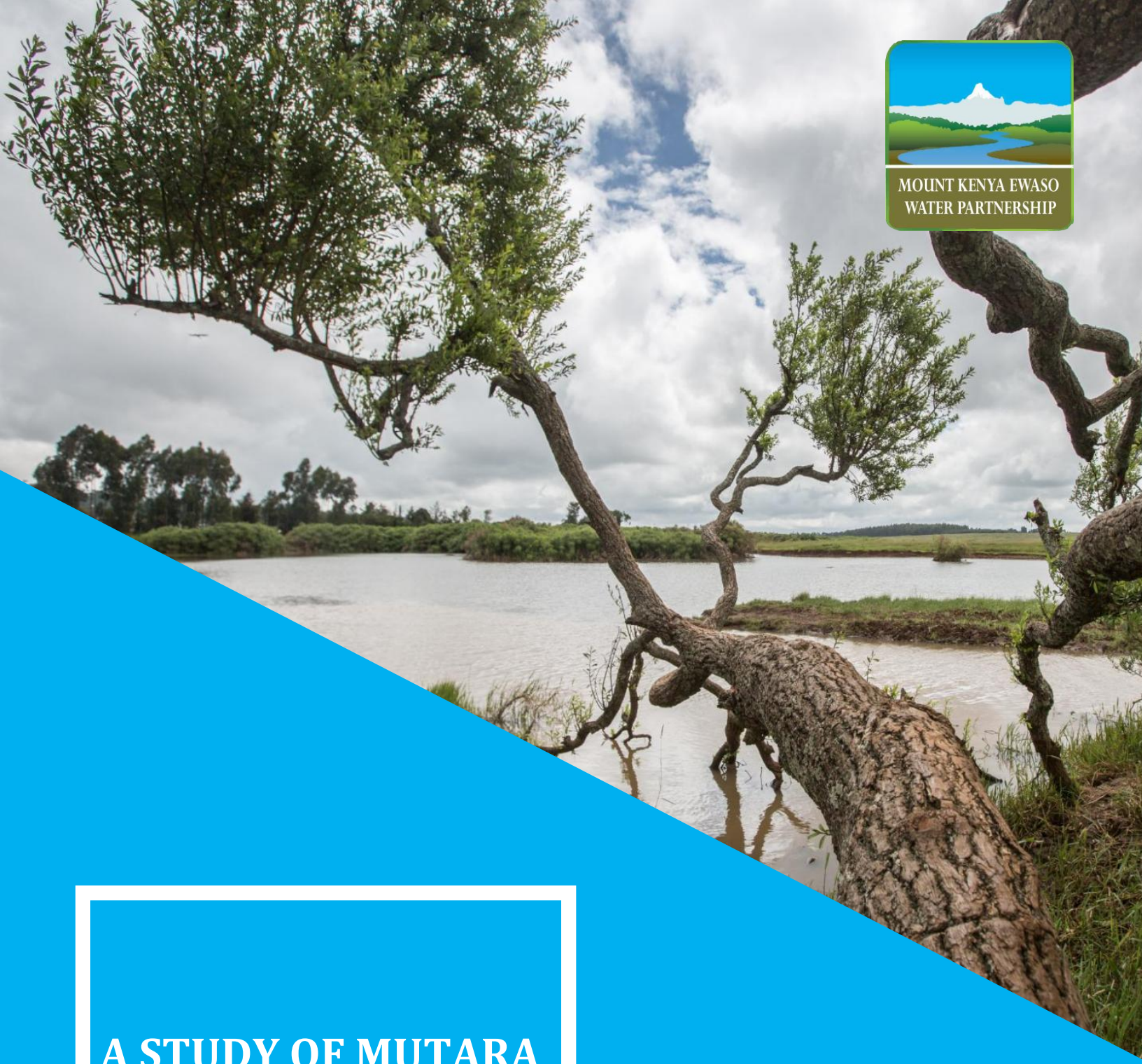

MOUNT KENYA EWASO
WATER PARTNERSHIP

A STUDY OF MUTARA SUB-CATCHMENT

SUB-CATCHMENT STUDY

Prepared by

CETRAD
Centre for Training and Integrated Research in ASAL Development

The Mount Kenya Ewaso Water Partnership is hosted by the Laikipia Wildlife Forum (LWF). The Partnership is an LWF member, is represented on the LWF Board, and is one of several associations in the greater Laikipia landscape supported by the LWF secretariat.

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LIST OF ABBREVIATIONS AND ACRONYMS

ACA	Athi Catchment Area
CETRAD	Centre for Training and Integrated Research for Arid and Semi-Arid Lands Development
ENNCA	Ewaso Ng'iro North Catchment Area
FFI	Fauna and Flora International
FGD	Focus Group Discussion
JICA	Japan International Cooperation Agency
LVNCA	Lake Victoria North Catchment Area
LVSCA	Lake Victoria South Catchment Area
MKEWP	Mount Kenya-Ewaso Water Partnership
SCMP	Sub-Catchment Management Plan
OPC	Ol Pejeta Conservancy
RGS	Regular Gauging Station
TCA	Tana Catchment Area
WRUA	Water Resource Users Association
WRA	Water Resources Authority
WSTF	Water Sector Trust Fund

1. INTRODUCTION

1.1 Overview

The availability of surface and groundwater resources is often a key factor in determining the patterns of human settlements and socio-economic development in Kenya. Through the JICA assisted study of the National Water Master Plan 2030, the available water resources availability has been assessed as shown below:

1.1.1 Available Water Resources by Catchment Area

(Unit: MCM/year)

Table 1.1 Water Resources by Catchment

Catchment Area	Area (km2)	2010	2030	2050
LVNCA	18,374	4,742	5,077	5,595
LVSCA	31,734	4,976	5,937	7,195
RVCA	130,452	2,559	3,147	3,903
ACA	58,639	1,503	1,634	2,043
TCA	126,026	6,533	7,828	7,891
ENNCA	210,226	2,251	3,011	1,810
Total	**575,451**	**22,564**	**26,634**	**28,437**

Source: JICA Study Team for NWMP 2030.

NWMP 2030 proposes the direction of water development plan and water management plan in Kenya based on Vision, 2030 with water development projects to solve water scarcity of Kenya, which has been severe for a long time.

ENNCA is the largest of all the six catchment areas but with least population, this is because it falls in Arid and Semi-Arid (ASAL) parts of Kenya. The EwasoNg'iro North River drains the southern part of the catchment (5AA, 5AB, 5AC, 5AD, 5BA, 5BB, 5BC, 5BD, 5BE, 5D) in an easterly direction, from the highlands around Mt. Kenya, Aberdare ranges and

Nyambene hills. The EwasoNg'iro North is the main river in this system and has the following tributaries: EwasoNarok, Likiudu, Liliaba, NgareNdare, Ngusishi, Timau, Sirimon, Teleswani, Ontulili, Likii, Nanyuki, Rongai, Burguret, NaroMoru, Isiolo, Moyok, Ngobit, Suguroi, Pesi and Mutara. The river flows into the Lorian swamp where it is an important source of water for recharging the groundwater and maintaining of vegetation cover.

