the provision of the Act. Also section 40 which talks of the community wildlife association and wildlife manager. Its states that anyone in the community who owns wildlife in their community can register to the relevant authorities. The objective of this is to prevent conflicts in the use of land and also cooperative wildlife conservation. This also helps in mapping out the wildlife land and any use of land around it can be sustainably conserved and managed.

3.2.6 Pest Control Products Act, (Revised 2012)

This Act (Cap. 346, 2012) requires all chemicals used in any agricultural undertaking to be registered by the Pest Control Products Board (PCPB). All pest control products sold in Kenya must bear a label showing a PCPB registration number. Under this Act, there are a number of pesticides whose use is banned in Kenya while training in the use of pesticides must be carried out by PCPB accredited institutions and persons. All pesticide storage and handling arrangements must be inspected and licensed under this Act. The proposed Irrigation Project will procure various agricultural biocides for its members and also organize trainings on the use of the same. It will be prudent for the management to familiarize themselves with provisions of this Act.

3.2.7 Occupational Safety and Health Act, 2009

This is an Act of Parliament that provide for the safety, health and welfare of all workers and all persons lawfully present at workplaces, to provide for the establishment of the Directorate of Occupational Safety

and Health Services and its purposes. It applies to all workplaces where any person is at work, whether temporarily or permanently. During the construction phase of the irrigation project, the works contractor must adhere to the requirements of this Act.

3.2.8 Irrigation Act, (Rev 2012)

Irrigation Act (Cap 347) applies only to public irrigation schemes managed by the National Irrigation Board. It is widely recognized that lack of a comprehensive irrigation policy and legal framework has constrained irrigation development in Kenya. Under the proposed new irrigation policy, organizations of public irrigation scheme will be required to operate under a legally recognized Irrigation Water User Associations whose duties will involve management of irrigation water, collection of operation and maintenance fees and conflict resolution.

Summary of the National laws that are likely to be triggered by the proposed project include those indicated in Table 3.1:

Table 3.1 : Legislation Summary

Legislation	Description
Environmental Management and Coordination Act, 1999 (Amended 2015)	This Act governs EIA studies in Kenya and requires that EIAs for Irrigation and drainage projects are carried out as per the second schedule of the Act. The Act also set-ups the NEMA.
Environment Impact Assessment and Audit Regulations, 2003	Under this Act submission of environmental reports became mandatory, and no proponent shall implement a project likely to have a negative environmental impact or one for which an EIA has been concluded and approved in accordance with these regulations.
EMCA (Noise and Excessive Vibration Pollution Control), 2009	These regulations prohibit excessive noise and vibration.
Waste Management Regulations, 2006 (Legal Notice No.121)	These regulations are meant to streamline the handling, transportation and disposal of various types of waste in order to protect human health and the environment.
EMCA (Wetlands, River, Lake and Sea) Regulations, 2009	This Act provides for the conservation and sustainable use of all wetlands and their resources whether occurring in private or public land in Kenya. It ensures the conservation of water catchments and the control of floods and sustainable use of wetlands for ecological and aesthetic purposes. Furthermore, the Act makes provision for the protection of wetlands as habitats for species of fauna and flora and provision of a framework for public participation in the management of wetlands.
EMCA (Biological Diversity and Resources, Access) Regulations, 2006	The Act does not permit any person to engage in any activity that may have an adverse impact on any ecosystem; may lead to the introduction of any exotic species or to unsustainable use of natural resources, without an Environmental Impact Assessment License issued by the Authority under the Act.
The Land Act, 2012	This law "gives effect to Article 68 of the Constitution, to revise, consolidate and rationalize land laws; to provide for the sustainable administration and management of land and land based resources, and for connected purposes". Section 143 and 144 of the Act provides for the establishment of Right of Way for public projects. The Act also provides for the rights and responsibilities of persons occupying the land for

	which the right of way is sought or has been provided.
The Forest Act 2005	This Act provides for the establishment, development and sustainable management, including conservation and rational utilization of forest resources for the socio - economic development of the country.
The Water Act of 2016	This Act provides for the management, conservation, use and control of water resources and for the acquisition and regulation of rights to use water; to provide for the regulation and management of water supply and sewerage services; to repeal the Water Act (Chapter. 372 of the Laws of Kenya) and certain provisions of the Local Government Act and for related purposes.
Occupational Safety and Health Act, 2009	This Act secures the safety, health and welfare of persons at work; and protects persons other than persons at work against risks to safety and health arising out of, or in connection with, the activities of persons at work.
Public Health Act, 1986 (Revised 2012)	This Act of Parliament makes provisions for securing and maintaining health. There are provisions within the Act to deal, in a general way, with water, air and noise quality as they pertain to human health. An environmental nuisance is defined and includes the emission from premises of wastewaters, gases and smoke which could be regarded as injurious to health.
Agriculture, Fisheries And Food Authority Act (No. 13, 2013)	This Act seeks to provide for the consolidation of the laws on the regulation and promotion of agriculture generally, to provide for the establishment of the Agriculture, Fisheries and Food Authority.
Wildlife (Conservation and Management) Cap 376 Laws of Kenya	This Act provides that where it is desirable that the present powers relating to the management and conservation of wildlife in Kenya should be amalgamated and placed in a consolidated Service of the Government.
The Valuers Act Cap 532	The revised edition 1985 of the valuers act cap 532 makes provisions for the relevant charges and conducts of valuers in relation to valuation of assets. This act help protect those people affected by the proposed project by providing the relevant regulations and guidelines in undertaking land valuation.
The Penal Code (Cap. 63)	The chapter on "Offences Against Health and Conveniences" contained in the Penal Code enacted in 1930 strictly prohibits the release of foul air into the environment, which affects the health of other persons.
The Employment Act, 2007	An Act of Parliament to repeal the Employment Act, declare and define the fundamental rights of employees, to provide basic conditions of employment of employees, to regulate employment of children and to provide for matters connected with the foregoing.
The Lake and Rivers Act Cap 409	The Act makes provision for regulating the use of lake or river for the transport of floating timber; regulating the traffic on a lake or river; for protecting the bird or animal life on or in a lake or river.

3.3 Institutional Framework

3.3.1 Institutions under EMCA, 1999

The Government established the following institutions to implement the EMCA 1999.

a) Ministry of Environment and Forestry

The Ministry is charged with the responsibility to protect, conserve and manage the environment and natural resources for socio-economic development through sustainable exploitation for socio-economic development aimed at eradication of poverty, improving living standards and ensuring that a clean environment is sustained. The ministry's mission statement and key objective is to facilitate good governance in the protection, restoration, conservation, development and management of the environment and natural resources for equitable and sustainable development.

b) National Environmental Council

The body was established under section 4(3) of EMCA 1999 and it consists of the line Ministry's Cabinet Secretary as the chairman, the principal secretary, representatives from public universities, research institutions, NGOs, the Director General to NEMA and such number of members as may from time to time be determined by the line Ministry's Cabinet Secretary.

The National Environmental Council (NEC) is responsible for policy formulation and directions for the purposes of the Act. The NEC also sets National goals and objectives and determines policies and priorities for the protection of the environment.

c) National Environmental Action Plan Committee

The committee was established under Section 37 of the Act. The committee is responsible inter alia, for the development of a five-year national environment action plan. The National environment action plan contains among other aspects analysis of the natural resources of Kenya and their distribution, quantity and various uses.

The committee is also responsible for recommending legal and fiscal incentives for business that incorporate environmental requirements into their planning and operational processes as well set out guidelines for the planning and management of the environment and natural resources. Upon adoption by Parliament, the National environment action plan becomes binding on all organs of government.

d) Standards and Enforcement Review Committee (SERC)

The SERC operates under NEMA as established under Section 70 of EMCA 1999. It serves as a technical committee mandated with the task of formulation of environmental standards, methods of analysis, inspection, monitoring and technical advice on necessary mitigation measures. The Principal Secretary under the Cabinet Secretary is the Chairman of the SERC. The members of the SERC are set out in the third schedule of EMCA 1999.

e) National Environmental Complaints Committee

The National Environmental Complaints Committee (NECC) is the body charged with the task of investigating complaints or allegations regarding the condition of the environment in Kenya and suspected cases of environmental degradation. The NECC also undertakes public interest litigation on behalf of the citizens in environmental matters. It is composed of seven members appointed by the Cabinet Secretary for Environment and Natural Resources headed by a chairman who is a person qualified to be appointed as a judge of the High Court of Kenya and members nominated by the Attorney-General, the Council of County Governors (Secretary), the Law Society of Kenya and the business community.

f) County Environment Committees

Section 29 (1) of EMCA 1999 provides that the Cabinet Secretary shall by notice in the gazette appoint County Environment Committees of NEMA in respect of every County. These committees assist NEMA in effectively carrying out its function of proper management of the environment at this level. It is instructive to note that the membership of these committees includes inter alia representatives of farmers or pastoralists, business community, women and youth.

g) National Environmental Management Authority (NEMA)

NEMA is the administrative body that is responsible for the coordination of the various environmental management activities in Kenya. NEMA is also the principal government authority for implementing all environmental policies. NEMA is also responsible for granting EIA approvals and for monitoring and assessing activities in order to ensure that the environment is not degraded by such project activities.

The authority's core functions are:

i) Advise the Government on legislative and other measures for the management of the environment or the implementation of relevant international conventions, treaties and agreements.
ii) Undertake and coordinate research, investigation and surveys, collect, collate and disseminate information on the findings of such research, investigations or surveys.
iii) Promote the integration of environmental considerations into development policies, plans, programmes and projects, with a view to ensuring the proper management and rational utilization of environmental resources, on sustainable yield basis, for the improvement of the quality of human life in Kenya.
iv) Coordinating the various environmental management activities being undertaken by the lead agencies
v) To take stock of the natural resources in Kenya and their utilization and conservation.
vi) Initiate and evolve procedures and safeguards for the prevention of accidents, which may cause environmental degradation and evolve remedial measures where accidents occur e.g. floods, landslides and oil spills. Carry out surveys, which will assist in the proper management and conservation of the environment.
vii) Mobilize and monitor the use of financial and human resources for environmental management.
viii) Identify projects and programmes for which environmental audit or environmental monitoring must be conducted under this Act and
ix) Monitor and assess activities, including activities being carried out by relevant lead agencies, in order to ensure that the environment is not degraded by such activities. Management objectives must be adhered to and adequate early warning on impending environmental emergencies is given.

h) Public Complaints Committee

The Act also established a Public Complaints Committee, which provides the administrative mechanism for addressing environmental harm. The committee has the mandate to investigate complaints relating to environmental damage and degradation. Its members include representatives from the Law Society of Kenya, NGOs and the business community.

i) Standards and enforcement Committee

Part VIII of the Act deals with environmental quality standards. It establishes a Standards and Enforcement Review Committee (SERC) whose functions include the establishment of standards for all environmental media.

Standards have been established as regulations to the Act as presented here-in. Standards for the following are still scheduled for release:

i) Air quality;
ii) Chemicals;
iii) Land use and
iv) Economic instruments.

3.3.2 Water Resources Authority

The Water Resources Authority (WRA) is of particular relevance to the project. Its mandate covers some sectoral issues which are applicable to environmental management, such as use of water resources, human settlement and administration of activities in the scheme.

Part III of the Water Act 2016 defines the powers and functions of WRA which include:

a) Developing principles, guidelines and procedures for the allocation of water resources;
b) Monitoring the national water resources management strategy;
c) Receiving and determining applications for permits for water use;
d) Monitoring and enforcing conditions attached to permits for water use;
e) Regulating and protecting water resources quality from adverse impacts;
f) Managing and protecting water catchments.

WRA may prosecute any offences arising under the Water Act and also provides the basis for the following:

a) Formulation of a National Water Resources Management Strategy;
b) Classification of water resources and resource quality objectives;
c) Determination of water reserves;
d) Designation of catchment areas;
e) Formulation of a catchment management strategy;
f) Declaration of protected catchment areas National monitoring of and information on water resource management and
g) Definition of state schemes and community projects.

3.4 African Development Bank Guidelines

3.4.1 Overview

African Development Bank has strong development-oriented Environmental and Social Assessment Procedures (ESAP) aimed at improving decision-making and project results in order to ensure that Bank-financed projects, plans and programmes are environmentally and socially sustainable, and in line with the Bank's policies and guidelines.

At the project identification phase, the screening exercise focuses on the environmental and social dimensions of a project to categorise it, in one of four categories listed in Table 4.1.

Table 4.1: AfDB categories for Environmental Assessments

Category	Requirement
Category 1	Projects that are likely to have the most severe environmental and social impacts and require a full ESIA.
Category 2	Projects likely to have detrimental and site-specific environmental and social impacts that can be minimised by the application of mitigation measures included in an ESMP.
Category 3	Projects that shall not induce any adverse environmental and social impacts and do not need further ESIA action.
Category 4	Projects involve investment of Bank's funds through Financial Intermediaries (FIs) in subprojects that may result in adverse environmental or social impacts. Specific requirements for this type of project include an assessment of FI capacities to handle environmental and social considerations.

The water supply project covers a fairly wider area. The impacts during operational phases are bound to be minimal on lives of the people, wildlife and plants within and in surrounding areas. According to Environmental Assessment classification of projects by the Bank, such a project falls into **category 2.**

Thus, there will be need for continued assessment of the impacts and the extent and scope of the identified impacts in line with the provisions in the Guidelines.

3.4.2 AfDB Environmental Policies

In January 2004 the Boards approved the new Bank Group Policy on the Environment, which incorporates and redefines the former policy on environmentally sustainable development in Africa. The new policy acknowledges that to sustain economic growth in Africa, there is an urgent need to preserve and enhance the ecological capital that enriches such growth. The main goals of the new policy are to:

a) Promote a long-term view and perspective of economic and social development;
b) Reverse where possible and halt the impoverishment process in Africa by enhancing the access of the poor to environmental resources;
c) Help Regional Member Countries (RMCs) to build their environmental management capacity and sensitize policymakers on environmental issues and bring about institutional changes to achieve sustainable development and
d) Reinforce the existing partnerships with international institutions and network also with regional and sub-regional organizations to coordinate interventions in environmental sustainable development.

Two guidelines relevant to the new Policy on the Environment were completed and disseminated in 2004, namely the Strategic Impact Assessment Guidelines (SIA) and the Integrated Environmental and Social Assessment Guidelines (IESA). The IESA Guidelines are designed to ensure that both environmental and social issues are mainstreamed in Bank projects throughout the project cycle.

In 2004 the Bank developed an Implementation Plan to execute its new Policy on the Environment.

3.4.3 Bank Group Policy on the Environment (2004)

The Environmental Policy sets out the broad strategic and policy framework under which all Bank Group lending and non-lending operations will be made to promote environmentally sustainable development in Africa. Its overall goals are two-fold: firstly, to help improve the quality of life of the people of Africa; and secondly, to help preserve and enhance the ecological capital and life-support systems across the continent of Africa. The development of the policy has been driven by a number of factors, including the recognition and acceptance of sustainable development as the dominant development paradigm for the 21st century; need for a greater focus on pro-poor growth policies and programmes to counter unacceptable impoverishment rates; rapid progress in the inevitable integration of Africa in the globalization process; and the need for an improved governance with a clearer commitment of the majority of African governments to provide the necessary leadership for sustainable development. They use a set of approaches and developing/strengthening procedures and guidelines, with particular focus on the full enforcement of the Environmental and Social Assessment Procedures for all lending operations of the Bank.

3.4.4 Integrated Environmental and Social Impact Assessment (IESIA) Guidelines (2003)

The IESIA Guidelines' are tools used in the implementation of the Bank's Environmental and Social Assessment Procedures. The major objective of the IESIA Guidelines' is to provide guidance to the staff of the Bank and RMCs on how to adequately consider crosscutting themes while assessing the environmental and social impacts of a project. These guidelines present the most frequent potential impacts and enhancement / mitigation measures for the considered sub-sector. They also provide a brief summary of external factors and the main hazards that can influence sectoral projects. The guidelines also outline indicators that could be useful for monitoring the considered project as well as series of references for further readings.

3.4.5 Bank Group's Handbook on Stakeholder Consultation and Participation (2001)

It provides guidelines and outlines specific actions that Bank staff should take to promote participation at every stage of the Bank's project cycle, including the preparation of Country Strategy Papers (CSPs), and Poverty Reduction Strategies (PRS'). The Handbook explains the concept of stakeholder participation, including a description of different levels of participation, its benefits and risks, and underlying principles. It provides an overview of some of the most frequently used participatory methods, tools, and techniques and also explores some key institutional and resource implications related to mainstreaming participatory approaches in the Bank's work. It also identifies current constraints and recommends specific steps that can be taken in order to translate the Bank's policy commitment to participation into action. Finally, the Annexes provide advice on where staff can go for further information on participation, including references for written materials, relevant web-sites and a variety of African and international institutions with such expertise.

3.4.6 Bank Group's Environmental and Social Assessment Procedures for Public Sector Operations (2001)

The main purpose of the Environmental and Social Assessment Procedures (ESAPs) is to improve decision-making and project results by ensuring that Bank-financed projects, plans and programs are environmentally and socially sustainable, and fully in line with Bank's policies and guidelines. The ESAPs describe the various steps that shall be followed to mainstream crosscutting issues along the project cycle, from Country programming to post-evaluation. The ESAPs present to Bank staff and clients various instruments for assessing projects to ensure the mainstreaming of environmental and social sustainability issues. These tools include the Strategic Environmental and Social Assessment (SESA), which can be used to assess, from the environmental and social point of view, the plans and programs to be financed by the Bank. The ESAPs also formalise the use of Environmental and Social Impact Assessment (ESIA), Environmental and Social Management Plan (ESMP) and Environmental and Social Audits as instruments to enhance project benefits

and (in order of priority) to prevent, minimise, mitigate, or compensate for adverse environmental and social impacts.

3.5 International Laws and Guidelines/ Multilateral Environmental Agreements

In addition, the following guidelines/international laws/multilateral environmental agreements were also reviewed:

3.5.1 Ramsar convention on wetlands

This is an intergovernmental treaty that provides the framework for National action and international cooperation for the conservation and wise use of wetlands and their resources. The Ramsar Convention is the only global environmental treaty that deals with a particular ecosystem. The treaty was adopted in the Iranian city of Ramsar in 1971 and the Convention's member Countries cover all geographic regions of the planet.

Unlike the other global environmental conventions, Ramsar is not affiliated with the United Nations system of Multilateral Environmental Agreements (MEA), but it works very closely with the other MEAs and is a full partner among the "biodiversity-related cluster" of treaties and agreements.

3.5.2 Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC)

The Kyoto Protocol is an international agreement linked to the United Nations Framework Convention on Climate Change, which commits its Parties by setting internationally binding emission reduction targets.

Recognizing that developed countries are principally responsible for the current high levels of GHG emissions in the atmosphere as a result of more than 150 years of industrial activity, the Protocol places a heavier burden on developed Nations under the principle of "common but differentiated responsibilities."

The Convention on Climate Change sets an overall framework for intergovernmental efforts to tackle the challenge posed by climate change. It recognizes that the climate system is a shared resource whose stability can be affected by industrial and other emissions of carbon dioxide and other greenhouse gases. The Convention enjoys near universal membership.

Under the Convention, Governments:

- Gather and share information on greenhouse gas emissions, national policies and best practices
- Launch national strategies for addressing greenhouse gas emissions and adapting to expected impacts, including the provision of financial and technological support to developing countries
- Cooperate in preparing for adaptation to the impacts of climate change
- The Convention entered into force on 21 March 1994.

3.5.3 Convention on biological diversity

In response to the growing threat posed by human activity to biodiversity and inspired by the world community's growing commitment to sustainable development, during the 1992 Earth Summit in Rio de Janeiro world leaders adopted the Convention on Biological Diversity (CBD). It is the most important Convention dealing with biodiversity conservation.

The Convention has three main objectives, to:

a) Conserve biological diversity
b) Use biological diversity in a sustainable manner and
c) To share the benefits of biological diversity fairly and equitably.

IUCN has been involved in the CBD since its drafting and through its further development. Its policy work has helped to ensure that decisions taken by the Parties to the Convention are as effective as possible to achieve the CBD objectives.

4 BASELINE INFORMATION

4.1 Climate

The nearest rain gauge is at the Mt. Kenya Naromoru Park Gate Station operated by Kenya Meteorological Department (Station No. 9037149) at an elevation of 2362. Its coordinates are Longitude 37.207314° E and Latitude 0.165349° S. Here the mean annual rainfall is 993 mm. The rainfall decreases to the west as one descends from the mountain and at the intake site, the mean annual rainfall is estimated to be 860 mm and the mean annual potential evapotranspiration is 1160 mm giving an aridity index (ratio of annual potential evapotranspiration to annual precipitation) of 1.34. According to the Agroclimatic zone map of Kenya (KSS, 1980), the area is a transitional one lying between semi-humid zone III to semi-humid to semi-arid zone IV. The monthly distribution of rainfall, potential evaporation and temperature is shown in Figure 4.1 and 4.2

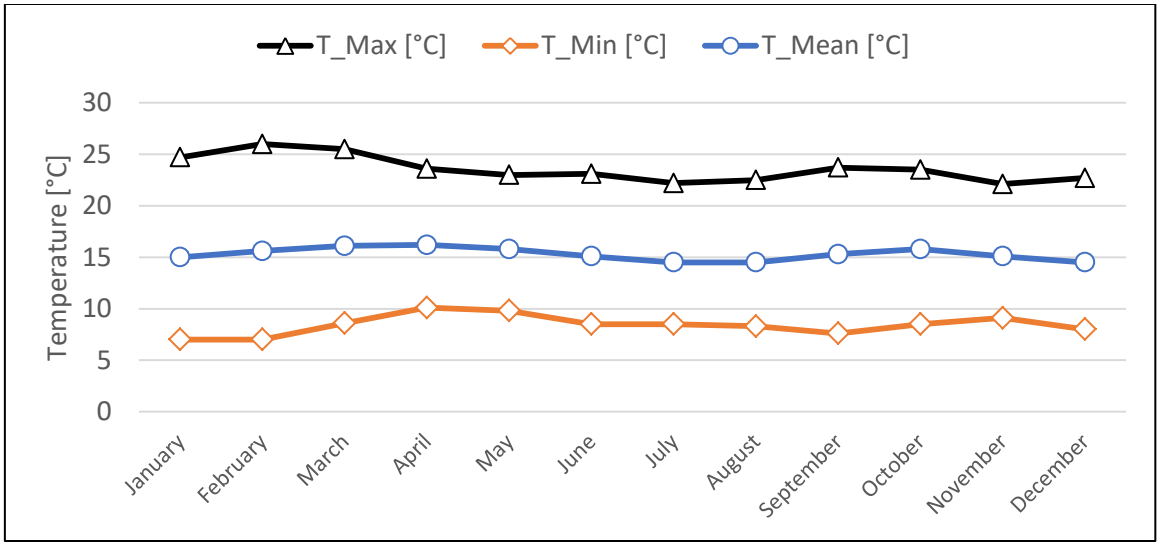


Figure 4.1: Mean monthly temperatures in the area around the intake point

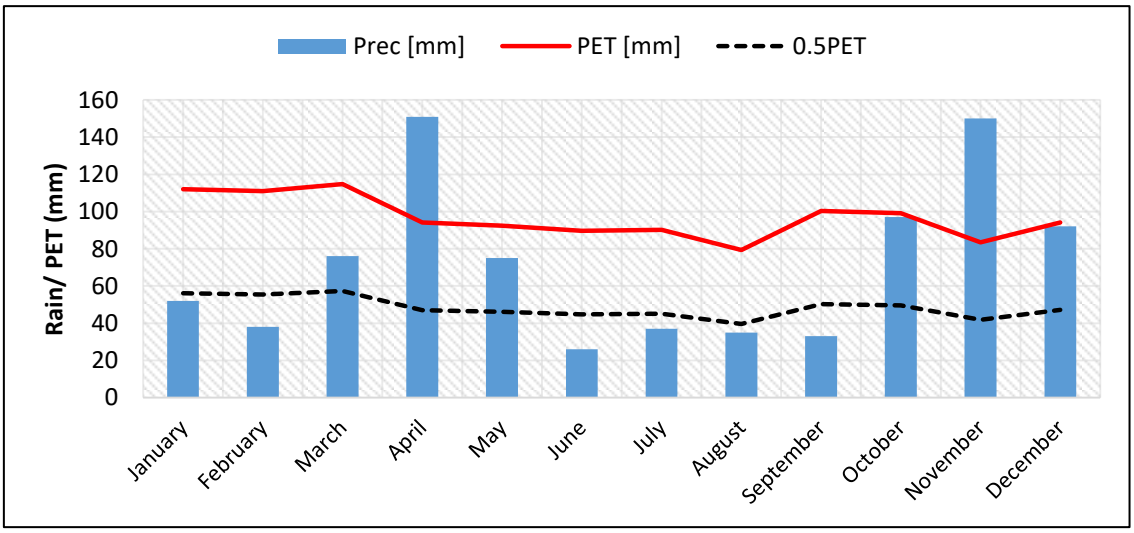


Figure 4.2: Mean monthly rainfall (red) and potential evapotranspiration (green) in the area around the intake point

4.2 Hydrology

4.2.1 Geographical location of River Naromuru

River Naromoru is a tributary of River Ewaso Ng'iro. Naromoru river flows westwards from the western side of Mount Kenya. The river gauging station RGS 5BC02 (coordinates 37.020275° E and 0.160631° S) is

located just downstream of the tarmac road from Naromoru town to Nanyuki (see Figure 1). The catchment boundaries upstream of RGS 5BC02 are within Longitude 37.017697° E and 37.317723° E and Latitude 0.156960° S and 0.193912° S. The elevation ranges from 4560 m to 1985 m above sea level. The coordinates of the proposed intake is 7km upstream of the RGS 5BC02 just downstream of the confluence of Northern Naromoru and Southern Naromoru at coordinates 37.079983° E and 0.178719° S.

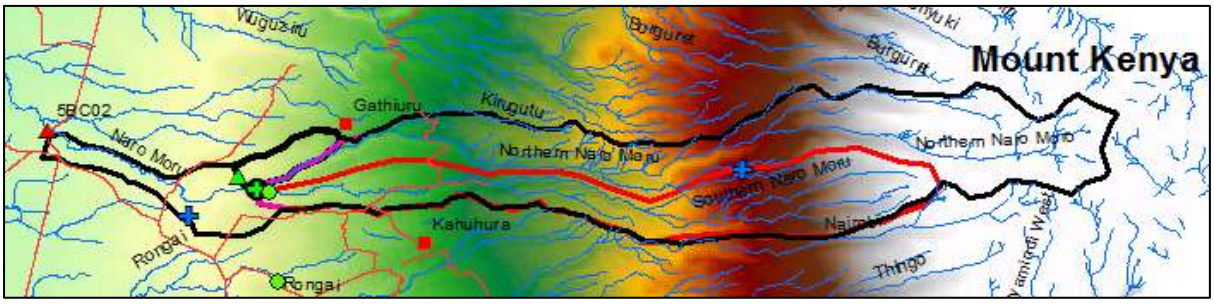


Figure 4.3: The Naromoru river catchment upstream of RGS 5BC02.

The catchment area size of the point of abstraction for Ndirit Aguthi project is approximately 75 km² while the catchment area of Kabunda dam is approximately 3 km². Table 1 below shows the catchment areas of other sites of interest.

Table 4.1 Sub Catchment areas represented by the Naromoru river upstream of RGS 5BC02, the Northern and Southern Naromoru and the dam site

Table 4.1 :: Sub Catchment Areas

Sub Catchment	Area (km²)
Naromoru river North & South (intake site)	74.865
North Naromoru	44.548
South Naromoru	30.317
Kabunda dam	2.68

Plate 4-1: River Naromuru

4.2.2 Data acquisition and hydrological modelling

A reconnaissance survey of the area was carried out on 10th June 2018 to get an appreciation of the available water and land resources, the current land uses and water abstractions and the irrigation water demand. Rainfall, potential evaporation and river flow data (Table 4.2) was used to fit a continuous, lumped rainfall runoff model called Australian Water Balance Model (AWBM) within the rainfall runoff library (RRL).

Table 4.2: Data used for hydrologic modelling

Data	Source	Station /Area	Period	Missing	Remarks
Daily River flow	WRA	5BC02	1/1/1947 to 31/10/2015	50%	for period 1947 to 2015
				25%	for period 1981-2015
Daily Rainfall	KMD	9037149	01/01/1978 to 30/11/2016	1%	Very good data
Temperature / Wind speed / Humidity / Solar radiation	NASA Power website	Centroid of 5BC02 catchment	1983 -2016	0%	None

4.2.3 Short description of the AWBM

The AWBM is a catchment water balance model that can relate runoff to rainfall with daily or hourly data and calculates losses from rainfall for flood hydrograph modelling. AWBM requires evapotranspiration as an input whereas most models will take PET as input. The model uses 3 surface stores to simulate partial areas of runoff. The water balance of each surface store is calculated independently of the others (Figure 4.4). The model calculates the moisture balance of each partial area at either daily or hourly time steps. At each time step, rainfall is added to each of the 3 surface moisture stores and evapotranspiration is subtracted from each store. The water balance equation is:

$store_n = store_n + rain - evap$ (n = 1 to 3)

If the value of moisture in the store becomes negative, it is reset to zero, as the evpotranspiration demand is superior to the available moisture. If the value of moisture in the store exceeds the capacity of the store, the moisture in excess of the capacity becomes runoff and the store is reset to the capacity. The three parameters A1, A2 and A3 representing the proportions of the areas of the catchment are constrained; thus only A1 and A2 can be set. The default pattern is A_1=0.134, A_2= 0.433, A_3= 0. 433 and this pattern is fixed (i.e. calibration tools will not modify it). When A_1 and/or A_2 are changed, A_3 will be adjusted to respect the constraint. If the user increases A_1, and A_3 cannot compensate, then A_1 is reduced to still respect the constraint.

When runoff occurs from any store, part of the runoff becomes recharge of the base flow store if there is base flow in the stream flow. The fraction of the runoff used to recharge the base flow store is BFI*runoff, where BFI is the base flow index, i.e. the ratio of base flow to total flow in the stream flow. The remainder of the runoff, i.e. (1.0 - BFI)*runoff, is surface runoff. The base flow store is depleted at the rate of (1.0 - K)*BS where BS is the current

moisture in the base flow store and K is the base flow recession constant of the time step being used (daily or hourly).

The surface runoff can be routed through a store if required to simulate the delay of surface runoff reaching the outlet of a medium to large catchment. The surface store acts in the same way as the base flow store, and is depleted at the rate of (1.0 - KS)*SS, where SS is the current moisture in the surface runoff store and KS is the surface runoff recession constant of the time step being used.

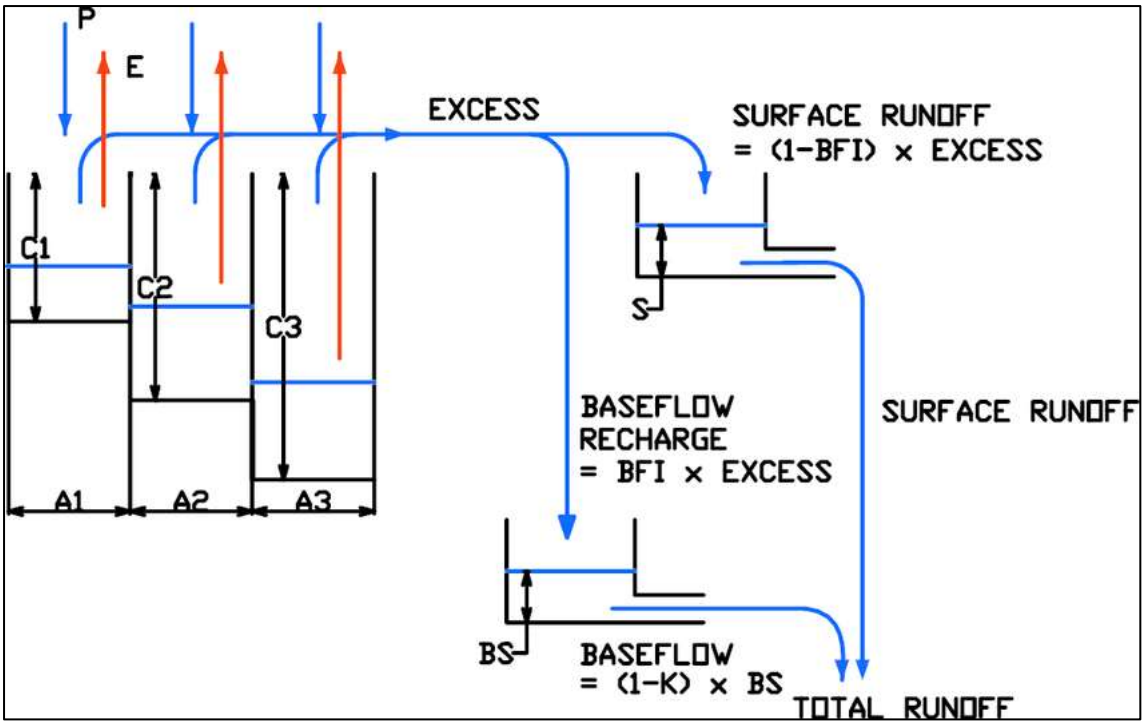


Figure 4.4: Schematic representation of the AWBM hydrological model

The major inputs to the model are as follows:

Rainfall – a continuous time series of rainfall data that represents the rainfall across the catchment

Potential evapotranspiration – a continuous time series of potential evapotranspiration or evapotranspiration data that represents the evapotranspiration across the catchment.

Flow gaugings – daily runoff values for the gauging station that is to be modelled. This data are used for model calibration and checking.

Catchment area – this is used to convert inputs and outputs between flow and depth of runoff.

4.2.4 Model Calibration and Simulation

The AWBM model was calibrated with flow data from RGS 5BC02 for the period from 01/01/2000 to 31/12/2015. The warm up period was three years (1/1/2000 to 1/1/2004). The model has eight parameters which were calibrated manually until the flow duration curve of the observed river flow data matched that of the simulated data (Figure 4.5). Goodness of fit was judged by visual assessment of the FDC (Figure 4.6), by the agreement between the mean observed and simulated runoff and by the coefficient of determination R^2 between the observed and simulated daily flows. The coefficient of determination R^2 of daily flow data was 0.534. The observed runoff was 2057 mm against simulated runoff of 2368 mm. This is considered satisfactory. The slight under-estimation of simulated flow can be explained by the high peaks in the observed data which could be a result of errors in measurement of the peak flows. On the basis of this calibration result, the simulation was extended to cover the period from 1985 to 2015 (31 years). One year of flow data was discarded for model warm and this left 30 years of data which is sufficient for statistical analysis. Having calibrated the model at the RGS 5BC02 (area 83 km^2), the flow for the small catchments (74.865 km^2 and 2.68 km^2) was simulated by keeping the rainfall and other weather data and parameters constant and changing the area of the catchment.

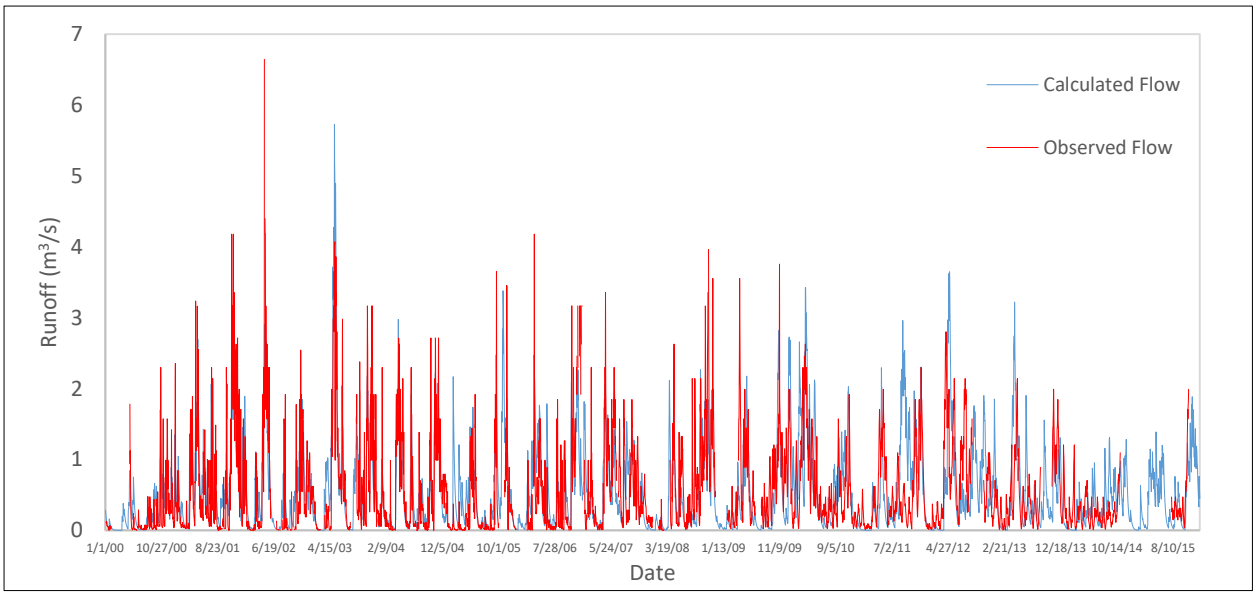


Figure 4.5: Observed and simulated flow at RGS 5BC02 from 2000 to 2015.

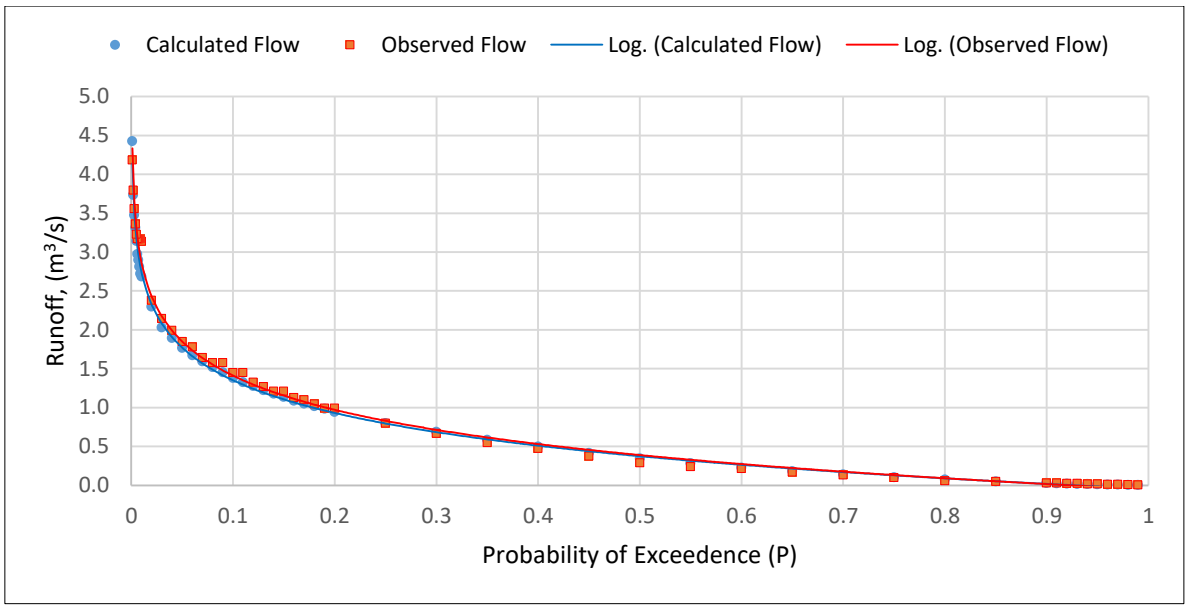


Figure 4.6: Model calibration using the flow duration curve and the parameter set that was obtained after calibration

4.2.5 Permitted abstractions and correction of flow data

Permit data obtained from Water Resources Authority showed permits and authorizations from 1978 to 2016 (Table 3). There are a total of 18 abstractors (permits or authorizations) on Naromoru river. During the field visit, some 15 abstractors on Northern and Southern Naromoru were identified, these are;

a) Northern Naromoru
b) Kihoto
c) Gitwe
d) Naromoru Scheme
e) Southern Naromoru
f) Njoguini
g) Kigama

h) Gitero / Kaduri
i) Kebendera
j) Kabunda
k) Ndiriti Aguthi
l) Downstream of confluence
m) Naruwasco (Gatuni)
n) Naruwasco
o) Kihato

The total quantity of water (Q.O.W.) represented by these permits and authorizations is 0.17 m3/s (14,642 m3/day). About 75% of the water is abstracted for irrigation (Figure 4.7). Since we do not have adequate information, we can assume that half of the amount of water permitted for abstraction is for the Northern and Southern Naromoru.

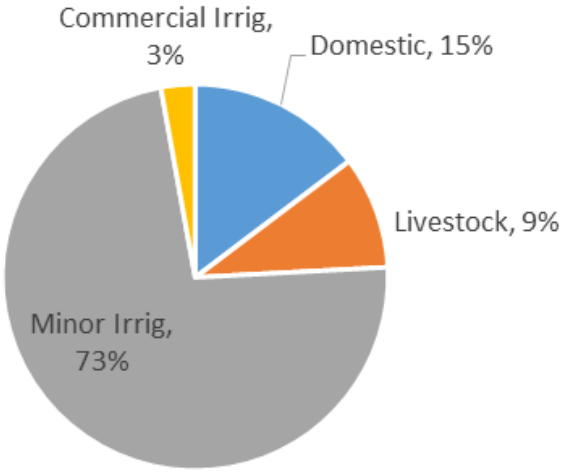


Figure 4.7: Proportion of water abstracted from Naromoru river for various uses

It is well known that abstractions from this river have been going on for much longer than the permit database shows. Just how much is abstracted for the period of the simulation is not clear. We opted to calibrate the AWBM model with the flow data as given and assumed that the existing abstractions have already been factored in the flow data and therefore we only need to confirm that the extra proposed abstraction would be available and that it would provide for the downstream releases required to meet environmental flows and other water demands downstream.