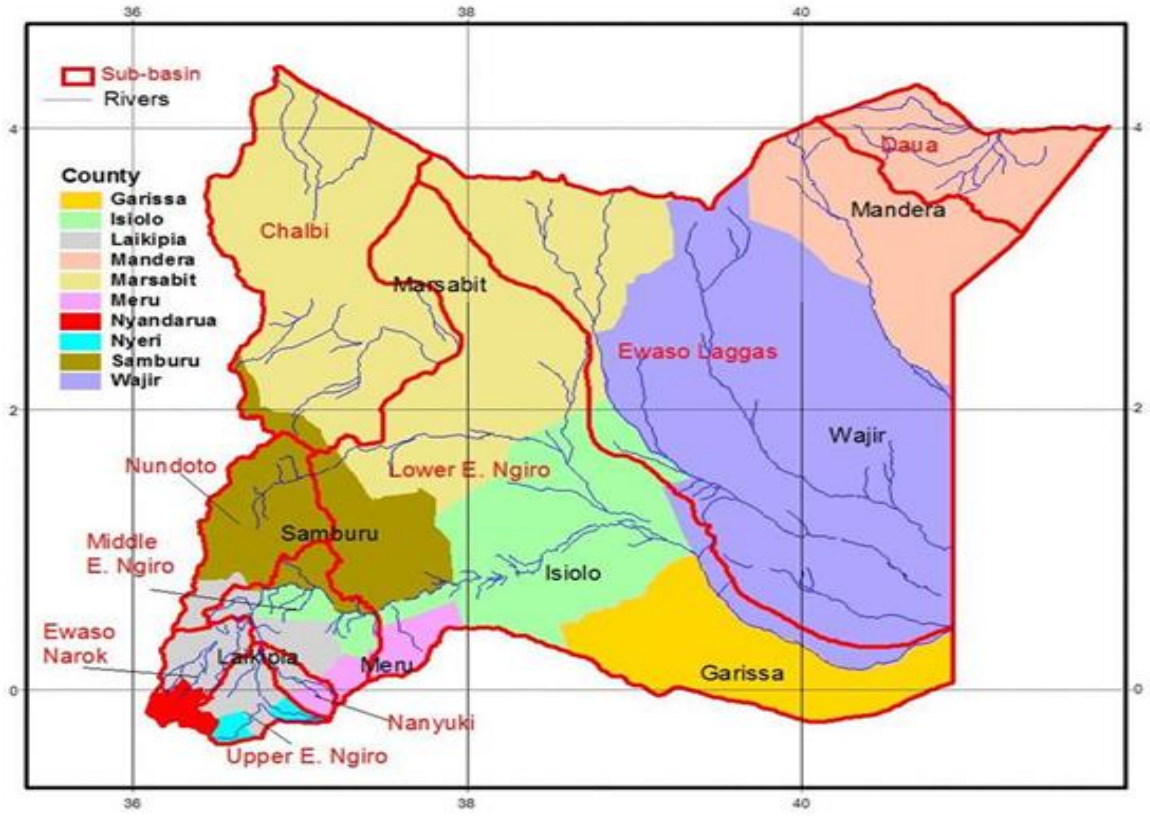


Figure 1.1: ENNCA's Geographical Coverage. Source WRA, 2018

The Daua and Chalbi system is part of the Ewaso Ngiro North Catchment Area. The Daua system is a perennial river that drains the north east tip of the catchment (5GB, 5HA, 5HD) and originates from the Ethiopian highlands and forms the border between the two countries before draining into Somali. Whereas the Chalbi system is an internal drainage lake that drains the north-west part of the catchment (sub-catchment 5J). It is a shallow lake which forms seasonally in response to rainfall (including some run-off from the Ethiopian highlands).

1.1.2 Water demand by Subsector in ENNCA

The annual water demands for 2010 and 2030 are summarized below. The trends show an increase in demand in all sectors with the total demand increasing more than ten times. This is a worrying trend as the water resources in ENNCA continue to become scarce due to catchment degradation, population increase and the effects of climate change.

Table 1.2 2010 and 2030 Water Demand in ENNCA

Year	Water Demands (MCM/year)						
	Domestic	Industrial	Irrigation	Livestock	Wildlife	Fisheries	Total
2010	58	1	92	57	0	4	212
2030	125	2	2,644	79	0	7	2,857

Source: NWMP 2030

1.1.3 Mutara Sub-Catchment

Mutara sub catchment traverses between in Nyandarua and Laikipia Counties with the upper zone passing through Ndaragwa central ward in Nyandarua County and the middle and lower zones through Salama ward in Laikipia County. The sub-catchment has a total area of 489 Km^2 and serves a combined population of 43,480 people living within eleven sub locations (with an area of 1,816 Km^2) that are partly or completely within the sub catchment. The area is dominated by semi-arid type of climate except for a small portion at the foot of the Aberdares which is semi-humid. This has impeded agriculture in the area with only about 4% under crops and settlements, 94% under grasslands and the remaining 2% of land is under forest, water and moorland (CETRAD, 2014).

Mutara WRUA was established in 2002 within the Engare Narok Merghis management unit 5AD and is categorized in the **ALERT** status. WRA led the sensitization and mobilization of the community and later the process was funded by WSTF .The WRUA was then registered at the AGs office and at the time of its Sub-catchment Management Plan (SCMP) formation in 2011, the WRUA had 400 registered members with 18 executive represented as Upper

zone [10%], middle-65%, lower zone-90%. The composition of WRUA members included illegal water abstractors, water projects, ranches, pastoralists, wildlife, institutions (ADC) and wildlife. The WRUA is surrounded Suguroi and Pesi WRUAs. Some of the challenges faced by the community that led to WRUA formation included: water scarcity, water conflicts, illegal water abstraction, catchment destruction and water pollution/poor drainage.

A study by Flora and Fauna International (FFI) and Ol Pejeta Conservancy (OPC) on Mutara WRUA capacity needs in November 2017 established the following as some of the challenges or capacity gaps of the WRUA:

i. Though the management committee is in place and frequently meet to discuss the direction of the WRUA; management team and WRUA membership of the WRUA are predominantly from one ethnic community / user group (farmers). It is important that the WRUA membership is reviewed to capture the interests of all water resource users who include pastoralists and ranches (ADC Mutara) etc.

ii. Documentation and storage of WRUA information is not well done. The list of membership was last updated in 2006 and for those who have registered as projects; the list of project members is not kept. The WRUA has a challenge in record storage and access due to the absence of an office and WRUA documents is under the custody of one of the officials.

iii. Conflicts are fueled due to water scarcity caused by over abstraction upstream for farming -thus conflicts occur among different zones along the WRUA. The WRUA has an informal conflict resolution strategy but largely untested, with most issues going unresolved or resolved informally. To ensure sustainable and efficient water use , capacity development on water allocation and use, water storage technologies and sustainable irrigation and agricultural practices is required

iv. The WRUA has no funds to implement majority of existing activities in the next 12 months. Plans are made without attaching budgets hence difficult to mobilize for

support. To ensure financial sustainability, there is need to develop skills of the WRUAs on fundraising and advocacy to mobilize service providers at relevant county and national government sectors to support their prioritized activities. The SCMP needs to be reviewed and used as a tool of fundraising.

v. The WRUA has Weak links between other WRUAs, National and Local Government.

vi. Lack guidelines and expertise to ; effectively consult beneficiaries on impact of WRUA activities, integration of poverty, inclusion and evaluating beneficiary impact- build capacity of WRUA to integrate gender, poverty and inclusion and ; to measure and document beneficiary impact.

vii. There is Lack of ownership by members as reporting channels are not well established and there is no communication flow between Management and beneficiaries.

2. MUTARA RIVER STUDY

2.1 Background of Mount Kenya Ewaso Water Partnership

Mount Kenya Ewaso Water Partnership (MKEWP) is Public Private Partnership (PPP) of water stakeholders in Upper Ewaso Ng'iro North Catchment Area. The partnership is committed to ensuring "**Water Security for All**" in a socially acceptable, economically favorable and environmentally sustainable way. The partnership's mission is to provide an effective and coordinated stakeholder engagement to address the challenges of managing water within its geographical scope. MKEWP draws its membership from water stakeholders such as The County Governments of Laikipia, Meru and Nyeri, Large scale farmers such as flower and horticultural farmers, Water Resource Users Associations (WRUAs), Water Resources Authority (WRA), Kenya Wildlife Service, Kenya Forest Service, Conservancies, Community Forest Associations, Research institutions, Water Service Providers, Financial Institutions and Non- profit institutions among others.

MKEWP's Motto is "**Maji Yetu Jukumu Letu**" and its operations are guided by the following principles:

1) **Open and Transparent:** Water institutions shall work in an open and transparent manner, using language understandable to the general public; decisions shall be transparent, particularly regarding financial transactions.
2) **Inclusive and Communicative:** wide participation shall be ensured throughout the decision making chain, from conception to implementation and evaluation; governance institutions shall communicate among water stakeholders both horizontally at the same levels and vertically between levels.
3) **Coherent and Integrative**: water resources management shall be coherent, with political leadership and strong responsibility taken by institutions at different levels ; water institutions shall consider all potential water users and sectors and their linkages with , and impacts on, the traditional water sector
4) **Equitable and Ethical**: equity between and among various water interest groups, stakeholders and consumers shall be carefully monitored throughout the strategy implementation process.

MKEWP has a strategic plan for the period between 2018 and 2022 with five strategic priorities. Related to the Mutara Sub-catchment study are two Strategic Priorities:

a) Strategic Priority 2: Improve Water Demand Management and Sustainability

This Priority acknowledges that water resources are finite and inadequate to meet all demands and therefore efforts should be made in ensuring that water is accessible in an equitable manner to all stakeholders. This would be attained by through achieving the following strategic objectives:

- ✓ Improved mechanisms for water allocation;
- ✓ Improved efficiency in water use;
- ✓ Improved water use accountability.

b) Strategic Priority 3: Improve Water Security and Governance

This priority recognizes that water security and governance failures lead to water use conflicts. Relevant strategic objectives under this Priority include:

- ✓ Put in place systems for water resource abstraction, Monitoring and enforcement strengthened.
- ✓ Ensure that the systems and infrastructure for irrigation and domestic water use are developed and managed in an environmentally, socially and economically sustainable manner
- ✓ Strengthened adaptation and coping mechanisms for climate change
- ✓ Enhanced protection and sustainable development and use of wetlands

The study aimed to assess the baseline information towards achievement of the above strategic goals in Mutara Sub-catchment.

2.2 The Study Terms of Reference

The terms of Reference will involve:

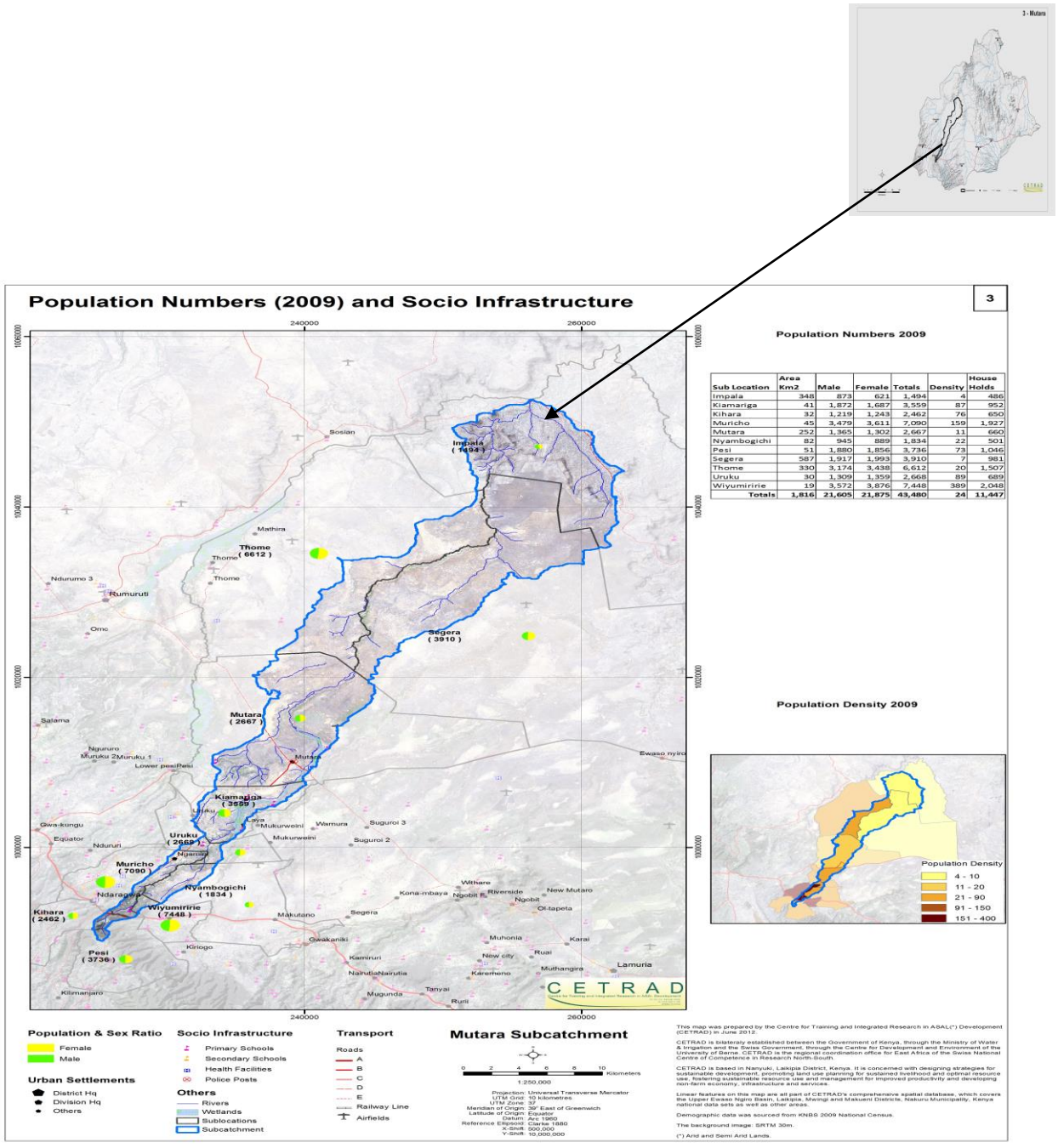
1. Gathering all the information on Hydrological data on the river establishing the following:
   a) The historical river flows.
   b) The Abstractions on the river (Volumetric)
   c) Abstraction Points coordinates.
   d) Water Balance on the river.
   e) Environmental flows.
   f) Projected Demand on Water up to 2030.
   g) Current pollution threats and type
   h) Future pollution threats
2. The extent of Degradation along the Riparian.
3. Recommendations on mitigation actions to:
   a) Improve management of riparian and estimated costs
   b) Improve Control and management of Abstraction especially during drought i.e. Common Intakes and recommended site(s)