Table 4.3: Abstractions from river Naromoru

#	Applicant Name	Category	Application Date	Status	System Entry Date	Approval Date	Expiry Date	Quantity (m3/day)
1	Athony L Frere	A	03/12/2010	Authorization Issued	14/11/2011	03/12/2015	03/02/2016	4.7
2	Elisabeth Brenda Woods	A	03/12/2010	Authorization Issued	14/11/2011	09/04/2015	09/06/2015	4.5
3	Naromoru Scheme Water Project	B	08/12/2010	Permit Issued	24/01/2011	24/01/2011	24/01/2016	292.1
4	Naromoru Water & Sanitation Co. Ltd	B	08/02/2016	Authorization Issued	12/02/2016	14/04/2016	14/05/2017	343.0
5	Aaa Growers Limited(Nanyuki)	B	28/12/2010	Posted Old Permit application	09/12/2015			94.5
6	Kabunda Water Project	B	08/12/2010	Permit Issued	18/01/2011	24/08/2017	18/01/2021	180.4
7	Kihoto Water Project	B	17/09/2012	Permit Issued	17/09/2012	09/11/2017	09/11/2022	360.0
8	Mwea B Water Project	B	23/01/2013	Permit Issued	23/01/2013	15/02/2016	15/02/2021	155.7
9	Mwiremia Water Project	B	20/09/1978	Permit Issued	03/12/2014	01/01/2012	01/01/2017	176.0
10	Aaa Growers Limited(Nanyuki)	B	17/08/2010	Permit Issued	19/08/2015	18/11/2016	18/08/2021	94.5
11	Matanya Weru-Ini-Water Project	B	08/10/2013	Authorization Issued	08/10/2013	16/10/2013	16/11/2014	300.0
12	Cinnabar Green Limited	B	27/02/2015	Authorization Issued	11/03/2015	08/06/2015	08/08/2015	138.0
13	Ndiriti Aguthi Water Project	C	08/12/2010	Permit Issued	19/01/2011	25/01/2016	25/01/2021	940.3
14	Mwichuiri Gitero Water Project	C	23/11/2010	Permit Issued	17/01/2011	12/01/2016	18/01/2021	608.7
15	Kabendera Self Help Water Project	C	11/05/2012	Permit Issued	11/05/2012	13/07/2017	16/07/2019	2907.0
16	Aaa Growers Limited(Nanyuki)	C	21/12/2010	Posted Old Permit application	21/12/2015	-	-	94.5
17	Aaa Growers Limited(Nanyuki)	C	28/12/2010	Permit Issued	21/09/2016	18/11/2016	28/12/2020	0.0
18	Ndiriti Aguthi Water Project	C	31/07/2012	Permit Issued	31/07/2012	23/10/2015	23/10/2020	500.0
19	Gitwe Irrigation Water Projects	D	01/12/2010	Permit Issued	06/01/2011	07/01/2011	07/01/2016	1360.2
20	Thome Water Project	D	15/02/2012	Extension of Time Issued	15/02/2012	28/01/2015	28/01/2016	6088.5
TOTAL QUANTITY OF WATER							m^3/day	14,642.7
							m^3/s	0.169

4.2.6 Analysis of rainfall data

The rainfall for Naromoru Met Station from 1/1/1985 to 30/11/2016 was used for the hydrological modelling. The mean monthly rainfall for this period is presented in Figure 4.8. The mean annual total was obtained as 1522 mm. Since this rainfall station is located within the catchment, it was assumed that the rainfall is representative of the northern and southern Naromoru tributaries. No corrections of the rainfall were made.

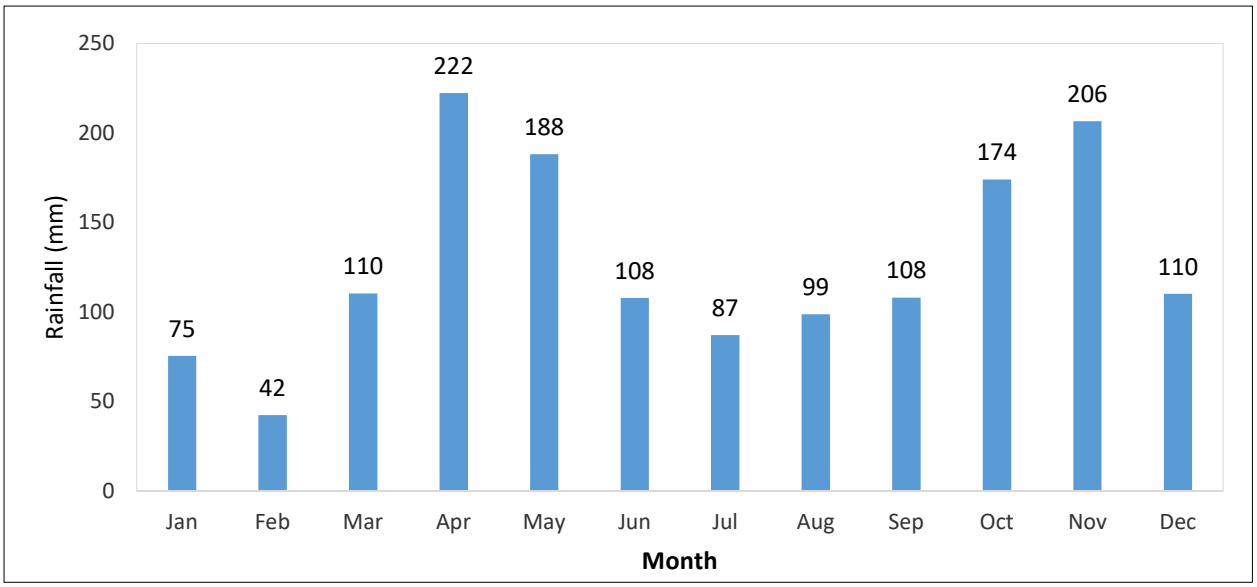


Figure 4.8: Mean monthly flow data at Naromoru Met Station

4.2.7 Results of statistical analysis of flow data

The 30 years of flow data at Aguthi intake and Kabunda dam site obtained from the hydrological modelling was subjected to statistical analysis using the statistical package Instat. From the Flow Duration Curve (FDC) analysis flow data at the Aguthi intake (~75km^2) and at the Kabunda dam (~3 km^2), the values of Q95, Q80 and Q50 are shown in Table 4.4. The mean monthly flows at Aguthi intake site and Kabunda dam site are shown in Figure 4.9 and Figure 4.10. The results of FDC analysis of monthly flow data is presented in Table 4.5 –4.7.

Table 4.4: Values of Q95, Q80 and Q50 and available water at the Aguthi Intake and Kabunda dam based on analysis of daily flows

	Aguthi Intake (m^3/day)	Kabunda Dam (m^3/day)
Q95	369	33
Q80	2,716	242
Q50	11,119	991
Water available for domestic use (Q80-Q95)	2,347	209
Water available for irrigation (Q50-Q80)	8,403	749

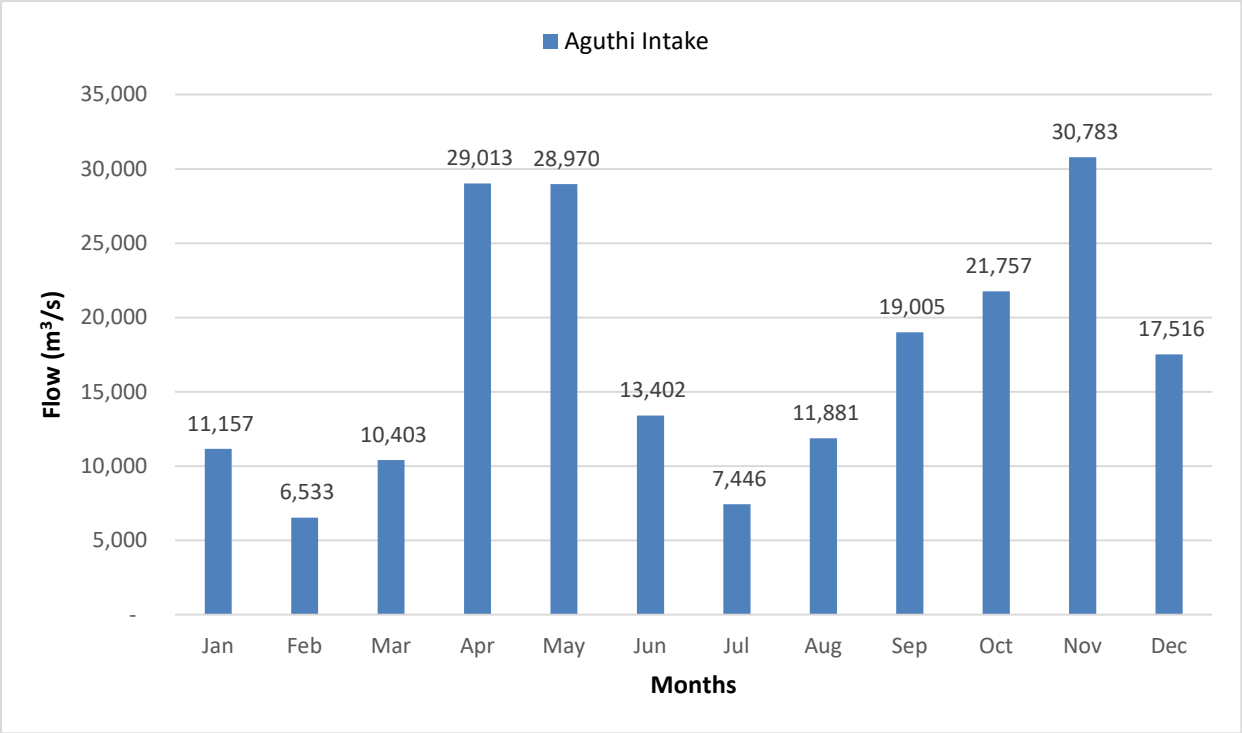


Figure 4.9: Long term average monthly flow at Aguthi intake

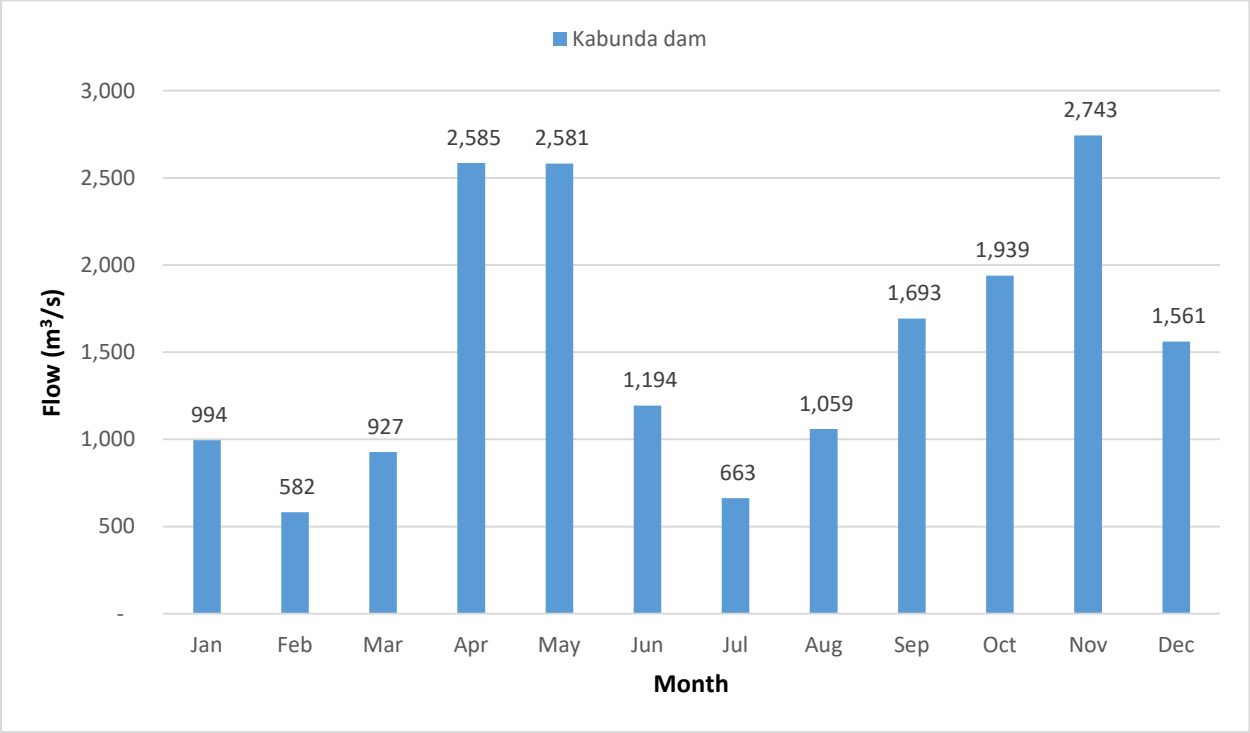


Figure 4.10: Long term average monthly flow at Kabunda dam site

Flow duration analysis of mean monthly flow data at 5BC02 (Table 4.5), Aguthi intake site (Table 4.6) and Kabunda dam (Table 4.7) site showing available domestic water (ADW) and available irrigation water (AIW) in m^3/day.

Table 4.5: Flow duration analysis of mean monthly flow data at 5BC02

Month	Reference Station	Q95	Q80	Q50	ADW(Q80-Q95)	AIW(Q50-Q80)
Jan	5BC02	2,412	4,194	14,830	1,783	10,635
Feb	5BC02	362	2,174	7,407	1,812	5,233
Mar	5BC02	703	7,153	20,793	6,450	13,641
Apr	5BC02	13,802	36,512	79,520	22,710	43,008
May	5BC02	26,139	39,128	69,798	12,989	30,670
Jun	5BC02	5,417	13,144	24,683	7,727	11,539
Jul	5BC02	2,871	9,288	15,903	6,417	6,614
Aug	5BC02	8,839	16,253	29,442	7,414	13,189
Sep	5BC02	4,375	23,695	47,363	19,320	23,668
Oct	5BC02	22,513	28,084	55,002	5,571	26,918
Nov	5BC02	23,805	50,947	85,561	27,142	34,613
Dec	5BC02	5,625	15,468	48,669	9,842	33,201

Table 4.6: Flow duration analysis of mean monthly flow data at Aguthi Intake Site

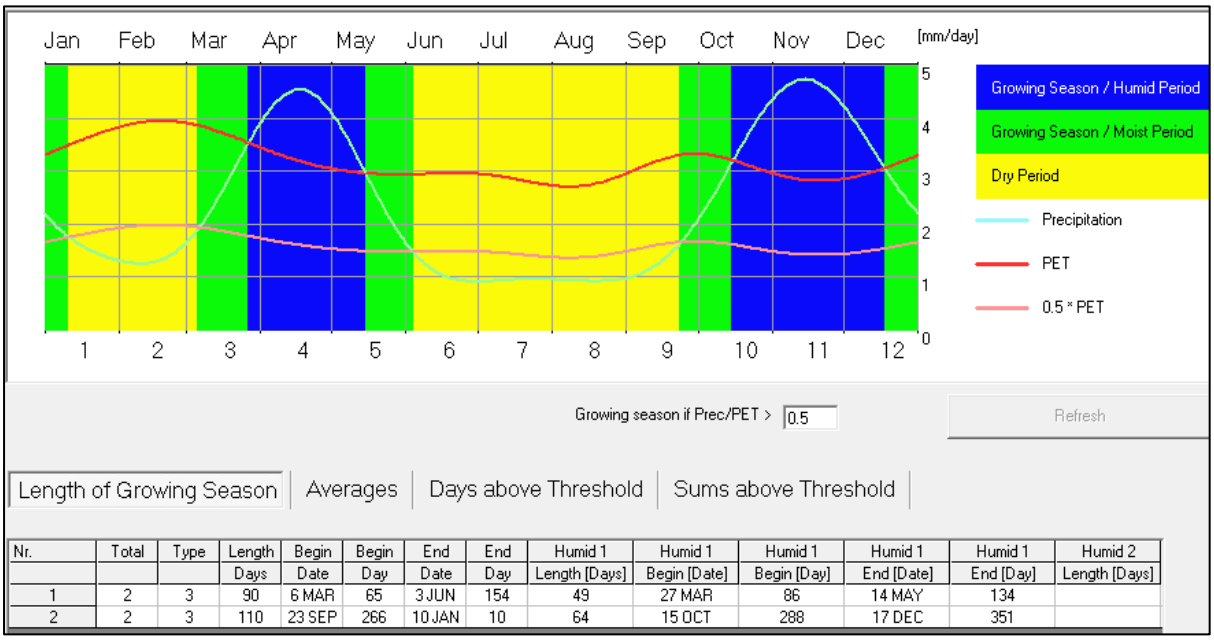
Month	Reference Station	Q95	Q80	Q50	ADW(Q80-Q95)	AIW(Q50-Q80)
Jan	Aguthi Intake	880	1,531	5,414	651	3,882
Feb	Aguthi Intake	132	793	2,704	661	1,910
Mar	Aguthi Intake	257	2,611	7,591	2,355	4,980
Apr	Aguthi Intake	5,039	13,329	29,029	8,290	15,700
May	Aguthi Intake	9,542	14,284	25,481	4,742	11,197
Jun	Aguthi Intake	1,978	4,798	9,011	2,821	4,212
Jul	Aguthi Intake	1,048	3,391	5,805	2,343	2,415
Aug	Aguthi Intake	3,227	5,933	10,748	2,707	4,815
Sep	Aguthi Intake	1,597	8,650	17,290	7,053	8,640
Oct	Aguthi Intake	8,219	10,252	20,079	2,034	9,827
Nov	Aguthi Intake	8,690	18,599	31,235	9,909	12,636
Dec	Aguthi Intake	2,054	5,647	17,767	3,593	12,120

Table 4.7: Flow duration analysis of mean monthly flow data at Kabunda Dam

Month	Reference Station	Q95	Q80	Q50	ADW(Q80-Q95)	AIW(Q50-Q80)
Jan	Kabunda Dam	78	136	482	58	346
Feb	Kabunda Dam	12	71	241	59	170
Mar	Kabunda Dam	23	233	676	210	444
Apr	Kabunda Dam	449	1,188	2,587	739	1,399
May	Kabunda Dam	850	1,273	2,271	423	998
Jun	Kabunda Dam	176	428	803	251	375
Jul	Kabunda Dam	93	302	517	209	215
Aug	Kabunda Dam	288	529	958	241	429
Sep	Kabunda Dam	142	771	1,541	628	770
Oct	Kabunda Dam	732	914	1,789	181	876
Nov	Kabunda Dam	774	1,657	2,783	883	1,126
Dec	Kabunda Dam	183	503	1,583	320	1,080

4.2.8 Cropping Seasons and irrigation water demand

The area has two growing seasons in Mar-Apr-May (MAM) and Oct-Nov-Dec (OND) season with two dry periods in between. On average the MAM season begins on 6th March and ends on 3rd June lasting 90 days. The OND season begins 23rd September and ends on 10th January lasting 110 days. On average irrigation will be required in the months of June to September and January and February.



Nr.	Total	Type	Length	Begin	Begin	End	End	Humid 1	Humid 1	Humid 1	Humid 1	Humid 1	Humid 2
			Days	Date	Day	Date	Day	Length [Days]	Begin [Date]	Begin [Day]	End [Date]	End [Day]	Length [Days]
1	2	3	90	6 MAR	65	3 JUN	154	49	27 MAR	86	14 MAY	134	
2	2	3	110	23 SEP	266	10 JAN	10	64	15 OCT	288	17 DEC	351	

Figure 4.11: Cropping seasons in the area targeted for irrigation.

4.2.9 Water balance

The water balance of the river section upstream of the proposed intake is given in Table 4.8. This is depicted on a monthly time step as it is the most conservative way to assess the environmental water requirements, Q95. The results show that the available domestic and irrigation water is higher than the permitted

abstraction at this site meaning there is still room for additional permit to abstract more, however, the volume varies significantly from month to month with the months of April and May depicting a significant volume available.

The total amount of water permitted for abstraction by the 18 water users is 0.170 m^3/s or 14,688 m^3/day. There were 12 abstractors identified during the field visit and we can assume that half of the water is allocated to these: that is 0.085 m^3/s or 7,344 m^3/day. 75% of the water is for irrigation and is expected to come from flood flows. Since the demand for irrigation depends on the irrigation water requirements, it is not clear how this abstracted water is distributed over the year. However, we expect very little abstraction during the months of rain and peak demand during the dry months.

Table 4.8: Water balance at proposed Aguthi Intake (m^3/day)

Month	Q95 (m^3/day)	Q80 (m^3/day)	Q50 (m^3/day)	ADW(Q80-Q95) (m^3/day)	AIW(Q50-Q80) (m^3/day)
Jan	880	1,531	5,414	651	3,882
Feb	132	793	2,704	661	1,910
Mar	257	2,611	7,591	2,355	4,980
Apr	5,039	13,329	29,029	8,290	15,700
May	9,542	14,284	25,481	4,742	11,197
Jun	1,978	4,798	9,011	2,821	4,212
Jul	1,048	3,391	5,805	2,343	2,415
Aug	3,227	5,933	10,748	2,707	4,815
Sep	1,597	8,650	17,290	7,053	8,640
Oct	8,219	10,252	20,079	2,034	9,827
Nov	8,690	18,599	31,235	9,909	12,636
Dec	2,054	5,647	17,767	3,593	12,120

The flow data obtained from Water Resources Authority was not naturalized. Although the permit data was obtained, it was difficult to know the actual water abstraction for the purpose of naturalizing the flow. Table 4.9 gives the net available domestic water (ADW) and available irrigation water (AIW) after abstraction has taken place.

Assuming there were no abstractions taking place the total available water would be ~4,200 m^3/day for normal flows and ~14,000 m^3/day for flood flows. We estimate that the current intake for Ndiriti Aguthi can supply a maximum of 2,347 m^3/day for normal flows and 8,403 m^3/day for flood flows. Kabunda dam site on the other hand can supply ~200 m^3/day for normal flows and ~750 m^3/day for flood flows.

Table 4.9: Water balance at Aguthi intake

	Net after current abstraction: Aguthi Intake (m^3/day)	Allocated flow upstream of Aguthi (m^3/day)	Available water if no abstractions
Q95	369		
Q80	2,716		
Q50	11,119		
Normal flow (Q80-Q95)	2,347	1,836	4,183
Flood flow (Q50-Q80)	8,403	5,508	13,911

4.2.10 Impacts to downstream users

Irrigation is supposed to be obtained from flood flows and therefore the construction of storage reservoirs is obligatory. Flood water can be harvested over the two rain seasons of MAM and OND. The amounts that can be harvested are shown in Table 4. If a storage reservoir sufficient to meet the irrigation demand is constructed and flow control devices installed at the intake to regulate the amount of water diverted to the dam, there will be no negative impacts to downstream water users.

4.3 Topography

The ground slopes gently from the eastern to western side, the altitude ranging between 1800 m and 1900 m above sea level

4.4 Geology

The geology of the project area consists of brown volcanic soil, Lateritic materials overlying a successive matrix of weathering products of clay which are interrupted by Basaltic, Phonolitic, Tuffaceous and Trachytic layers. Between these lava flows are the old land surfaces which are usually highly aquiferous.

4.5 Agriculture and Agronomy

Agriculture in Kieni East Sub-County is carried out on 570 Km2 (5700 Ha) of land which is arable and suitable for crop production. Food and horticulture industry is one of the main sources of income in the Sub County and over 70% of the farm families are employed directly or indirectly by the industry. The total number of farmers in the Sub-county is estimated at 21,753. The sector has however been adversely affected by prevailing economic trends with many exporting companies closing and cancelling contracts with contracted farmer groups e.g. Home grown exporter and Everest. The horticulture sector plays an important role in Ndiriti Sub Location employing 60% of the population (1200 persons- 2009 census) directly or indirectly.

Agriculture in the Sub-County depends mainly on the short rains as the major season and most water is harvested in this season. Marketing of farm produce by the farmers in the area has been a problem especially with the exit of some horticultural companies in the area for example homegrown. This has left 25 farming groups with no further market linkage to sell their produce.

Some of horticultural crops grown are cabbages, bulb onions, spring onions, potatoes, kales, shallots, Field beans, snow peas, French beans, garlic, broccoli, cauliflower, sugar snaps, carrots, tomatoes, capsicum,

Courgette, Cut flowers Statice and Arabicum and Ammi, . fruit tree tomatoes, Avocadoes and macadamia. Plate 4 2: shows mixed farming and irrigated vegetables for sell

Plate 4-2: Mixed Farming and irrigated vegetables

The crops are mainly grown under micro irrigation & with most being rain fed and supplemented from various water sources.

Plate 4-3: Flowers and Citrus fruits for commercial farming

The ranking of crops in terms of contribution to food and income is as shown in the table below ranging from 1- (highest) to 4- (lowest.)

Table 4.10: Ranking of crops in terms of contribution to food and income

CROP	Contribution to food	Contribution to income
Mixed Horticulture	1	2
Potato	2	1
Beans	3	3
Maize	4	4

4.5.1 Collaborators in Horticulture Industry

Table 4.11: Collaborators in Horticulture Industry

Name of Collaborator	Activities undertaken during the year	Remarks
Fresh Produce Exports (AAA, Vegpro, Homegrown, Wilmar, Maara etc)	Marketing of vegetables and cut flowers for export, extension services to farmer groups on production, pruning and pest & diseases control.	Main exporting agencies
Agro input Companies (Osho, Syngenta, bayer, green life, agrosolutions, mavuno fertilizers, Toyota Tshusho, etc	Crop protection and fertilizer application through farmers training during field days.	Extension services on Agric-inputs
Seed companies	Carry out demonstrations on new varieties in various farms in the division. E.g East Africa Seed companies which have given farmers seeds for demonstrations of new cabbage and carrots varieties.	
Earth oil limited	Provision of tee tree seedlings	Processing of essential oils.

Harvesting of farm produce is dictated by planting programme, company quotas and crop husbandry techniques.

4.5.2 Seasonal calendar

Agriculture activities in the area follow a seasonal calendar as indicated below:

January Harvesting of potatoes, beans, wheat.

February Land preparation.

March Land preparation and Planting.

April Late planting and Weeding.

May Weeding and spraying

June Early/ premature harvesting of potatoes, peas.

July Harvesting beans, potatoes, peas and wheat.

August Land preparation and harvesting.

September Land preparation and early planting.

October Planting of maize, beans, potatoes, wheat and peas.

November Weeding, spraying and tree planting

December Premature harvesting of potatoes, peas and tree planting.

NB: The above activities are subject to onset of rain or availability of water for irrigation.

4.5.3 Marketing.

Harvested local market crops find their outlets to both local and outside markets of Nyeri, Karatina, Nanyuki, Kagio, Nakuru, Nairobi and Mombasa.

4.6 Soils and Land suitability

4.6.1 Project Site Soil Characterization

A survey was carried out and the project area divided into 6 zones whose soil characteristic was studied as shown in Table 4.12. Figure the division of study area into zones

Table 4.12: Project Site Soil Characterization

S/No	Zone	Soil Ecological Zone (FAO-Class)	Dominant Soils
1)	LENANA	VC	Valley complex soils- Geysols; Fluvisols; Cambisols; Vertisols
2)	KAHUHO	LB3	Plateau soils of high to moderate fertility-Ortholuvic Phaeozems, with Chromic Luvisols
3)	KABENDERA	LB3/RB4	Plateau soils of high to moderate fertility-Ortholuvic Phaeozems, with Chromic Luvisols /Volcanic footridges, fertile but very erodible, Nito-Ferric Luvisols with Humic Nitisols
4)	MURUA	LB3/RB4	Plateau soils of high to moderate fertility-Ortholuvic Phaeozems, with Chromic Luvisols /Volcanic footridges, fertile but very erodible, Nito-Ferric Luvisols with Humic Nitisols
5)	CENTRAL	LB3	Plateau soils of high to moderate fertility-Ortholuvic Phaeozems, with Chromic Luvisols
6)	RONGAI	LB3	Plateau soils of high to moderate fertility-Ortholuvic Phaeozems, with Chromic Luvisols
KEY VC-Valley complex soils LB3-Plateau soils of high to moderate fertility RB4-Volcanic foot ridges, fertile soils but very erodible			

4.6.2 Map of Zones Within the Project Area

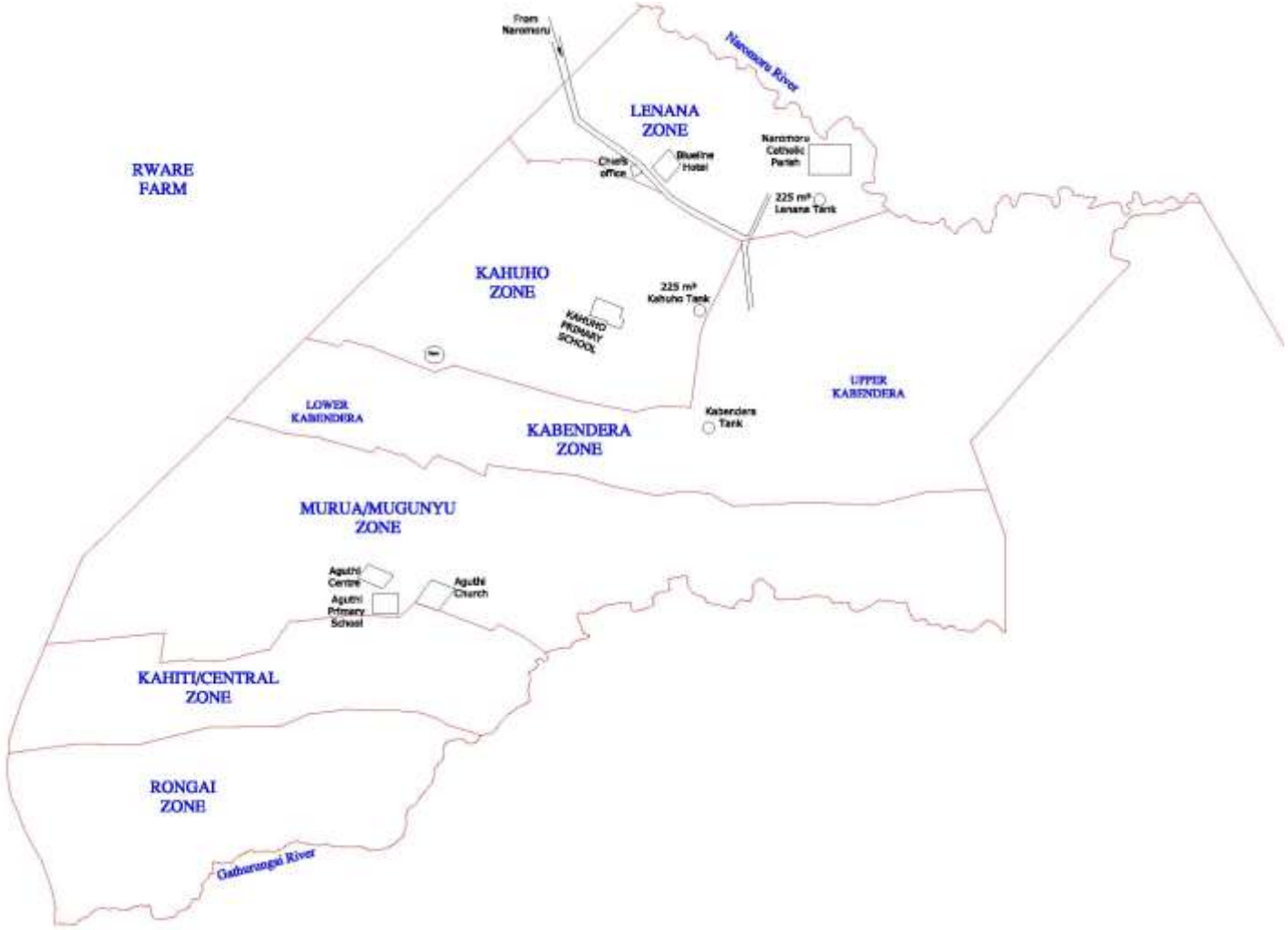


Figure 4.12:: Division of Study Area into Zones

4.6.3 Soil Map and Characterization

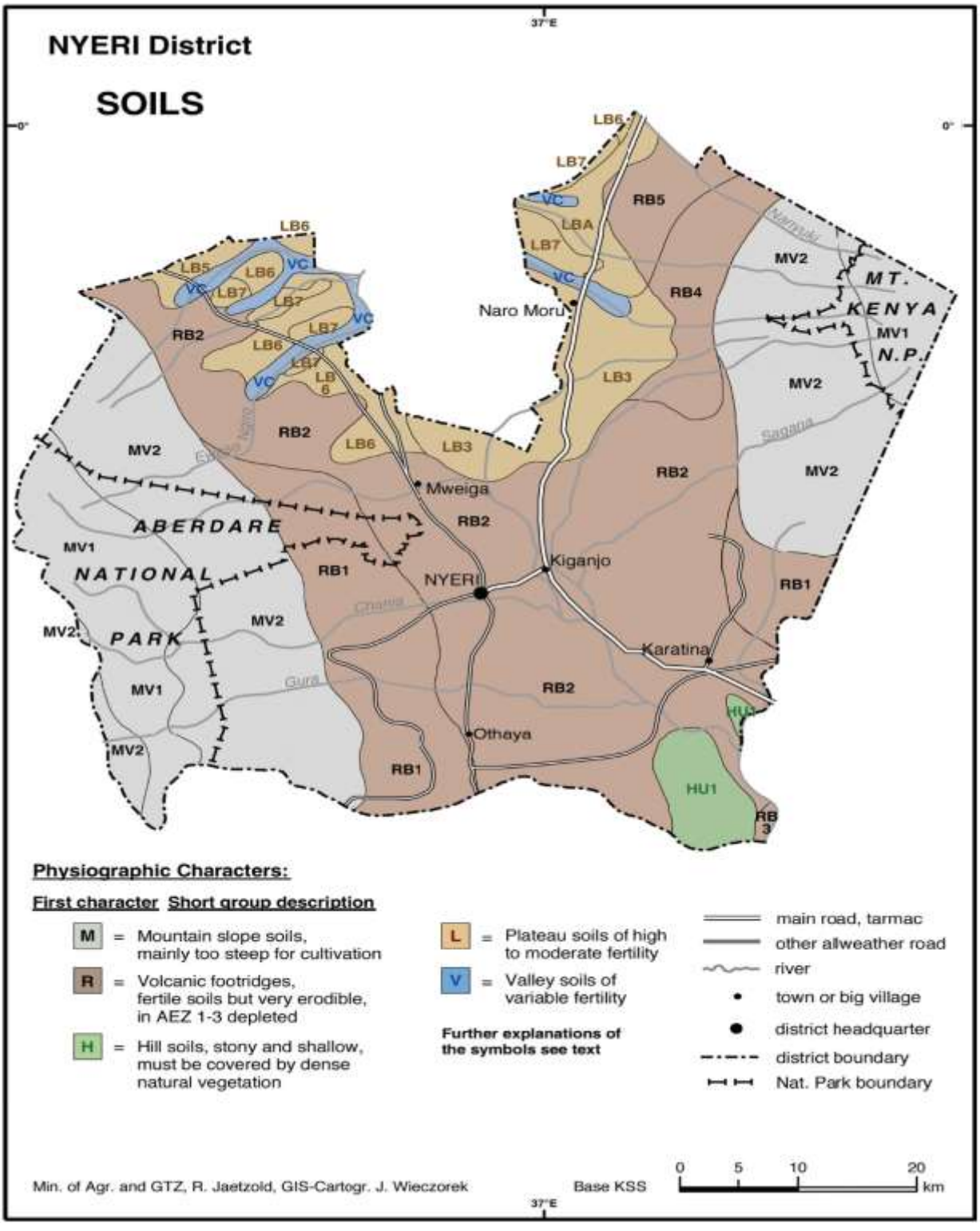


Figure 4.13: Site soils Suitability Map

4.6.4 Current land use

The current land use in the catchment comprises of Moorland in the upper zone, Forest in the middle zone and small holder agriculture in the lower zone (Figure 4). The farmers grow potatoes, cabbages, carrots, peas and beans among other crops for subsistence and for sale. They also keep cows and sheep.

The moorland and forest areas lie in the Mount Kenya National Park and Mount Kenya Forest under the jurisdiction of Kenya Wildlife Service and Kenya Forest Service while the agricultural land is under individual land tenure.

Figure 4.14: Current land use asrepresented by Google-Earth image

4.6.5 Results of the Soil Study

Results from the six (**6)** zones indicated that they were all suitable for irrigated agriculture. However, OC and N levels in all the Zones were low and could be improved by application of organic fertilizers (FYM) or Nitrogen-rich fertilizers. Moreover, Crop rotation with leguminous plants should be practiced to improve Nitrogen levels gradually. The soil pH for all the zones in the project site were rated as suitable. However, **Murua** and **Central** zone exhibited seemingly higher pH levels of up to 8.2 and 8.4 respectively which could affect availability of micronutrients in the long run.

Bulk density (g/cm^3) results from all the zones indicated that they were all optimum for soil water movement and crop root development. However, **Lenana** and **Kahuho** exhibited some degree of hardpan formation. Other than OC and N levels, which were rated as moderately/marginally suitable, the soils in the zones exhibited suitable chemical and physical characteristics for irrigated agriculture.

Kahuho zone has the most ideal slope (class A/B - 0.2-4.0%), for most irrigation methods which is very ideal for most irrigation methods. However, permeability (infiltration) results indicated that the zone experiences high water table thus application of irrigation water should be controlled to avoid water logging. Soil pF (water release/water retention) was moderately suitable but should be improved through proper tillage practices as well as addition of FYM. The zone had suitable soil physical and chemical characteristics (apart from OC and N) for irrigated agriculture. **Kabendera** zone had the most optimum pH range (6.0) as well as drainage pattern.

The soils in Rongai were imperfectly drained hence exhibits water logging in some places. **Murua** zone had shallow soils, which affect crop rooting and water holding capacity thus requiring close irrigation scheduling to meet crop water requirement. **Central** zone exhibited high Phosphorus levels, which could interfere with uptake of other elements such as; Iron, Manganese and Zinc. A recommendation is made to limit Phosphoric fertilizers particularly compound fertilizers with high amounts of P. The zone had the highest level of Organic Carbon compared to other zones although (still) below the recommended range.

4.6.6 Recommendations of the Soil Study

Soils of all the six (6) zones under investigation exhibited low Organic Carbon content (<3%), therefore organic manure /fertilizer should be applied to improve OC content, water holding capacity and soil structure.

During early irrigation stages, excess water should be applied to leach salts in areas with seemingly high alkalinity levels (>8.0). This was particularly observed in **Murua** and **Central** Zones.

Soils from **Central** zones had high levels of Phosphorus. Use of compound fertilizers with low Phosphorus content should be considered in these Zones. Excess phosphorus affects the uptake of micronutrients (e.g. Boron, Iron Manganese and Zinc) by plants.

Trials on conservation tillage/agriculture practices should be embraced to reduce on energy use, water loss and overall returns.

Establishing appropriate cropping patterns was highly recommended to gradually improve soil structure and fertility levels.

Kahuho, parts of **Rongai** as well as **Central** zones exhibited poor soil permeability as indicated by infiltration results. Moreover, the zones had accumulation of water in the lower horizons of the profile pits. Water application during irrigation should be monitored especially in areas with high water table to alleviate water-logging.

4.7 Water Quality Study

This section contains the results of quality analysis of water samples that were collected from the sources of water for the existing and proposed improvement of Ndiriti Aguthi Irrigation Scheme in Nyeri County. The report also contains our interpretation of the results. The sources of water for this scheme include the reservoir located at (coordinates 37N 0285427and UTM 9981196 with elevation asl of 2074 m), borehole located at (coordinates 37N 0282802 and UTM 9979294 with elevation asl of 2073 m) and the River Naromoru sampling points located at 37N 0283384 (at the intake) and UTM 9980718 with elevation asl of 2042 m. The purpose of the analysis was to ascertain the suitability of the water from these sources with regard to domestic and irrigation applications.

Samples of water were collected by the consultant on 29th September, 2018 as shown in Table 8-1 in close liaison with the scheme's committee members. The samples were delivered to the Public Health Engineering Lab at the Department of Civil and Construction Engineering, University of Nairobi to be analyzed for physical, chemical and bacteriological quality.

For the purposes of comparing the quality results to the acceptable limits for domestic and irrigation purposes, reference was made to the NEMA Quality Standards for Sources of Domestic and Irrigation Water, WHO Guidelines for Drinking Water Quality, 2011 and KEBS Standards for Drinking Water.

The results of the laboratory analysis on the water samples are as shown in Table 4.13.

Table 4.13: Water Sampling Points

Sample No.	Source of water	Exact sampling point	Number of samples collected for	
			Physical and Chemical quality	Bacteriological quality
1	River Naromoru	Existing river intake	1	1
2	Dam	Outlet pipe	1	1
3	Borehole	Direct pipe	1	1
Total			**3**	**3**

There should be concern if the drinking water contains any of the following:

4.7.1 Physical Properties

a) Turbidity (i.e. the presence of material in suspension rather than in solution) and
b) Unpleasant physical characteristics such as bitter, hard, odiferous, cloudy (or tinted) conditions.

4.7.2 Chemical Properties

a) Presence of nutrients especially Nitrates and Nitrites;
b) High concentrations of Sodium, Chloride and Hydrogen Sulphide;
c) Excess levels of Iron and Manganese;
d) Toxic elements such as Lead, Selenium and Arsenic;
e) Dissolved solids such as organic, inorganic or toxic elements and
f) Industrial chemicals or toxins.

Careful and complete monitoring of private and public water supplies is a necessity since they provide drinking water for domestic and for consumption by human and animals. When the chemical properties of water exceeded acceptable limits for intended use, water quality is impaired.

4.7.3 Microbial contamination

a) High concentrations of bacteria particularly coliform and e-coli .

The most common tests for physical, chemical and microbiological water quality analysis are:

a) Physical which includes turbidity, color, taste, odour and temperature;
b) Chemical which includes pH, total alkalinity, hardness, salts, chlorine, fluoride, dissolved oxygen, metals etc. and

- Bacteriological which includes determination of disease-causing pathogens
- .