c) Establishment of Water Storage Facilities in the sub-catchment at Household level, Community Water project level and or at Sub-catchment level.
d) The Sites for (c) and estimated costs
e) Assessment on Capacity of Governance/ leadership issues and recommendations.

4. Adoption of the above recommendation by the leadership/Community.

3. STUDY METHODOLOGY

Study Area: Mutara Sub-catchment



Sub Location	Area Km2	Male	Female	Totals	Density	House Holds
Impala	348	873	621	1,494	4	486
Kiamariga	41	1,872	1,687	3,559	87	952
Kihara	32	1,219	1,243	2,462	76	650
Muricho	45	3,479	3,611	7,090	159	1,927
Mutara	252	1,365	1,302	2,667	11	660
Nyambogichi	82	945	889	1,834	22	501
Pesi	51	1,880	1,856	3,736	73	1,046
Segera	587	1,917	1,993	3,910	7	981
Thome	330	3,174	3,438	6,612	20	1,507
Uruku	30	1,309	1,359	2,668	89	689
Wiyumiririe	19	3,572	3,876	7,448	389	2,048
Totals	1,816	21,605	21,875	43,480	24	11,447

Figure 3.1 : Mutara Sub-Catchment Source: CETRAD, 2014

3.1 The Study Design

The Study adopted a qualitative design which involved the development and administering of Focus Group Discussions (FGDs) guide (See annex 1), consolidation and review of relevant literature on Mutara sub-catchment and data collection through observation with the help of a check list. The study target population involved water stakeholders in Mutara sub-catchment such as the WRUA members, the local community, WRA officers, other allied officers in the government including senior assistant chief and assistant chief for the area, NGOs and the Private sector working in the area. A total of 58 community members both at the WRUA and local farmers were interviewed (See Annex 2).

Figure 3.2: Focus Group Discussion with a section of the Respondents

4. STUDY FINDINGS

4.1 Mutara River Hydrology

Mutara River stretches 75kms through Laikipia west, Laikipia East and Nyandarua north. The River has its source in Aberdare ranges from where it runs underground then re-surfaces at Thigio hence the high number of springs in the area. Additional springs are located in Subego and these feed into Mutara River. There are two RGSs, one in the upstream (5AD1) and another one in the lower stream (5AD4). The sub-catchment has wetlands/swamps at Kiamariga, ADC and Kihika. The wetlands have functional importance; filters water, act as water reservoir. At the lower zone the river is smaller, silted and usually dries up during dry spell.

Water Availability in the sub-catchment varies spatially with the upper reaches in Aberdares receiving more liters per second (l/sec) compared to the lower zone that is faced with challenges in water access both for domestic and farming. The following were outlined as the leading to water scarcity and conflicts in the area:

- Inefficient use of water
- Illegal water abstraction
- Uncontrolled water abstraction due to lack of meters
- Absence of a common intake

According to the department of Agriculture in the county, the government is currently working on construction of boreholes in the lower zone to increase water availability and holding demonstrations on water use efficiency. This leaves out the common intake which is an important tool in ensuring equitable distribution of water hence resolves conflicts based on available evidence in meters.

4.2 Water Balance

There are number of springs distributed in Mutara area which have their sources from Aberdare ranges. The springs are important in recharging the river thus maintaining the

River flows throughout the year. The River flow is however being affected by environmental degradation, pollution, high population and over abstraction causing the water volume to dwindle at a high rate. Water demand in the sub-catchment is great throughout the year for various purposes; therefore there is need for an urgent action in order to create harmony between the community and the environment.

It should be noted that no studies haves been done in Mutara Sub-catchment to establish the current water balance. Available data represent estimated water use during SCMP development in 2011 and the 2030 National Water Master Plan estimates as shown in Tables 4.1 and 4.2 below.

Table 4.1 **Mutara Sub-catchment Estimated Water Balance in 2011**

	Water available	**Water use**	**Balance**
Ground water[springs and boreholes	10 %		
Stream flow[river]	90 %		
Total	100 %		
Reserve[environment]		10%	
Domestic demand		20%	
Livestock demand		40%	
Irrigation		100%	
Industrial		10%	
		180%	-80

Mutara water balance, Source: Mutara SCMP 2011

During SCMP development the participants pointed out a deficit of about 80% in water demand. It should be noted that Irrigation uses all the water (100%) in the sub-catchment completely depleting water for the reserve flow, livestock and domestic use. This is a clear depiction of a non –sustainable use of a resource thereby leading conflicts among water users and finally to its depletion.

Balance between Water Demand and Supply in 2030 in Mutara Sub-catchment (5AD)

The National Water Master Plan draws a picture of water demand in Mutara Sub-catchment in 2030. It is clear from table 4.2 below that river water will have the highest demand of approximately (70%) of the total demand. This does not paint a great picture of the future given the current pressure that is already being exerted on the river. Interventions that provide alternative water sources such as flood and rainwater harvesting mechanisms need to be put in place.

Table 4.2 Mutara Sub-catchment Water balance in 2030

Unit: MCM/Year

Total Demand	River Water	Dam	Transfer	Small Dam/Water Pan	Ground Water	Balance
6.7	**4.7**	**0.0**	**0.0**	**1.6**	**0.4**	**0.0**

Source, NWMP 2030

4.3 Control and Management of Water Abstraction

Water is a scarce resource both in ENNCA and especially in Mutara Sub-catchment. Increase in populations and intensifying of agriculture has exerted a lot of pressure on water resources in the sub-catchment. In order to ensure water use efficiency and equitable access to water, water abstraction needs to be to be regulated. It was agreed that a common intake would be an effective tool in controlling water supply with the changes in River discharge in the sub-catchment.

The respondents agreed that the ideal location of a common intake would be on the upper zone of the river. The following were the proposed locations for a common intake:

- **Jiani Farm Limited**
- **The area between Ngamini and Magutu next to a waterfall**

4.4 Water Harvesting and Storage

The scarcity of water especially surface water in the sub-catchment makes water harvesting and storage an important alternative in ensuring that the needs of the entire population are met for various uses such as domestic, farming, Livestock and industrial use. In order to promote water storage in the sub-catchment, the County Government of Laikipia in the last five years provided thirty (30) individual farmers who already had excavated water pans with dam liners. This was to ensure ownership and hence sustainability of the water storage project. It was however noted that there was no clear data on who exactly was given the dam liners and even the locations of the water pans. The respondents who had the water pans also cited a challenge with the liners provided as some were not able to hold water hence seepage of the harvested water. The respondents acknowledged the existence of low quality liners in the market and companies such as Green Acre and KFC were identified to provide good quality liners.

There was still a big gap in water harvesting and storage structures evident by the large number of respondents (86%) who voted for individual water pans. The respondents voted unanimously for a community water storage structure. However about 47% were for community water pan and 53% proposed a community check dam, this was due to the soil structure of the area. The following were the proposed sites for community water pans:

- **Upper Zone : Muruai Primary School**
- **Middle Zone: Kiamariga**
- **Lower Zone: Public Land along Nyahururu- Nanyuki Road**

The respondents could not however agree on the location of the check dam. Due to the great solar insolation in the area, high evaporation of water was also mentioned as a challenge. It was however agreed that locating the water pan in a shaded area would be ideal. The soil structure of the area was also mentioned as one of the factors affecting the sustainability of the water pans.

Two community water pans and a farm pond are proposed for consideration to meet the water demands of the community. One water pans would supply water for domestic use only while the other water pan would be for both domestic and irrigation.

I. Community water pan for domestic water supply

Mutara sub-catchment has a population of 43,480 people who on average consume 125,222m^3 in four months. To meet this demand, a pan of 126,000m^3 (200m* 180m* 3.5m (Average depth)) should to be constructed at a total cost of **Ksh. 36,761,230.** This includes the cost of construction; the dam liner and 10% contingency (***see Annex 4)***.

II. Community water pan for domestic use and drip irrigation

Assuming that each household had approximately five (5) people, a population of 43,480 people will have 8,696 households. If for instance each household has an irrigation area of 40m^2, the land area under irrigation would be about 35 Ha. The total water demand for irrigation and domestic use becomes 440,280 m^3. The total cost of excavation, the gauge liner and 10% contingency is approximately Ksh**. 129,252,200 (*See Annex 5)*.**

It should however be noted that for large water pans, depending on the type of soil in the construction area, dam liners are not necessarily needed as the soil is compacted during construction by the machines hence reducing its porosity. The soil type of the area is mainly vertisol that is also easily compacted making it less porous.

III. Lined Farm Pond for 0.25 acres (0.1 Ha)

A farm pond of 20m by 15m by 3m (average depth) holding approximately 750 m^3 would cost about Ksh. **323,400** which includes the cost of excavation, 1mm gauge liner, Solar or Pedrollo pump, PVC pipes and 10% contingency (***See Annex 6).***

4.5 River Discharge

Hydrological characteristics of a River are determined by its velocity and discharge. The velocity (sometimes referred to as flow) of the river water is the rate of water movement given as m s-1 or cm s-1. The discharge (m3 s-1) is determined from the velocity multiplied by the cross-sectional area of a river. Discharge (or surface runoff Qs) refers to the horizontal water flow occurring at the surface in rivers and streams.

The discharge of a river is an important measurement because:

- It provides a direct measure of water quantity at a particular time and hence the availability of water for specific uses,
- It allows for the calculation of specific water quality variables,
- It provides the basis for understanding river basin processes and is essential for interpreting and understanding water quality.