Table 4.14: Comparison of water analysis results to the standards

Feasibility Study, Design, Tender Document Preparation and Supervision for Construction of Ndiriti Aguthi Irrigation Scheme in Nyeri County									
WATER QUALITY ANALYSIS: CHEMICAL AND BACTERIOLOGICAL								**DATE: 29TH SEPTEMBER, 2018**	
Parameter	**SAMPLE 1 River NaroMoro**	**SAMPLE 2 Dam Water**	**SAMPLE 3 Borehole water**	**WHO Guidelines for drinking water**	**KEBS Guidelines for drinking water**	**NEMA Quality Standards for Sources of Domestic Water**	**NEMA Standards for Irrigation Water**	**Remarks for**	
								Domestic water	**Irrigation water**
Physical and chemical quality									
pH	6.55	7.49	7.68	6.5-8.5	6.5-8.5	6.5-8.5		satisfactory	
Apparent Colour, °H	5	15	5					satisfactory	
True Colour, °H	5	10	5	15	15				
Conductivity, µ/S/CM, mg/l	20	112	525	4000		4000	(50-500)	satisfactory	satisfactory
Turbidity (F.T.U.)	0.8	6.7	1.1	5.0	5.0	5.0		satisfactory	
Calcium Hardness as $CaCO_3$, mg/l	2		8.0					satisfactory	
Total Hardness as $CaCO_3$, mg/l	6	24	28	75-200	500	75-200			
Total Alkalinity as CaCO3, mg/l	20	72	235	100		100			
Carbonate Alkalinity, mg/l	0	0	0						
Iron (Fe), mg/l	0.2	0.3	0.4	0.3	0.3	0.3	1	satisfactory	satisfactory
Fluoride (F), mg/l	0.05	0.40	1.52	1.50	1.50	1.5	1	satisfactory	satisfactory
Sulphates (SO_4^{2-}), mg/l	0	20	25	250	400	250		satisfactory	
Dissolved Oxygen, p.p.m.	6.80	6.7	6.30			100		satisfactory	
Nitrates (NO_3)	0.8	0.5	5.0	45.0	10.0	10		satisfactory	
Nitrites (NO_2)	0.0	0.0	0.0	0.0		3		satisfactory	
Chlorides (Cl)	24	32	114	250		250		satisfactory	
Dissolved Solids, mg/l	60	290	430	500		1200	1200	satisfactory	satisfactory
Suspended Solids, mg/l	0	110	0			30		satisfactory	
Total Solids, mg/l	60	400	430						
Biochemical Oxygen Demand, mg/l									
Chemical Oxygen Demand, mg/l									
Residual chlorine (FRC)						0.5			
Bacteriological quality									
Plate/Colony/Total Viable Counts at 37°C									
MPN of coliform organisms	5	20	0	3	Nil	3		unsatisfactory for river and dam	
MPN of E-coli	0	0	0	Nil	Nil	Nil	Nil	satisfactory	satisfactory

5 SOCIO-ECONOMICS REPORT

5.1 Respondents Characteristics

5.1.1 Baseline and Demographic Characteristics

Information used in the analysis and preparation of this report was collected from 326 respondents (household heads with 47% being males and 53% females), this number reduced to 318 after data cleaning. The gender distribution varied across the study locations (Table 5-1). Generally, the female subset ratio was higher compared to males. This ratio however concurs with the documented statistics in the general Kenyan population. For instance, in 2015, there were 98.81 males per 100 females in the country's demographic trends (World Data Atlas, 2015).

Table 5-1 Distribution of respondents by Zone based on Gender

	Cross Tabulation of Respondents per Zone						
	Central	**Kabendera**	**Kahuho**	**Lenana**	**Murua**	**Rongai**	**TOTAL**
Female	34	24	43	27	24	21	**173**
Male	19	29	13	31	27	34	**153**
Total	**53**	**53**	**56**	**58**	**51**	**55**	**326**

***Total Population – 326; Females – 173; Males – 153

Figure 5.1 indicates the variation in family sizes of the respondents in Kieni East. The largest family proportion had 4-6 members (51.8%) while smallest percentage was comprised of 7-9 members per household (12.6%). In addition, the 4-6 family size was dominated by household heads in the 30-59-year age bracket. However, majority of these household heads (respondents) were in the age bracket of 45-59 (34.4%) indicating an active and dynamic population followed closely by the 30-34 years. The lowest ages of the heads of households interviewed were between 18-29 years (3.9%) (Figure 5.2).

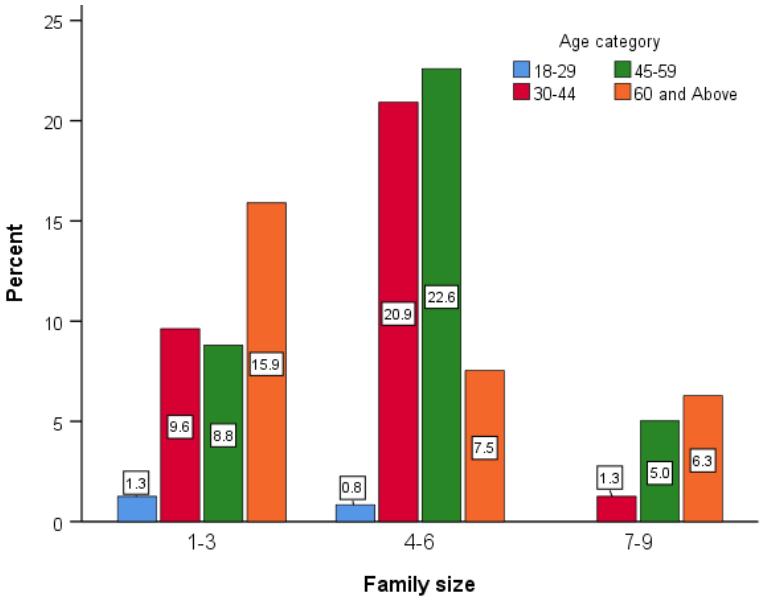


Figure 5.1 Composition and distribution of household family size across the age categories of house heads.

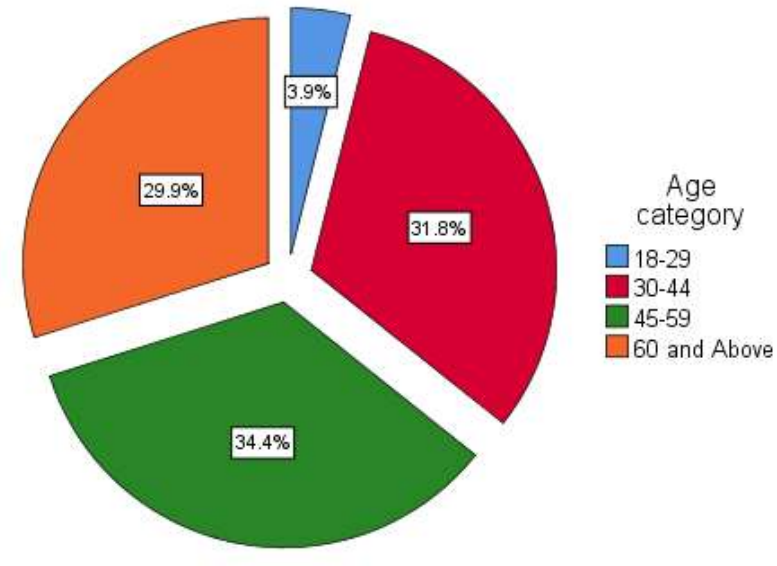


Figure 5.2 Segregation of household heads by dominant age-groups

The level of education levels of the respondents also varied with age (Figure 5.3). Majority of the respondents had primary level education, representing 46.9% of the household head population. This observation is similar to Kenya's National education level statistics according to the Kenya Institute of Policy and Public Research (KIPPRA) in 2013, indicating that a majority of rural populations have primary level of education. This is the basic certification level in the Country and qualifies holders for trained in various life skills such as agricultural practices, artisan and basic management as well as advanced level education (Odebero, Maiyo & Mualuko, 2007). Therefore, the population are viable for inclusion in the irrigation project as they can have training on better and applicable technology that will accompany the investment option.

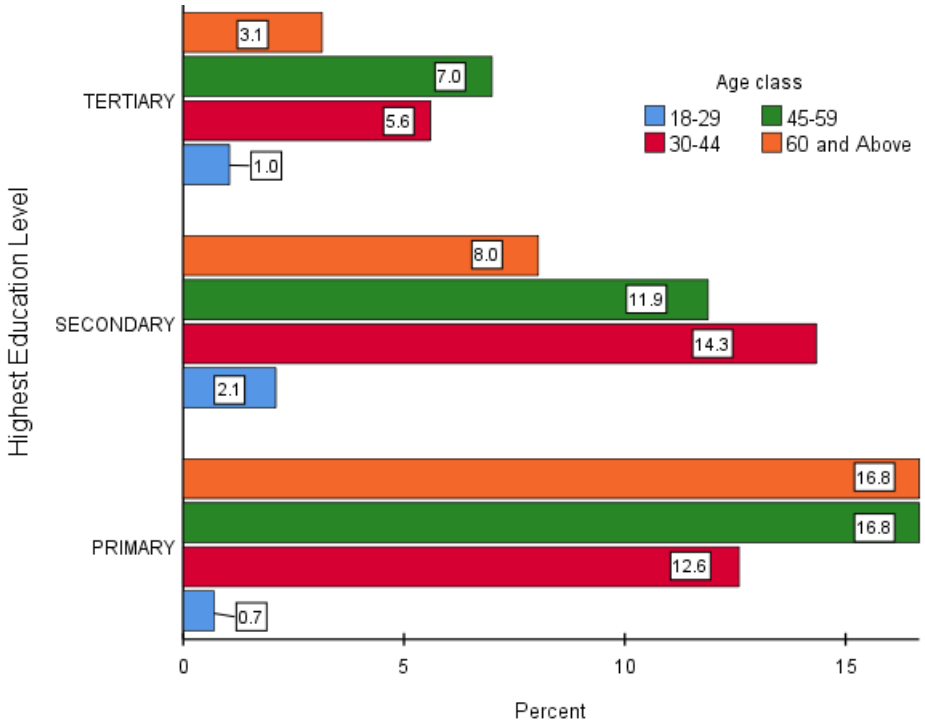


Figure 5.3 Level of education with the age differences of the household heads

A comparison of family across the six zones displayed an erratic pattern with 42% of respondents in Lenana recording 1-3 members followed by Central zone where 24% of households also falling under this size range. Rongai on the other hand, had the highest percentage of households with 4-6 family members category at 31%, Kahuho second at 23% while Kabendera gave the lowest score of 3% in the same

group. In the 7-9-member size-group, Kahuho scored highest overall (47%) with Rongai zone trailing from a distance at less than half this value (20%). In summary, Rongai zone was fairly represented in all the family-size classes with total percentage score of 85% (Figure 5.4)

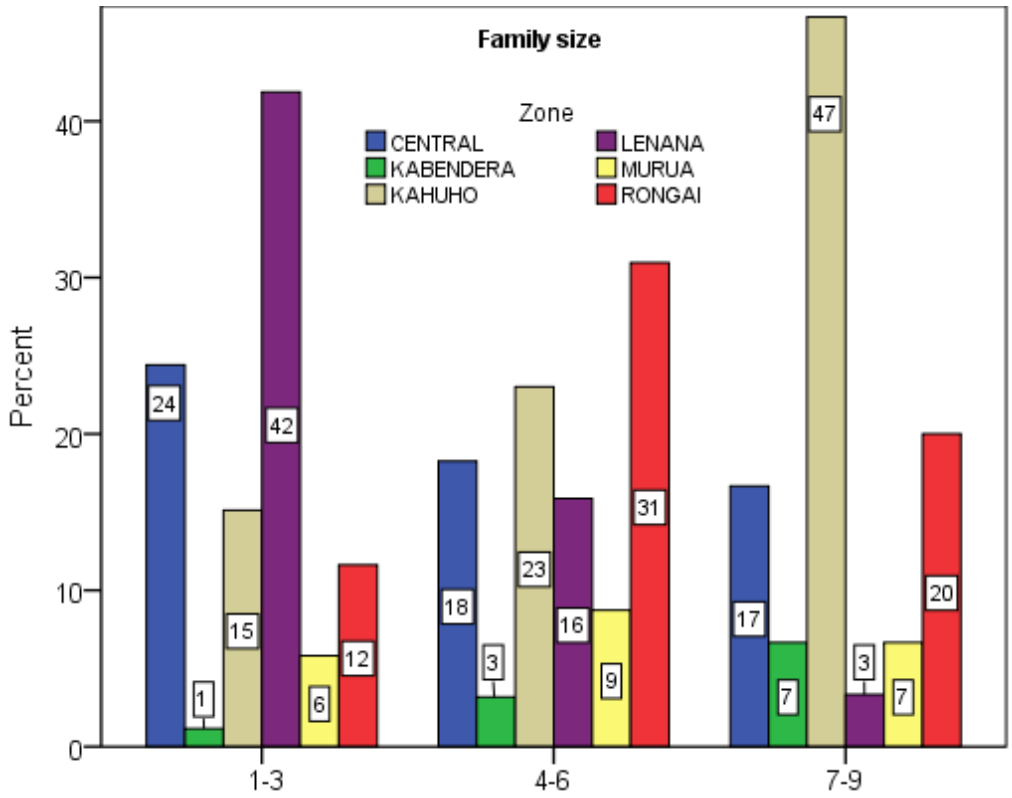


Figure 5.4: Family size distribution in each zone

In Figure 5.5, concern should be focused on the residents of both **Central** and **Lenana** where 40% of household heads had no formal education. Follow-up on heads of family at Kabendera zone where 20% had not acquired formal education is necessary. However, majority of household heads in Kahuho had attained some level of education; 33% pre-primary, 17% primary, 24% secondary and 12% post-secondary education. Two other zones, Rongai and Lenana followed a similar pattern with Central zone showing a lot of improvement at primary (16%), secondary (11) and tertiary level (25%) compared to the high level of illiteracy initially observed.

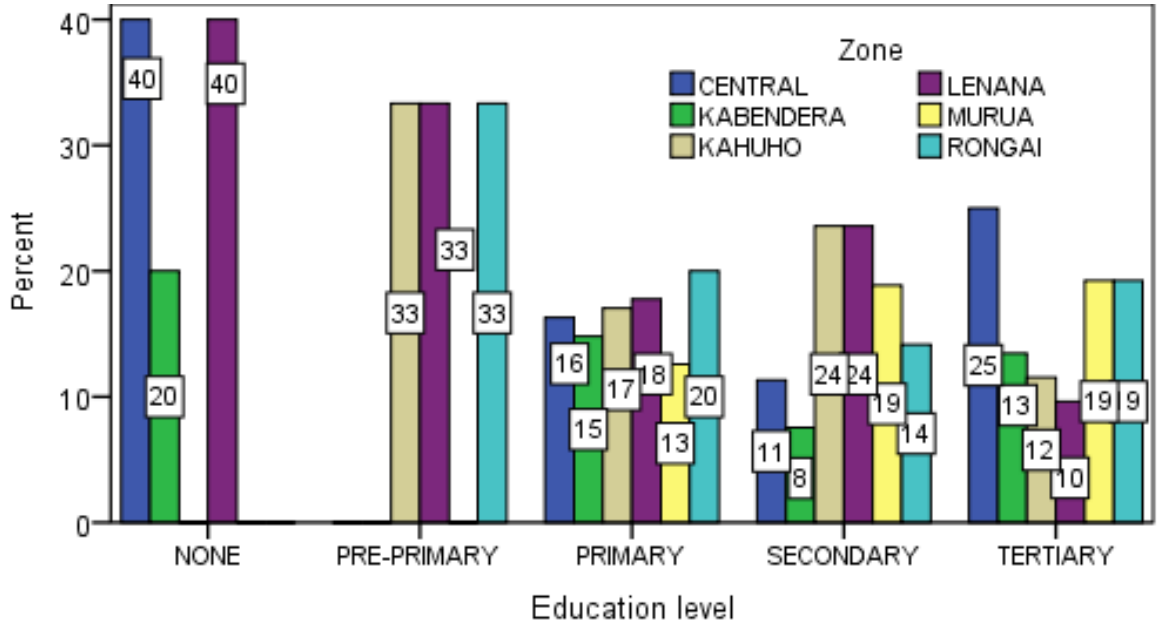


Figure 5.5: Distribution of Education Level of Household Heads across the six zones

5.1.2 Migration Trends

Most of the respondents (82.4%) were natives of the area with only a small proportion (16%) relocating into different parts of Kieni for some reason or the other. The most common reason for the resettlement at 54%, was due to purchase of land in Kieni East (Figure 5-.6). This is evidence that there is availability of land areas and space which can be further exploited for agricultural production and other economic investments. Other reasons included inheritance of ancestral land (23%), business reasons at 12% and farming at 8% and a minor 4% who just preferred to relocate for other reasons. It was notable that most of the inhabitants who responded did provide concrete economic justification for their movement into the areas. There was curiosity regarding small proportion the respondents showing that they immigration was based on a need to join the area for farming. Therefore, an irrigation scheme which would improve agricultural outcomes, has a potential improving livelihoods in the area by encouraging commercialized farming.

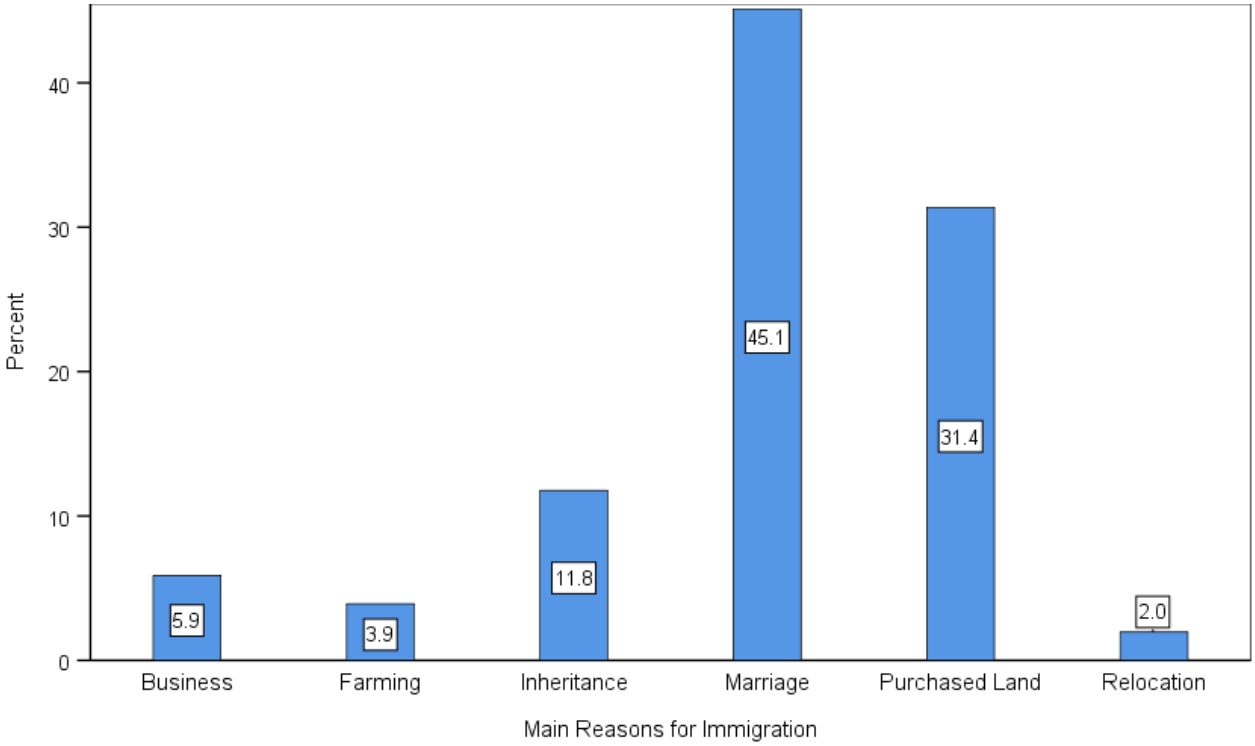


Figure 5.6 Main reasons for immigration of respondents to Kieni East

Considering the different zones, all the respondents in Rongai immigrated largely to conduct trade and at the same time settled down. About 50% of Rongai and Kahuho residents were farmers. Nearly 33% of Murua residents had inherited ancestral land and only 9% of respondents in the same zone had relocated via marriage. Over a third of Kabendera residents (38%) had immigrated in the zone to occupy purchased land but only a dismal proportion (6%) of families settled in Lenana and Rongai respectively had purchased their parcels of land as depicted in Figure 5.7.

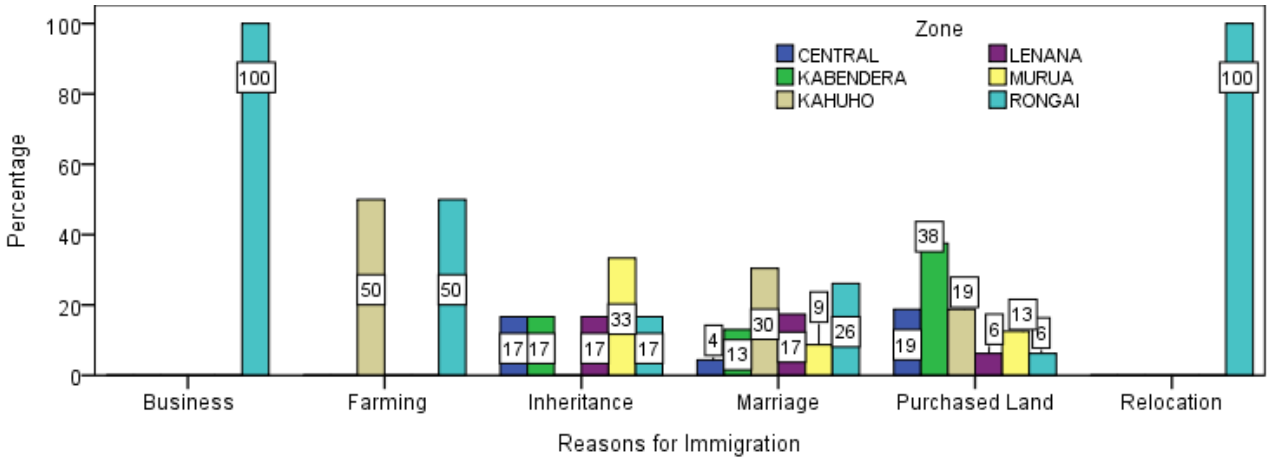


Figure 5.7: Main reasons for immigration of respondents in the different zones in Kieni East

5.1.3 Land Tenure and Housing Characteristics

5.1.4 Land Tenure

Most respondents (84.0%) owned the piece of land in which they resided. Individual purchase of land was the common (45.1%) land acquisition process, whereas the least approach was through leasing from other owners (Figure 5.8). Apart from the residential pieces, more than two-thirds (69.2%) of the respondents did not have other parcels of land in different locations. Only 13.2% had alternative land property in other locations. The land sizes are average with majority (49.4%) owning sizes ranging between 1-3 acres of land. This was almost half of the population. However, a significant of almost one-third (23.3%) own less than 1 acre. However, some respondents own large pieces of land larger than 3 acres. Land sizes greater than 3 acres would support subdivision for commercialization and still support residential options for family members. However, the population owning less than an acre would face much risk. This indicates that the proposed projects must be planned in a humane and considerate way to avoid the risk of creating displacement of residents or interfering with their long-term livelihood support base.

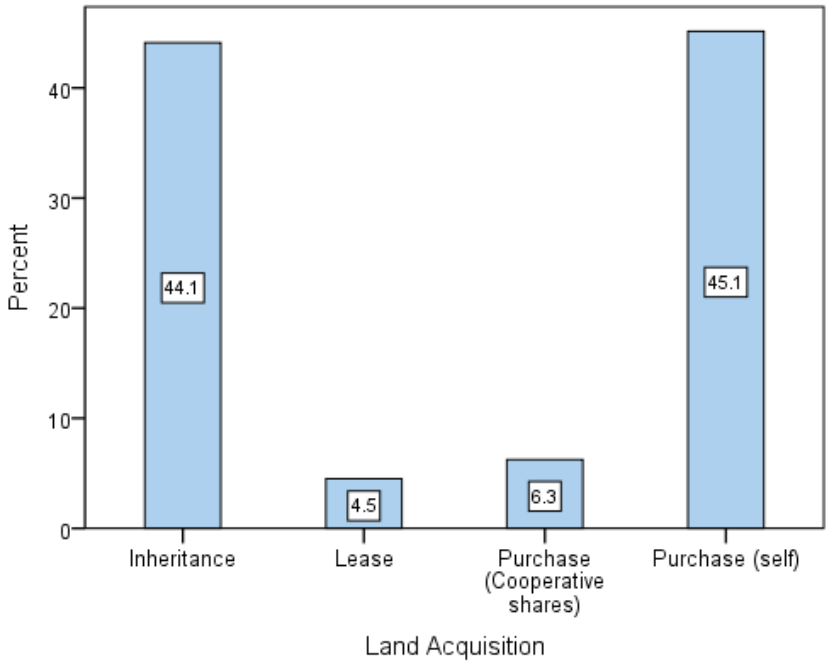


Figure 5.8 Description of the various land acquisition methods

Across the six zones as illustrated in Figure 5.9, purchase of land through co-operative shareholding was the most popular way of acquiring land in Lenana zone (67%). In Kahuho, 31% of land owners occupied under lease agreements while still others (18%) in this zone had purchased land parcels. About 20% of Rongai residents lived on ancestral land, 31% under lease and only 18% had bought land in the zone.

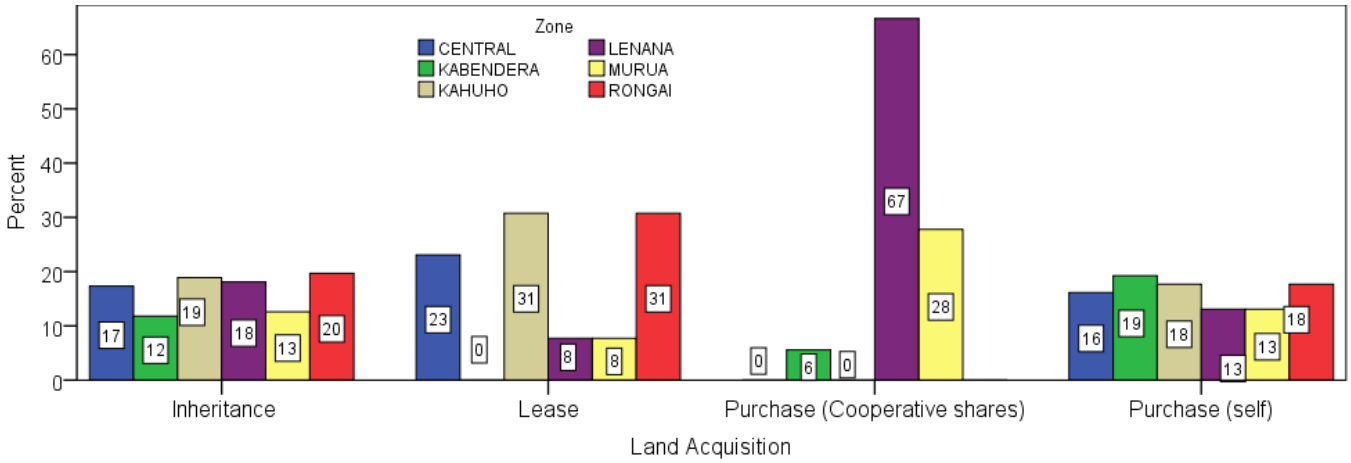


Figure 5.9: Characterization of ways of acquiring land in the different zones of Kieni East

5.1.5 Land Ownership Types

The land ownership types indicated that a great proportion of the respondents had absolute ownership and can make development decisions on their property (Figure 5.10). Title-deed ownership was the most common document (82.9%) showing property rights by the residents. A negligible proportion (2.4%) having leasehold rights. A concern should be directed on the 7% of the residents who had no form of evidence to claim ownership of the land which they occupied. Other ownership documents were temporary occupation (0.3%), allotment letters (5.2%) and titles from cooperative shares titles (1.7%). Therefore, the form of land ownership indicates that the residents can be engaged in discussions culminating in reorganizing their owned lands into the proposed project activities.

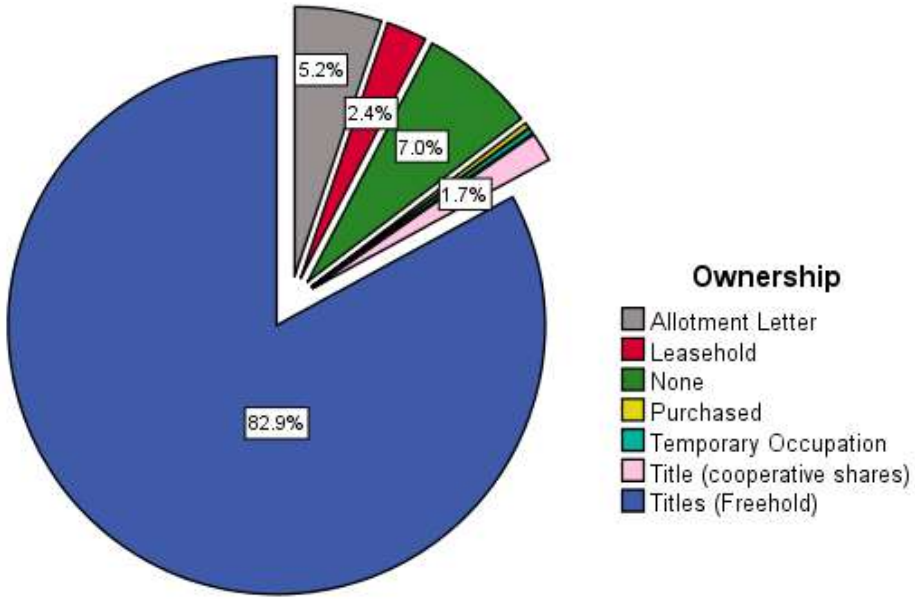


Figure 5.10 Forms of land ownership among the respondents

From Figure 5.11, about 60% of Rongai residents had allotment letters, another 16% had been issued with freehold titles and only 5% had no form of evidence of land ownership. In Kahuho, most respondents (60%) had no proof of land ownership with only 13% possessing land titles. In contrast, all the respondents from Lenana had either evidenced of purchase by self or through cooperative shareholding. Also, all Kabandera residents had been issued with temporary land occupation documents.

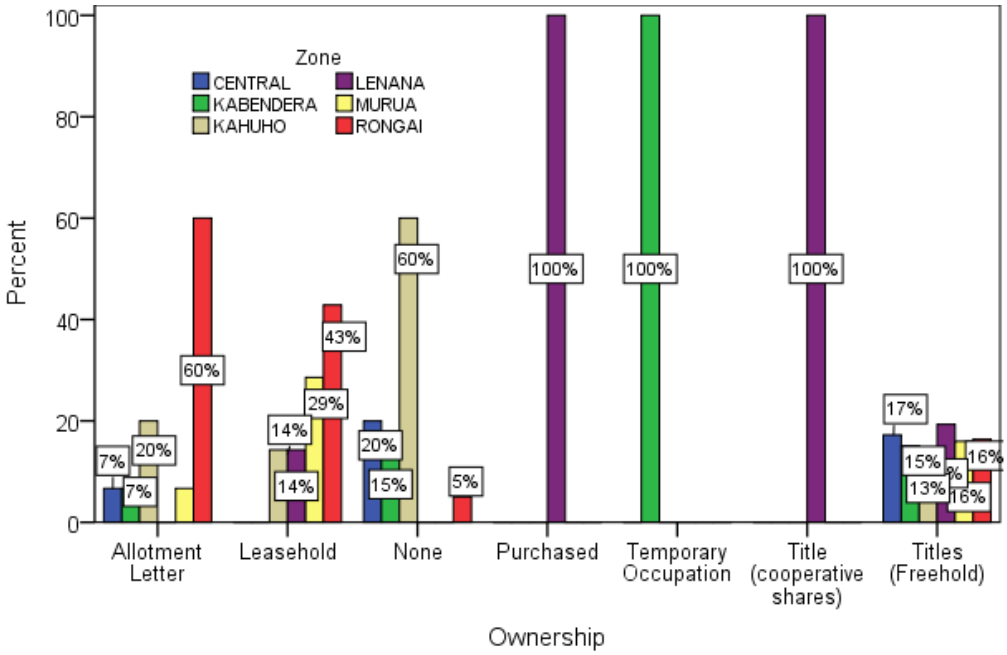


Figure 5.11: Evidence of land ownership in the different zones

5.1.6 Housing Types and Assets

5.1.7 Housing Materials

Variables on housing types analyzed shows the area have a wide range of types of houses and materials used as an indicator of economic wellbeing and equality. The key structural sections documented were the materials used for the following parts; foundation, floor, walls and roofs. These components can be used as indicators of the quality of housing which can further be correlated with income and assets. International, a decent home is a measure based on individual perception on the quality of housing. However, there are underlying structural designs and materials that would be classified as improved or non-improved housing. The study did not further review the quality of housing in terms of issues such as ventilation, age, leaking roofs, illumination etc.

Foundation of buildings play a significant role of ensuring structural stability of the superstructure. Structural engineering recommendations indicate that concrete based foundations provide better foundation, but in this study majority buildings had earthen foundation (32.4%). On the other hand, majority of the floors were cemented (45%). Roofing materials were mainly from iron sheet and tins (85.8%) and this statistic is similar to statistics from most parts of Kenya. Wood walling lead at 65.7%, this was because the area is neighbored by high forest covers and trees perform relatively well. The initial cost and maintenance cost of such facilities are equally affordable to the population. However, such structures are high risk in case of fire. In terms of environmental conservation, they encourage deforestation and have a negative impact on forest cover. Table 5-2 provides the statistics showing various housing materials used.

5.1.8 Assets

Asset ownership is quite important when gauging the level of social security and community priorities because of the opportunities and options it gives the property owner. It is a key guiding variable in addition to economic income in understanding the community or household value and basic investments. The information sharing platform documented was the ownership of Television which indicated that 67.6% owned one. This shows interest not only in information but also the access to power sources that would support use of television. However, ownership of basic means of transport at household level which was measured by ownership of bicycles and motorcycles was relatively low at 35.5% and 17.6% respectively. The statistics shows that delivery of farm products to markets would face challenges as farmers would always procure transportation services at higher cost compared to if they had their own machinery. On the other hand, car ownership was relatively low at 11%. This is consistent with socio-

economic surveys done across Kenya indicating that car ownership still ranks as a low priority among the rural populations. Ownership of tractors was documented as a variable that would inform the extent of farm mechanization. However, the study objectives did not expect that each household would own a tractor. Only 1.6% had a tractor and in most parts of the country such would be commercialized (tractor hire services) to serve more farmers hence still meet the demands of an area. Nevertheless, there is room for expansion and introduction of more machinery. Any decision towards such options should follow a comprehensive needs analysis

Table 5.2 Statistics showing housing materials

Section	Material	Percentage
Foundation	Blocks	17
	Bricks	8
	Concrete	29
	Earthen*	37
	Stone	3
	Wood	7
Floor	Cement*	51
	Concrete	4
	Cow dung	1
	Earthen	40
	Tiles	3
	Wood	1

Section	Material	Percentage
Wall	Blocks	12
	Bricks	3
	Cement	4
	Cement and Wood	0
	Corrugated Iron sheet/tin	1
	Cow dung	1
	Mud	3
	stones	2
	Wood*	74
Roof	Corrugated Iron sheet/tin*	98.9
	Wood	1.1%

*Variables that had the highest percentage proportion of use

5.2 Economic Activities

5.2.1 Household Economic Status

Spectrum of primary economic activities were evaluated to cover all activities that are intended to support household economic ventures. Some household had cross cutting income activities but the study intention was to document activities which provided the most significant livelihood support to each household. Mixed farming (85.9%) was the highest primary economic earner even though other sources complimented household income**.** Figure 5.12 illustrates the various forms of economic sources reported in the study area.

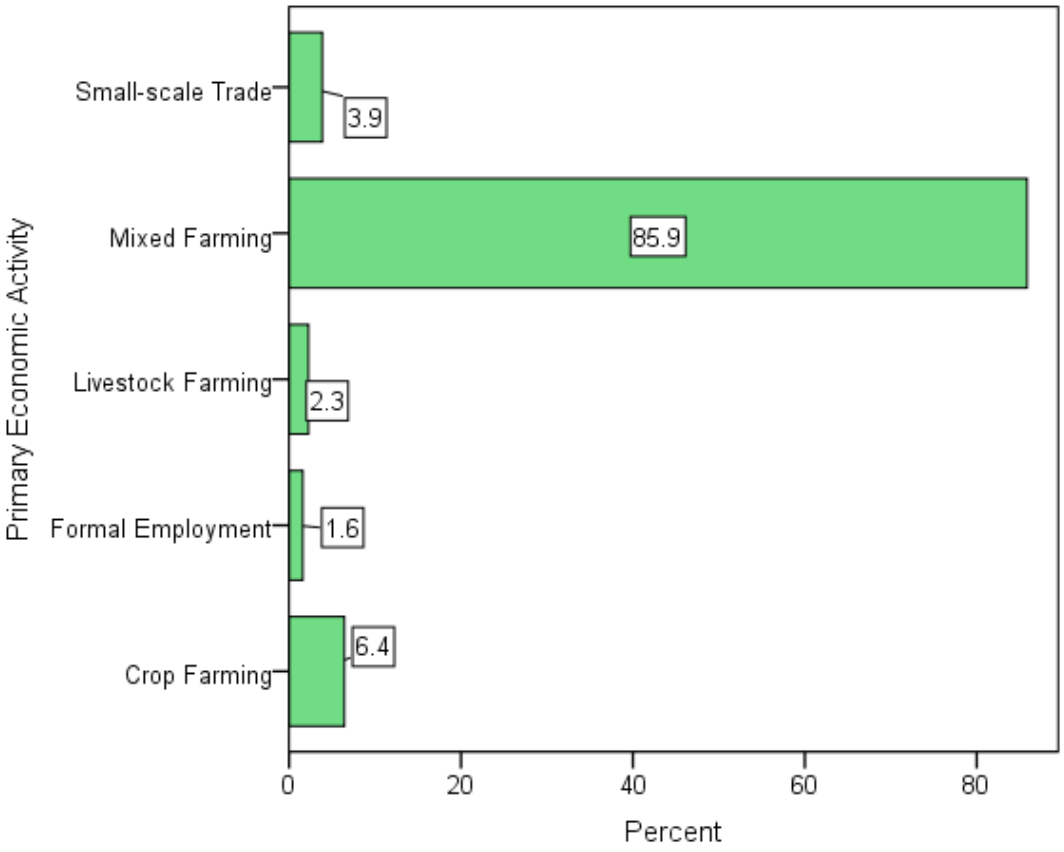


Figure 5.12 Primary source of livelihood per household

At the zonal level, majority of household heads were predominantly farmers particularly in Lenana (23.9%) and Kahuho (23.4%) while Kabendera trailed with only 7% taking up farming as the core activity for economic gain (Figure 5.13).

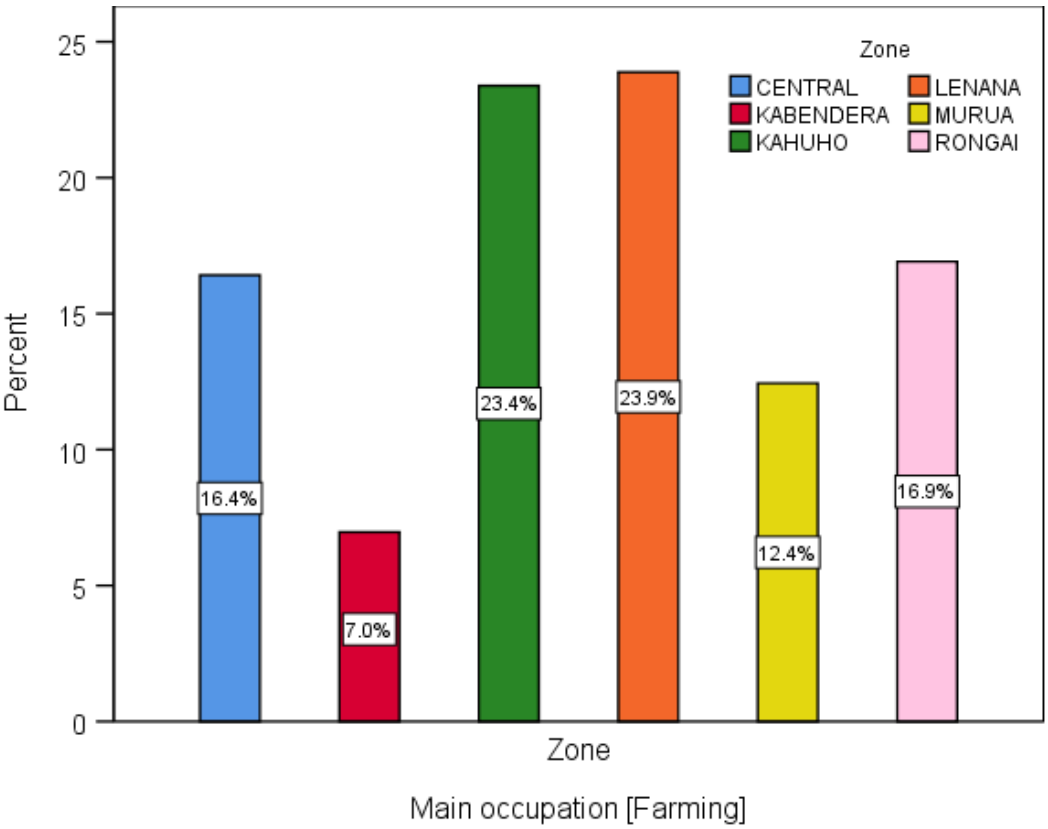


Figure 5.13 Distribution of farming as primary economic activity of household head across the six zones in Kieni

Others income generation activities included business (6%), salary (3.5%), wages and remittance (1.9%). Relationship between income and expenditure indicated high cost of expenses across the community with a difference of Kshs 1,667. The scenario may explain the lower rates of savings that was documented. Saving culture was not common and even common saving systems which are available in most parts of the country are a missing phenomenon. More than half (60.1%) of the population do not save in any form of financial institution. Therefore, improvement of incomes through income generating activities would reverse the documented scenario and improve aspects of saving across the community.