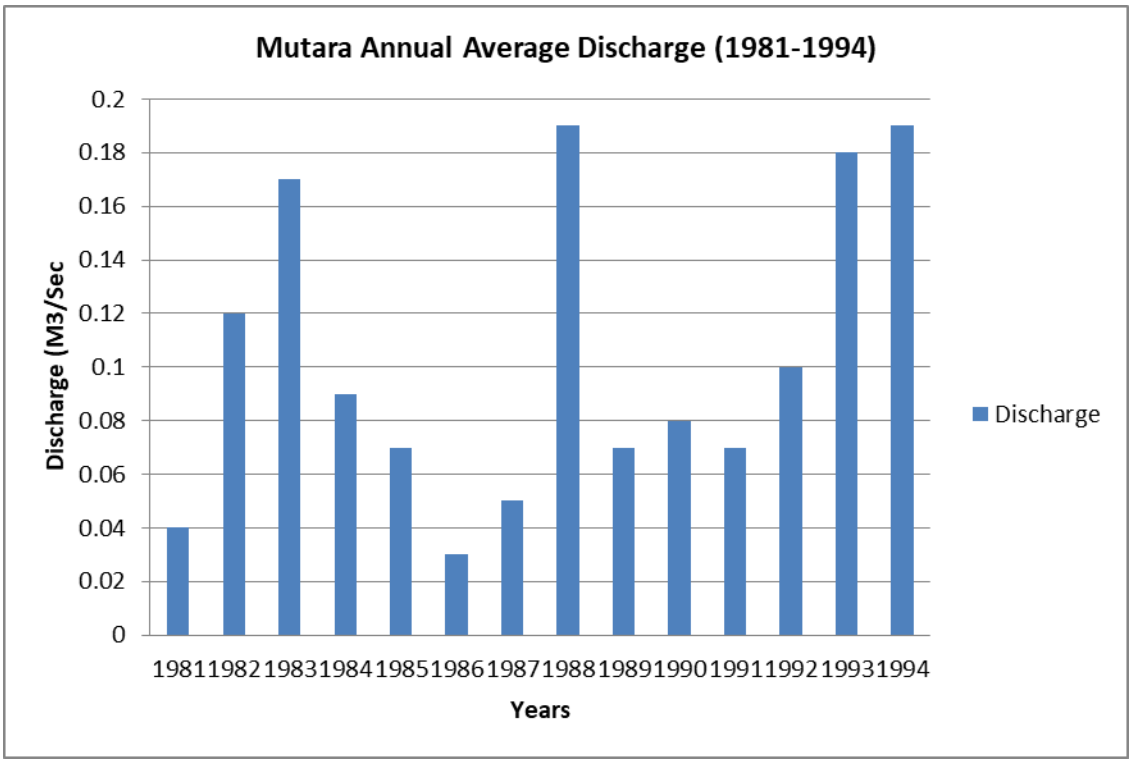


Figure 4: Annual River Discharge (1981-1994) Source: CETRAD database, 2018

Historical data of between 1981 and 1994 shows a trend in discharge of between 0.01 m3 s-1 to 0.19 m3 s-1. The average discharge for this period of time is 0.1 m3 s-1. This is an indication of generally low flows for that period of time in the sub-catchment. The same trend is seen between 2006 and 2018 where the discharge of the River was between 0.09 m3 s-1 in 2009 and 1 m3 s-1 in 2010 with an average discharge of 0.35 m3 s-1. A change in discharge is often attributed to the weather conditions and the status of the catchment. Increased precipitation within the river catchment increases its discharge while dry conditions reduce the river discharge.

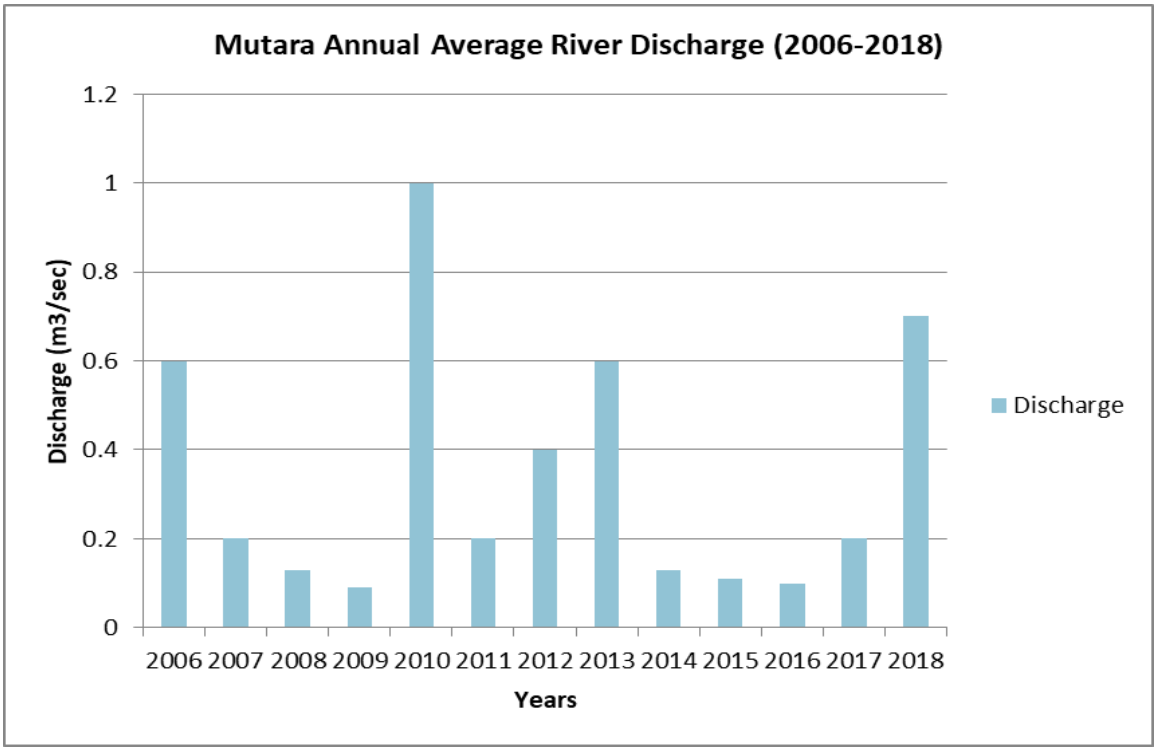


Figure 5: Annual Average River Discharge (2006-2018) Source: WRA database 2018

Mutara River has two RGSs; 5AD01 and 5AD04 which are placed strategically to collect River discharge data. The two RGSs are calibrated independently depending on the cross-sectional area of the River to depict river discharge at three levels: environmental /reserve flow, normal flow and flood flow depicted by Q 95, Q 80 and Q50 respectively as shown in tables 4.3 and 4.4 below. RGS 5AD01 has more flows compared to RGS 5AD04 and this is evident from the calculated Q values at different discharge levels. It should be noted that for station 5AD01, the environmental flow (Q95) is the same as the normal flow (Q 80). This is due to the springs located upstream of the station that regulates the river discharge throughout the year.

Table 4.3 Mutara River flows at 5AD01

Q values	Flow[m3/sec]	Flow[m3/d]
Q50	0.09892	8546.7
Q80	0.07166	6191.4
Q95	0.07166	6191.4

Source: WRA, 2018

Where:

Q 50 – Flood Flow

Q 80 – Normal Flow

Q 95 – Reserve Flow /Environmental Flow

The Reserve/Environmental flow (Q95) represents 30% of the total discharge should not be allocated as it sustains the river ecosystem. The World Bank defines environmental flows as " the quality, quantity, and timing of water flows required to **maintain** the **components, functions, processes, and resilience** of aquatic ecosystems which provide goods and services to people". The Normal Discharge (Q80) represents normal flows of the River while flood flow (Q50) represents an increase in discharge above the normal flow which is often due to precipitation in the catchment area thus increasing river discharge.

Table 4.4 Mutara River flows at 5AD04

Q Values	Flow[m3/sec]	Flow[m3/d]
Q50	0.076141	6578.6
Q80	0.017321	1496.5
Q95	0.004041	349.1

Source: WRA, 2018

4.6 Water Resources and Abstraction Points

In a study done in 2014 by CETRAD, the water abstraction points in the map below were identified. It should be noted that abstraction survey has not yet been done for the sub-catchment and currently WRA has prioritized Mutara sub-catchment for the study. The authority however gives permits for water abstractions and keeps a list of water abstractors which includes applications for abstraction, permitted and authorized abstractors (See Annex 3).

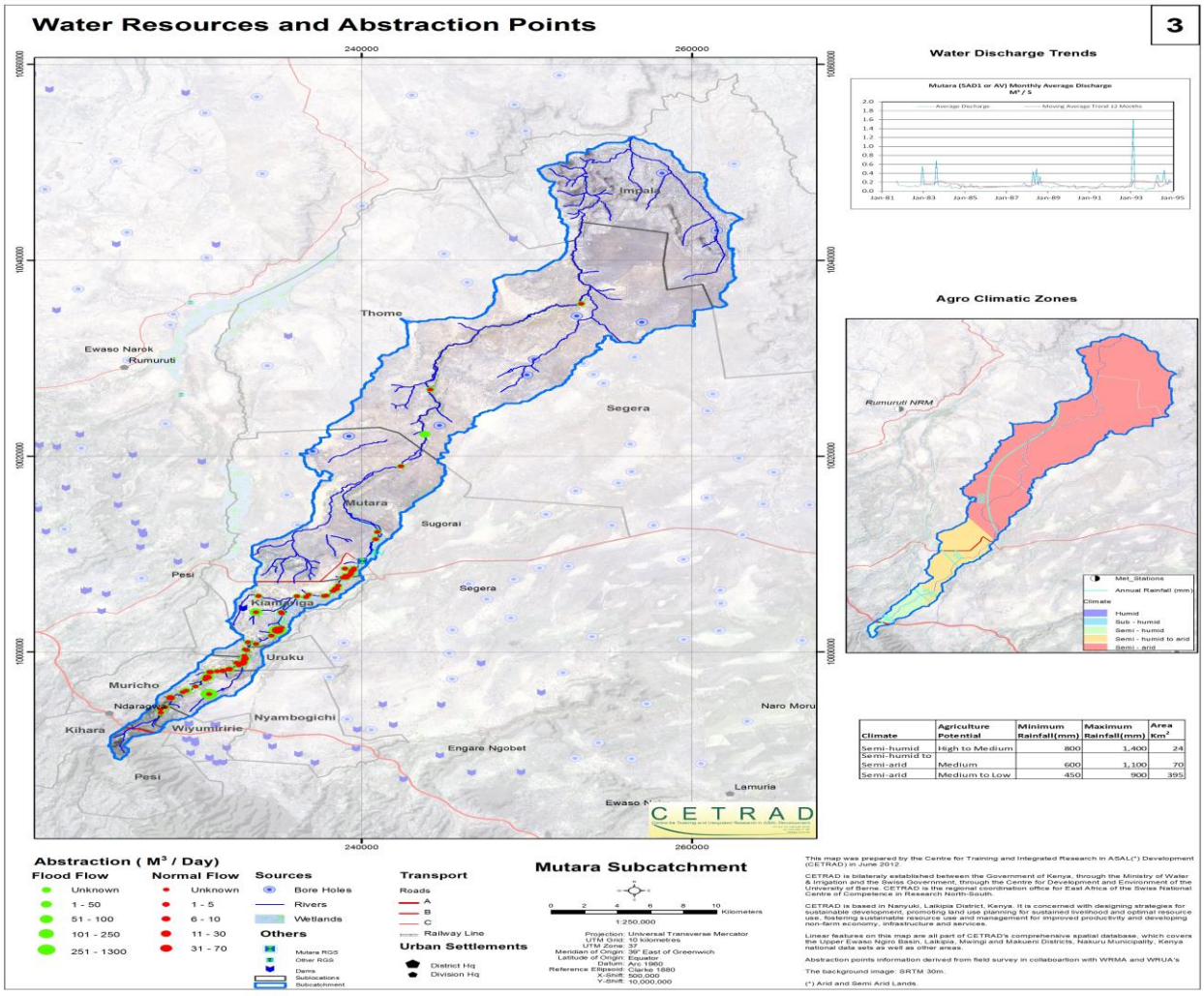


Figure 4.2: Water Resources and Abstraction Points in Mutara Sub-catchment, CETRAD, 2014

In Mutara sub-catchment water more water (2899.2 m3 /day) is abstracted for irrigation purposes, this represents 74% of all the water abstracted. Water for domestic purposes constitutes about 13% of all the water abstracted at 501 m3 /day which is nearly similar to water that is abstracted for other purposes at 508.9 m3 /day. Fishing is not a popular activity in the sub-catchment with only 10 m3/day abstracted for that purpose as shown in table 4.5 below.

Table 4.5: Volumetric Water Abstractions in Mutara River in 2018

Unit - M3/Day

Domestic	Irrigation	Fishing	Others	Total Abstractions
501.04	**2899.2**	**10**	**508.9**	**3919.14**

Source: WRA, 2018

4.7 Riparian Management

Riparian zone is the point of interaction between terrestrial and aquatic ecosystems. The area is important as they intercept debris from soil erosion in the sun-catchment thereby impeding their transport in the River channel hence reducing siltation of rivers. Riparian vegetation also increases water infiltration into the soil during precipitation by intercepting rain through the leaves and branches of the trees enabling slow percolation into the soil. The vegetation is also know to reduce the speed of run-off water leading to infiltration and hence recharge of the River water.

The Riparian vegetation in Mutara Sub-catchment reduces in density from the upper, through the middle stream to the lower reaches of the River. It should be noted that the vegetation in most parts remain intact however, Eucalyptus tree species cover a considerable amount of the zone. The water use of Eucalyptus is a controversial issue,

and the impacts of these fast-growing trees on water resources are well documented making them less preferred in the riparian zone.

Figure 4.2: A photo showing Eucalyptus spp plantation on Mutara River Riparian Zone, 2018

It should be noted that institutions like Ol Pejeta Conservancy (OPC) and the County government through the department of Agriculture have promoted the establishment of tree nurseries. OPC has established six (6) tree nurseries between Mutara and Suguroi and the county government has promoted the growth of fruit trees by provision of six hundred (600) mango tree seedlings to one hundred and two (102) farmers. It was however not clear on the survival rate of the Mango trees at the time of the study.

Giant Bamboo was seen as a new attraction to the respondents with a great number of them appreciating the many uses of the bamboo not only in Riparian protection but also in livelihood enhancement by making products such as furniture, bags, bracelets and necklaces for the women. The challenge with the Giant bamboo was on acquisition to seedlings which were not easily found. The respondents agreed that the Bamboo would be planted on the Swampy areas of the Riparian zone.

4.8 Current and Future Pollution Threats

Catchment degradation around Aberdare Ranges through deforestation has negatively impacted on the river. Soil erosion has increased and this is evident by the amount of silt in the river channel. The use of chemicals in farming was cited as another source of water pollution and the two sources are expected to rise in future with the increase in population. Population growth will directly affect agriculture thereby leading to the clearing of forests and chemical use for intensive agriculture in the study area. These activities compounded by the effects of global warming such as increased frequency of floods pose a pollution threat on the river ecosystem. Catchment rehabilitation, use of organic manure and riparian zone conservation provide sustainable solutions for the future of the sub-catchment.