5.2.2 Three-year Agricultural Crop Farming Patterns

The main crops farmed in the study area include intercropping (maize, beans, potatoes and peas), vegetables (spinach, cabbages, kales, onions and carrots) and fodder (Napier and hay grass). The trends in the number of farmers practicing these approaches was documented from 2016 to 2018. Some cropping approaches have increased over the years with intercropping growing from 30.8% in 2016, 34.1% in 2017 and 43.7% in 2018. This shows that there may be an increase in revenues from such approaches hence positive reception from the residents.

However, vegetable production has had an irregular graph with an increase in adoption from 2016 to 2017 (7.2% to 11%) and a further great drop in 2018 to 5%. This presents a key area of concern which should be further reviewed. It may be due to market forces and other natural hazards such as weather and pests. On the other hand, issues of appropriate technology and associated management shortfalls may have contributed to the documented significant drop in production.

Most farms have small pieces of land hence animal production is mainly domiciled in small parcels. Therefore, animal production is largely supported through zero grazing and feeding them using fodder. However, a small proportion of farmers invested in fodder production in the first season with only 0.6% in the 2016 and 2017 and a further 0.9% in 2018.

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5.2.3 Challenges in Crop Production

Crop production is integral to most rural communities across the country and even small failures in agricultural output presents massive impacts on the economy, nutrition and community stability**.** Recent changes in climate have caused unpreceded challenges to agricultural communities across Kenya which include pest and diseases, extreme weather conditions etc. However, the study area faces its greatest challenge from pests and diseases which was reported by more than half of the respondents (63%). Other challenges include; extreme weather condition, 15.5%, water shortage 11.7%, lack of farm inputs 2.6%, lack of markets, 3.4%, absence of financial support, 1.8% and post-harvest losses at 2.3% (Figure 5.14). These challenges can be solved at community level to ensure involvement of all the stakeholders with an aim of long term prosperity.

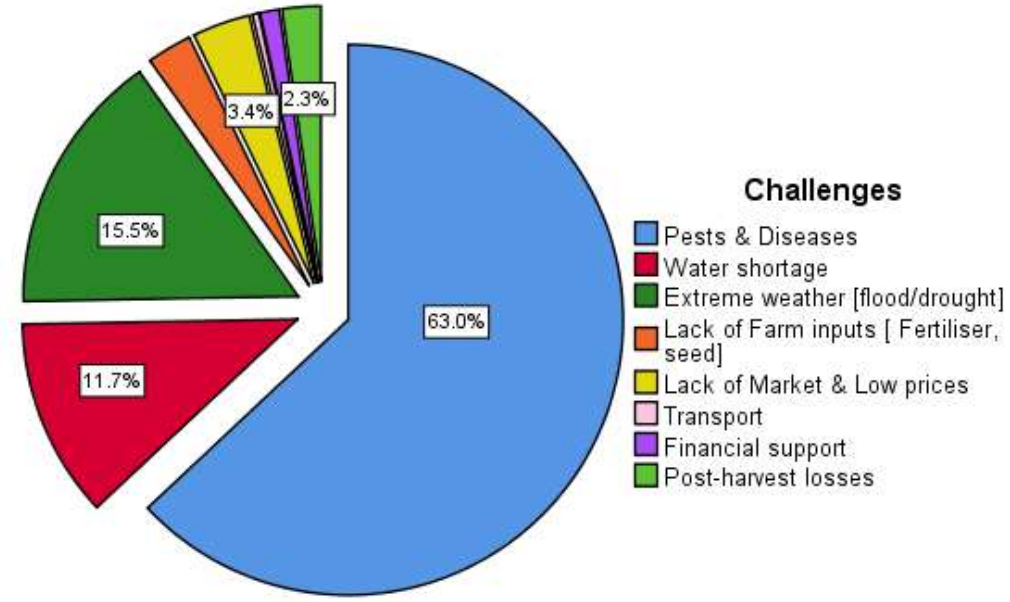

Figure 5.14 Challenges in crop farming

In Figure 5.15, about 20-25% of farmers in Kahuho, Lenana and Murua cited pest infestation and diseases as a major challenge in farming. Water shortage was a major issue in Kabendera (39%) while unpredictable weather was a concern to Central zone farmers (39%). Lack of farm inputs needed attention in Rongai whereas lack of markets coupled with low prices was a challenge again in Lenana (56%). Farmers in Central, Kahuho and Rongai equally agreed (33%) that financial support was vital in enhancing farming in the respective zones.

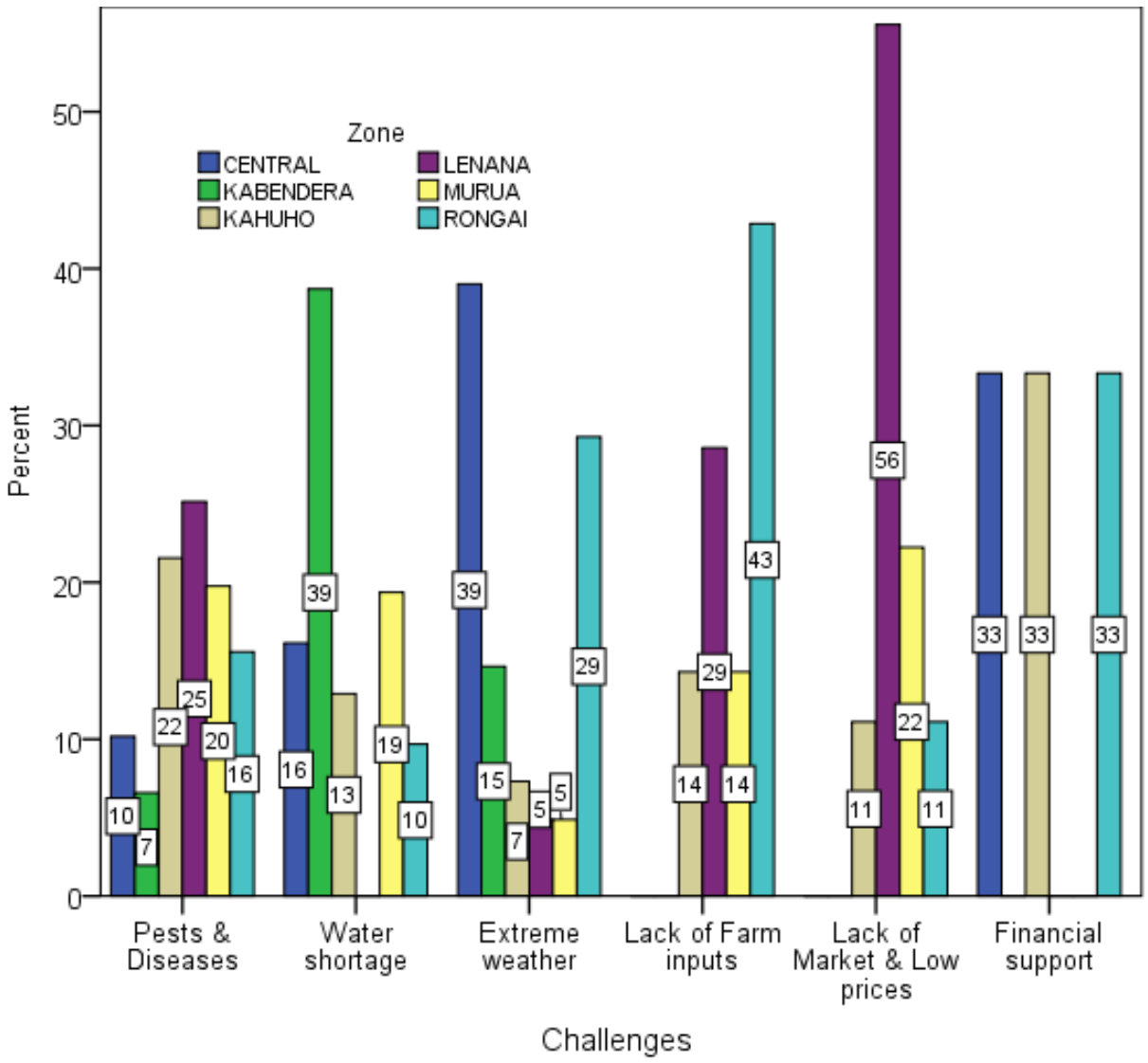

Figure 5.15: Challenges in Crop Farming by Zone

5.2.4 Current Mitigation Measures

The current mitigation measures employed across the community to the identified problems varied from household to household. It was notable that a significant population solved the key problem of pest and diseases through use of pesticides (78%). However, it was equally worrying that a large proportion did not attempt to seek direct solution to the underlying issue. This is a key area that would need attention if crop production is to improve. Figure 5.16 indicates the other actions taken by the community in solving the current problems faced by farmers.

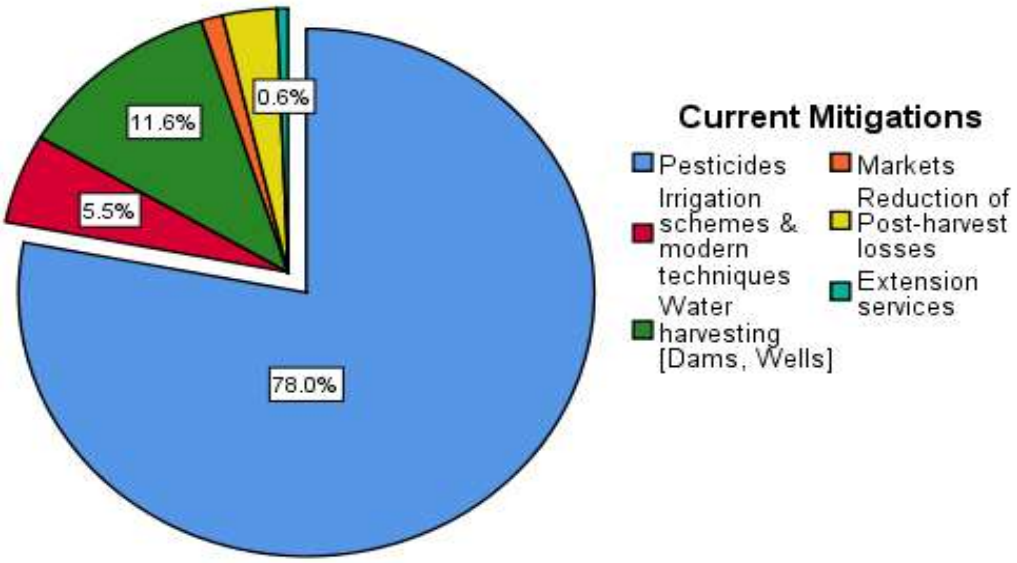

Figure 5.16 Current mitigation measures executed to solve crop farming challenges

In Figure 5.17, 33% of respondents in Kahuho proposed higher access to farm inputs, 50% of Central zone residents proposed increased water harvesting and storage infrastructure. Also, 26% of residents in Kabendera and Rongai preferred increased supply of water for agriculture. Extension services were the main concern for Rongai residents at 42% while residents of Kahuho wanted training on modern farming methods. Lenana and Murua highlighted new markets (63%) and infrastructure (67%) as proposed mitigation measures.

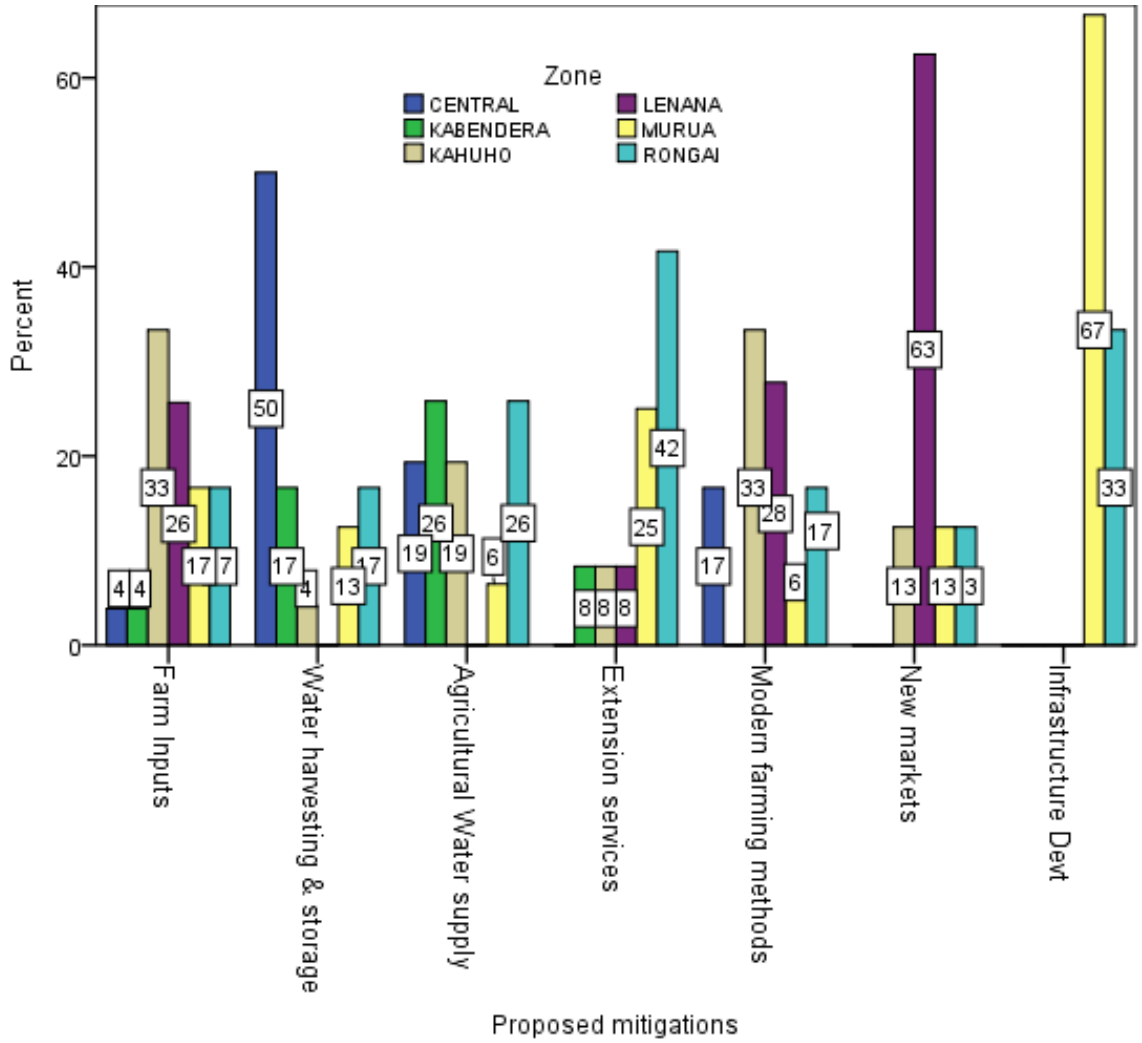

Figure 5.17: Proposed mitigations to improve crop farming for increased food production

5.3 Challenges in Livestock Farming

The challenges in livestock farming varied across the study areas but was consistent with literature reports across the region. The farmers have livestock held in controlled grazing zones or in zero grazing units. Therefore, mechanization and operations are high intensity because a great proportion is meant for milk production. The most common challenge was the high cost of veterinary services (46.2%). This is a common scenario due to the limited number of such officers plus the almost non-functional agricultural extension services within the area and across Kenya. Other challenges included; inadequate feeds (38.9%), inefficient husbandry skills (1.4%) and disease infestation (13.5%) (Figure 5.18).

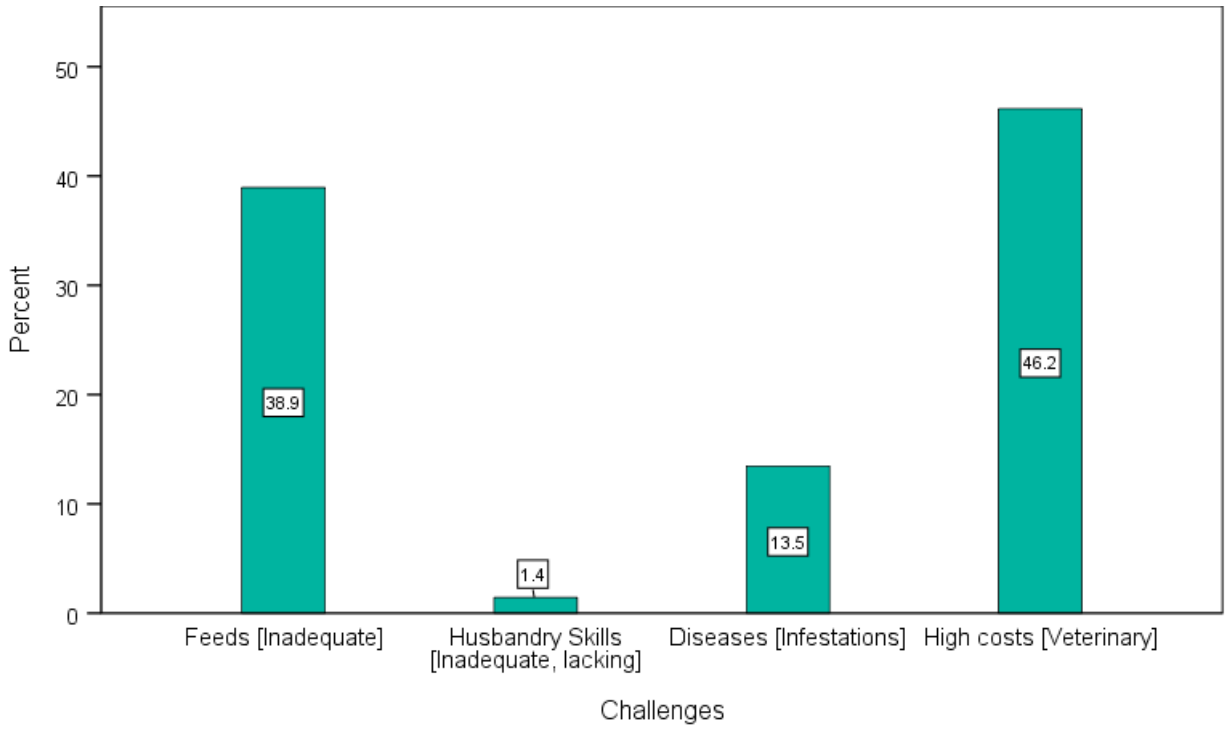

Figure 5.18 Challenges experienced by livestock farmers in Kieni East

In Figure 5.19, 27% of farmers in Murua and 25%in Lenana faced challenges in procuring adequate feeds for livestock feeds. Inadequate husbandry skills was the major challenge among farmers in Central zone (33%). Livestock diseases was a problem in Lenana and Rongai zones for 32% of farmers while 27% and 25% of farmers in Central and Kahuho zones respectively decried high cost of farm services.

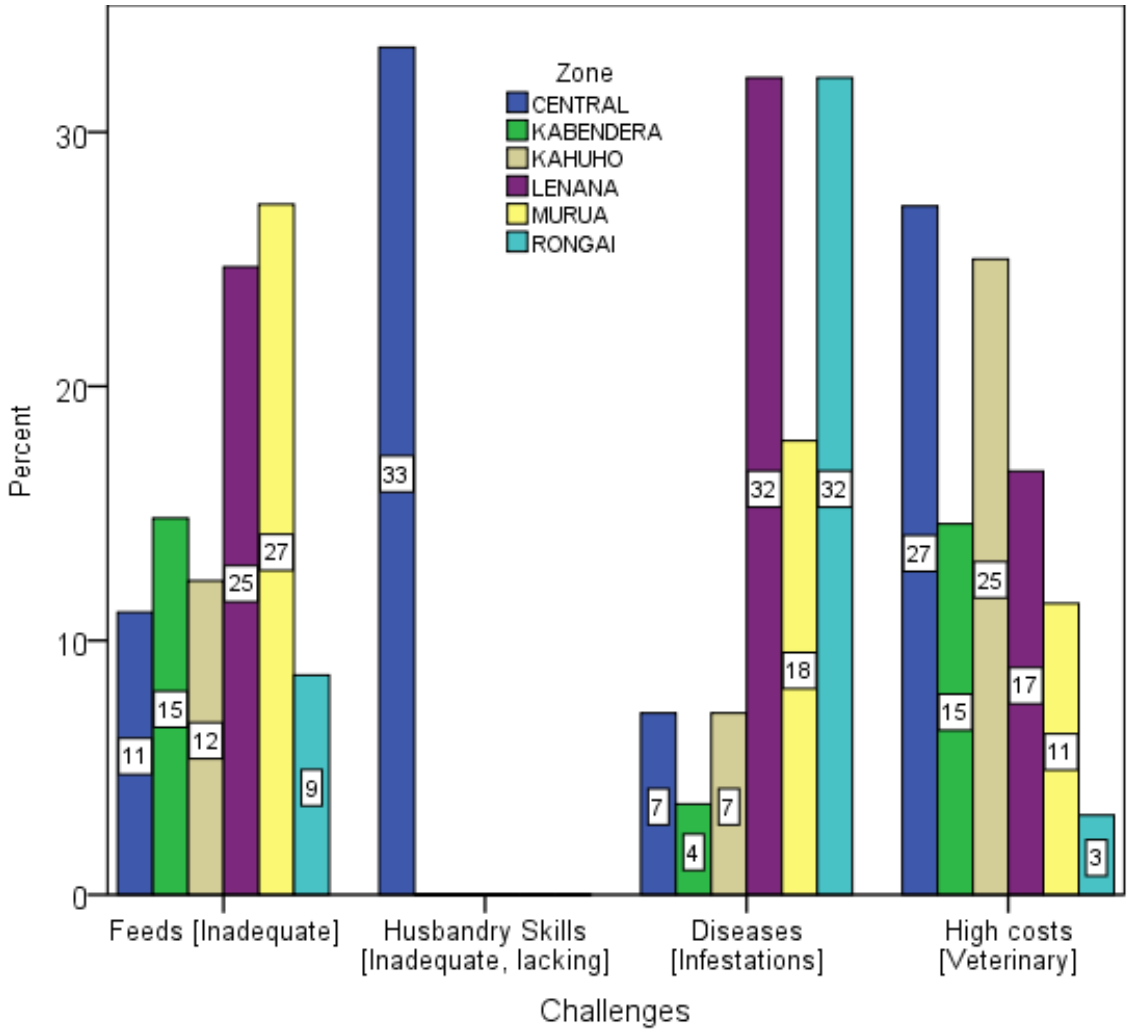

Figure 5.19: Current challenges to livestock production across the six zones

5.4 Current and Proposed Mitigation Measures

The preferred mitigation measure to the above stated identified problems is application of smart farming approaches such as fodder crop production, zero grazing and use of livestock supplements. Figure 20 illustrates the current methods applied by the community in mitigation of various identified problems. The proposed mitigation measures focused mainly on smart agricultural production and practices, but there is also the need for extension services by government and other stakeholders. Other proposals included the need for government subsidies such as farm inputs (11%), farmer groups such as SACCOS (6%) and smart farming (0.3%).

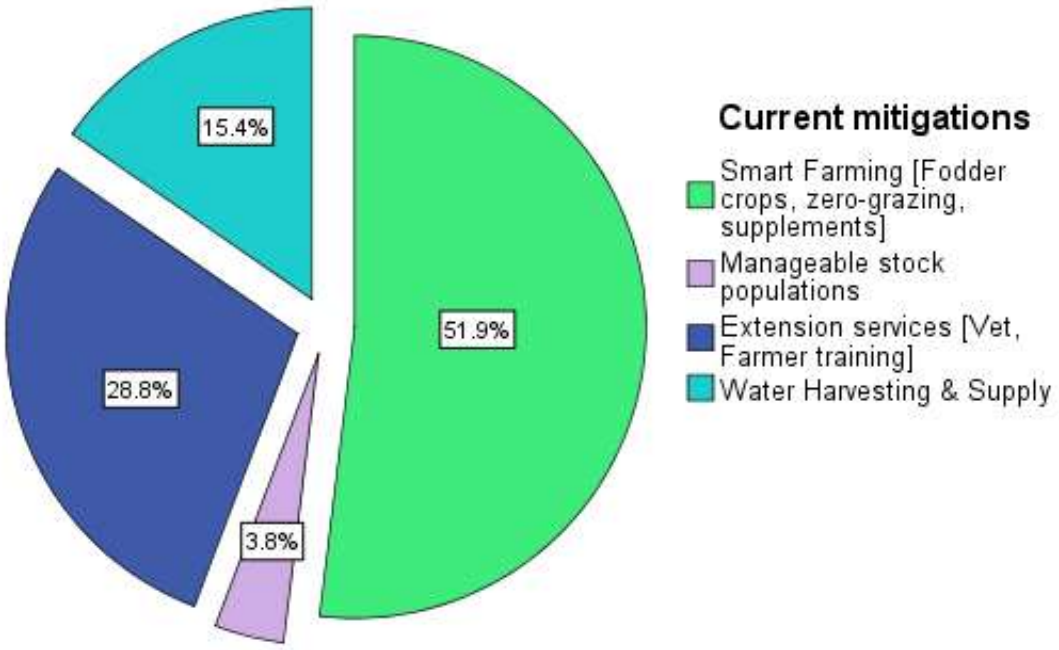

Figure 5.20 Current mitigation measures against challenges in livestock production

More than half of farmers in Kahuho (53%) suggested improved Government services to increase livestock production, 25% proposed adoption of smart livestock production technologies in Central and Kabendera while all the farmers contacted in Murua supported formation of farmer groups. In Central zone 37% proposed upscaling of government subsidies towards acquisition of farm inputs and services while 26% from the same zone considered increased provision of agricultural water to increased livestock production (See Figure 5.21).

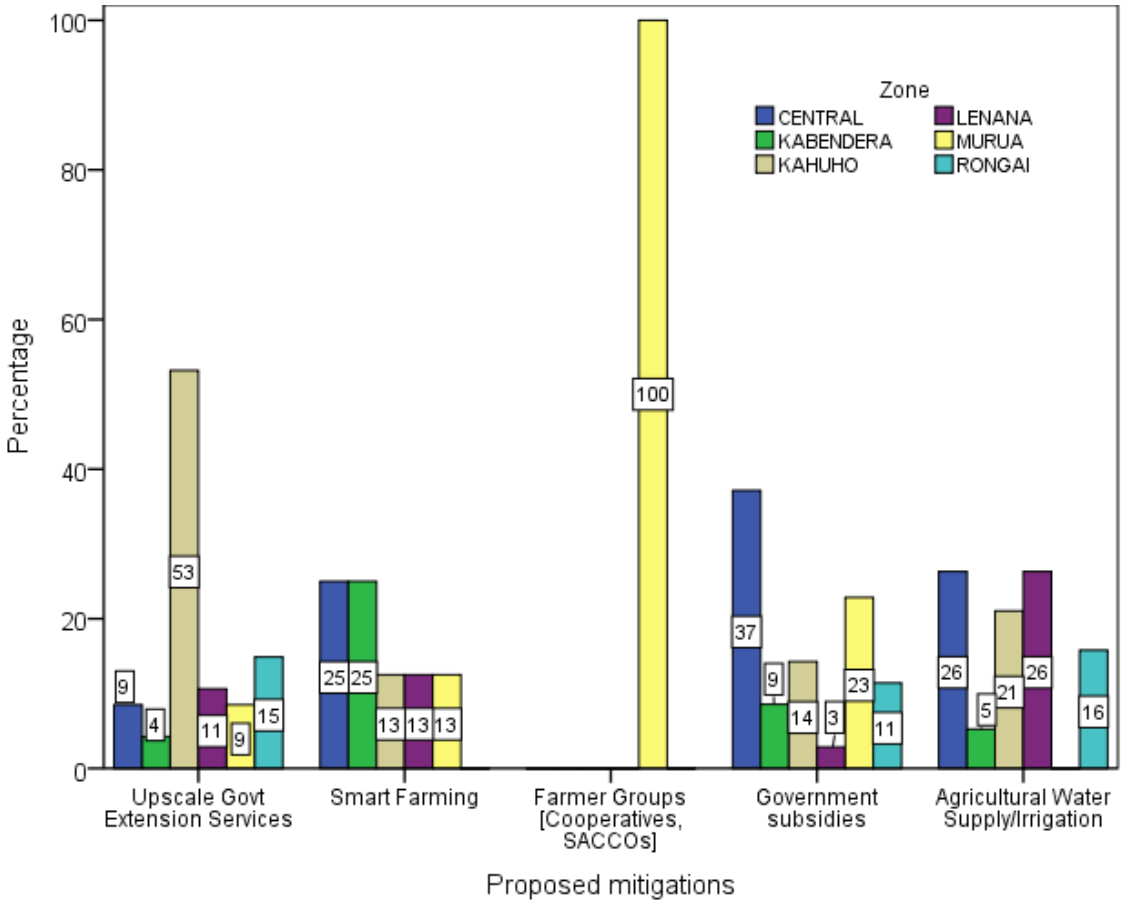

Figure 5.21: Proposed measures to mitigate challenges in livestock production in different zones

5.5 Access to Credit

The spectrum of evaluation regarding credit access focused on all forms of funding institutions. Private and public financial facilities were reviewed in the study. Only 20.1% of the respondents had access to credit facilities. Credit facilities are quite crucial in improving production. However, the scenario in the study area indicates that the community maybe greatly impeded by this factor of production. It was noted that the greatest reason why the community was not accessing credit was associated with high interest rates (68.1%). Table 5.3 shows information on the responses as to why the respondents were not taking credit facilities.

Table 5.3 Reasons of lack of Credit Facilities

	No information on Services		High interest rates		Not necessary		Not Available		High Risks		Total
	Count	%	Count	%	Count	%	Count	%	Count	%	Count
No	8	8.5	64	68.1	12	12.8	8	8.5	2	2.1	94

NR for no option=141, therefore responses =94

From Figure 5.22, half of respondents from Rongai and 38% from Lenana are unaware of available credit facilities. About 34% of Central zone residents do not prefer credit due to high interest rates charged on repayment but most respondents in the zone (50%) however feel the facilities are not available. Nearly 50% of Kabendera and Kahuho consider credit to be a higher risk endeavor.

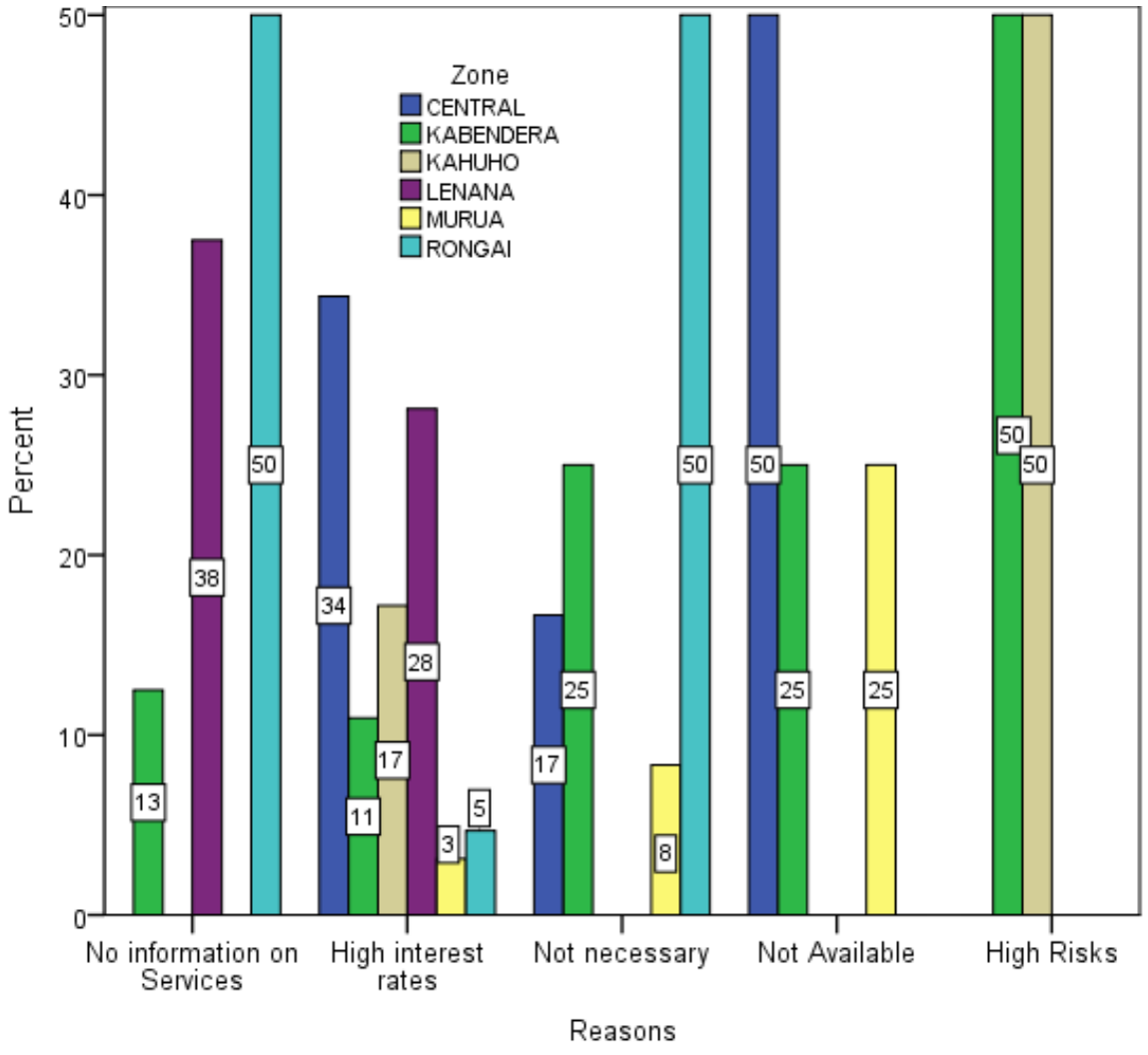

Figure 5.22: Main reasons for lack of access to financing in the different zones

5.6 Infrastructure and Utilities

5.6.1 Accessible Facilities

Analysis of infrastructure available was used to understand accessibility of the resources. In addition, it can provide a clear deduction of the key issues that affect demand of some parameters of utilities within the location. In addition, understanding their availability would give an indicator of facilities that are missing and the community would provide better benefits to the people. Some of the available utilities within the location include; schools, hospitals, churches, social hall, public market, roads, public lands, banks, piped water supplies and post office. The section below provides a description of all analysed infrastructure and utility within the area.

5.6.2 Water Sources and Use

The water sources available and used by the community varied across households (Table 5.4). This was based on availability and purpose of use. The water used for domestic purposes is mainly from piped water sources (62.2%). This is an improved water source since by Kenyan regulation all piped water must undergo complete water quality analysis and treatment. Therefore, majority of the population are using water that could be classified safe and portable water sources. Livestock water were also majorly drawn from piped water sources (71.9%). High use of the same source can also lead to high water bill costs to the farmers hence lowering the profit margins to the farmers. Irrigation that consumes high volumes of water also drew most of the water resources from piped systems. The current water sources, mainly (piped water) presents a competing water source use which can lead to resource conflicts if not properly managed. Equal sharing of the resource should have a basis on proper allocation and sharing strategies (Pimentel *et al.,* 2004). Moreover, better and more accessible water sources should be a development priority in the area so as to achieve a common progress status in the community. However, most farmers used rain water for farming hence an irrigation system would improve production.

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Table 5.4 Different sources of water and their use

Water sources for main applications		%
Domestic Water	Rain	24.0
	River/Stream	3.4
	Piped	**62.2***
	Borehole/Well	2.0
	Dam	8.4
Livestock water	River/stream	5.8
	Piped	**71.9***
	Well/Borehole	3.3
	Dam	6.6
	Rain	12.4
Irrigation water	River/stream	3.6
	Piped	**73.4***
	Well/Borehole	4.0
	Dam/water pan	1.6
	Rain	17.3

- *Variable with the highest percentage use per sector

In Lenana, 51% and 80% of respondents have access to rain and river water respectively for domestic consumption. A small proportion (4%) however, in Lenana, can access piped water for domestic purposes. Most Kabendera residents (72%) use water stored in dams or boreholes (33%) for domestic consumption. Half of the respondents from Rongai have ground water sources for domestic use while 20% also access river water for the same purpose (Figure 5.23).

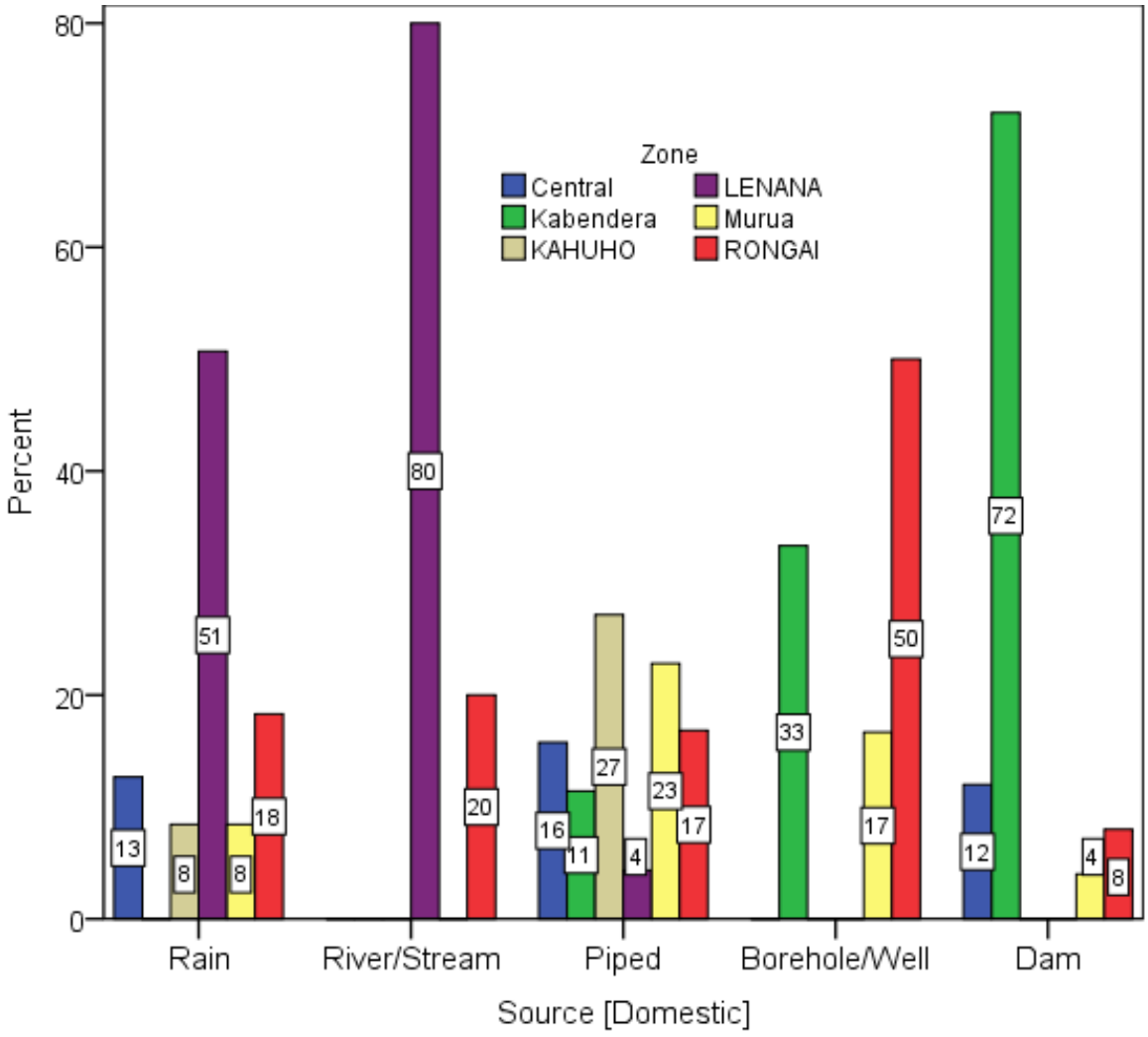

Figure 5.23: Sources of water for domestic consumption

Bore hole (63%) and river water (57%) are the main sources of livestock watering in Rongai (Figure 5.24). Most Kabendera residents use water from dams (57%) and a small percentage (17) from river and yet a smaller proportion (9%) use piped water. In Murua, 38% mostly use ground water and 24% have piped water for this purpose. About 27% of residents in Rongai use piped water while 7 and 6% use rain and dam water to water livestock respectively.

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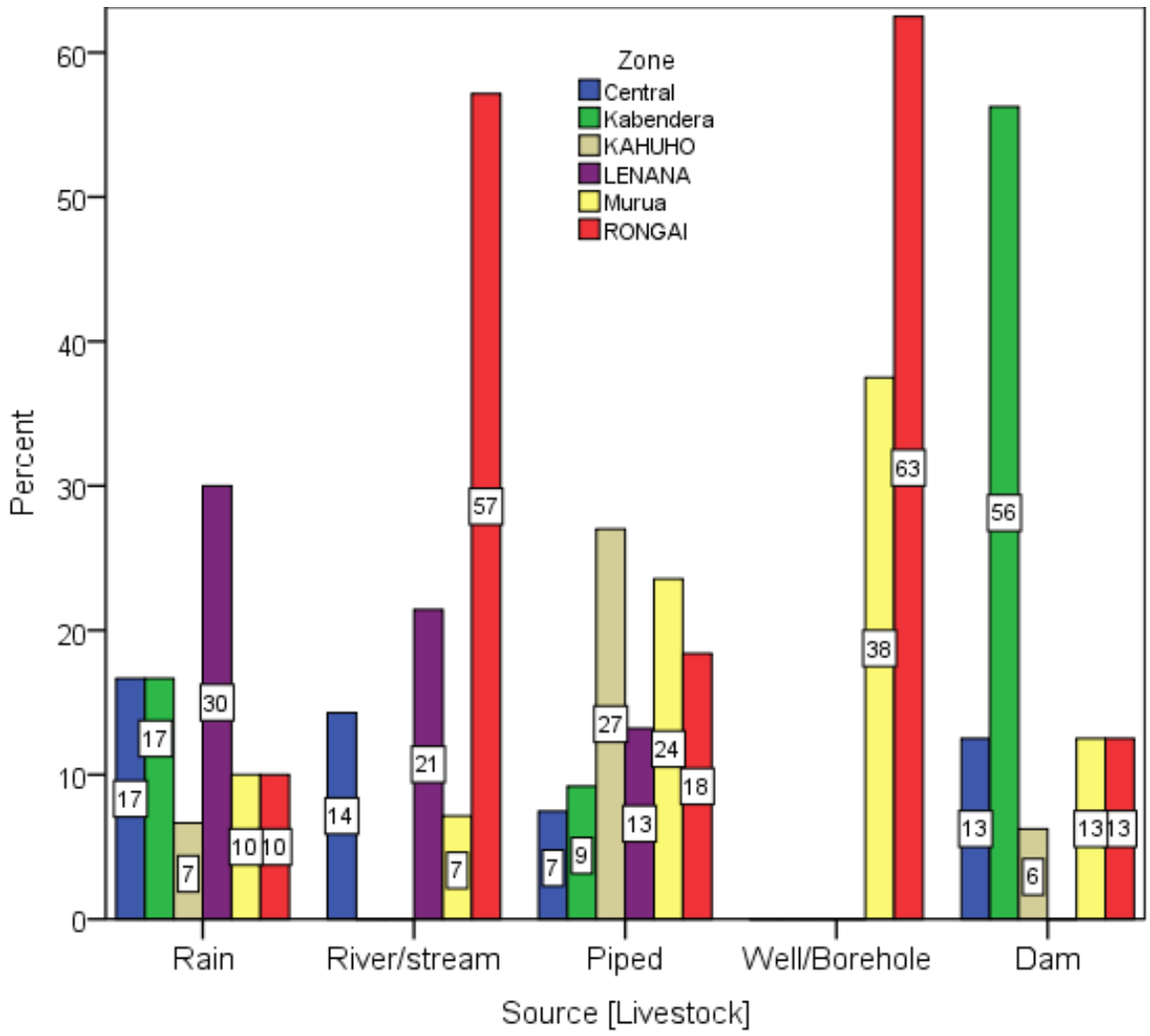

Figure 5.24: Sources of water for livestock watering

In Figure 5.25, 44% and 13% of Lenana residents use rain and piped water respectively for irrigation. In Kabendera, 28% use rain water and another 11% obtain irrigation water from piped supply. River water is the most preferred source in Rongai (100%) although 60% and 25% also use water from borehole and dams respectively for irrigation. In Central zone the major source is dam or water pan (50%) followed by borehole (20%) and piped water supply (8%).

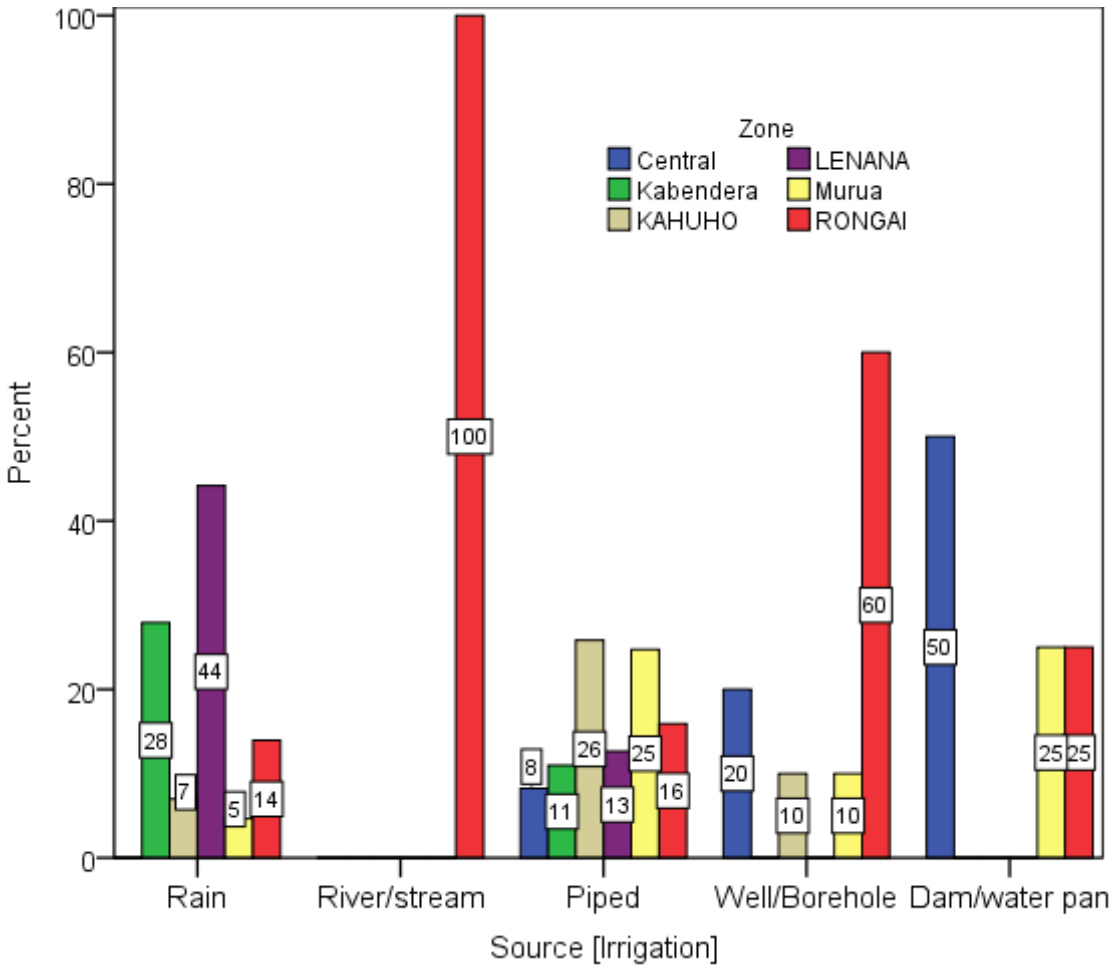

Figure 5.25: Water sources for irrigation

5.6.3 Proximity to Utilities

The distance to utilities is important in determining how effective the services are received by the community. In addition, it helps in determining resource allocation in accessing the different utilities. This variable was documented in terms of average distance travelled to the utility site or source. Most of the respondents (29.6%) travel averagely short distances of up-to 1km to utility sites. Equally, there are some respondents who travel long distances to access utilities. A significant percentage travelled more than 10 kilometers (9.8%) to access utilities. The average distance travelled to various utilities are as described in Figure 5.26. This leads to time loss and can deny populations access to fundamental resources (Feikin *et al.*, 2009).

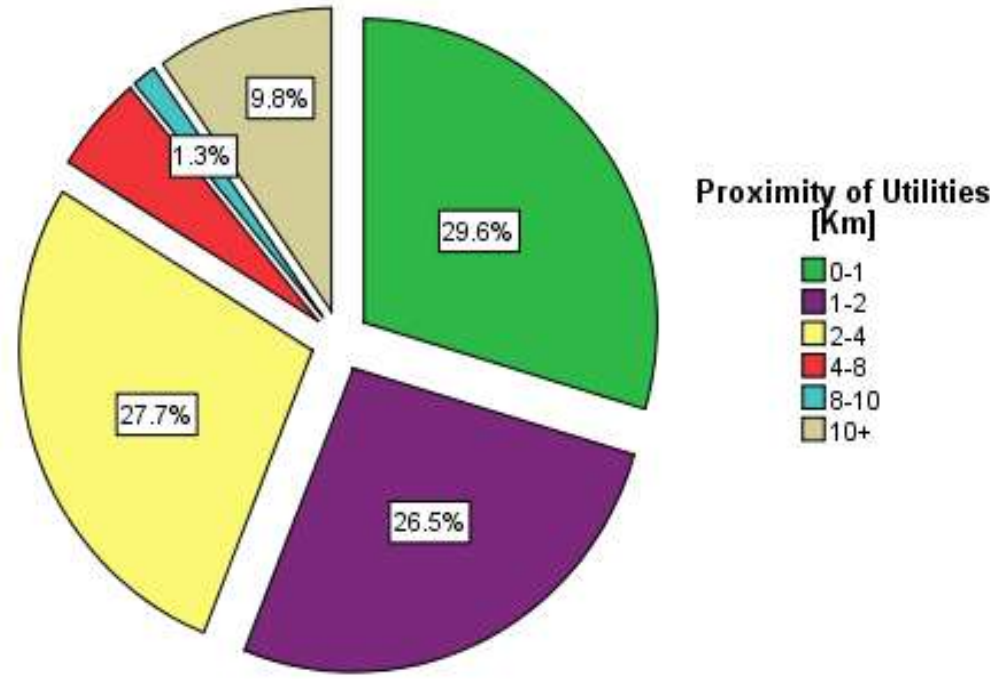

Figure 5.26 Proximity of utilities to residents

5.6.4 Utility Providers and Condition

The utilities are provided by the Government in most cases. The government provides 83.1% of the services, followed by the church (8.0%), private service providers (6.5%), NGOs (2.2%) and the community is the lowest utility provider (0.2%). This distribution of the service providers gives more power and control of all utilities on Government as they are the major stakeholders. Sustainability of such resources would be better and improved if community have more involvement and stake in shared resources as utilities. Therefore, development programs and future utility projects should have a basis of ensuring participation of users and sense of ownership that lead to community synergies (Smith *et al.*, 2016).

Regarding the condition of the utility services, there was a critical aspect on the status/perception of the community regarding conditions of services delivered to them. It was notable that most residents gauged the conditions as fair. Both the government and church services were viewed as fair by 65.1% and 3.3% respectively. There, is room for improvement of the condition of services across the major stakeholders. Figure 5.27 shows responses regarding the condition of services delivered to the community.

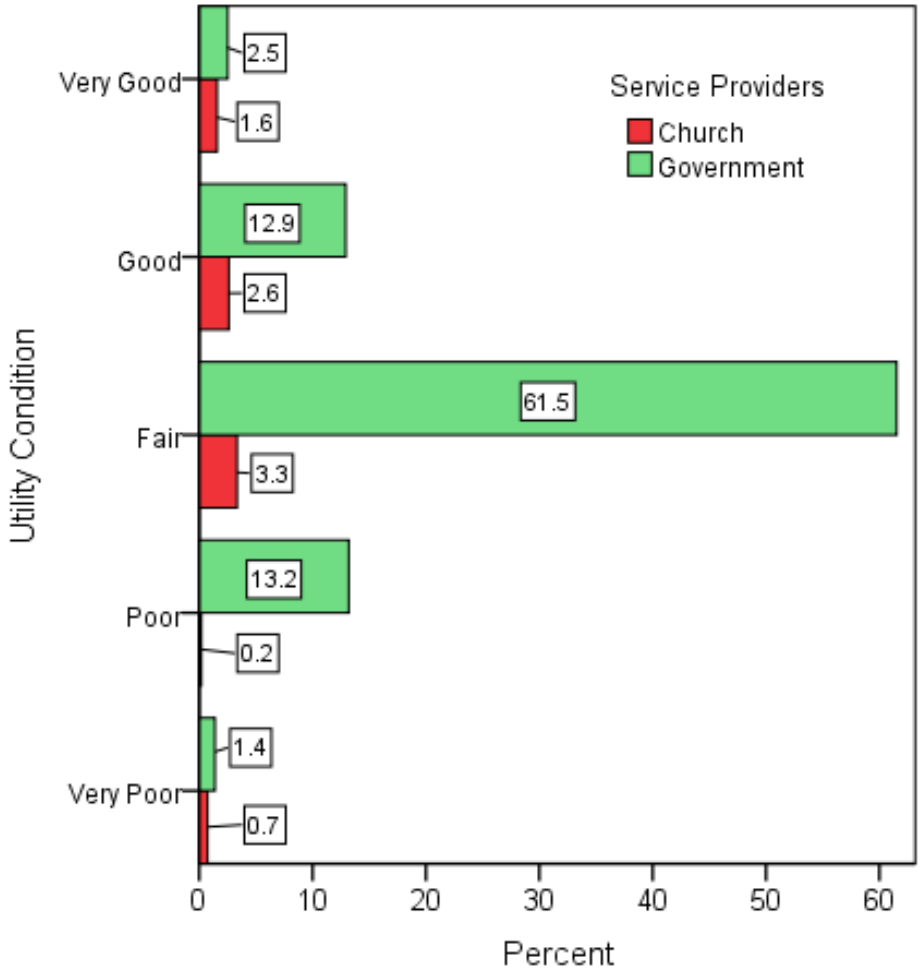

Figure 5.27 Perception of the condition of utility services

5.7 Development of Irrigation Project

5.7.1 Main development Projects in the Area

The area has experienced some recent development activities which vary in the kind of services to the community. Most of the services are in regards to water supply and associated storage (30.7%). Other projects documented included infrastructure in terms of housing, roads and medical facilities (21.7%), irrigation (18.9%), farming; crop and livestock (16%) and electrification (12.7%). These developments have an effect on improving the welfare of the community but do not improve production.

5.7.2 Awareness of the Irrigation Project

The proportion of members of the public who had knowledge regarding the proposed irrigation scheme was slightly more than half of the respondents (57.6%) (Figure 5.28). This was positive regarding improved information sharing on the projects. There is need to create more awareness regarding the project among the community so as to improve awareness. Community reception and embracing of the project can be improved by creating awareness (Gu & London, 2010).

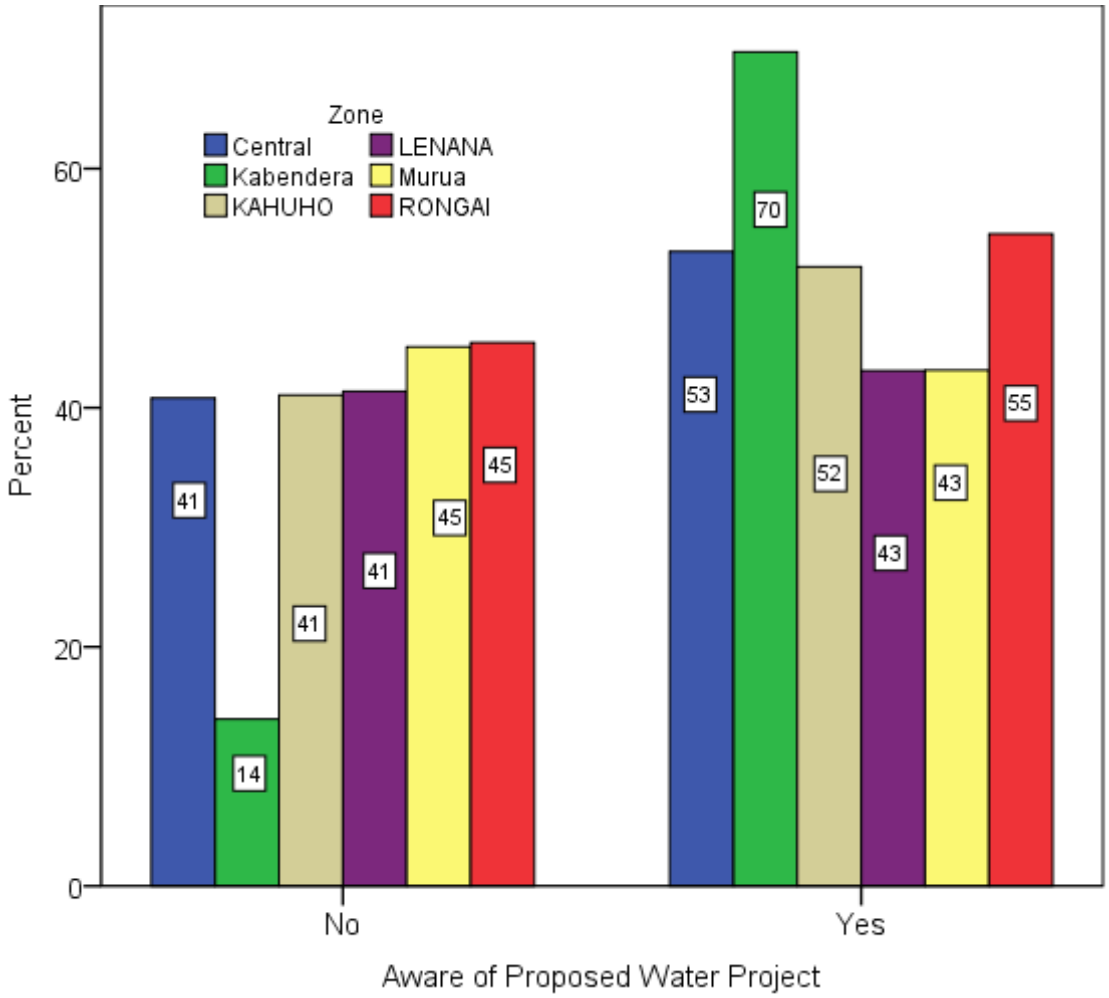

Figure 5.28: Proportion of respondents who were aware of the proposed water project

5.7.3 Benefits of Irrigation Project and Willingness to Pay for Irrigation Water

Almost all the respondents (98.9%) had a strong conviction on the key benefits they would extract and consume from the proposed project. This is mainly associated with supply of water for irrigation purposes. The perception of such benefits is an indication that there is a serious need for such a project and feasibility of demand.

Equally, most respondents (97.5%) were willing to pay for the services associated with the project. Projects have operation costs and initial capital needs to be recouped after a certain duration. These are fundamental aspects that contribute to the aspect of breaking-even by key stakeholders (Tiwari, 1998). Therefore, the ability to handle all these issues would be a key indicator of potential project success.

Majority of respondents in Kieni East concurred on provision of irrigation water as the main benefit ranging from 38% in Lenana to 82% in Cental zone. Only 2% of Kahuho and Rongai residents saw the initiative to be a source of domestic water supply (Figure 5.29).

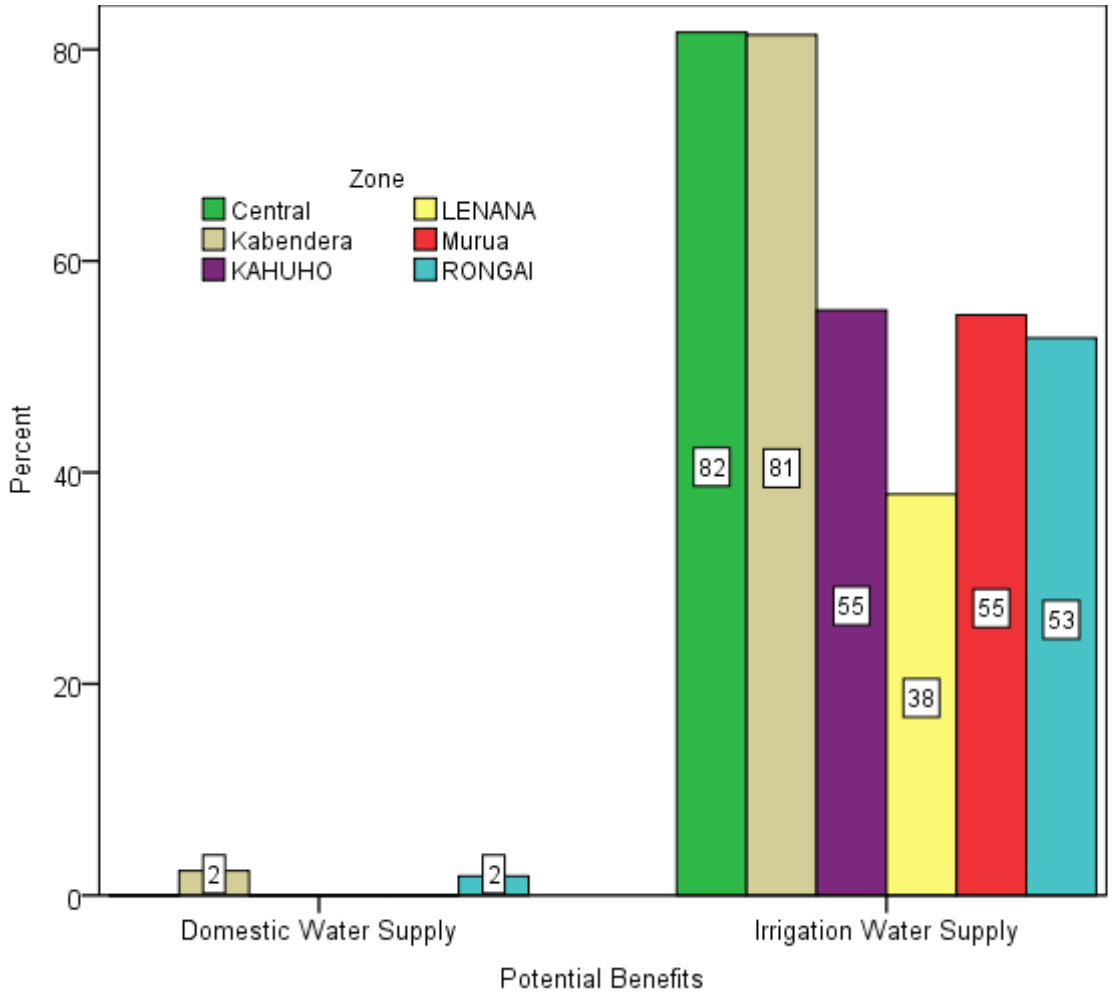

Figure 5.29: Main potential benefits of proposed water project

5.7.4 Potential Negative Impacts of the Project

The proposal is deemed to be a key development project within the area with a potential of improving livelihoods. However, the community has few reservation and thoughts regarding its negative perspectives. One of the most outstanding negative impacts is water shortage given that most of the available water will be used for agricultural production hence limiting available water allocated to other competing uses. The use of water for agricultural production in water scarce regions require innovative and sustainable research models accompanied by transfer of appropriate technologies to stakeholders. Some solutions should include use of waste water and applying supplemental irrigation models to ensure minimal wastage plus use of water in controlled systems (Pereira, Oweis & Zairi, 2002). Other key factors that may have a negative impact as on the community include high operation cost and mismanagement. However, all these are operational attributes and can be managed and adjusted through transparency, accountability of resources and evidence-based models of utilization. Figure 5.30 provides the statistical representation of all the other variables that the respondents perceived to have potentially negative impacts.

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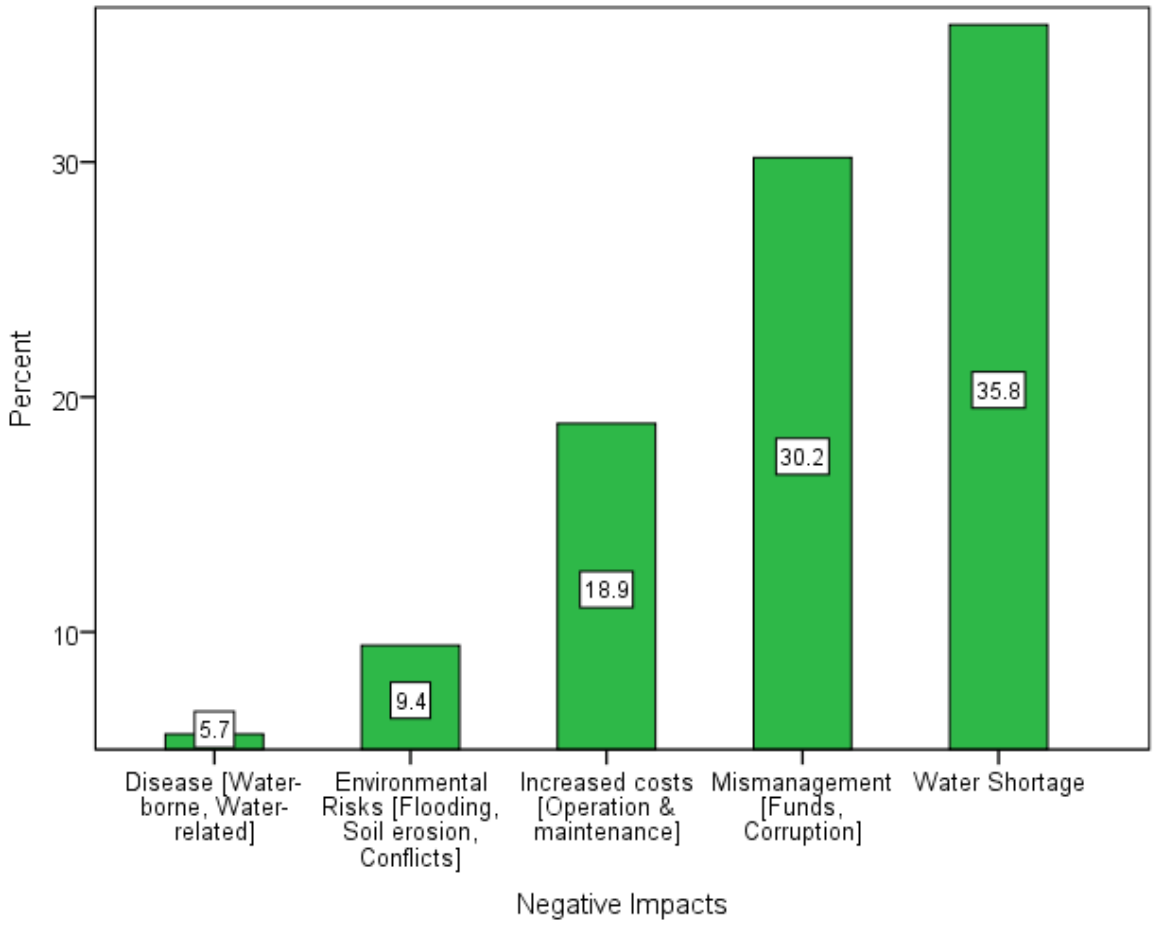

Figure 5.30 Predicted potential project negative impacts

From Figure 5.31, water shortage would be a major challenge (27%) followed by negative impacts on the environment (5%) and management challenges (4%) in Rongai. Increased costs of operation (12%) and mismanagement (7%) is a concern to Kabendera residents while in Central zone, mismanagement (8%) and water shortage (4%) is likely to arise.

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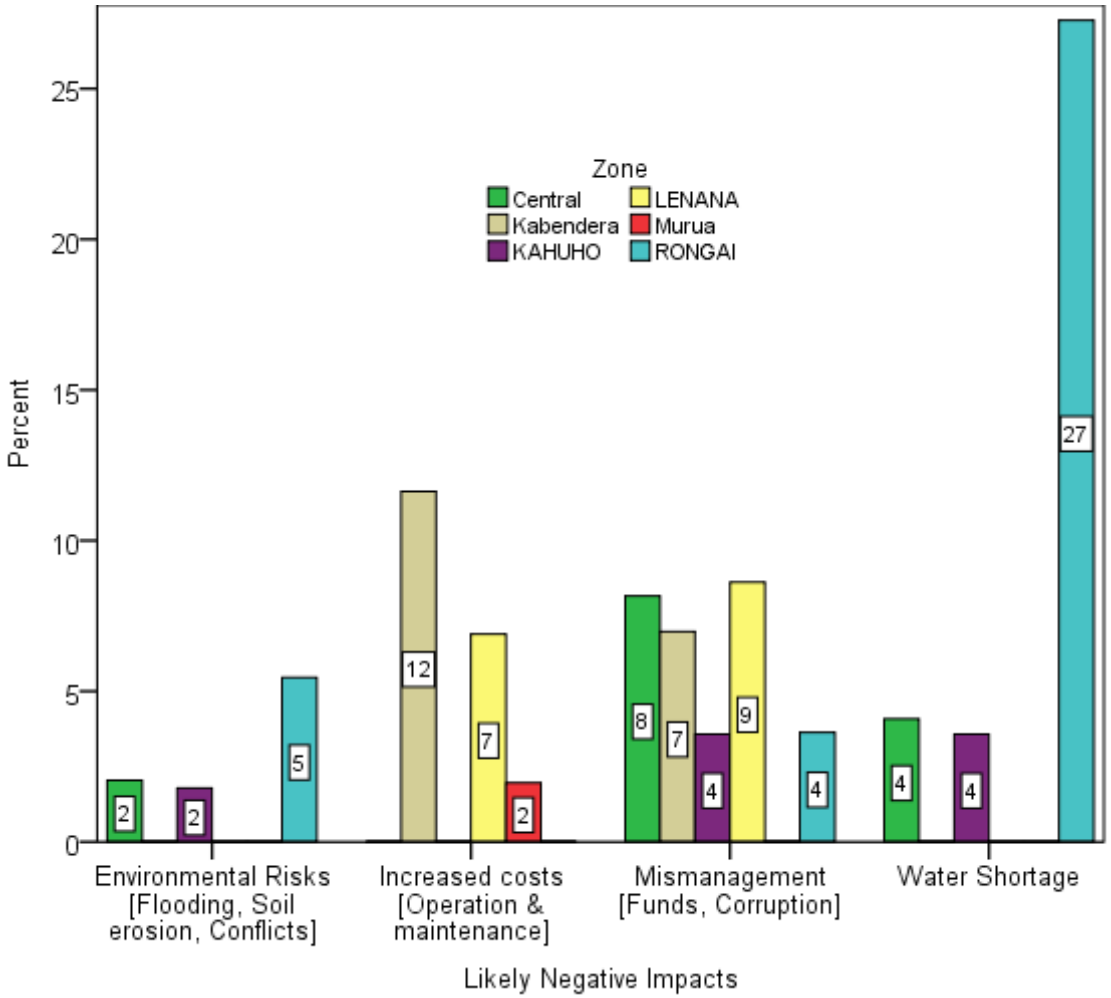

Figure 5.31: Potential negative impacts of the proposed water project in Kieni East

5.8 Priority Development Projects

The community had numerous priority issues regarding what they felt was lacking and need consideration if their lives were to be improved. It was notable that infrastructure in terms of road network, electricity and health facilities are not key problem areas that may need immediate consideration. This is contrary to most parts of Kenya where priority issues are in terms of the mentioned variables. The respondents presented key priority issues around aspects of water supply and irrigation water sources that would improve agriculture. Some notable variables that had prominence included; poor health services (4.2%) and high cost of energy (11.9%). It was notable that inadequate irrigation water was the most important priority variable because it had the highest percentage interest (32.8%) and followed by high energy cost (21.5%). Figure 5.32 shows the priority areas according to the respondent's needs analysis. Therefore, an irrigation project that would solve the issue of water supply targeted at irrigation with a focus on reducing current competition for the resource would be a great welcome idea in the area.

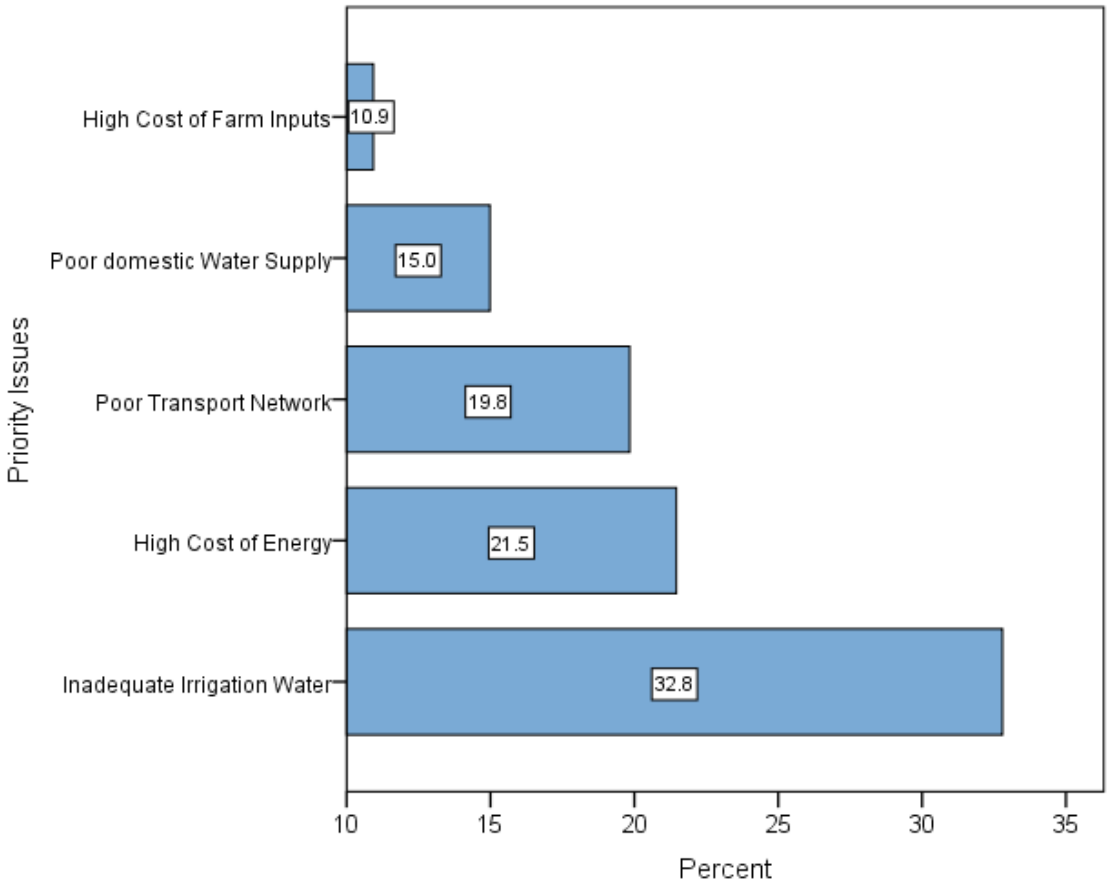

Figure 5.32 Priority community development options

Residents in the zones considered provision of adequate water for agricultural production as a priority development issue (Figure 3-54), particularly in Kahuho (52%), Rongai (33%) and Central (27%). Tackling the high cost of farm inputs is priority among Lenana residents (29%) while Kabendera residents consider high energy costs (33%), poor road network (23%) and inadequate irrigation water (19%) as major considerations during development planning. Also, 35% of residents in Central see the need to provide adequate domestic water alongside other development.

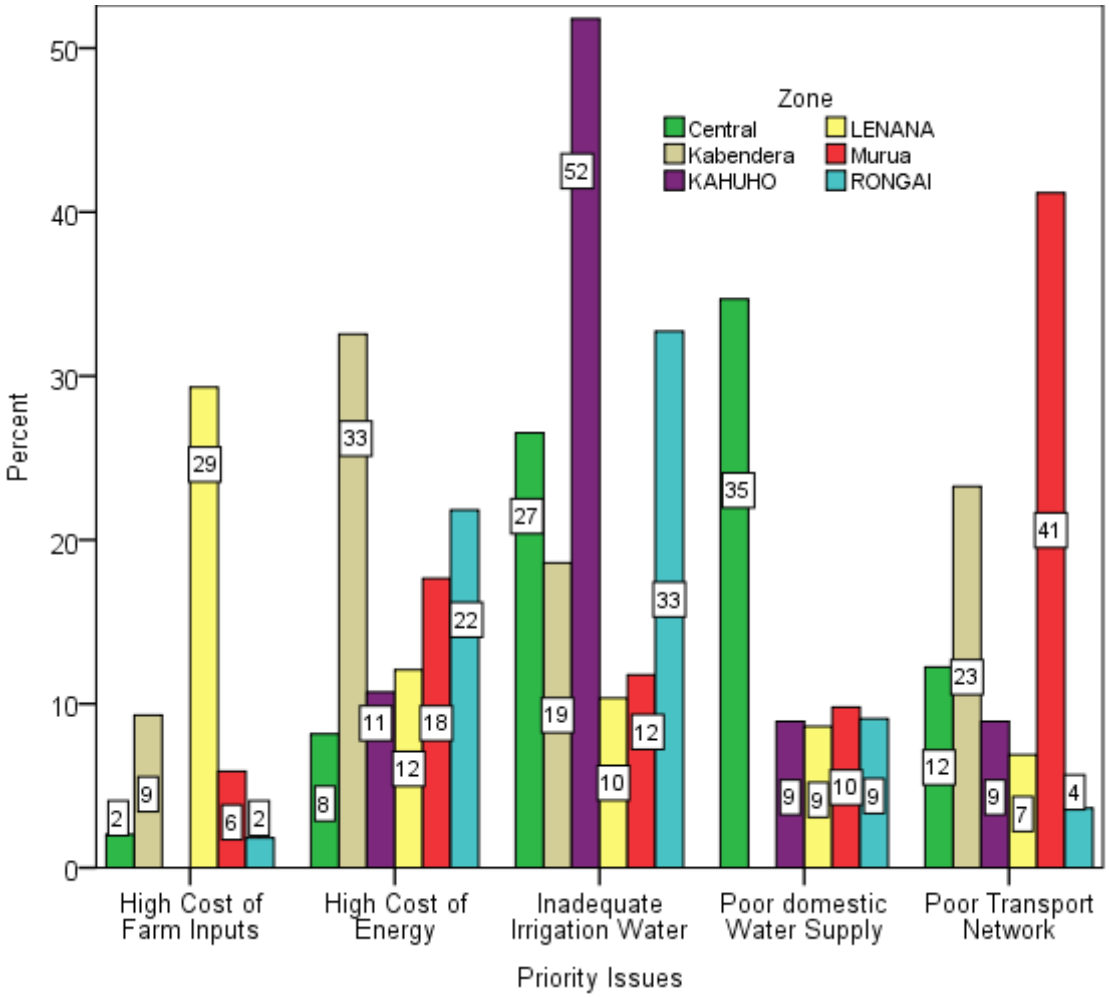

Figure 5.33: Priority issues to be considered in the development plan of the different zones

5.9 Conclusion

The principle objective of the study was to determine the feasibility of the water supply project in Kieni East. In addition, there was an aim to document livelihood support systems to make an informed decision of the potential of the water project benefit to the community. Various variables have been analyzed with focus on those that affect agricultural production while documenting changes in farm outputs over three years preceding this study. Mixed farming is a key farming option used in the community as a source of income and for supporting household level consumption. However, factors that would improve production such as extension services and associated training are a major missing link. The main source of water supply is through piped systems, the same source ranks highest for use in agriculture and for household consumption. There is potential for conflict over the resource for the different uses, domestic versus irrigation.

It was notable that most residents have property rights to their land hence can be incorporated in projects with minimal land tenure related tussles that maybe associated with use options if the lands were owned by third parties. Infrastructure development is a major determining factor in the overall improvement of agricultural productivity and livelihoods in Kieni East. The proposed irrigation project would be such an infrastructure to improve livelihoods and economic status of the community based on the findings and needs of analysis that have been documented

5.10 Recommendations

a) There is need to empower the farming community in Kieni East both in knowledge and technology that will boost agricultural productivity and food security in the area and Nationally. Extension services and capacity building should be promoted further.

b) There is need to develop key infrastructure and utilities, including adequate water supply, that will enhance agricultural productivity, socioeconomic development and improved livelihoods in Kieni East.
c) An integrated water resources management approach is therefore proposed to mitigate against the foreseen conflicts/ competing interests from utilization of water resources

6 PUBLIC CONSULTATION AND PARTICIPATION

6.1 Introduction

The following section describes the consultations and public participation held to assess the opinions and attitude of the various stakeholders to the irrigation project. The goal and objective of public participation is to ensure adequate information is provided to all stakeholders in a clear and timely manner and to present sufficient opportunity to these groups to voice their concerns and opinion so that their views can be incorporated into the project design and development as well as augment overall benefits and avoiding potential conflicts.

The client is committed to pro-active and on-going communication with all parties interested in the development of the project. During our field inspections, we established that the project, stakeholders including individuals and groups had been actively engaged in the consultation process. Public consultations in relation to the ESIA occur at all stages, starting with inception and planning when the potential lands and alternative sites are being considered. A participatory approach was adopted as an on-going strategy throughout the entire project cycle. Public participation and consultations were done through individuals, groups and community meetings. Selection of ways to consult, and expand participation by community and other stakeholders, took into consideration literacy levels prevalent in affected communities; ethnicity and cultural aspects and practical conditions (like distance). The role of political and cultural leaders, including the community elders, in the participation strategy was important.

6.2 Stakeholders

During the public consultations, multiple groups of stakeholders were consulted. The stakeholders were those who have an interest in the project development, and who will be involved in the further consultative process. The main groups of stakeholders are:

6.2.1 Directly Affected People

These are the people who reside in Kieni East or derive their livelihood from the affected land. These people will benefit from the irrigation project. Most of the directly affected people were informed and consulted on major issues concerning the proposed project, livelihood enhancement and income generation. They participated in the socio economic survey.

6.2.2 Indirectly Affected Persons

This group of stakeholders includes all those who reside in areas neighbouring the project area or are reliant on resources in the project area and will have no change or the project may not adjust their livelihood e.g. groups such as those residing downstream of the river.

6.2.3 Government Agencies and other organizations

These included:

a) Kenya Forest Service (KFS)
b) Water Resources Authority (WRA)
c) National Environment Management Authority (NEMA)
d) Ministry of Agriculture Livestock, Fisheries and Irrigation
e) Ministry of Water and Sanitation
f) National Drought Management Authority (NDMA)
g) County government of Nyeri
h) Kieni East Sub County Offices

Plates 6.1-6.11 show the varoius levels of public consultations.

Plate 6.1 :Consultant team and the scheme members during a baraza

Plate 6.2: Focused group discussions

Plate 6.3: Consultative Meeting with the Scheme Officials and Sub-County Officers

Plate 6.4: Training of Enumerators.

Plate 6.5: Discussions with the County and sub-County staff.

Plate 6.6: Consultant de-briefing meeting

Plate 6.7: Meetings with sub-County staff

Plate 6.8Meeting with County water and irrigation officers

Plate 6.9: Consultant Team Presentation as Members follow the Proceedings

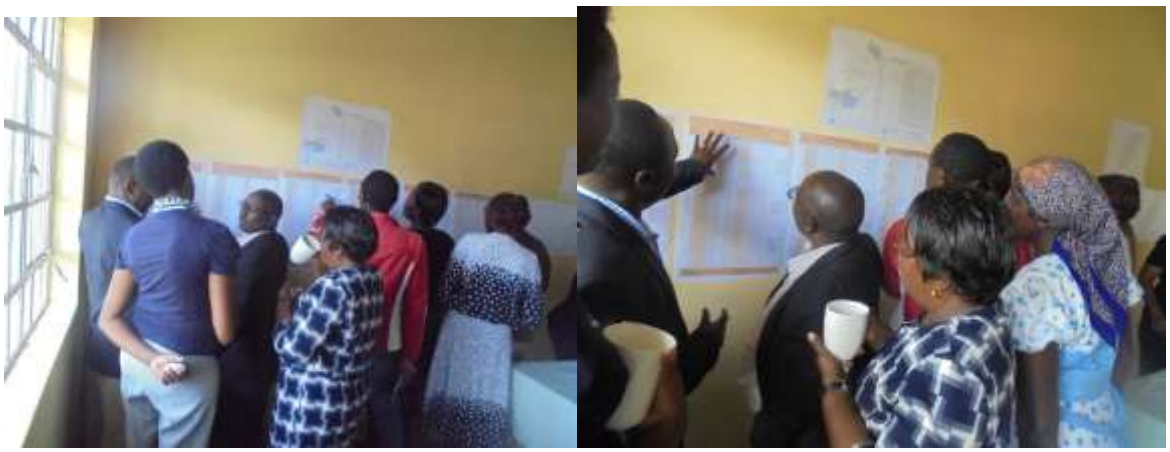

Plate 6.10: Members are Enlightened on the Project Developments and Outputs

Plate 6.11: Administering the questionnaire

6.3 Key Issues Arising from Public Participation Meetings

The consultant held a public consultative meeting (*barazas*) with the community in conjunction with the proponent and the administration

The lists of attendees are presented in Appendix I. The agenda for the meeting was to inform the community about the project and receive comments and suggestions from the participants.

The following is a summary of issues raised by the members who attended the meetings:

6.3.1 Perceived Benefits

(a) The proposed project will create significant economic and social benefits to the communities and contribute to the attainment of the National priority goals and ongoing National efforts to accelerate economic growth and alleviate poverty.
(b) Irrigated agriculture will contribute to enhanced food security and improved nutrition at the household level. This will alleviate the negative impact of erratic and unreliable rainfall pattern on the community's productive resources.
(c) Income diversification strategy; Investment in irrigation development is a strategy in reducing risks associated with rainfall variability and achieving food security.
(d) Employment opportunities will be offered to the construction workers and any other person who will be hired to provide her/his services during the construction phase. In addition to direct employment, supplies of basic necessities to the workers will also lead to more employment opportunities and acquisition of entrepreneurial skills. This will engrain a sense of project ownership within the community.
(e) The irrigation scheme will also play a role in reduction of idleness particularly amongst the youth due to an increase in income generating activities both directly or indirectly.
(f) The standard of living of the community especially vulnerable beneficiaries (elderly, female headed households and children) since there will be a reduction in distances traveled and time spent in search of water and time on agriculture. Therefore playing a significant role in income generation and increasing food and nutritional security amongst the vulnerable households.
(g) By providing direct and indirect local employment, the project will ease the direct resource dependency pressures on forest and forest resources.
(h) Reduced poverty levels through increased incomes and improved livelihoods resulting from construction of the proposed project and maintenance employment and consumption from the local markets, emergence of other associated economic opportunities and activities.

6.3.2 Issues and Concerns

a) Inadequate water for farmers at the downstream, the community expressed concern over water distribution and rationalization. The project management will put in place mechanisms to enable all to access water in compliance with regulations.

b) Health risks associated with increased incidences of mosquito and malaria borne diseases due to increased breeding sites. This would be mitigated through capacity building of the community on mosquito preventive and control measures.
c) Lack of marketing strategy and infrastructure for products; currently farmers do not have a crop storage and marketing plan. There is an urgent need for scheme beneficiary farmers to develop collaborative and effective marketing strategies to access larger and more sustainable markets.
d) Lack of adequate knowledge in irrigation; the community in the project area have limited knowledge on irrigation crop development. This could be attributed to limited knowledge and lack of irrigation crop production skills, tillage services, fertilizer, seed, chemicals and operation of irrigation equipment and management.
e) Damage of road infrastructure that is currently being developed during transportation and haulage of construction materials to project sites.
f) Clearing of vegetation during construction phase, this would be addressed through reforestation programs and sparing of indigenous trees during the clearing process.
g) The potential for pesticide and agro-chemical residues getting into the aquatic resources as the agricultural activities intensifies
h) Lack of credit especially for irrigation purposes to enable farmers to grow high value crops and source inputs on time, and at competitive rates may hamper scheme productivity and adoption of climate smart agriculture techniques. The Project beneficiaries through collective action can enhance access to financial service providers.

Almost all the respondents (99%) had a strong conviction on the key benefits they would have from the proposed project. This is mainly associated with supply of more water for irrigation purposes. The perception of such benefits is an indication that there is a serious need for such a project and feasibility of demand. Equally, most respondents (97.5%) were willing to pay for the services associated with the project. Projects have operation costs and initial capital needs to be recouped after a certain duration. These are fundamental aspects that contribute to the aspect of breaking even by key stakeholders. Therefore, the ability to handle all these issues would be a key indicator of potential project success.

7 PROJECT ALTERNATIVES

7.1 Introduction

This chapter looks at the alternatives to the proposed project in terms of site, technology, design, scale and extent. The comparisons of these with the proposed project give rise to the best project option for adoption.

7.2 The proposed alternative.

This report has been prepared based on sound desktop and field studies made by the ESIA team. The findings and recommendations are based on the proposed site, materials and the proposed technologies to be used in implementation of the proposed project. Sprinkler irrigation is a method of applying irrigation water that is similar to natural rainfall. Water is distributed through a system of pipes usually by pumping. It is then sprayed into the air through sprinklers so that it breaks up into small water drops which fall to the ground. The pump supply system, sprinklers and operating conditions must be designed to enable a uniform application of water. This system is ideal to the extent that it conserves irrigation water.

With drip irrigation, water is conveyed under pressure through a pipe system to the fields, where it drips slowly onto the soil through emitters or drippers which are located close to the plants. Only the immediate root zone of each plant is wetted. Therefore this can be a very efficient method of irrigation. Drip irrigation is sometimes called trickle irrigation. This technology is too labour intensive and is expensive to operate. That notwithstanding, the consultant proposes for consideration and adoption of the technology.

7.3 Project Alternatives

7.3.1 Alternatives to Site

The proposed site has been selected by the State Department for Crop Development, based on selection criteria for irrigation development in the country. The consultant was therefore supposed to come up with the best irrigation system that suits this location. A feasibility study and ESIA was conducted in the area and the best irrigation technology for the area was identified.

7.3.2 Alternative to Technology

There are various alternative irrigation technologies that may be applied to the scheme and they include the following:

- Surface Irrigation

Surface irrigation is the application of water by gravity flow to the surface of the field. Either the entire field is flooded (basin irrigation) or the water is fed into small channels (furrows) or strips of land (borders).

i. Basin Irrigation

Basins are flat areas of land, surrounded by low bunds. The bunds prevent the water from flowing to the adjacent fields. Basin irrigation is commonly used for rice grown on flat lands or in terraces on hillsides. In general, the basin method is suitable for crops that are unaffected by standing in water for long periods (e.g. 12-24 hours). The crops proposed for irrigation in this system do not fall in this category. Environmental and public health impacts associated with this system are also numerous and it is on this account that it is not considered in this scheme

ii. Furrow Irrigation

Furrows are small channels, which carry water down the land slope between the crop rows. Water infiltrates into the soil as it moves along the slope. The crop is usually grown on the ridges between the furrows. This method is suitable for all row crops and for crops that cannot stand in water for long periods (e.g. 12-24 hours). Environmental impacts associated with this technology are also enormous and this informed the consultant's decision not to consider it for implementation.

iii. Border Irrigation

Borders are long, sloping strips of land separated by bunds. They are sometimes called border strips. Irrigation water can be fed to the border in several ways including opening up the channel bank, using small outlets or gates or by means of siphons or spiles. A sheet of water flows down the slope of the border, guided by the bunds on either side.

- Sub-Surface

Sub-irrigation systems provide water to crops by controlling the water-table level so that crop roots can reach the capillary fringe above the water table and extract all their water needs from it. Although sub-irrigation often provides some benefits, the extra investments required in durable inputs are not always offset by the benefits. Managers need to evaluate the changes in the input-output relationships and prices associated with the new technology to determine profitability. From a financial perspective, the key factors to consider when making capital investment decisions are a project's profitability and potential risk.

7.3.3 No project Alternatives

Kenya's GDP was US$29.5 billion in 2007, of which the Agricultural sector contributed 24% and a further 27% through value adding by the sector[1]. The agricultural sector accounts for large percentage of rural employment. Kenya relies on rainfed agriculture for production of foodstuffs and other marketed crops. Rainfall is intermittent and unreliable in some years. The estimated potential area for irrigation in Kenya is about 540,000 hectares (3,240Km^2)[2]

The country is faced with the problems of an increase in the number of people living below the poverty line of less than US $ 1 per day. Currently there has been a dramatic increase in food prices in the country necessitating the need for increase in food production. The proposed project will go a long way in improving the current situation on food prices in the country and the standards of living of the people near the project area.

Not rehabilitating the existing irrigation scheme and continuing with the current farming practices and information systems would mean that benefits, including increased agricultural production expected from the project and the associated National economic benefits, would not be achieved. Current system uses domestic and irrigation water as one system, hence bringing competition towards domestic use. At the same time, the negative impacts associated with the project would not materialize Therefore the 'No Action' alternative is not feasible for Kieni East, Ndiriti Aguthi Irrigation Project.

[1] GOK/MOA: Economic Review of Agriculture,, Min of Agric, 2007

[2] Source: Ministry of Water Development, National Water Master Plan, 1992

8 POTENTIAL ENVIRONMENTAL AND SOCIAL IMPACTS

8.1 Preamble

This chapter presents the assessment of the issues likely to arise as a result of implementation of the proposed Ndiriti Aguthi irrigation project. The anticipated impacts are discussed in three phases namely: construction, operational and decommissioning phases and as well in-regard to their likelihood of occurrence on the physical, biological, occupational and socio-economic environments.

8.2 Impacts during Construction Phase

8.2.1 Positive Impacts

I. Creation of Employment opportunities for residents of the project area

The proposed project will provide short term and long term employment opportunities to the local community. During the construction of the proposed Ndiriti Aguthi Irrigation Project, there will be employment opportunities for both professionals and unskilled workers. Several workers including casual labourers, plumbers and engineers are expected to work on during the construction period. Semi-skilled, unskilled labourers and formal employees are expected to obtain gainful employment during the period of construction. With labour intensive construction technologies, the project will provide employment for youths and provide support to the Government of Kenya initiatives on creation of jobs.

The creation of employment opportunities is beneficial both from the economic and social point of view. Economically, it means abundant unskilled labour will be used in digging of trenches, laying of pipes, and transport of construction materials. Socially these people will be engaged in productive employment and minimize social ills like alcohol abuse which is rampant in the project area. This positive social change in the social behaviour will be one of the anticipated transformational indicators in the project area.

II. Injection of money into the local economy

The project will contribute to the National kitty. The contractor will pay Value Added Tax (V.A.T) on purchasing materials for the project. Construction workers will also pay income tax from their earnings while working on the project. A large sum of the project money shall be released into the local economy due to the construction activities. This money will be inform of payments for skilled and unskilled labour; Purchases of construction materials; and payments for local provisions including fuel, foods and accommodation.

III. Creation of market for construction materials

The project will require materials, some of which will be sourced locally within the project area. Some of this include sand, hard-core and soft stones for the construction of the trenches, minor road, crossing e.t.c. Servicing of the and strengthening of the spillway. Local suppliers will be given first priority in supply of construction materials.

8.2.2 Negative impacts

I. Soil Erosion

Impact

The project will involve excavations. These earthworks will result in soil erosion and especially along the steep sections. Improper drainage of runoff from the project area to lower catchments can also cause erosion. Clearing of vegetation during the construction and excavation works for the pipeline could also result in an increase in runoff along the line and thus encourage erosion.

II. Interference with the physical setting

Impact

The proposed project could result into the interruption of existing infrastructure such as access roads to farm, water supply lines, fences and farm structures. These services are critical and have implications with the general social and economic performance.

III. Noise Pollution and Vibrations

Impact

Construction of the proposed project will most likely result in noise emissions as a result of the machines used such as tractors, bulldozers, excavators, vehicles delivering materials to the site etc. Noise could impact negatively on the workers during the construction phase. Noise can also be a nuisance to the local community if construction works begin too early in the day and continues into the night. Noise levels from construction activities exceeding 60 dB (A) at the construction campsite have a negative impacts to the environment.

IV. Slope stability

Cases of landslides, mainly triggered by rainfall and human activities have been reported in the past and of recent in Nyeri County. Moreover, the areas along the pipeline route where it is characterized by highly mountainous landscapes with ragged terrain. Trenching activities during construction phase might interfere with dormant shear zones there thus leading to land damages where volumes of soil being transported downhill where proper care is not taken.

V. Air Quality Degradation/ Dust Emissions

Impact

Dust will be emitted during excavation, movement of vehicles and related earthworks. Particulate matter pollution is likely to occur during the route clearance, excavation and during the transport of construction materials. This is likely to affect site workers and the residents, in extreme situations leading to respiratory problems and eye site problems.

VI. Workers Accidents and Hazards during Construction

Impact

Construction workers are likely to have injuries and hazards at the construction works, unavoidably exposing them to occupational health and safety risks. The workers are also likely to be exposed to risk of accidents and injuries resulting from accidental falls, injuries from hand tools and construction equipment.

VII. Extraction and use of Construction Materials

Impact

Construction materials such as hard-core, soft stones and sand will be obtained from quarries. These materials will be harvested from natural resource and banks such as rivers and land. The proposed development is being carried out at a level that can create considerable damage to the resource due to materials extraction.

VIII. Rock Blasting

Impact

There will be local community members whose crops will be affected by the excavation work, rock blasting, and storage of materials which may affect their crops / animals. There is risk of rock falls during

blasting. The contractor should adopt controlled blasting techniques, preventing flying rock debris and high intensity vibrations.

IX. Generation of Liquid and Solid Waste

Impact

Solid wastes generated during construction include papers used for packing, plastics, cuttings and trimmings off materials among others. Dumping around the site will interfere with the aesthetic status and has a direct effect on the surrounding community. Disposal of the same solid wastes off-site could also be a social inconvenience if done in the wrong places. The off-site effects could be pest breeding, pollution of physical environment including water resource, invasion of scavengers and informal recycling by communities. Liquids generated include used oil, petrol/diesel, greases etc. When this waste gets into surface and subsurface water, resources it causes pollution and this might affect humans and animals.

X. Loss of flora and fauna

Impact

There are no trees established where the water pipes would be laid; there are also no habitats for rare/ extinct faunal species. The reserve harbours scattered shrubs and grasses. Lower class animals and variety of insecta family are common and will inevitably be affected during the construction stage. Construction activities will therefore have minimal impact on flora and fauna characteristic of the area.

The removal of natural vegetation will also lead to loss of biodiversity. However, some natural trees within the agricultural landscape can be retained to ensure maintenance of biodiversity. Agro-forestry can also be adopted. The conversion of semi-natural grasslands to improved irrigated pastures will significantly reduce indigenous plant and invertebrate biodiversity. This can be mitigated by proper planning and management of the Project's activities.

The nature of irrigation scheme will radically change both the agricultural and natural ecology in the project area. The creation of reservoirs and channels provides the possibility of enhanced aquatic habitats. In particular, reservoirs and channels may also offer favourable habitats for disease transmitting insects and snails. The consumption of water for irrigated agriculture and the reduced quality of return flows is likely to adversely impact on downstream ecosystems. Reduced flows, increased salt concentrations, lower oxygen levels, higher water temperatures and increased pollution and silt loads all tend to favour vigorous, tolerant species (aquatic weeds). Marked changes to the water environment, both in quantity and quality, are liable to have negative impacts on downstream aquatic biota which may be adversely affected by changes to the hydrology or morphology of a river system.

The introduction of exotic species of plant or animal may oust indigenous species or introduce disease agents which may affect plants, animals and/or man, causing ecological imbalances

XI. Public Health

Impact

Construction and rehabilitation works and traffic during operation will create dust, air and noise pollution, which can have an impact on public health. Oil wastes from vehicles can also impact on public health if they find their way into water sources. The leaded compounds will accumulate on any vegetation planted for consumption purposes. Sanitation and hygiene in the workmen's camp are also issues of concern, and if not properly addressed can lead to outbreaks of illness such as hepatitis, typhoid, intestinal worms, etc. Construction works are associated with an increase in sexually transmitted diseases such as STDs and, HIV/AIDS due to the influx of workmen interacting with the local people. Construction teams can also cause social upheaval among communities near the project area.

XII. Workers accidents and hazards during construction

Impact

During construction of the proposed project, it is expected that construction workers are likely to encounter occupational health hazards as a result accidents at the construction site. Because of the construction activities including metal grinding and cutting, concrete work, steel erection and welding among others, construction workers will be exposed to risks of accidents and injuries. Such injuries can result from injuries from hand tools and construction equipment cuts from sharp edges of metal sheets and collapse of building sections among others.

8.3 Impacts during Operational Phase

8.3.1 Positive Impacts

I. Contribution to the flora, fauna and micro-climate

The supply of irrigation water to the farms in the project area will motivate the farmers to grow crops, fodder crops for the animals and trees. Through this, it is envisaged that the number of flora and fauna species will increase. This means that micro climate within the project area will be enhanced. This will immensely contributed to the property value, land value and aesthetic value of the area while ensuring that the environment remains healthy and productive.

II. Creation of Employment

During operational phase, there will be employment opportunities especially for those who will be employed to manage, maintain irrigation water supply system. A number of youths within the project area will be employed in the farms to undertake such activities as cultivation, weeding, harvesting collecting centers and storage & cooling facilities among others. This will improve their living standards and by engaging, they will also change their social behaviour.

III. Creation of Wealth

The proposed irrigation project will ultimately provide revenues to the beneficiaries and expand the wealth base for the Nation. It will pump both liquefied and tied up wealth hence making the nation gain. It will also go a long way in uplifting Nyeri County and its neighbourhood as a whole. Once the people will be empowered in the project area, some will invest and develop the nearby towns.

IV. Improved Food Security

Crop production through rain-fed agriculture and minimal irrigation has not been reliable due to the unreliable rainfall in the area. This has led to the rampant cases of food shortage in the households. The improvement and use of irrigation water through the proposed project will increase crop production and thus alleviate the food shortage problem in the households. Surplus produce could be sold and earn households much needed income.

V. Improved Well-being of Women and Children

At the household level, women and children bear the burden of fetching water. Other than the time spent in getting water from long distances, these practices has far reaching consequences on their health and wellbeing.

Improved Irrigation water accessibility at homesteads would translate to time saving by the women. Time saved thus would be invested in other engagements that could bring financial benefits to the family. Children also bear the brunt of water borne diseases while women are tied down to provide nursing care

to the sick family members. With proximity of water all these negative impacts will be reversed in the project area.

8.3.2 Negative Impacts

I. Water logging and Soil salinity

Impacts

Water-logging and salinization of soils are common problems associated with irrigation. Water-logging results primarily from inadequate drainage and over-irrigation and, to a lesser extent, from seepage from canals and ditches. It concentrates salts, drawn up from lower in the soil profile, in the plants' rooting zone. Alkalization, the build-up of sodium in soils, is a particularly detrimental form of salinization which is difficult to rectify. On irrigated land, salinization is the major cause of land being lost to production and is one of the most prolific adverse environmental impacts associated with irrigation. However, very limited research has been conducted to quantify the economic impact of irrigation induced salinization. The use of irrigation water might also alter the structure of the soil. This can be mitigated by performing salinity test which will help ensure the soils are not destroyed in the long run and proper choice of the irrigation method.

During the operation of the irrigation scheme it is expected that soil erosion will occur from the tilled land (agriculturally induced erosion), the canals, dykes, drains etc. The method of irrigation profoundly affects the vulnerability of the land to erosion. Because irrigated land is wetter, it is less able to absorb rainfall and runoff will therefore be higher.

Reasons for an increase in soil salinity on the irrigation scheme could be as a result of the following:

- Salts carried in the irrigation water are liable to build up in the soil profile, as water is removed by plants and the atmosphere at a much faster rate than salts.
- Solutes applied to the soil in the form of artificial and natural fertilizers as well as some pesticides may not all be utilized by the crop.
- Salts which occur naturally in soil may move into solution or may already be in solution in the form of saline groundwater. This problem is often severe in arid areas where natural flushing of salts (leaching) does not occur.

II. Increase in Waterborne Diseases

Impact

Once the irrigation water is supplied to the farms, most households will use the same as drinking water and for domestic use without any treatment. This would increase the chances of contracting waterborne diseases such as typhoid and cholera. There will be increased chances of stagnating water in the farmers and thus attracting the breeding of mosquitoes, which will be responsible for the spread of malaria. This will lead to ill health problems among the residents and even increase the chances of child mortality rates in severe cases. Aim is to have separate system for domestic and irrigation water.

III. Reduced socio-economic conditions

Impact

Uneven distribution of irrigation water between the beneficiaries will result into water use conflicts. This scenario will arise when some farmers in the upper section of the project will over abstract the water and minimize the water availability to the downstream users. This will result in conflicts and could even interfere with the sustainability of the project. Secondly, too much abstraction of water from the River would result into conflicts between the upstream and downstream users. This will be a one of the worst case scenarios that could result to the withdrawal of the water abstraction permit for Ndirithi Aguthi Irrigation Project by WRA.

Increased inequality

The impact of irrigation on poverty reduction depends upon the structure of a rural economy and on how the additional farm income generated by improved access to irrigation is actually spent within a rural economy, and its feedback impacts on rural employment and rural wage structures. In some cases new technologies and interventions can unintentionally create new burdens for women

IV. Pollution of Water

Impact

The key environmental issue during operation will be the increased use of agricultural biocides (insecticides, herbicides, fungicides etc.) and fertilizers due to expected intensification of agricultural activities in the project area. Production of horticultural crops will demand increased use of biocides many of which are toxic and can have a long term effect in soils. This might also find their way into the River and thus impact negatively the downstream ecosystems.

The pollution of surface & underground water by agricultural chemicals leads to the deterioration of water quality while increased nutrient levels in the irrigation and drainage water results in algal blooms, proliferation of aquatic weeds and eutrophication in irrigation canals and downstream waterways. This can be mitigated by the enforcement of relevant legislations in the upstream areas.

V. Soil Erosion and Slope stability

Impact

Some parts of Nyeri County is susceptible to landslides. The operation phase of the project will be characterised by periodic excavation to repair the pipeline to connect new distribution networks. Excavation along existing shear zones within the water pipeline may trigger landslides. Furthermore, pipe bursts and water leakages from the pipeline system may also cause soil liquefaction and slope instability leading to lands damages.

Soil erosion from cultivation of steep slopes and stream banks in the project area will lead to silt deposition in the rivers. This will increase the turbidity levels in the rivers and could also affect the hydrology of the rivers and the downstream ecosystems.

VI. Negative impacts on Hydrology

Flow regime

The water used for irrigation from the Naru Moru River will inevitably lead to the reduced flow downstream which are often utilized by other farmers or wildlife habitats. Changes to the flow regime may have significant negative impacts on downstream users.

Rise of water table

In the long-term frequent problems of irrigation schemes is the rise in the local water-table (water logging). Low irrigation efficiencies are one of the main causes of rise in water table. Poor water distribution systems, poor main system management and old in-field irrigation practices are the main reason. The problem can be of particular concern in scheme, parts of project area in Rongai have salinity problems. High water table also makes the soil difficult to work. Good irrigation management, closely matching irrigation demands and supply should be put in place.

VII. Ecological change

The nature of irrigation scheme will radically change both the agricultural and natural ecology in the project area. The creation of reservoirs and channels provides the possibility of enhanced aquatic habitats. In particular, reservoirs and channels may also offer favourable habitats for disease transmitting insects and snails. The consumption of water for irrigated agriculture and the reduced quality of return flows is likely to adversely impact on downstream ecosystems. Reduced flows, increased salt concentrations, lower oxygen levels, higher water temperatures and increased pollution and silt loads all tend to favour vigorous, tolerant species (aquatic weeds). Marked changes to the water environment, both in quantity and quality, are liable to have negative impacts on downstream aquatic biota which may be adversely affected by changes to the hydrology or morphology of a river system.

Changes to the morphology of river estuaries can result from increased erosion or sedimentation. Areas of mangrove may be threatened by changes to the estuary morphology. Mangroves need both significant fresh water recharges and sediment rich flows in order to thrive. A reduction in flow leads to an increase in the soil salinity which favours more salt-tolerant species. Mangroves trap silt, transported by flood flows, and obtain their inorganic nutrients from it. These flushing flows also serve to keep the deltaic channels open. Irrigation can have a direct impact on wetlands by either changing the hydrological conditions or by reducing water quality in downstream areas.

The introduction of exotic species of plant or animal may oust indigenous species or introduce disease agents which may affect plants, animals and/or man.

VIII. Occupation Health and Safety

There will be numerous activities in the many enterprises in the Irrigation Project. There will be many people working in the farms. The activities in the sectors pose numerous occupational and health risks. The players in these sectors need to take precautionary measures for the workers such as use of safety kits, trainings and awareness creation on health and safety issues and insurance schemes for workers. A full pledged health and safety plan need to be

8.4 Impacts during Decommissioning

8.4.1 Negative Impacts

I. Reduced availability of Irrigation water to users

The termination of the project at the end-of-project life will reduce the amount of water for irrigation available to the established beneficiaries. This will cause increased competition for the water resources e.g. for household use diverted for irrigation. Consequently, water-related conflicts and utilisation of contaminated sources will occur. Aim is to have separate system for domestic and irrigation water.

II. Slope stability

The decommissioning phase will involve excavation of the pipeline to remove pipe sections and fittings. Excavation activities might interfere with dormant shear zones thereby triggering water land inflicted damages.

III. Soil erosion and Siltation of Surface Water Resources

Excavation activities during decommissioning will loosen soil thereby making it vulnerable to erosion due to wind and surface water run-off. Excavated soils could be swept into surface water bodies by storm water floods during rains. This will increase the turbidity and sediment loads of the water bodies nearby thereby increasing the cost of surface water de-siltation.

IV. Air Quality Degradation/ Dust Emission

Potential air quality degradation will occur as a result of vehicular and equipment emissions/ exhaust gases. Generation of dusts from trucks and vehicles accessing the project site and camp sites as well as piling of excavated material is expected to degrade the local air quality.

V. Interruption of Existing Infrastructure and Services

The water pipeline route traverses an existing road reserve but some sections will cross tarmacked and feeder roads. Construction work will interfere will existing supply and distribution pipeline networks thereby interrupting irrigation water supply services. These services are critical and have implications with spill over from the weirs effects on the social and economic performance.

VI. Effect on Socio-Economic Activities

During the decommissioning phase, any crops planted along the irrigation water pipeline will be cleared to make way for decommissioning activities. Visits to the project area will have minimal encroachment by way of farmlands. This impact will therefore have minimal adverse effect to the local communities.

VII. Loss of Flora and Fauna

There will be no trees established within the pipeline rout reserve during the operational phase of the project other than shrubs and grasses. Decommissioning activities will therefore have minimal impact on flora and fauna.

VIII. Increased Vehicular and Human Traffic

An influx of workers to the project sites will be experienced during the decommissioning phase of the project. This might contribute to the disruption of social order within the local communities. Increased vehicular traffic during the transportation of decommissioning wastes and salvaged materials might result in the destruction of light traffic roads and increase the risk of transportation accidents.

IX. Generation of Liquids and solid wastes

Decommissioning activities will generate various solid wastes ranging from earth material, pipe and fitting debris, wrappings, equipment oils and greases, waste asphalt concrete, human wastes to food wastes. Poor handling and disposal of such waste will lead to environmental pollution. Such wastes have the potential to enter and clog the local drainage channels thereby causing flooding.

X. Health and Safety Hazards

Workers and the local community will be susceptible to health and safety hazards during the decommissioning phase of the project. Inherent occupational risks include muscular-skeletal injuries, falls into un-marked/ uncovered trenches and accidents from construction vehicles. The influx of construction workers may put pressure on existing local resources, cause social conflicts, promiscuity and related sexually transmitted diseases

9 IMPACT ENHANCEMENT AND MITIGATION MEASURES

9.1 Preamble

In the context of sustainable development, projects should be implemented in a manner to enhance the living standards of the targeted beneficiaries and the resident communities. The consultant was guided by the principles of sustainability in the formulation of practical mitigation measures for potential impacts identified through stakeholder engagement, public consultation and expert knowledge. The main objective was to maximize social, environmental and economic benefits of the project and to minimize any associated adverse impacts. This chapter presents the proposed enhancement and mitigation measures of potential impacts for the project.

9.2 Enhancement Measures for Positive Impacts

Enhancement refers to the deliberate attempts taken in the design and subsequent phases of the project to ensure the success of a wider range of direct and indirect positive outcomes to communities and/or the biophysical environment. This can be in the form of opportunities for social and community development, improved health and wellbeing, improved biodiversity, restored ecosystems and landscape character, and protected and respected cultural heritage[3].

The project will strive to enhance the positive impacts envisaged. The proponent will support the implementation of the Environmental and Social Management Plan (ESMP) at construction and operation phases of the project. Any impacts not envisaged under the ESMP will be identified through structured monitoring and evaluation under the project. The proponent will improve the experience its customers through better irrigation services and expansion of coverage area. The contractor will maximise the utilisation of local labour for construction activities to enhance the socio-economic status of the local communities.

9.3 Mitigation Measures for Negative Impacts

9.3.1 Construction Phase

I. Soil Erosion

Incorporating soil conservation measures during construction would help to mitigate damage caused by erosion.

II. Interference with the physical setting

During construction, adequate survey should be done on the water pipeline route and anyone whose property is affected should be compensated for disturbance. This can be sought by engaging formally with land owners within the project area.

The contractor should be in a position to pass relevant information to each of the affected persons and at the end, an equal engagement should be done to assess whether there is grievances.

[3] João , E., Vanclay, F., & Broeder, L. (2011) Emphasising enhancement in all forms of impact assessment: introduction to a special issue, Impact Assessment and Project Appraisal, 29:3, 170-180, DOI: 10.3152/146155111X12959673796326

III. Noise Pollution and Vibrations

The contractor should maintain the levels of noise pollution from the machinery in accordance to the manufacturer's specification. The required decibels should be adhered to and to those operating the machines they should put on ear masks to prevent direct noise from the machinery.

The contractor should use machines that are less vibrating and those that are well serviced to prevent excessive vibration. Where vibration due to compacting is very high, We propose the compaction to be done during the day.

IV. Slope stability

The contractor shall avoid the usage of heavy excavation machinery along the pipeline route. Manual labour shall be used for trenching and backfilling during construction.

V. Air Quality Degradation/ Dust Emissions

The following measures will be observed during the construction phases of the project to mitigate against the degradation of local air quality/ dust emissions;

i) Supply and construction vehicles will only use the designated transport routes. The drivers will also be advised to stick to prescribed speed limits
ii) The contractor will ensure proper repair and maintenance of vehicles and equipment to minimize exhaust gases
iii) The contractor shall ensure appropriate vehicle speeds road sections that will be used by construction vehicles on a needs basis to eliminate the creation of dusts
iv) Construction workers will be provided with dust masks to mitigate against occupational health risks of inhaling exhaust gases and dust
v) The contractor should sprinkle water to maintain dust to the low minimum at all times

VI. Workers Accidents and Hazards during Construction

Proponent will develop and commit the contractors to Site Occupational Health and Safety rules and regulations as stipulated in the Occupational Safety Act of Kenya of 2007 and revised in 2010. It provides for the safety, health and welfare of workers and all persons lawfully present at workplace. It shows that it is the responsibility of every employer to ensure the safety, health and welfare of all employees at work working in his/her workplace.

Section 101 of the occupation safety and health Act, requires that in workplaces where employees are exposed to any injurious or offensive substances, the employers must provide and maintain clothing and appliance that are adequate, effective and suitably protective, including where necessary, suitable gloves, footwear, goggles and head coverings. Again, section 102 provides that employer supply suitable goggles or effective screens to protect the eyes of person

Should an accident occur on the site;

i) The injured person should be given first aid and immediately taken to the hospital
ii) An investigation should be initiated immediately to ascertain the cause of the accident and preliminary findings released within 12 hours.

VII. Extraction and use of Construction Materials

The contractor should ensure that after the construction materials such as marram, ballast, soft stones etc. have been extracted, the site should be backfilled to help retain the value of the land resource, before the site is to be backfilled it should be fenced to prevent the following: Deaths of persons and livestock due to falling in it or drowning when filled with rainwater, and creation breeding ground for mosquitoes, which cause malaria

VIII. Rock Blasting

There will be local community members whose crops will be affected by the excavation work, rock blasting, and storage of materials which may affect their crops / animals. There is risk of rock falls during blasting. The contractor should adopt controlled blasting techniques, preventing flying rock debris and high intensity vibrations. Blasting of rock should be done in line with the provisions of the Explosives Act Cap 115, and only after a stability analysis has been conducted. The management should equally observe relevant explosives use and blasting permits provided by the Inspector of Mines and Geology.

Blasting should be done during the day, and residents in the vicinity of the quarry should be suitably warned in advance of the proposed blasting activities, including the time and date that the blasting is to take place. Blasting should not be carried out at night or anywhere near houses or public utilities. The movement of the people on nearby roads and any other movement in the vicinity of the blast must be must be told to keep a safe distant during the blast.

A time-table should be developed regarding rock blasting, so as to prevent stress arising from noise pollution. Blasting activities should be done during the day and the public should be properly informed of the activity in time. Community should be pre warned on the times of using explosives for rock blasting purposes. The contractor must prepare rehabilitation management plans for each quarry opened which shall be a part of the contracting document. Signage and flag bearers are to be stationed at the safe distance to restrict movement during such times. These requirements must be specified in the specifications.

IX. Generation of Liquid and Solid Waste

The project contractors should take adequate measures on the spilled substance on land and water bodies during construction. They should ensure that there is minimal spillage and if it is more, then scooping and adequate, dumping required. With liaison with the relevant authorities they should as well make sure that the required measures is followed on the spillage.

The project contractor will provide solid waste collection facilities (waste bins) for the temporary storage of wastes prior to disposal at an appropriate and designated location. The contractor will also liaise with the County government and the local NEMA office for direction on licensed waste collectors and suitable dumping sites for generated wastes. The contractor will also sensitize construction workers on proper disposal of wastes.

X. Loss of flora and fauna

The proponent shall ensure that clearing of any vegetation is limited to the water pipeline trench area (i.e. 0.5 meters width) within the road reserve and that transportation of construction materials is done through the existing local roads. The areas to be cleared for the water pipeline trench, camp-site and materials holding yard shall be identified and marked out prior to the start of construction activities. In addition, clearance of vegetation on riparian land will be avoided.

The construction work-force will be sensitized on the importance of environmental conservation and ecological protection to prevent the exploitation of natural resources around the project area and destruction of ecosystems. On completion of the construction work, the trenched pipeline areas will be allowed to re-vegetate with fibrous rooted vegetation species.

XI. Occupational Safety and Health

The following measures will be observed/ implemented to reduce/ eliminate potential health and safety risks;

The contractor shall erect an appropriate project signboard as directed by the proponent. The signboard shall include information on the project proponent, funding organization, project contractor, project manager, civil and structural engineer among other relevant information that will be required by the proponent

The contractor will erect the appropriate safety signage along the construction route cautioning against various health and safety risks and prescribing particular mandatory actions. Road signs will also be erected to warn pedestrians and motorists of construction activities and diversions at road sections where the pipeline will cross.

The contractor and the proponent will provide adequate first-aid facilities in the project sites to handle medical emergencies during construction. A standby vehicle will also be provided to swiftly transport ill/ injured staff and members of community to the nearest medical facility.

The contractor will comply with National and international labour laws in recruiting construction staff. All workers will be required to produce their National identification cards, NHIF and NSSF registration numbers. Child labour will not be used in construction work.

All construction workers will be required to wear Personal Protective Equipment (PPE) i.e. helmets, gloves and safety boots during the construction phase. The workers will also be sensitized on health and safety standards that they should observe.

A comprehensive HIV/AIDs sensitization programme will be formulated to create awareness among construction workers and local community. The programme will be supported by a qualified community health practitioner who will also offer testing and counselling services. Information fliers and protection devices will also be made freely available during the construction phase.

9.3.2 Operation Phase

I. Water logging and Soil salinity

Careful management should be practiced to reduce the rate of salinity build up and minimize the effects on crops. Management strategies include: leaching; altering irrigation methods and schedules; installing sub- surface drainage; changing tillage techniques; adjusting crop patterns; and, incorporating soil ameliorates.

II. Increase in Waterborne Diseases

Waterborne diseases such as bilharzia, malaria, foot rot will be realised during the operation phase of the project. Prevention is by choosing an irrigation system that is very efficient and does not cause water logging in the field. As well, the design irrigation scheduling should be followed to prevent an increase in the irrigation hours in one section.

During the operation phase of the project, repair and maintenance staff shall drain the pipeline sections to be worked on to avoid spillage of water. Any pipeline leakages or bursts shall be swiftly repaired to avoid triggering land-damages on steep slope

III. Reduced socio-economic conditions

Water use Conflicts

Water abstraction from any water body in Kenya, is guided by Water Resources Authority (WRA). The authority outlines the quantity of water abstracted by any user. Within the catchment, WRUAs solves any conflict of water use in any river in that catchment. In an irrigation field, there is Irrigation Water Users Association (IWUA) who will be formed to guide the use of the water in the irrigation fields. The IWUA will assist in the following:

Assist in the formation of the committee who will be required to form strict by-laws that will guide on water usage and conflict resolution in the irrigation scheme. Conduct farmers training on best irrigation

practices that aims at efficient water use. Install a water meter at the intake and at household levels in order to control water usage and form a basis of rationing. Strictly enforce the Water Act 2016, in order to guide on water usage for the benefit of all stakeholders.

Increased inequality

- Targeting and empowering women starts at the household level to manage water resources and related irrigation technologies.
- Increasing women's access to market and production information, joint financial services and mobile money services
- Mobilize groups of women to adopt technology to ensure more accountability for its management, use, and transparency of benefits.
- Establish clear, precise rules for incorporating women in water management
- Strengthen the role of women, improving their ability to enhance their self-esteem, degree of integration, and position, and increasing their democratic participation in water management
- Train women in production issues
- Highlight and value women's contribution to their household's economy.

IV. Pollution of Water

The loss and deterioration of water quality has both regional and national costs through impacts on recreation and other amenity values, human health and vulnerable ecosystems. This risk may be partly offset by the method of irrigation used and other improved land management techniques.

V. Soil Erosion

The project contractor shall ensure that excavated earth materials and grass planted on them to prevent it from being washed away. The same soil can be used for backfilling the water pipeline trenches where needed. The backfilled soil will also be sprinkled with water and compacted to a similar density to the existing ground. The cleared sites will be re-vegetated to improve ground cover and minimize soil erosion and also improve on aesthetics of the project area. Some of the following activities will further improve soil management.

i) Promote good farm management practices that aim at soil conservation
ii) Training should be conducted during project implementation to ensure that members, IWUAs and scheme management understand and take up their role in catchment management;
iii) Train farmers in soil and water management to avoid land degradation
iv) Proper tillage methods e.g. minimum tillage

VI. Negative impacts on Hydrology

Flow regime

Ensure sustainable abstraction of water from River Naru Moru

Rise of water table

Use of good irrigation management, closely matching irrigation demands and supply

Installation and maintenance of adequate drainage system. This will help reduce seepage and increase irrigation efficiency, thereby reducing groundwater recharge.

VII. Ecological change and imbalances

The use of herbicides should be limited as far as possible. Herbicides should only be used under strict control and only when other options are not available. Herbicides may not be used near sensitive environments especially wetland areas

Use "best practices" in handling/ using agricultural chemicals

The proponent and other relevant government should ensure that invasive alien plant species are not introduced to the area and should they be identified then this should be immediately removed

VIII. Occupation Health and Safety

All workers will be required to wear Personal Protective Equipment (PPE) i.e. helmets, gloves and safety boots during the operation phase. The workers will also be sensitized on health and safety standards that they should observe

During the operation phase of the project, repair and maintenance staff shall drain the weir and should be cleaned of debris and logs to avoid clogging and hence spillage of water to the neighbouring farms, homesteads and possible landslides. Protective clothing's should be used as well.

9.3.3 Decommissioning Phase

I. Reduced availability of Irrigation water to users

The proponent shall provide an alternative source of irrigation water to the beneficiaries of the project. Assessment on the water resources in the area will be done.

II. Slope stability

The use of manual labour for excavation and backfilling is recommended. Avoidance of utilisation of heavy machinery near steep landscapes and as well this activities to be conducted during dry season.

III. Soil erosion and Siltation of Surface Water Resources

The project contractor shall ensure that excavated earth materials during decommissioning should be well extracted and prevented from flowing to the nearby water bodies to cause siltation. The same soil should be returned to the same spot and gentle compaction done manually to prevent it from being washed away. The cleared sites will be re-vegetated to improve ground cover and minimize soil erosion and also improve on aesthetics of the decommissioned area.

If the soil causes siltation, then proper desiltation should be done along the sites that decommissioning would be done.

IV. Air Quality Degradation/ Dust Emission

The following measures will be observed during the decommissioning phases of the project to mitigate against the degradation of local air quality/ dust emissions;

- Supply and construction vehicles will only use the designated transport routes. The drivers will also be advised to stick to prescribed speed limits
- The contractor will ensure proper repair and maintenance of vehicles and equipment to minimize exhaust gases
- The contractor shall ensure appropriate vehicle speeds on road sections that will be used by construction vehicles on a needs basis to eliminate the creation of dusts
- Construction workers will be provided with dust masks to mitigate against occupational health risks of inhaling exhaust gases and dust
- The contractor should sprinkle water to maintain dust to the low minimum at all times

V. Interruption of Existing Infrastructure and Services

The project proponent will apply for authorisation from relevant National authorities to interfere with existing infrastructure. The proponent will liaise with KURA and KeRRA for authorisation to cut through main roads and feeder roads that fall under their jurisdiction. The contractor will immediately restore the damaged sections of roads and water supply networks to pre-construction conditions.

VI. Effect on Socio-Economic Activities

The local community members whose farms have encroached on the reserve will be notified of pending construction activities in advance and asked to harvest any crops and salvage any useful fence materials there-in.

VII. Loss of Flora and Fauna

The proponent shall ensure that clearing of any vegetation is limited to the water pipeline trench area when the pipes are removed in decommissioning phase. The areas to be cleared should be of minimal plants and birds for campsite and decommissioned materials holding yard shall be identified and marked out prior to the start of decommissioning activities. In addition, unnecessary clearance and especially in riparian land discouraged.

Sensitisation to the work force on environment and ecological protection to prevent the exploitation of natural resources around the project area and destruction of ecosystems encouraged. On completion of the decommissioning, the trenched pipeline areas, soil will be put back and re-vegetate with the surrounding vegetation.

VIII. Increased Vehicular and Human Traffic

Transportation of decommissioned material to specific sites will be done through the existing local roads where possible. The contractor will rehabilitate the local roads that will be damaged during decommission phase. Vehicular and human traffic shall be restricted to the road reserve as much as possible. Drivers/ operators of vehicles will be advised to comply with prescribed speed limits to reduce the risk of road accidents.

IX. Generation of Liquids and Solid wastes

The project contractors should take adequate measures on the spilled substance on land and water bodies during decommissioning. They should ensure that there is minimal spillage and if it is more, then scooping and adequate, dumping required. With liaison with the relevant authorities they should as well make sure that the required measures are followed on the spillage.

The project contractor will provide solid waste collection facilities (waste bins) for the temporary storage of wastes prior to disposal at an appropriate and designated location. The contractor will also liaise with the County Government and the local NEMA office for direction on licensed waste collectors and suitable dumping sites for generated wastes. The contractor will also sensitize construction workers on proper disposal of wastes.

X. Health and Safety Hazards

The following measures will be observed/ implemented to reduce/ eliminate potential health and safety risks;

i) The contractor shall erect an appropriate project signboard as directed by the proponent. The signboard shall include information on the project proponent, funding organization, project contractor, project manager, civil and structural engineer among other relevant information that will be required by the proponent

- The contractor will erect the appropriate safety signage along the construction route cautioning against various health and safety risks and prescribing particular mandatory actions. Road signs

will also be erected to warn pedestrians and motorists of construction activities and diversions at road sections where the pipeline will cross.

- The contractor and proponent will provide adequate first-aid facilities in the project sites to handle medical emergencies during construction. A standby vehicle will also be provided to swiftly transport ill/ injured staff and members of community to the nearest medical facility.
- The contractor will comply with National and international labour laws in recruiting construction staff. All workers will be required to produce their National identification cards, NHIF and NSSF registration numbers. Child labour will not be used in construction work.
- All construction workers will be required to wear Personal Protective Equipment (PPE) i.e. helmets, gloves and safety boots during the construction phase. The workers will also be sensitized on health and safety standards that they should observe. During the operation phase of the project, repair and maintenance staff will also be required to use PPEs.
- A comprehensive HIV/AIDs sensitization programme will be formulated to create awareness among construction workers and the local community. The programme will be supported by a qualified community health practitioner who will also offer testing and counselling services. Information fliers and protection will also be made freely available during the construction phase.
- During the operation phase of the project, repair and maintenance staff shall drain the weir should be cleaned of debris and logs to avoid clogging and hence spillage of water to the neighboring farms and homesteads and also landslides.

10 ENVIRONMENTAL AND SOCIAL MANAGEMENT AND MONITORING PLAN

10.1 Preamble

The purpose of the **ESMP** is to ensure that environmental and social impacts and risks identified during the ESIA are effectively managed during the construction, operation and decommissioning of the proposed project. The **ESMP** specifies the mitigation and management measures for each impact/ risk, party allocated responsibility, means of monitoring and frequency, objective verifiable indicators and an indicative budget. The **ESMP** also establishes a monitoring plan, capacity building plan and institutional arrangements to support its implementation.

The project proponent shall avail this **ESMP** to the successful contractor awarded the tender for construction work for this project. The contractor will be required to formulate a more specific **ESMP** and work methods that will ensure construction of the project in compliance with established standards and legislation. The contractor will factor the costs of implementing the **ESMP** into their budget. The project proponent will take the necessary steps to ensure that the **ESMP** is fully implemented.

10.2 Environmental and Social Management Plan

Figure 10.1: Environmental and Social Management Plan

Potential Impact	Mitigation/ Enhancement Measures	Responsibility	Monitoring means / Frequency	Verifiable Indicators	Estimated Costs (Kshs.)
Construction Phase					
Soil Erosion	• Incorporating soil conservation measures during construction would help to mitigate damage caused by erosion. • Carry out inspection of each of the sites' soil stability before excavation; • All borrow pits sites shall be clearly indicated on a plan and approved by the Engineer; • Borrow pits and quarries to be located more than 100 metres from watercourses to minimize storm water runoff into watercourse	Contractor	During construction	• Soil erosion rates, • stability of bank	Contractor Cost
Interference with the physical setting	• Adequate survey should be done on the water pipeline route • Anyone, whose property is affected to be compensated for disturbance • Engagement shall be do to assess whether there is grievances.	MOALF&I	Prior to project implementation	• No. of person affected • No. of properties destroyed	500,000
Noise pollution and vibration	• Noise maintained in accordance to the manufacturer's specification • Operators to put on ear masks to prevent direct noise from the machinery • Machines that are less vibrating to be used • When high vibration needed, to be done during the day	Contractor	During construction	• State of machines used • Type of machines used for compaction	250,000

Potential Impact	Mitigation/ Enhancement Measures	Responsibility	Monitoring means / Frequency	Verifiable Indicators	Estimated Costs (Kshs.)
Slope Instability	• Use of manual labour for trenching and backfilling • Avoid utilisation of heavy machinery near steep landscapes • Construction activities to be conducted during dry season	Contractor	Throughout the construction phase	• Type of technique utilised for trenching and backfilling	150,000
Air Quality Degradation/ Dust Emissions	• Supply and construction vehicles will only use the designated transport routes. The drivers will also be advised to stick to prescribed speed limits • The contractor will ensure proper repair and maintenance of vehicles and equipment to minimize exhaust gases • The contractor shall ensure the appropriate speed limits are observed at along all road sections that will be used by construction vehicles on a needs basis to eliminate the creation of dusts • Construction workers will be provided with dust masks to mitigate	Contractor	Daily Monitoring	• Records of speed limits signs erected • Records of machine and vehicle service • Evidence of use of dust masks by workers on site	150,000
Workers Accidents and Hazards during Construction	• Contractors to adhere to Occupational Health and Safety rules and regulations as stipulated in the Occupational Safety Act of Kenya of 2007 and revised in 2010 • Employers must provide and maintain clothing and appliance that are adequate, effective and suitably protective, including where necessary, suitable gloves, footwear, goggles and head coverings • In case of accidents, injured persons should be given first aid and immediately	Contractor	Daily Monitoring	• No of persons injured • Type of injury experienced	Contractor Cost

Potential Impact	Mitigation/ Enhancement Measures	Responsibility	Monitoring means / Frequency	Verifiable Indicators	Estimated Costs (Kshs.)
	taken to the hospital • Investigation on the cause of accidents done and adequate conclusion to be arrived at				
Extraction and use of Construction Materials	• The construction extraction site should be backfilled to help retain the value of the land resource • Fencing to be done before backfilling to prevent accidents of humans and livestock	Contractor	After extraction of construction materials	• No. of open sites • Type of fencing required	Contractors costs
Rock Blasting	• In case of blasting: Obtain a current and valid authorization from the Department of Mines and Geology prior to any blasting activity; o A qualified and registered blaster shall supervise all blasting and rock-splitting operations; • Develop a safety policy on site.	Contractor		•	Contractors costs
Generation of Liquid and Solid Waste	• Provision of solid waste collection facilities (waste bins) • Contracting licensed solid waste handlers • Sensitization of construction workers on proper disposal of solid wastes • The contractor will maintain all site vehicles and equipment is a serviceable state • Temporary latrines will be provided on site to be used by construction workers • Oils and greases emanating from repair and maintenance activities will be collected in containers to avoid entry into local drainage channels	Contractor	Daily Inspection	• Presence/ absence of scattered solid wastes at sites • Availability of waste receptors • No. of sensitization meetings held with workers	100,000

Potential Impact	Mitigation/ Enhancement Measures	Responsibility	Monitoring means / Frequency	Verifiable Indicators	Estimated Costs (Kshs.)
	• Water from cleaning of equipment will be utilised within the project site and will not be discharged into watercourses.				
Loss of Flora and Fauna	• The proponent shall ensure that clearing of vegetation clearing is limited to the pipeline trench area (i.e. 0.5 meters width) within the road reserve • Transportation of construction materials to be done through the existing local roads • Avoidance of vegetation clearing along riparian land • Sensitization of construction work-force on environmental conservation and ecological protection • Re-vegetation of completed pipeline route with fibrous rooted indigenous vegetation species • Define ecological requirements. • Operate reservoirs to suit downstream requirements and encourage wildlife around reservoirs. • Designate land (in law and supported by protection institutions) for flood plains; wetlands; watersheds; drainage water disposal; river corridors	MOALF&I / Contractor	Routine inspections	• No. and type of vegetation cleared • No. and type of indigenous species re-planted • Size of area cleared • Size of area re-vegetated	250,000
Increased Vehicular and Human Traffic	• Transportation of construction material to specific sites will be done through the existing local roads • The contractor will rehabilitate the local roads that will be damaged during	Contractor	Routine inspections	• No. of accidents involving project vehicles • Transportation control logs • No. of road spots rehabilitated	Routine project activity

Potential Impact	Mitigation/ Enhancement Measures	Responsibility	Monitoring means / Frequency	Verifiable Indicators	Estimated Costs (Kshs.)
	construction activities • Consultation with the local communities on planned road diversions if any • Restriction of Vehicular and Human Traffic to the road reserve where possible • Sensitization of drivers to comply with prescribed speed limits			• Community complaints	
Occupation Health and Safety	• Continuous supervision of occupational, health and safety management to ensure compliance	MOALF&I	Routine Inspection	• HSE inspection reports	50,000.00
	• Occupational Safety and Health Training for contractor's staff	Contractor	Throughout construction phase	• Training reports • Training attendance sheets	30,000.00
	• Conduct orientation talks and visits	Contractor	At employment of new staff	• Orientation report	No direct costs anticipated
	• Conduct toolbox talks	Contractor	On a daily basis	• No. of toolbox talks conducted	No direct costs anticipated
Sub-Total of Cost Estimates for the Construction Phase					**1,980,000**
Operation Phase					
Increased soil salinity	• Improve Irrigation and Drainage operation to match demand both how much and when • Provide drainage including disposal of water to evaporation ponds if quality of river flow adversely affected by drainage water	• MOALF &I • Farmers		•	200,000 per month

Potential Impact	Mitigation/ Enhancement Measures	Responsibility	Monitoring means / Frequency	Verifiable Indicators	Estimated Costs (Kshs.)
	• Maintain channels to prevent seepage, and reduce inefficiencies resulting from siltation and weeds • Allow for access to channels for maintenance in design. • Provide water for leaching as a specific operation. • Set-up or adjust irrigation management infrastructure to ensure sufficient income to maintain both the irrigation and drainage systems. • Analyse soils and monitor changes so that potential problems can be managed. • Careful management should be practiced to reduce the rate of salinity build up and minimize the effects on crops.				
Increase in Waterborne Diseases	• Choice of irrigation system that is efficient in water use • Removal of any stagnant water • Use of nets at homes • Use of gumboots in the irrigation field • Manage Irrigation and Drainage to prevent disease spread. • Educate about causes of disease • Improve health facilities.	• MOALF &I • Farmers	On need basis	• Type of irrigation system used • Amount of stagnant water	Proponent's cost
Slope-instability	• Operations and maintenance staff shall drain the pipeline sections to be worked on to avoid spillage of water • Pipeline leakages or bursts shall be swiftly attended to	• MOALF &I	On a needs-basis	• No. of water inflicted lad damages attributable to the project	Proponent's cost

Potential Impact	Mitigation/ Enhancement Measures	Responsibility	Monitoring means / Frequency	Verifiable Indicators	Estimated Costs (Kshs.)
Water use conflicts	• Water abstraction laws followed • Farmers training on water use • Installation of water meters • Enforcement of water Act, 2016 • Establishment of an Irrigation Water User Committee • Allow sufficient time and money for extensive public participation to ensure that plans are optimal, that all sections of affected society are considered and that local institutions are in place to sustain irrigated agriculture, particularly in respect of land and water rights.	• WRA • IWUA • Farmers	During water abstraction and use	• Amount of water flowing in a river • Amount of water abstracted • Number of farmers plots • Irrigation frequency per plots • Committee Established	Proponent's cost
Pollution of Water	• Machines used during operation maintained in good condition • Oils and greases emanating from operations and maintenance activities will be collected in containers to avoid entry into local drainage channels • All polluted water treated before discharging to water bodies	• MOALF &I • Farmers	All farming operations	• Number of machines e.g. tractors used	Proponent's cost
Soil erosion and Siltation of Surface water resources	• Use erosion control techniques which disperse erosive energy and avoid concentrating it e.g providing good vegetative cover will disperse the energy of rain drops and contour drainage will slow down surface runoff • Proper maintenance of irrigation infrastructures.	• MOALF&I • Farmers	On a needs-basis	• Soil conservation techniques put in place	Proponent's cost

Potential Impact	Mitigation/ Enhancement Measures	Responsibility	Monitoring means / Frequency	Verifiable Indicators	Estimated Costs (Kshs.)
	• Adopt conservation tillage systems and ripping to control hardpan				
• Negative impacts on Hydrology	• Ensure sustainable abstraction of water from River Naru Moru • Use of good irrigation management, closely matching irrigation demands and supply • Installation and maintenance of adequate drainage system. This will help reduce seepage and increase irrigation efficiency, thereby reducing groundwater recharge.	MOALF&I WRA WRUA Project Engineer	Monthly	• River Flow Readings	50,000
Ecological change and imbalances	• The use of herbicides should be limited as far as possible. Herbicides should only be used under strict control and only when other options are not available. Herbicides may not be used near sensitive environments especially wetland areas • Use "best practices" in handling/ using agricultural chemicals • The proponent and other relevant government should ensure that invasive alien plant species are not introduced to the area and should they be identified then this should be immediately removed	MOALF&I NEMA PCPB (Pest Control and Products Board)	Periodic activities	• No. Water Quality Tests Undertaken	50,000
Health and Safety Hazards	• Train all workers on Health, Safety and Environment (HSE) with an aim of improving awareness • The proponent will erect appropriate safety signage during operations and maintenance activities	MOALF&I	On a needs-basis	• Training on HSE conducted • Prominently erected safety signage during R&M work • Availability of first-aid kit during R&M work	Proponent's cost

Potential Impact	Mitigation/ Enhancement Measures	Responsibility	Monitoring means / Frequency	Verifiable Indicators	Estimated Costs (Kshs.)
	• The proponent shall provide first-aid facilities for R&M staff • Proponent's staff will be required to use PPEs during R&M work				
Decommissioning Phase					
Reduced availability of irrigation water to users	• The proponent shall provide an alternative source of irrigation water to the users of the project	MOALF&I	During and after the decommissioning phase	• Customer complaints • Alternative sources of water provided	Proponent's cost
Slope Instability	• Use of manual labour for excavation and backfilling • Avoid utilisation of heavy machinery near steep landscapes • Decommissioning activities to be conducted during dry season	Contractor	Throughout the decommissioning phase	• Type of technique utilised for trenching and backfilling • No. of water inflicted land damages that occur during the decommissioning phase	No direct costs (integrated in the works costs)
Soil erosion and Siltation of Surface water resources	• Use excavated earth materials for backfilling • Sprinkling of backfilled trenches with water • Compaction of backfilled trenches • Re-vegetation of excavated areas • Channelling of surface water runoff away from the pipeline route	Contractor	Daily Inspection	• Presence/ absence of stockpiled excavated earth material • No. of silt traps installed • No. of surface drains constructed	No direct costs (integrated in the works costs)
Air Quality Degradation/ Dust Emissions	• Evacuation vehicles will only use the designated transport routes. The drivers will also be advised to stick to prescribed speed limits • The contractor will ensure proper repair and maintenance of vehicles and equipment to minimize exhaust gases	Contractor	Daily Monitoring	• Records of water sprinkling • Number of speed limit signs erected • Evidence of use of dust masks by workers on site	Contractors cost

Potential Impact	Mitigation/ Enhancement Measures	Responsibility	Monitoring means / Frequency	Verifiable Indicators	Estimated Costs (Kshs.)
	• The contractor shall ensure recommended speeds on road sections that will be used by construction vehicles are adhered to on a needs basis to reduce the creation of dusts • Construction workers will be provided with dust masks to mitigate				
Interruption of Existing Infrastructure and Socio-Economic Activities	• The proponent will liaise with KURA and KeRRA for authorisation to cut through main roads and feeder roads that fall under their jurisdiction. • The contractor will immediately restore the damaged sections of roads and water supply networks to pre-construction conditions	MOALF&I Contractor	Before and during the decommissioning phase	• Permit from KURA/ KeRRA • Engineer's inspection of repaired road sections • Complaints from the local community	Proponent's cost
Impact on Socio-Economic Activities	• Notification to local community members whose farms have encroached on the reserve will be notified of pending decommissioning activities	MOALF&I	Before the decommissioning phase	• Complaints from the local community during decommissioning activities	No direct costs anticipated
Loss of Flora and Fauna	• The proponent shall ensure minimal clearing of vegetation • Transportation of decommissioning wastes to be done through the existing local roads • Sensitization of decommissioning work-force on environmental conservation and ecological protection • Re-vegetation of cleared areas with indigenous vegetation species	MOALF&I Contractor	Routine inspections	• No. and type of vegetation cleared • No. and type of indigenous species re-planted • Size of area cleared • Size of area re-vegetated	Routine project activity
Increased Vehicular and	• Transportation of decommissioning wastes to specific sites will be done	Contractor	Routine inspections	• No. of accidents involving project vehicles	Routine project

Potential Impact	Mitigation/ Enhancement Measures	Responsibility	Monitoring means / Frequency	Verifiable Indicators	Estimated Costs (Kshs.)
Human Traffic	through the existing local roads • The contractor will rehabilitate the local roads that will be damaged during decommissioning activities • Consultation with the local communities on planned road diversions • Restriction of Vehicular and Human Traffic to the road reserve where possible • Sensitization of drivers to comply with prescribed speed limits			• Transportation control logs • No. of road spots rehabilitated • Community complaints	activity
Generation of solid and liquid waste	• Provision of solid waste collection facilities (waste bins) • Contracting licensed solid waste handlers • Sensitization of construction workers on proper disposal of solid wastes • The contractor will maintain all site vehicles and equipment to a serviceable state. • Oils and greases emanating from repair and maintenance activities will be collected in containers to avoid entry into local drainage channels • Water from cleaning of equipment will be utilised within the project site and will not be discharged into water courses.	Contractor	Throughout decommissioning phase	• Presence/ absence of scattered solid wastes at sites • Availability of waste receptors • No. of sensitization meetings held with workers • Evidence of oil leaks and greases on site • Evidence of waste water flowing through local drainage channels	100,000.00
Health and Safety	Continuous supervision of occupational, health and safety management to ensure compliance	MOALF&I	Routine Inspection	• HSE inspection reports	50,000.00
	• Occupational Safety and Health Training for contractor's staff	Contractor	Throughout	• Training reports • Training attendance sheets	30,000.00

Potential Impact	Mitigation/ Enhancement Measures	Responsibility	Monitoring means / Frequency	Verifiable Indicators	Estimated Costs (Kshs.)
			decommissioning phase		
	• Orientation talks and visits	Contractor	At employment of new staff	• Orientation report	No direct costs anticipated
	• Toolbox talks	Contractor	On a daily basis	• No. of toolbox talks conducted	No direct costs anticipated
Sub-Total of Cost Estimates for Decommissioning Phases					180,000.00
Grand-Total of Cost Estimates					1,660,000.00

11 CONCLUSIONS AND RECOMMENDATIONS

11.1 Conclusion

Based on the findings, it is evident that rehabilitation, construction and operation of the proposed irrigation project will result in overall economic growth and development of a result as improvement in the availability of water for agricultural use within the project area. As it is indicated in chapter nine, the potential negative impacts can be easily mitigated without any major effect to the environment. However, some important resources may be affected negatively such as flora, fauna, and water resources within the project area. These impacts vary from temporary to short term impacts. These impacts can however be mitigated as indicated in the Environmental and Social Management Plan (ESMP) discussed in chapter 10 of this report.

The water diversion and intake works will be constructed across a river valley with minimal destruction to the environment. Any destroyed vegetation and trees will be planted elsewhere through massive afforestation activities to protect the intake works catchment. Many people are also likely to benefit from the project and the agricultural improvement anticipated will lead to improved food security not only within the area but across the region and Nationally. No conflict between domestic and irrigation water since we envisage to harvest flood water.

11.2 Recommendations

The following should be observed:

I. Minimal vegetation destruction

Ensure minimum destruction of vegetation especially at the water diversion and intake works for the scheme. If possible, all project –related activities should be done within the designated project alignment areas.

II. Rehabilitation of quarries and borrow pits

Rehabilitate quarries, borrow and gravel pits to avoid potential health hazards.

III. Afforestation within intake works area and along river valleys

Replant bare areas within the vicinity of the intake works with vegetation cover to prevent soil erosion. This should also be done along the river valleys to help in ensuring that siltation of water courses from the anticipated increased agricultural activities are mitigated.

IV. Occupational Safety and Health (OSH) management

Ensure that both construction and agricultural worker's occupational health and safety standards are maintained through capacity building, proper training on protection, clothing and managing their residential camps up to the required health standards. The proponent, project beneficiaries and the contractor therefore need to ensure all the workers wear safety gears/clothinglike gas masks while in dusty working areas. Use of earmuffs must also be ensured by the contractor especially for the people working in areas where the noise level is high.

V. Environmental audits and monitoring

Annual environmental audits should be carried out on the project in order to ensure compliance of the project with the mitigation measures outlined in the ESMP. To ensure that the impact on the environment can be completely minimized, a monitoring and training activity should be carried out as outlined in the report.

VI. Good Housekeeping

The design and the quality of construction of the abstraction works need to be strictly controlled to ensure maximum life of the works in order to get value for money from the investment. All activities concerning construction and maintenance such as, work execution, site inspection and material testing, shall be strictly monitored by an engineer or a designated official. This is important to ensure the quality of maintenance works. Engineers and/or designates official shall be trained and experienced enough to judge the appropriateness of the work executed in order to carry out the monitoring properly.

VII. Community Participation

There is need for strengthening and promotion of the role of community groups, women and youth to fully participate in health, sanitation, water resources and environmental management and conservation.

VIII. Water Quality Tests

Strengthen various water testing laboratories within the project area through the provision of adequately trained personnel and necessary laboratory equipment. These would in turn strengthen field operations especially water quality monitoring. The laboratories should also research into suitable technologies to support standards on drinking water, effluent discharge and solid waste disposal and waste water management.

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13 APPENDICES

Appendix A: Results of The Laboratory Water Analysis

UNIVERSITY OF NAIROBI
DEPARTMENT OF CIVIL & CONSTRUCTION ENGINEERING

File:
Telegrams: "Varsity"Nairobi
Telephone: Nairobi +254-20-318262
Email: dept-civilengineering@uonbi.ac.ke

P.O. Box 30197-00100
NAIROBI
KENYA

CHEMICAL ANALYSIS FOR WATER SAMPLES

SAMPLE SOURCE & DESCRIPTION: RIVER NAROMORU.

SAMPLED BY: CLIENT

CLIENT: AGENN ASSOCIATES

PARAMETER	RESULT	REMARK
pH	6.55	
APPARENT COLOUR °H	5	
TRUE COLOUR °H	5	
CONDUCTIVITY µ/S/CM, mg/l	20	
TURBIDITY, F.T.U	0.8	
CALCIUM HARDNESS AS $CaCo_3$, mg/l	2	
TOTAL HARDNESS AS $CaCo_3$, mg/l	6	
TOTAL ALKALINITY AS $CaCo_3$, mg/l	20	
CARBONATE ALKALINITY, mg/l	0	
IRON, mg/l	0.2	
FLUORIDES, mg/l	0.05	
SULPHATES, mg/l	0	
DISSOLVED OXYGEN, p.p.m	6.8	
NITRATES, mg/l	0.8	
NITRITES, mg/l	0	
CHLORIDES, mg/l	24	
DISSOLVED SOLIDS, mg/l	60	
SUSPENDED SOLIDS, mg/l	0	
TOTAL SOLIDS, mg/l	60	
BIOCHEMICAL OXYGEN DEMAND, mg/l	-	
CHEMICAL OXYGEN DEMAND, mg/l	-	
RESIDUAL CHLORINE, mg/l	-	

BACTERIOLOGICAL EXAMINATION OF WATER

1. MPN of Coliform organisms.....5......./100ml
2. MPN of E.coli.....0......./100ml

Name of the Expert: S.K. Ngari **Sign:** ..... **Date:** 1st oct, 2018

UNIVERSITY OF NAIROBI
DEPARTMENT OF CIVIL & CONSTRUCTION ENGINEERING

File:
Telegrams: "Varsity"Nairobi
Telephone: Nairobi +254-20-318262
Email: dept-civilengineering@uonbi.ac.ke

P.O. Box 30197-00100
NAIROBI
KENYA

CHEMICAL ANALYSIS FOR WATER SAMPLES

SAMPLE SOURCE & DESCRIPTION: KABUNDA DAM WATER.

SAMPLED BY: CLIENT **CLIENT:** AGENN ASSOCIATES

PARAMETER	RESULT	REMARK
pH	7.49	
APPARENT COLOUR °H	15	
TRUE COLOUR °H	10	
CONDUCTIVITY µ/S/CM, mg/l	112	
TURBIDITY, F.T.U	6.7	
CALCIUM HARDNESS AS $CaCo_3$, mg/l		
TOTAL HARDNESS AS $CaCo_3$, mg/l	24	
TOTAL ALKALINITY AS $CaCo_3$, mg/l	72	
CARBONATE ALKALINITY, mg/l	0	
IRON, mg/l	0.3	
FLUORIDES, mg/l	0.40	
SULPHATES, mg/l	20	
DISSOLVED OXYGEN, p.p.m	6.7	
NITRATES, mg/l	0.5	
NITRITES, mg/l	0	
CHLORIDES, mg/l	32	
TOTAL COLIFORM/100ml	20	
TOTAL FAECAL COLIFORM/100ml	0	
DISSOLVED SOLIDS, mg/l	290	
SUSPENDED SOLIDS, mg/l	110	
TOTAL SOLIDS, mg/l	400	
BIOCHEMICAL OXYGEN DEMAND, mg/l	-	
CHEMICAL OXYGEN DEMAND, mg/l	-	
RESIDUAL CHLORINE, mg/l	-	

BACTERIOLOGICAL EXAMINATION OF WATER

1. MPN of Coliform organisms.....20...../100ml
2. MPN of E.coli.....0...../100ml

Name of the Expert: S.K. Ngari **Sign:** ..... **Date:** 18th oct 2018

UNIVERSITY OF NAIROBI
DEPARTMENT OF CIVIL & CONSTRUCTION ENGINEERING

File:
Telegrams: "Varsity"Nairobi
Telephone: Nairobi +254-20-318262
Email: dept-civilengineering@uonbi.ac.ke

P.O. Box 30197-00100
NAIROBI
KENYA

CHEMICAL ANALYSIS FOR WATER SAMPLES

SAMPLE SOURCE & DESCRIPTION: BOREHOLE WATER.

SAMPLED BY: CLIENT **CLIENT:** AGENN ASSOCIATES.

PARAMETER	RESULT	REMARK
pH	7.68	
APPARENT COLOUR °H	5	
TRUE COLOUR °H	5	
CONDUCTIVITY µ/S/CM, mg/l	525	
TURBIDITY, F.T.U	1.1	
CALCIUM HARDNESS AS $CaCo_3$, mg/l	8	
TOTAL HARDNESS AS $CaCo_3$, mg/l	28	
TOTAL ALKALINITY AS $CaCo_3$, mg/l	235	
CARBONATE ALKALINITY, mg/l	0	
IRON, mg/l	0.4	
FLUORIDES, mg/l	1.52	
SULPHATES, mg/l	25	
DISSOLVED OXYGEN, p.p.m	6.3	
NITRATES, mg/l	5.0	
NITRITES, mg/l	0	
CHLORIDES, mg/l	114	
TOTAL COLIFORM/100ml	0	
TOTAL FAECAL COLIFORM/100ml	0	
DISSOLVED SOLIDS, mg/l	430	
SUSPENDED SOLIDS, mg/l	0	
TOTAL SOLIDS, mg/l	430	
BIOCHEMICAL OXYGEN DEMAND, mg/l	-	
CHEMICAL OXYGEN DEMAND, mg/l	-	
RESIDUAL CHLORINE, mg/l	-	

BACTERIOLOGICAL EXAMINATION OF WATER

1. MPN of Coliform organisms.....0...../100ml
2. MPN of E.coli.....0...../100ml

Name of the Expert: S.K. Ngari **Sign:** ..... **Date:** 18th OCT. 2018

Courtesy Call at the CEC's Office Nyeri County

Republic of Kenya
Ministry of Agriculture & Irrigation

MINISTRY OF AGRICULTURE AND IRRIGATION

STATE DEPARTMENT FOR CROPS DEVELOPMENT
Small-scale Irrigation and Value Addition Project (SIVAP)

Venue : Nyeri County Offices

Date: 12th April, 2018

NO	NAME	ORGANIZATION	POSITION	PHONE	EMAIL	SIGNATURE
1.	Henry Kinyua	Nyeri County	CEC-	0700652027	kinyuahk@gmail.com	
2.	Peter G. Ndirangu		Surveyor	0722-892690	pgeorsd@yahoo.com	
3.	Eng. N.K. Mwinga	SIVAP	Project Engineer	0714238899	nmkgrth@gmail.com	
4.	H. N. [illegible]	SIVAP	HS	07222[illegible]		
5.	Mwangi Edwin	ALFD	DESK OFFICER SIVAP	0724050512	cdanyario@gmail.com	
6.	Ayub Gitau	AGENN	Director	0722878029	gitaua@yahoo.com	
7.	Eng. S.K. Ngari	AGENN	Civil Eng.	0722852053	samuelkibacha@gmail.com	
8.	[illegible] W. Humphrey	AGENN	Agric – Economist	0720848841	humphreymwangi[illegible]	
9.	Ruth Mwangi	AGRICULTURE	C.O.	0722292120	agriculturenyeri@gmail.com	
10						

Courtesy Call at the Sub-County Office, Naromoru

Republic of Kenya
Ministry of Agriculture & Irrigation

MINISTRY OF AGRICULTURE AND IRRIGATION

STATE DEPARTMENT FOR CROPS DEVELOPMENT
Small-scale Irrigation and Value Addition Project (SIVAP)

Venue : Kieni East Sub-county Offices   Date: 12th April, 2018

NO	NAME	ORGANIZATION	POSITION	PHONE	EMAIL	SIGNATURE
1.	CAROLINE K.M.	AGRIC	SCAO	0723361905	[illegible]	
2.	Jane Njuguna	Livestock	SCLPO	0722495146	dlpokieni@yahoo.com	
3.	VIRGINIA MUYA	AGRIC	FEO	0721119836	[illegible]	
4.	Beretha Nguyai	KANC	WAO	0721800905	[illegible]@yahoo.com	
5.	Robert N. Mathenge	AGENN	Project Officer	0733632604	[illegible]@gmail.com	
6.	Peter K. Kimani	AGENN	Consultant	0733260697	peter.kangethe@gmail.com	
7.	[illegible] Gitau	AGENN	AGENN	0722-878029	gitau@yahoo.com	
8.	Agnes Mwangi	Agric	FEO	0722638778	[illegible]	
9.	Charles Mango	water	SCWO&IO	0712272135	[illegible]@gmail	
10						

Meeting with the farmers at Upper Kabendera

Republic of Kenya
Ministry of Agriculture & Irrigation

MINISTRY OF AGRICULTURE AND IRRIGATION

STATE DEPARTMENT FOR CROPS DEVELOPMENT
Small-scale Irrigation and Value Addition Project (SIVAP)

ATTENDANCE LIST

ACTIVITY: CONSULTATIVE MEETING WITH FARMERS (NDIRITI AGUTHI IRRIGATION SCHEME IN NYERI COUNTY - TENDER NO.: MOALF/SIVAP/T002/2017-2018) ON 17TH APRIL 2018

VENUE- UPPER KABENDERA (NEW TANK)

NO	NAME	ORGANIZATION	POSITION	PHONE	EMAIL	SIGN
1.	ESAU W. KIBIRU	Ndiriti Aguthi W/P	Chairman	0721699822	-	
2.	Patrick Mutuni	Ndiriti Aguthi Water Project	Committee Central Zone	0718 [illegible] 533	-	
3.	FRANCIS KINUTHIA	NDIRITI AGUTHI WATER PROJECT	Committee Central Zone	0720244435	-	
4.	LUCY N WAITHAKA	NDIRITI AGUTHI WATER PROJECT	COMMITTEE MEMBER MUGUNDA	0706031769	-	
5.	Lucy Wanjiku Kamau	Ndiriti Aguthi Water Project	Member Committee	0729044012	-	
6.	MARY MUTHONI MAINA	NDIRITI AGUTHI WATER PROJECT	member committee	0712205300	-	
7.	MARGARET WAMBUGU	NDIRITI AGUTHI WATER P.	TREASURER	0725671609	-	
8.	MOSES K Ndiritu	Ndiriti Aguthi W/project	Vice/Sec	0726068625	-	
9.	WANJOHI PD MURIUKI	NDIRITI/AGUTHI W/P	SECRETARY	0721902813	MURIUKIPSGGE@gmail.com	
10.	~~EG~~MOSES N. MUMERO	NDIRITI/AGUTHI W/P	V.CHAIRMAN	0725686272	[illegible]@gmail.com	

Republic of Kenya
Ministry of Agriculture & Irrigation

MINISTRY OF AGRICULTURE AND IRRIGATION

STATE DEPARTMENT FOR CROPS DEVELOPMENT
Small-scale Irrigation and Value Addition Project (SIVAP)

ATTENDANCE LIST

ACTIVITY: CONSULTATIVE MEETING WITH FARMERS (NDIRITI AGUTHI IRRIGATION SCHEME IN NYERI COUNTY - TENDER NO.: MOALF/SIVAP/T002/2017-2018) ON 17TH APRIL 2018

VENUE- UPPER KABENDERA (NEW TANK)

NO	NAME	ORGANIZATION	POSITION	PHONE	EMAIL	SIGN
1.	CHARLES Ndiriti	Ndiriti Aguthi Water Project Kabendera TANK	Committee member	0715470643		
2.	Solomon Muriuki	NDIRITI AGUTHI Water Project	Committee members	0729939131		
3.	Paul Muriuki	〃	〃	0711119913		
4.	GEORGE NYORO WAIGI	AGENN		0700199555	waigi.george@gmail.com	
5.	Zebulon Gitau	AGENN	Director	0722878029	gitauan@yaho.co.uk	
6.	Peter Kimani	AGENN		0722260693	peter.kangethe@gmail.	
7.	Robert Mathenge	AGENN		0733632604	Romwanuc@gmail.com	
8.						

Sample Household Questionnaire

CONSULTANCY SERVICES ON: FEASIBILITY STUDY, DESIGN AND SUPERVISION OF NDIRITI AGUTHI IRRIGATION SCHEME IN KIENI EAST NYERI COUNTY.

HOUSEHOLD QUESTIONNAIRE

Declaration: *This information is confidential and it will be used purely for the planned purposes as understood by the community.*

Constituency..KIENI EAST.....Ward..MARUMORU / KIAMATHAGA

Location MARUMORU............. Sub-location...MAIRATI.....................

Date of Interview .... Name of enumerator..BERNARD MUTIA.........Tel..0725426971

Start time..............430Pm........ End Time..............625 PM.............

Latitude:........~~2.822750~~ -5.189465..........Longitude:..............~~997932/4~~ 37.04463 S

Note: Make sure the GPS in your phone GPS app ((Handy GPS) is set to WGS84 dd.ddddddd

QUESTIONNAIRE NUMBER

BM/01.......

Example: JD/13. JM means John Doe and 13 means the 13th questionnaire since day 1

SECTION 1: RESPONDENT'S INFORMATION

1.1 Name and Mobile No.	1.2 Age (Yrs)	1.3 Gender 1 = Male 2 = Female	1.4 Relationship with HH head: 1=Spouse 2=Son 3=Daughter 4=Relative 5=Other	1.5 Zone 1=Central 2=Kahuho 3=Rongai 4=Kabendera 5=Murua 6=Lenana	1.6 Ethnicity
PAULINE MWAMIKI 0726500807	55YRS	FEMALE	1	KAHUHO	KIKUYU

1.7 Marital Status: Married ( ) Single ( ) Divorced ( ) Widow (✓)

1.8 Religion: Christian (✓) Muslim ( ) Other, specify ( )

SECTION 2: DEMOGRAPHIC CHARACTERISTICS OF MEMBERS OF HOUSEHOLD

2.1 What is the size of your household? (number of household members including respondent) 2

(For section 2.5 use: Pre-primary=1, Primary level = 2, Secondary level = 3, Tertiary = 4, None=5)

2.2 Members of HH	2.3 Sex	2.4 Age	2.5 Highest Level of education	2.6 Main occupation	2.7 Location of main occupation	2.8 Other occupation	2.9 Location of other occupation	2.10 Lives on or off Farm
PAULINE MWAMIKI	F	55	2	FARMING	KAHUHO	N/A	N/A	LIVES ON THE FARM
PAUL MAMBO	M	40	2	TAX DRIVER	NANYUKI TOWN	N/A	N/A	LIVES OFF THE FARM

1=Household head2=spouse3=Sons4=Daughters 5=Sons & Daughters in law 6=Grandchildren7=other relatives

SECTION 3: MIGRATION TRENDS

Immigration

3.1 Have you lived in Nyeri County since birth? Yes ( ) No (✓)

3.2 If No, where were you living before you came to Nyeri County? THIKA TOWN

3.3 Which year did you relocate to Nyeri County? 1998

3.4 If No, state the reasons for coming to Nyeri County. (Tick where necessary)

Purchased land	Land Allocation by government	Inheritance	Marriage	Business	Farming	Other
✓						

Emigration

3.5 Have any of your HH members left to permanently settle elsewhere? Yes ( ) No (✓)

3.6 If Yes, where to: 1.Within County( ) 2. Outside the County( )

SECTION 4: LAND TENURE AND HOUSING CHARACTERISTICS

4.1 Size of Household land (acres)? 2.5 ACRES 4.2a) Do you own the land? Yes (✓) No ( )

4.2b) If yes to (4.2a) above,

a) How did you acquire the land (tick appropriately)?

Inheritance	Lease	Allocation by National government	Allocation by County government	Purchased (Cooperative shares)	Purchased (self)	Others (Specify)
					✓	

b) What ownership documents do you have (tick appropriately)?

Titles (Freehold)	Leasehold	Temporary Occupation License	Allotment Letter	None
✓				

4.3a) Do you own other parcels of land besides this one? Yes (✓) No ( )

4.3b) If yes, state the location and size

(a) Parcel No.	(b) Year of acquisition	(c) Admin. Location of land	(d) Within/Outside County	(e) Acreage
	1990	MWEA	WITHIN	1/4 ACRE

4.4a) Was your land part of a bigger parcel that was sub divided? Yes ( ) No (✓)

4.4b) If yes, provide the following

(a) Initial size of land	(b) Subdivided into how many portions	(c) Size of the portions	(d) Transferred to	
			Male	Female

4.5 Housing characteristics

		Main house	Other houses on the farm (specify)		Other structures	
			Kitchen, if separate	Granary		
Number of rooms		5	1	1		
Foundation	Materials	7	2	1		
Floor	Materials	1	2	1		
Wall	Materials	7	5	1		
Roof	Materials	5	5	1		

Notes: 1=Cement, 2=Mud, 3=Cow dung, 4=Wood, 5=Corrugated Iron sheet/tin, 6=Tiles, 7=Blocks, 8=Bricks, 9=Grass thatched, 10=Other, specify

4.6 Do you have the following assets / items? Tick.

Assets / Items	Yes	No
Radio	✓	
TV	✓	
Bicycle	✓	
Motorbike	✓	
Vehicle		✓
Tractor		✓
Solar		✓
Biogas		✓
Cooking oil	✓	
Sugar	✓	
Tea leaves	✓	

SECTION 5: SOCIO-ECONOMIC CHARACTERISTICS

5-1 Income and Expenditure

5.1 Economic Activities

a) What is the primary economic activity for the household? *(Tick appropriately)*

1. Mixed farming ( )
2. Crop farming (✓)
3. Livestock keeping ( )
4. Small business/ trading ( )
5. Formal employment ( )
6. Informal employment/casual labour ( )
6. Others (specify) ( ).....

b). What is your major source of income? *(Tick appropriately)*

(1) Farming ( )
(2) Business ( )
(3) Salaried employment ( )
(4) Casual labour ( )
(5) Remittances (✓)
(6) Others *(specify)* ( ).....

c) If salaried, what is your profession?

1) Teacher N/A ( )
2) Government/ administrative officer ( )
3) Nurse ( )

4) Doctor ( ) N/A
5) NGO employee ( )
6) Other *(specify)* ( )……

d) What is your approximate monthly income from each of the following sources?

Source	Salary	Crops Sale	Livestock Products Sale	Diaspora remittance	Local remittance	Other (specify)	Total Income
Amount (Kshs/P.M)	N/A	N/A	N/A	N/A	5000	—	5000

e.) What is your household expenditure per month on the items below?

Item	Food	Clothing	Health	Education	Rent	Water	Energy	Transport	Other	Total
Cost (KES)	10,000	500	500	—	—	250	500	1000	—	12700

5.2 Do you save (cash or other assets) for investment? Yes( ) No (✓)
5.3 If yes, where do you save cash? ……N/A……

1) Bank ( )
2) Cooperatives/SACCOs ( )
3) Chamas ( )
4) Mobile Money ( )
5) Other, Specify ( )……N/A……

5-2 Nutrition

(a) Food type	(b) Stew (1. Meat 2. Greens 3. Eggs 4. Fruits)	(c)Frequency/week	(d) Reasons
BREAKFAST	Porridge	7	Availability
LUNCH	RICE	7	AVAILABILITY
SUPPER	VEGETABLES	7	AVAILABILITY

5.4 Can you name the centers from which you buy the following items?

Food Items: Maize meal, Shelled maize, Cooking fat/oil, Sugar etc;
Non-food Items: Clothes, Foot-wear, Stationary, Furniture and Building materials;
HH services: Repair for household items;
Farm inputs: Fertilizers, Poultry feeds, Fodder crops, Salt lick, Milking jelly;
Farm tools: Panga, Fork jembe, Wheel barrow, Shovel, Spray pump, Water tanks;
Farm equipment: Animal-drawn cart, Plough, Water-pumps, Animal crusher, Milk cooler; Farm machinery; Lorries; Cars and Tractors

Items	(a) Main Centre of purchase	(b) Approx. Distance, km	(c) Secondary Centre's of purchase	(d) Approx. Distance, km
Food items	NARUMORU	2 KM	BLUE LINE	1/2 KM
Non-food items	"	"	"	"
Household services	"	"	"	"
Farm inputs	"	"	"	"
Farm tools	KIRIKA	16KM	NARUMORU	2KM
Farm machinery	—	—	—	—

5.5. Main Crops grown on the farm last year 2017

(a) Crop	(b)Acreage/farm size (Acres)	(c) Quantity of seed used (Kgs)- Season 1	(d) Price of seed (Ksh)	(c) Production Season 1, 2017, kgs	(d) Production Season 2,2017, kgs	(e) Income Season 1, 2017 (Ksh)	(f) Income Season 2, 2017 (Ksh)
BEANS	1/4 ACRE	8KG	1600	NO HARVEST			
POTATOES	"	40KG	6000	OBTAINED			
MAIZE	"	3KG	750				

5.6 What other crops if planted have the potential to grow in this area of Ndirithi Aguthi? CABBAGE & PASSION FRUITS

5.7 Costing of farm operations in crop farming in the irrigation scheme

a) Land preparation

i) How many times do you plough your land before planting? 1=Once 2=Twice 3= Thrice.....1..

ii) What do you use in land preparation? 1=Tractor 2= Oxen 3=Donkey 4=Own family labour 5= Hired labour 6=Other (specify).....4.....

iii) Costs of land preparation;

	Tractor cost (Ksh/acre)	Hired labour			Oxen / Donkey (Ksh/acre)
		No. of Person hired	No. of days	Wage rate (Ksh/person/ day)	
1st Ploughing					
2nd Ploughing (Harrowing)					
3rd Ploughing					

b) Planting

Type of crop planted	Quantity of seed used	Cost of seed (Ksh)	Hired labour cost		
			No. of persons hired	No. of days	Wage rate (Ksh/person/day)
POTATOES	40KGS	1600			

c) Weeding

	1=Own family labour 2=Hired labour	Hired labour cost		
		No. of persons hired	No. of days	Wage rate ksh/person/day)
1st Weeding	1			
2nd Weeding	1			
3rd Weeding	1			

d) Fertilizer application

	State type (DAP, CAN, UREA, Other)	1=Own family labour 2=Hired labour	Hired labour cost		
			No. of persons hired	No. of days	Wage rate ksh/person/day)
Planting fertilizer	DAP	1			
Top dressing fertilizer					
Foliar fertilizer					

e) Pesticide application

	1=Own family labour 2=Hired labour	Hired labour cost		
		No. of persons Hired	No. of days	Wage rate ksh/person/day)
1st pesticide application	1			
2nd pesticide application	1			

f) Harvesting

	1=Own family labour 2=Hired labour	Hired labour cost		
		No. of persons hired	No. of days	Wage rate ksh/person/day)
Harvesting of the crop	1			

5.8 State the cropping cycle you normally use in your farm?

Main crops planted	Season 1	Season 2	Season 3
2016	Beans / maize / Potatoes	May / Beans / Potatoes	
2017	Beans / maize / Potatoes	Maize / Beans / Potatoes	
2018	Beans / Maize / Potatoes	Maize / Beans / Potatoes	

5.9. Number of animals kept on the farm and product Quantities sold last year 2017.The product quantities should be as recorded in the following units: Milk= L, Beef = Kg, Fish = Kg, Eggs = pieces, Honey = Kgs.

Livestock		No.	Product	Output (specify product/quantity)	Quantity consumed by HH	Quantity sold	Unit Price (Ksh)	Appro. Income earned/month
Dairy cows	Grade(exotic)							
	Crossbreeds							
	Zebu/local							
Beef cattle	Grade(exotic)							
	Crossbreeds							
	Zebu/local							
Dairy Goats								
Sheep								
Pig								
Poultry	Broilers							
	Layers							
	Local Breeds							
Fish								
Bees								
Others (specify)								

5.10. In which trading centres do you sell your farm produce?

Type of farm produce	Units of sale	Main Centre of sale	Price at main centre of sale (ksh/Unit)	Secondary Centre of sale	Price at secondary centre of sale (Ksh/Unit)	Income/month
POTATOES	BAGS	NAIROBI	3000	BLUELINE	2600	

5.11. What problems do you face in crop production?

Crop	Problems	Current mitigation measures	Proposed mitigation measures
POTATOES	BLIGHT	crop spraying	—

5.12. Do you receive training on farm activities? 1. Yes( ) 2. No(✓)

5.13a) If yes, which ones ..... 5.13b) Frequency .....

5.12 Farmer Training	5.13b) Frequency, M=Monthly, QY=Quarterly, BA=Twice a year, Y=Yearly, Other, specify
1) Pest Management	( )
2) Best Farming Practices	( )
3) Soil and Water Conservation	( )
4) Livestock production	( )
5) Agroforestry	( )
6) Fish farming	( )
7) Bee keeping	( )
8) Other, specify	( )

5.14a) What are the problems faced in livestock production (tick all that apply)? 5.14b) What mitigation measures are currently in place? 5.14c) What mitigation measures would you propose?

5.14a) Problems	5.14b) Current mitigation measures	5.14c) Proposed mitigation measures
1) Expensive vet services/medication( )		
2) No sufficient feeds for livestock ( )		
3) Lack of knowledge/skills ( )	N/A NO	animal keeping
4) Human-wildlife conflict ( )		
5) Too many diseases ( )		
6) Other, specify ( )		

5.15a) Do you receive livestock extension services? Yes ( ) No ( ) N/A
5.15b) If yes, which ones .....5.15c) Frequency.....

5.15b) Livestock Extension Services	5.15c) Frequency, M=Monthly, QY=Quarterly, BA=Twice a year, Y=Yearly, Other, specify
1) Veterinary services ( )	
2) Training on best practices ( )	
3) Marketing of our produce ( )	N/A
4)	
5)	
6) Other, specify ( )	

5.16. How are the farmer training/extension services given? Through:

1) Seminars and workshops ( )
2) Onsite/On-farm training by extension officers ( )
3) Universities/ colleges ( )
4) Others (specify) (-)

5.17a) Do you have access to credit facilities? Yes ( ) No (✓)

5.17b) If no, why .....
1) Interest rates too high ( )
2) No credit facilities nearby ( )

3) I don't need a loan/we have sufficient resources ( )
4) I don't know about credit facilites ( )
5) No response ( )
6) Other, specify ( )……

5.17c) If yes;

i.) For what purpose did you apply the latest loan?

1) Buy farm implements ( )
2) Buy land ( )
3) Pay school fees ( )
4) Medical expences ( )
5) Open a business ( )
6) Buy livestock ( )
7) Buy seedlings and other farm inputs ( )
8) Other, specify ( )……

ii) From which institution do you obtain these facilities? ……

1) Bank ( )
2) Cooperatives/SACCOs ( )
3) Chamas ( )
4) Mobile Money ( )
5) AFC (Agricultural Finance Coorporation)
6) Other, Specify ( )……

iii)What collateral/security do you use for the above loans? (*Tick*)

1) Title deed ( )
2) Farm Produce ( )
3) Household Items ( )
4) Vehicle/Machinery/House ( )
5) No collateral ( )
6) I prefer not to say ( )
7) I don't know ( )
8) Other, Specify ( )……

iv.) How much was the loan?……

v.) How did you use the loans? ……

vi.) Has the loan helped you improve farm production and HH income? Yes ( ) No ( )

vii.) What has been your experience with institutions that give loans?

1) Loans are easy to access ( )
2) Loans are difficult to access ( )
3) They have good service and follow up ( )
4) They have low interest rates ( )
5) They have high interest rates ( )
6) I prefer not to say ( )
7) I don't know ( )
8) Other, Specify ( )……

viii.) Do you get any financial management advice from these institutions? Yes ( ) No ( )

ix.) If yes (viii above) which advice?

1) How to service the loan without compounding penalties ( )
2) Where to invest ( )
3) Financial management ( )
4) I prefer not to say ( )
5) I don't know ( )
6) Other, Specify ( )……

5-3 Labour

5.18 Where did you source labour for your farm activities during the last year (two seasons). Tick as appropriate.

Source	Food crops	Cash/Horticultural crops
1) Household members	✓	
2) Hired exclusively		
3) Household and hired		
4) Household and communal		
5) Household and relatives		
6) Others (specify)		

5.19 How often did you make use of hired or communal labour during last season?

Type of labour Frequency of use	Hired	Communal
1) Rarely	✓	
2) Sometimes		
3) Often		
4) Always		
5) Others (specify)		

5.20 How much did you approximately spend on farm labour operations last season-Labour wage rate per person day worked by hired labour?

a) Food crops ……

b) Horticultural / Cash crops ……

5.21 What farm equipment do you own or hire (specify)

Equipment	Own	Hire
1) Tractor		
2) Plough		
3) Sprayer	✓	
4) Baler		
5) Jembe	✓	
6) Hand-hoe		
7) Wheelbarrow	✓	
8) Other, specify		

5.22 Did you experience any labour shortages during the last season? Yes ( ) No (✓)

5-4 Marketing

5.23. Which channels do you use for the sale of your crop / horticultural produce?

Channel	Crop products	Price offered (Ksh)	Reasons/ benefits	Challenges
Co-operatives				
Middle people	Maize ✓	30	Low prices	Rotation Avenue
Individually				
Others (specify)				

5.24. Which channels do you use for the sale of your **animal produce?**

Channel	Livestock products	Price offered (Ksh)	Reasons/ benefits	Challenges
Co-operatives				
Middle people				
Individually				
Others (specify)				

5.25 Which mode of transport is used to move farm produce?

1) Manual ✓
2) Animal carts ( )
3) Vehicle ( )
4) Other, specify ( )……

5.26 What are the challenges you face in marketing your farm produce?

1) Poor market prices ✓
2) Markets are far ( )
3) Don't know where to sell ( )
4) Poor roads to transport ( )
5) ( )
6)
7) Other, specify ( )……

SECTION 6: INFRASTRUCTURE AND UTILITY SERVICES

Notes:

6.1 Indicate the **distance** of these facilities from your homestead to the following services

6.2 For the **providers** of the above facilities, insert numbers as follows: -
(1) County Council of Nyeri (2) Church (3) NGOs (specify) (4) Private individuals
(5) Government (6) others (specify)

6.3 For the **conditions** of the facilities, insert numbers as follows: -
1) Very poor 2) Poor 3) Fair 4) Good 5) Very good

6.4 For the **adequacy** of the community facilities, insert numbers as follows: -
Well provided = 1, Moderate = 2, Inadequately provided = 3, None = 4

Services	0-1Km	1-2Km	2-4Km	4-8Km	8-10Km	10+ Km	Provider	Condition	Adequacy
Nursery school		✓					5	3	2
Primary school		✓					5	2	2
Secondary school			✓				5	2	3
Village polytechnic									
Tertiary institution									
Public library									
Hospital with in-patient facilit						✓	5	2	3
Health centre/dispensary									
Religious facilities		✓					2	2	1
Administrative/civic offices	✓						5	3	2
Security/Police post		✓					5	3	3
Social hall/youth centre									
Recreational / public park									
playing field		✓					5	4	3
General retail shop (duka)	✓								
Open air market		✓							
Supermarket		✓							
Cooperative society store									
Posho-mill	✓						4		
Cold stores / sheds									
Ware house/communal store									
Silos / cribs									

Coffee factory									
Tea buying centre									
Milk collection centre									
Bank									
Post office									
Homes for the elderly									
Rehabilitation Centres									
Piped water									
Well, spring									
Electricity									
Earth road									
Murram road									
Tarmac road									
Bus/matatus terminal									
Cattle dip									
Cemetery									
Land fill (solid disposal)									

6-1 Water

6.5 Where do you get water for your domestic and agricultural use?

Source	Domestic	Animal consumption	Irrigation	Others (specify)	Distance
Rain water	✓	—	✓		—
River/stream					
Well/water pan					
Borehole					
Natural spring					
Piped	—		✓		—
Dam					
Other (specify)					

6.6 a) How many litres of water do you use per day? ..... 150 LITRES

b) What is the general quality of the water?

(1) Good ( ) (2) Fair ( ) (3) Poor (✓)

c) How far is your homestead from the water source?

1) <1km ✓
2) 1.1 -3 km ( )
3) 3.1–5 km ( )
4) Over5.1km ( )

d) How do you ensure water is safe for drinking?

1) Boiling (✓)
2) Filtering ( )
3) Decanting ( )
4) Use of Chemicals ( )
5) Others (specify) ( )

6.7 (a) What challenges do you face in water use? (b) What solutions would you propose for the above challenges?

6.7a) Challenges	6.7b) Proposed Solutions
1) Poor water quality	AVAILABILITY OF PIPED WATER
2) Insufficient water for agriculture uses	"
3) Insufficient water for domestic uses	"
4) Water source is far	"
5) Water is expensive	"

6) Water is unreliable, seasonal	AVAILABLE PIPED WATER
7)	
8) Other, specify	

6.8 Are there any water conservation measures undertaken by the community/ individuals? Yes (✓) No ( )
If yes, which water conservation measures?

Drip/micro/ sub-surface irrigation	
Bottle irrigation/pitcher	
Zai pits/Negarims	
Drought tolerant crops	
Ripper-Furrower planting system	
Water storage	
Other, specify STOP WATERING THE LAND FOR DOMESTIC USE	

6-2 Transport

6.9 What is the mode of transport to the following service points?

	Distance	Walking	PSV	Motorcycle	Vehicle	Bicycle	Reason
Work							
Market	2Km		✓				Easily Accessible
Shops							

6.10 How would you rate the condition of roads in this area?

1. Very Good ( )2. Good ( )3. Fair ( ) 4. Poor ( )5. Very poor (✓)

6-3 Energy

6.11 What is the type of energy used?

Type of energy	Source	Cooking	Lighting	Heating	Other uses	Cost/Month
Electricity			✓			
Kerosene						
Charcoal		✓				
LPG Gas		✓				
Biogas		—				
Firewood		✓				
Wind		—				
Solar		—				
Other (specify)						

6.12a) What challenges do you get in accessing and using these sources of energy?6.12b) What are the suggested solutions?

6.12a) Challenges	6.12b) Proposed Solutions
1) Electricity is expensive	They are Expensive
2) Gas is expensive	
3) Charcoal is hard to find	
4) Shops are far	
5) Few to No alternatives for the energy sources	
6) Other, specify	

6-4 Communication

6.13 Which of the following means of communication do you frequently use?
Daily = 1, Weekly = 2, Monthly = 3Very Reliable=1, Reliable=2, Un-reliable=3, Very Un-reliable=4

Means	Voice Calls	Data Bundles	Letters & parcels	Comments on reliability	Frequency
1) Landline					
2) Cell phones	✓				
3) Postal services					1
4) Courier					
5) Internet					
6) Others (specify)					

6.14 What media do you use to obtain market information: (specify station)?

Media	Health	Education	Farming	Business	Entertainment	Others
1) TV	✓	✓	✓	✓	✓	
2) Radio	✓	✓	✓	✓	✓	
3) Mobile						
4) Newspaper						
5) Internet						
6) Others (specify)						

6.15a) What challenges do you get in accessing and using these sources of information? 6.15b) What are the suggested solutions?

6.15a) Challenges	6.15b) Proposed Solutions
1) LANGUAGE	TO INTRODUCE SEVERAL VERNACULAR STATIONS
2) HIGH POWER CHARGES	- introduction of solar
3)	
4)	
5)	
6)	
7) Other, specify	

SECTION 7: LEADERSHIP AND LOCAL DEVELOPMENT

7.1 Who has contributed most towards development of your sub-location?

	Actor	How have they contributed
a)	N/A	According to the Lady no one
b)		
c)		
d)		
e)		

7.2 What projects have the actors identified above and initiated?

Actor	Name of project	Location	Impact on the lives of the community
a)			
b)			
c)			
d)			
e)			

7.3 Were you involved? 1. Yes ( ) 2. No ( )

7.4 At what stage were you involved in these projects?

Name of project	Identification	Planning	Resource mobilization	Implementation	M & E

7.5 How frequently were you informed on the progress of the project?
Frequency; Daily = 1, Weekly = 2, Monthly = 3, Never = 4

Type of project	Identification	Planning	Resource mobilization	Implementation/ resource use	M & E

7.6a) What kind of development project would you like to be initiated in the area, name three most important to you? 7.6b) Why are such projects important to you?

Project	Importance
1) Road construction	- Ensier movement
2) Water Project (reliable)	- Availability of farming water
3) Extension services	- acquire knowledge

7.7 When you look into the future of this area what kind of Nyeri County would you like your children and grandchildren to live in (*Vision*)?A Nyeri County that is:.....Productive.....

7-1 Project Knowledge

7.8 Are you aware of an irrigation project being proposed in this area? 1)Yes 2) No

7.9 If yes, how did you get that information? **Through;**

1) Extension Service/MOAI ( )
2) Chief's Baraza ( )
3) Friends/Neighbors ( )
4) Mass /Print Media ( )
5) Others (specify) (✓) Through Chairman Aguthi, Ndiriti Water Project

7.10 What benefits will this irrigation project bring to the people of this area? *(Multiple Responses possible)*

1) Water for crop production (✓)
2) Water for human consumption (✓)
3) Water for livestock drinking (✓)
4) Employment creation (✓)
5) Increased income (✓)
6) Increased food production thus food security (✓)
7) Others (specify) (✓).....

7.11 If you get water for irrigation to grow your proposed crops, are you willing to pay for the cost of the services to deliver water in your farm? 1. Yes (✓) 2. No ( )

7.12 What negative issues/concerns will be brought by this irrigation Project?

1) None
2)
3)
4)
5)

SECTION 8: CONFLICT RESOLUTION

8.1a) Are there any conflicts in this area? 1) Yes..... 2) No.(✓).....

8.1b) If yes, of what nature?.....N/A.....

8.1c) What effects do these conflicts have on development of this area?

.....N/A.....

8.1d) Who assists you in conflict resolution locally?

Type of conflict	Institution
N/A	N/A

8.2 Are they effective in resolving conflict? 1) Yes..... 2) No.....

8.3 Give reasons. ..... N/A .....

8-1 New Constitution, Planning and Public Participation

8.4 Are you aware of planning and resource allocation provisions in the new constitution? 1) Yes..... 2) No...✓...

8.5 If yes, what do you know..... N/A .....

SECTION 9: ENVIRONMENT AND RESOURCES

9.1 Environmental change and vulnerability

a.) Over the years, has the rainfall patterns changed in this area? 1) Yes...✓... 2) No.....If yes, what changes have occurred?.....Reduction rainfall.....

b.) Has the planting season changed in the past few years? 1) Yes...✓... 2) No.....If yes, how?

Inconsistency due to changed of rainfall Pattern

c.) How has it affected your household?.....Reduction of produce

d.) Are there new invasive species of weeds and/or insects that have emerged which were not found in this area in the past?

Weed Species /Insects	Year	Impact (Specify)
NEMATODA (WORM).	2017	Low production

e.) Are there natural disasters occurring which used not to happen? 1) Yes..... 2) No✓.....

f.) If yes in above, please specify.....

9-1 Adaptation measures

9.2a) Have you started growing crops that you did not previously grow in your farm? 1) Yes... 2) No....✓...

9.2b) If yes, give reasons for this..... N/A .....

9.3. What kind of environmental challenges does this area experiences? ***(Tick category)***

Challenge	Most frequent	Frequent	Least frequent	Non-occurrence
1) Deforestation				
2) Pollution (water, air and noise)				
3) Harvesting sand/soil/murram				
4) Quarrying				
5) Farming on riverbed & valleys				
6) Landslides				
7) Shamba systems (forest farming)				
8) Others (specify) Water Logging — poor drainage				

9.4. What have been the effects of the above environmental challenges? ***(Tick category)***

Effect	Most frequent	Frequent	Least frequent	Non-occurrence
1) Landslide and soil erosion				✓
2) Water and airborne diseases	✓			
3) Reduced crop and animal productivity	✓			

4) School dropout			✓	
5) Family and communal conflicts/ feuds			✓	
6) Others (specify)				

9.5a) What intervention measures as an individual have you put in place to mitigate above environmental challenges?
9.5b) What intervention measures has community put in place to mitigate above environmental challenges?

9.5a) Intervention-Individual	9.5b) Intervention-Community
Planting of trees	
[illegible] of [illegible]	
Seeking private extension services	

9.6a) Are there other agencies/ stakeholders that are involved in environmental conservation in this area? 1) Yes. 2) No ✓
9.6b) How are they involved?............N/A..

9.6a) Agency	9.6b) How involved
N/A	N/A

SECTION 10: PRIORITY ISSUES AND SUMMARY
10.1a) What are the 3 main concerns / issues in your zone? 10.1b) Rank them in order of importance. 1-being highest.

Issues	Tick	Rank
1) Domestic water services are poor	✓	2
2) Irrigation water not enough	✓	1
3) Energy is costly and lacking		
4) Poor health services	✓	3
5) Agriculture inputs are inaccessible		
6) Transport is poor and expensive		
7) No market for horticultural produce		
8) Poor extension services		
9) No storage / cold rooms for produce		
10) Others. Specify		

10.2. Any other comments on the issues/questions that were asked by the enumerator?

....

....

....

THANK YOU

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Sample Filled Key Informant Questionnaire

CONSULTANCY SERVICES ON: FEASIBILITY STUDY, DESIGN AND SUPERVISION OF NDIRITI AGUTHI IRRIGATION SCHEME IN KIENI EAST NYERI COUNTY.

KEY INFORMANT QUESTIONNAIRE

Lead Agency:	AGRICULTURE LIVESTOCK & FISHERIES DEPARTMENT
Respondent's Name:	MWANGI EDWIN
Telephone No:	0724 05 05 12
Designation:	SSE (A)
Date of Interview:	19/06/2018

1. What are the main challenges faced by the farmers of Ndirithi Aguthi irrigation project?
   a) ADEQUATE WATER FOR IRRIGATION
   b) ORGANISED MARKETING CHANNEL FOR FARM PRODUCE
   c) PEST & DISEASE (EMERGING) - HIGH COSTS OF INPUTS
   d) POOR ROAD NETWORKS
   e) DECLINING SOIL FERTILITY
2. List the activities that have taken place in the project area over the last 30 years
   (a) Negative activities
   - POOR IRRIGATION METHODS / OVER IRRIGATION
   - POOR CROP HUSBANDRY PRACTICES RESULTING TO SOME OF THEIR EXPORT PRODUCE BEING REJECTED
   - NON-ADHERANCE TO CONTRACTUAL FARMING WITH SOME EXPORT COMPANIES
   (b) Positive activities
   - CONSTRUCTION OF INDIVIDUAL WATER PANS & ROOF WATER HARVESTING
   - TREE PLANTING INICIATIVES
   - THE EXISTING IRRIGATION WATER USERS ASSOCIATION IS PROACTIVE AND HAS BEEN ABLE TO ATTRACT DONORS
   - FARMERS HAVE FULLY EMBRACED IRRIGATED FARMING AS A SOURCE OF LIVELIHOOD

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NYERI COUNTY
P.O. Box 28-10100.
NYERI

3. What are your suggested intervention measures?

a) WATER STORAGE CAPACITY OF THE EXISTING DAM TO BE INCREASED
b) WATER EFFICIENT TECHNOLOGIES TO BE PROMOTED
c) COMMUNITY TO BE MOBILIZED TO FORM MARKETING GROUP
d) IMPROVEMENT OF SOIL HEALTH BY UNDERTAKING SOIL TESTING
e) INDIVIDUAL WATER HARVESTING TECHNOLOGIES AT HOUSEHOLD LEVEL TO BE PROMOTED

4. How do you think the proposed project will affect the operations of your organization?

a) COMPETITION OF THE SAME STAFF WITH OTHER PROJECTS
b) WHERE STAFF RETIRING ARE NOT BEEN REPLACED
c)
d)
e)

5. What are your main concerns regarding the proposed irrigation project?

a) DELAY IN PROJECT IMPLEMENTATION THUS AFFECTING
b) COMMUNITIES EXPECTATIONS
c) LOCAL POLITICAL INTERFERENCE MIGHT AFFECT SOME ACTIVITIES
d) CLIMATE CHANGE THREAT

6. How do you suggest that these concerns be addressed?

a) THE FEASIBILITY STUDY / DESIGN / TENDER AWARD SHOULD
b) BE COMPLETED WITHIN THE SHORT TIME
c) MORE SENSITIZATION OF THE COUNTY LEADERSHIP ON
d) THE PROJECT
e) CLIMATE SMART TECHNOLOGIES TO BE PROMOTED AND PROMOTED

7. What positive impacts do you anticipate from the proposed irrigation method?

a) IMPROVEMENT OF FOOD SECURITY AT HOUSEHOLD LEVEL
b) INCREASED FAMILY INCOME DUE TO INCREASED PRODUCTION
c) AND MARKETING CHANNELS
d) DIVERSIFICATION TO OTHER INCOME GENERATING ACTIVITIES
e) INVESTMENT IN VALUE ADDITION BUSINESS
f) A MORE COHESIVE FARMING COMMUNITY THAT HAVE EMBRACED FARMING AS A BUSINESS

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NYERI COUNTY
P. O. Box 28-10100,
NYERI

8. What negative impacts do you anticipate from the irrigation method?
   a) SOCIAL ISSUES DUE TO ~~INCREASED~~ AVAILABLE DISPOSABLE INCOME
   b) CONFLICT DUE TO INCREASED WATER DEMANDS
   c)
   d)
   e)
9. Suggest ways through which the positive impacts can be enhanced
   a) ENHANCED COMMUNITY MOBILIZATION AND TRAINING
   b) INVESTMENT IN VALUE ADDITION PROJECTS
   c) PROMOTING PPP INICIATIVES
   d) INCORPORATION SWAP ACTIVITIES IN CIDP AND UP-SCALING TECHNOLOGIES
10. Suggest ways through which the negative impacts can be avoided, reduced or mitigated
   a) CAPACITY BUILDING ON FINANCIAL LITERACY AND
   b) CONFLICT RESOLUTION MECHANISM
   c) SENSITIZATION MEETINGS WITH THE LOCAL LEADERSHIP
   d)
   e) INVOLVEMENT OF ALL STAKEHOLDERS IN ~~PLAN~~ DURING PLANNING AND IMPLEMENTATION PROCESS
11. What are your recommendations on the proposed irrigation project?
   a) DAM CAPACITY TO BE IMPROVED
   b) INDIVIDUAL WATER HARVESTING TECHNOLOGIES TO BE EMPHASIZED
   c) VALUE ADDITION TO BE ~~PROMOTED~~ PRIORITIZED
   d) STRONG MARKETING GROUPS TO BE FORMED
   EXPLORE WAYS OF AVAILING AFFORDABLE CREDIT AND INPUTS

Signature _____ Date 19/06/2018

THANK YOU

COUNTY DIRECTOR OF AGRICULTURE
NYERI COUNTY
P. O. Box 29-10100,
NYERI

CONSULTANCY SERVICES ON: FEASIBILITY STUDY, DESIGN AND SUPERVISION OF NDIRITI AGUTHI IRRIGATION SCHEME IN KIENI EAST NYERI COUNTY.

KEY INFORMANT QUESTIONNAIRE

Lead Agency:	AGRICULTURE
Respondent's Name:	CAROLINE K.M.
Telephone No:	0786773302
Designation:	CAO
Date of Interview:	28/5/2018

1. What are the main crops grown in the Sub-County
   a. Maize Beans potatoes & wheat - Food crops
   b. Assorted horticultural crops - French beans, snowpeas, sugarsnap
   c. babycorn, Arabicum, Erygium, Scabiusa, Army, Cabbages,
   d. Carrots, Tomatoes, Avocadoes, Tamarilla, ETC
   e. ....
   f. ....
2. How many seasons do farmers in Ndirithi Aguthi have in a year and in which months?

SEASON	MONTHS
2	3, 3

3. What is the cropping pattern adopted by the farmers in Ndirithi Aguthi?

SEASON 1 CROPS	SEASON 2 CROPS	SEASON 3 CROPS
food crops & rainfed horticulture	Breakcrop under irrigation	food crops & horticulture

4. Do they practice crop rotation? If so what is their cropping cycle? Fabacea Graminae → Cruciferae → Solanaceous → Alliums
5. What is their Productivity level in terms of output per unit of land?

TYPE OF CROP	SEED RATE /ACRE	UNIT OF OUTPUT (KGS,90 KG BAGS	AVERAGE OUTPUT REALIZED BY FARMERS/ACRE	POTENTIAL PRODUCTION/ACRE
Tomatoes				

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Beans	20-25	90 bags	4	8
Kales	6	9		
Irish potatoes	16-20	50kg bags	40	120
Carrots		3	80 bags@120kgs	120
Onions		9	4tonnes	6
Cabbage		9		
Maize	10	kgs	4	20
Other Crops(Specify)				

6. Market prices of agricultural products?

AGRICULTURAL PRODUCT	UNIT OF MEASURE	AVERAGE MARKET PRICE PER UNIT (KSH/UNIT)
Carrots	120kg bag	2,000 current
Irish Potatoes	50kgs	1800
Cabbages	120 kg bags	2000
Dry beans	90 kg	7200
Kales	70 kg bag	350
Maize	90kg	2700
Tomatoes	65kg crate	2250
Onions	12 kg net	500/=

7. Do you have extension officers up to the Ward level? (Yes; No)..... ✓ Yes
8. If yes, is there an agricultural officer serving the farmers of Ndithi Aguthi Irrigation scheme? (Yes; No)..... Yes
9. What is the mode of extension service delivery in your sub-county-is it demand driven or supply driven? Demand driven
10. Do you have any gross margin analysis data for the main crops grown by the farmers in your Sub-County? (Yes; No)..... Yes
11. What are the main challenges faced by the farmers of Ndirithi Aguthi irrigation scheme in terms of crop production?
    1. Insufficient irrigation water
    2. Inefficient & ineffective irrigation methods
    3. Poor markets & roving channels
    4. Huge post harvest losses
    5. Impoverished soils
    6. Pests & diseases
    7. Poor feeder roads
    8. Economic regression

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12. If the Ndithi Aguthi Irrigation scheme is rehabilitated, what are the anticipated benefits that will be realized from the Irrigation scheme? (Direct and indirect benefits)

a) Direct benefits

1. Increased production volumes
2. Increased area under production
3. Scheduled Irrigation cropping Calenders
4. Crop diversification from available water
5.

b) Indirect benefits

1. Improved roads
2. Increased number of buyers since produce would be available
3. Improved living standards from increased income
4. Improved Nutrition and food security

13. What are your recommendations with regard to the challenges the farmers in Ndirithi Aguthi are facing?

1. Increased Irrigation by Storage
2. Installation of Irrigation Infrastructure
3. Training on Irrigation agronomy
4. Market and marketing channels

Signature _____ Date 26/5/2018

THANK YOU

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CONSULTANCY SERVICES ON: FEASIBILITY STUDY, DESIGN AND SUPERVISION OF NDIRITI AGUTHI IRRIGATION SCHEME IN KIENI EAST NYERI COUNTY.

KEY INFORMANT QUESTIONNAIRE

Lead Agency:	PARTNERS LINK
Respondent's Name:	S. WANJIRU
Telephone No:	0733736234
Designation:	Coordinator
Date of Interview:	

1. What are the main challenges faced by the farmers of Ndirithi Aguthi irrigation project?
   a) Lack of enough Water to Sustain Irrigation
   b) .....
   c) .....
   d) .....
   e) .....
2. List the activities that have taken place in the project area over the last 30 years

   (a) Negative activities

   - Rationing of Water Minimises maximum production

   (b) Positive activities

   - People are Understanding Irrigation in Small Scale and therefore are able to grow food crops with ease

3. What are your suggested intervention measures?
   a) Expansion of Water quantity
   b)
   c)
   d)
   e)

4. How do you think the proposed project will affect the operations of your organization?
   a) ~~None~~ No
   b)
   c)
   d)
   e)

5. What are your main concerns regarding the proposed irrigation project?
   a) It should be large enough to cater for evenuse
   b)
   c)
   d)
   e)

6. How do you suggest that these concerns be addressed?
   a) Community members to be involved to give their opinion
   b)
   c)
   d)
   e)

7. What positive impacts do you anticipate from the proposed irrigation method?
   a) Large scale growth of farm produce
   b) Sustainable Water to upscale production
   c)
   d)
   e)

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8. What negative impacts do you anticipate from the irrigation method?
   a) None
   b)
   c)
   d)
   e)
9. Suggest ways through which the positive impacts can be enhanced
   a) Larger pipes
   b) Bigger Intake Intake to be constructed
   c) Longer tank to be built.
   d)
10. Suggest ways through which the negative impacts can be avoided, reduced or mitigated
   a) Consultation among the members.
   b)
   c)
   d)
   e)

11. What are your recommendations on the proposed irrigation project?
   a) Its Welcome.
   b) Let it be planned adequately
   c)
   d)

Signature _____ Date _____

THANK YOU

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CONSULTANCY SERVICES ON: FEASIBILITY STUDY, DESIGN AND SUPERVISION OF NDIRITI AGUTHI IRRIGATION SCHEME IN KIENI EAST NYERI COUNTY.

KEY INFORMANT QUESTIONNAIRE

ADMINISTRATION (WARD ADMINISTRATOR, CHIEF)

NAME OF THE SUB-COUNTY/COUNTY: KIENI EAST SUB-COUNTY, NYERI COUNTY

LOCATION: NAROMORU

WARD: NAROMORU KIAMATHAGA

TITLE OF OFFICER INTERVIEWED:

1. What are the main challenges to irrigation scheme farmers are facing in Ndirithi Aguthi Irrigation scheme?
   a. Lack of adequate water for irrigation
   b. Poor investation
   c. Prolonged drought
   d. Poor infrastructure
   e. Lack of certified seeds
   f. Lack of proper farming inputs both for agriculture & liv
   g. Produce marketing
   h.

2. If the Ndirithi Aguthi Irrigation scheme is rehabilitated, what are the anticipated benefits that will be realized?
   a) Direct benefits
   1) Food Security
   2) High production of yields
   3) Members will be economically empowered
   4) Easy movement of produce to the market
   5) Good health both human and domestic animals

b) Indirect benefits

1) Job creation
2) Poverty eradication
3) Minimize conflict
4) Crime reduction

c) Societal benefits

Good education for our children
Value addition on our produce
Have exposed to international markets

3. What are your recommendations to address the challenges Ndirithi Aguthi farmers are facing?

a) Have enough water for irrigation
b) Have proper infrastructures for good access to the markets
c) Proper marketing structures eg marketing shades
d) Introduction of proper methods of farming and livestock management.
e) Frequent training of farmers.

Signature ..... DATE ..... Date 18/6/2018

THANK YOU

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CONSULTANCY SERVICES ON: FEASIBILITY STUDY, DESIGN AND SUPERVISION OF NDIRITI AGUTHI IRRIGATION SCHEME IN KIENI EAST NYERI COUNTY.

KEY INFORMANT QUESTIONNAIRE

Lead Agency:	NDMA
Respondent's Name:	Kamwea Kiragu
Telephone No:	0734931979
Designation:	CPC
Date of Interview:	22/06/18

1. What are the main challenges faced by the farmers of Ndirithi Aguthi irrigation project?
   a) Drought.
   b) Inadequate water
   c) Frost
   d) ......
   e) ......

2. List the activities that have taken place in the project area over the last 30 years

   (a) Negative activities

   - use of fallows (high spillage)
   - use of over-head sprinklers
   - used of outdated farming techniques.

   (b) Positive activities

   - Introduction of piping system
   - Solar powered borehole
   - 90 days reservoir

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3. What are your suggested intervention measures?
   a) Livelihood diversification.
   b) Increased capacity of the dya days reservoir
   c) Cover all targeted beneficiaries mainly at tail end of the project
   d)
   e)

4. How do you think the proposed project will affect the operations of your organization?
   a) When complete & running, drought incidences will have reduced.
   b) Households will have regular income from produce sales.
   c)
   d)
   e)

5. What are your main concerns regarding the proposed irrigation project?
   a) Target groups - who is targeted
   b) Land signing considering land parcels are private.
   c) Will the existing layout support irrigation activities
   d) Capacity of the management committee to handle extra responsibilities
   e) Adequacy of water to meet domestic and irrigation needs.

6. How do you suggest that these concerns be addressed?
   a) Capacity build the management Committee
   b) Introduce modern irrigation techniques eg use drip kits (green house)
   c) Expand if not construct the dya days reservoir
   d) Redesign the project to accomodate the irrigation aspects
   e)

7. What positive impacts do you anticipate from the proposed irrigation method?
   a) Food secure Community
   b) Increased economic activities
   c) Job creation
   d) Cohesion
   e)

8. What negative impacts do you anticipate from the irrigation method?
   a) Introduction of horticultural farming in place of staple food cropping.
   b) Emergency of slums or informal settlement
   c) Loss of markets.
   d) ....
   e) ....
9. Suggest ways through which the positive impacts can be enhanced
   a) Support to farmers group, cooperatives & unions
   b) Extension services
   c) ....
   d) ....
10. Suggest ways through which the negative impacts can be avoided, reduced or mitigated
   a) Coordinated settlement
   b) Develop marketing strategies
   c) Promote food crops
   d) Group marketing of farm produce.
   e) ....
11. What are your recommendations on the proposed irrigation project?
   a) Involve all actors who have in one way or another funded the pro[illegible]
   b) There should no interference with existing waters due to accountability [illegible]
   c) Support should be in areas of extension and livelihood diversi[illegible]
   d) ....

Signature ______

NATIONAL DROUGHT MANAGEMENT AUTHORITY
COUNTY DROUGHT COORDINATOR
CDC
P.O. Box 582 - 10100, NYERI COUNTY

Date 22/06/18.

THANK YOU

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CONSULTANCY SERVICES ON: FEASIBILITY STUDY, DESIGN AND SUPERVISION OF NDIRITI AGUTHI IRRIGATION SCHEME IN KIENI EAST NYERI COUNTY.

KEY INFORMANT QUESTIONNAIRE

Lead Agency:	**WRA**
Respondent's Name:	**Justus Mwaura**
Telephone No:	**0726291928**
Designation:	**Surface Water Officer**
Date of Interview:	**31/5/2018**

1. What are the main challenges faced by the farmers of Ndirithi Aguthi irrigation project?
   a) Inadequate water during the dry period for irrigation
   b) Conflict amongst themselves because of inadequate water
   c) Lack of capacity to manage the project
   d) -Wastage of the available water

2. List the activities that have taken place in the project area over the last 30 years

   (a) Negative activities

   Over cultivation and over abstraction of the water resources in the project area because of introduction of commercial farming

   (b) Positive activities

   None reliance on 100% rain fed farming
   Introduction of horticultural farming in the area

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WATER RESOURCES MANAGEMENT AUTHORITY
EWASO-NG'IRO REGIONAL OFFICE
P.O. BOX 1331 TEL 52510 NANYUKI

3. What are your suggested intervention measures?

a) Introduction of efficient method of irrigation.
b) Construction of adequate water storage.
c) Introduction of self-regulating intake to abstract allowed volume.
d) Proper water conveyance method.
e) Capacity build project management committee.

4. How do you think the proposed project will affect the operations of your organization?

a) Over abstraction during the low and normal flow river regime.
b) More water use related conflicts are bound to increase.
c) It will be source of revenue in terms of water use charges.

5. What are your main concerns regarding the proposed irrigation project?

a) Will the project be able to store enough water for use during the dry spell when water is needed most?
b) Construction of self-regulating weir at the intake to ensure they only abstract flood flows.

6. How do you suggest that these concerns be addressed?

a) The project should adhere to 100% design and other approved documents.
b) Water storage should be adequate to cater for at least 90 days.
c) Introduction of efficient methods of irrigation.
d) Avoid water wastage during conveyance to the point of use.
e) Installation of flow master meters.

7. What positive impacts do you anticipate from the proposed irrigation method?

a) Improve community food security.
b) Improve community standard of living.
c) Create employment to the youth
d) Land value will improve.
e) Open up the area to outsiders coming to purchase the produce.

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8. What negative impacts do you anticipate from the irrigation method?

a) Water pollution from farm chemicals.

b) Water related conflicts with other water users.

c) Influx of outsiders which could be source of security threat in the area.

9. Suggest ways through which the positive impacts can be enhanced

a) Each farmer should be metered and pay for the amount of water used.

b) Growing of more valued crops.

c) Efficient water use will assist increasing the acreage under irrigation.

10. Suggest ways through which the negative impacts can be avoided, reduced or mitigated

a) The project should be a member of wrua.

b) Introduction of effluent discharge control plans to ensure permitted quality of water is discharged into the environment.

c) Introduction of drip irrigation for efficient water use.

d) Adhere to agreed schedule of rationing for irrigation.

11. What are your recommendations on the proposed irrigation project?

a) The project is noble but adequate water storage is a must.

b) In a great way it will improve community food security.

c) Self-regulating weir a must to ensure abstraction of flood flow only.

Signature _____ Date 31/5/2018

THANK YOU

WATER RESOURCES MANAGEMENT AUTHORITY
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P.O. BOX 1331 TEL 32510 NANYUKI

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