5. RECOMMENDATIONS

Mutara WRUA was established in 2002 and nearly ten (10) years later through help from WRA and WSTF the WRUA developed a SCMP in 2011. Most of the activities in the SCMP remain untouched even as it awaits review as it is already past the time it was to be implemented. Several activities need to be undertaken in the sub-catchment in order to meet the initial mandate of the WRUA which was conflict resolution through effective management of the sub-catchment. The following are the recommendations that the study outlines:

1) Map all water pans in the sub-catchment to establish their locations, condition and capacity to harvest flood water.
2) Carry out feasibility studies for the proposed community water pans and common intake locations to establish their suitability.
3) Establish water pans at the household levels and water pans/ Check dams at the community levels to increase water storage from flood water harvesting in the area thus improving climate change adaptation in the community.
4) Construct a common intake at the upper zone of River Mutara for conflict resolution and management between users through controlled water abstraction and minimized water wastage from unmetered abstractions.
5) Conduct a survey of the Riparian zone to determine its extent and map out the locations where Bamboo plantations would be established starting with the locations with Eucalyptus trees.
6) Contribute to Riparian conservation and protection through the introduction of giant bamboo in the riparian zone that also has a ripple effect on improving the community livelihood.
7) Capacity build the WRUA on water governance structure, Resource mobilization and Fund raising, Effective communication and reporting and the importance of integrating all water players (upstream- downstream) in water resources management.

6. REFERENCES

- CETRAD's Sub-Catchment Directory, 2014
- FFI and OPC WRUA needs assessment reports
- Mutara WRUA SCMP, 2011
- National Water Master Plan 2030
- WRA website

Annex 1: Focus Group Discussion Guide

Facilitator's welcome, introduction and instructions to participants

Welcome and thank you for volunteering to take part in this focus group. You have been asked to participate as your point of view is important. I realize you are busy and I appreciate your time.

Introduction: This focus group discussion is designed to assess your current thoughts the management of water in Mutara Sub-catchment for equitable access to water and conflict resolution. The focus group discussion will take no more than one hour.

Anonymity: I would like to assure you that the discussion will be anonymous. The transcribed notes of the focus group will contain no information that would allow individual subjects to be linked to specific statements. You should try to answer and comment as accurately and truthfully as possible. I would appreciate it if you would refrain from discussing the comments of other group members outside the focus group. If there are any questions or discussions that you do not wish to answer or participate in, you do not have to do so; however please try to answer and be as involved as possible.

Questions

1. What is the Riparian Zone?
2. What is the extent of degradation of Mutara riparian area?
3. How can we improve the management and conservation of the riparian zone?
4. Which are the current pollution threats in Mutara River?
5. What do you think will pose as pollution threats in the Future?
6. What kinds of conflicts do you experience in water resource management?
7. How do you resolve these conflicts?
8. What are the benefits of having a common intake?
9. How do you harvest and store water?
10. Which are the preferred areas / sites for water storage facilities?

Conclusion

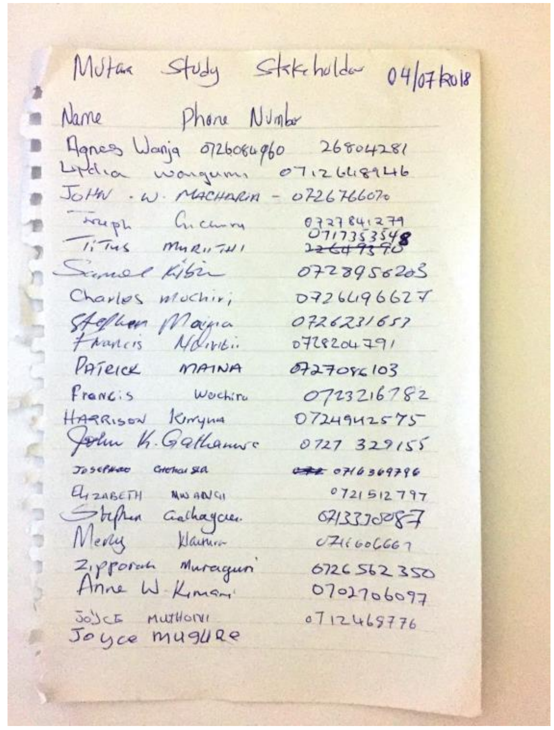
* Thank you for participating. This has been a very successful discussion
* Your opinions will be a valuable asset to the study
* We hope you have found the discussion interesting

Annex 2: List of Respondents

04/07/2018

MUTARA STUDY STAKEHOLDERS

MARGARET MURIUKI	0722874030
JACKSON KAHIHU	0728205604
RICHARD NGUNJIRI	0721750719
SAMUEL NJOGU	0713385237.
DANIEL KABUE	0726304193
MARTIN RWENGO	0792431583
GEORGE GATHERU	0723327333
AHMED MOHAMED	0703515966
Wachira Simon.	0708455374.
Harun Muchiri	0727561499
Samuel Ndoria	0723694580
MARGARET CHICHO	0720107316
ESTHER WANGECHI	0728581125
MARY WAMUYU	0706445903
DANIEL MWANGI	0727893474
John mathenge	0727264380
MICHAEL KARIRI	0725665565
FARAH MOHAMMED	0722715397



Mutara Study Stakeholder 04/07/2018

Name	Phone Number
Agnes Wanja	0726084960 26804281
Lydia wangumi	0712648946
JOHN. W. MACHARIA	0726766070
Joseph Gichuru	0727841279
TITUS MURIITHI	0717353548 ~~2264 9390~~
Samuel Kibira	0728956203
Charles Muchiri	0726496627
Stephen Maina	0726231657
Francis NdirITU	0728204791
PATRICK MAINA	0727086103
Francis Wachira	0723216782
HARRISON Kinyua	0724942575
John K. Gathanwe	0727 329155
JOSEPHAT GICHOBA	0716369796
ELIZABETH MWANGI	0721512797
Stephen Gathogue.	0713370087
Mercy Wairimu	0711606667
Zipporah Muraguri	0726562350
Anne W. Kimani	0702706097
JOYCE MUTHONI	0712469776
Joyce MUGURE	

Gladys Mathenge	0726064611
Milliam Wangui	0707571695
Mary Wambui	0729560007
Tereza Wanjiku	07
Margaret Wairimu	0725687499
Elizabeth Wanjiru	0717147916
Beatrice Wairimu	0700620877
Jemmima Wacera	0728497327
Washington Ngatia	0722222663
Eunice NJOGU	0714261525
Esther WAIRIMU	0728623042
GEOFFREY MAHINDA	0729753003
Watson Kaigi	0712648972
Patrick Maina Kaman	0728779960
Francis Ngethe	0720326913
NANCY N. KARURI	0725284095
JAMES N. Mwai	0710613353

Annex 3: Mutara River Volumetric Abstractions

S/ No	FILE NO.	NAME	CATEGORY	PURPOSE				PERMIT STATUS	REMARKS
				DOMESTIC M^3/D	IRRIGATION M^3/D	FISHING M^3/D	OTHERS M^3/D		
1.	NYA/9/1	Thigio Farmers	B	9.05	44.06		66.08	933	H.E.P-Expired
2.	NYA/9/2	Ndemi Farm	A	3.825	18.9			2100 permit	
3.	NYA/9/3	Muhuha Farm	C		754.05			4214 permit	
4	NYA/9/4	Ngamini Farmers Co. Society	D	3.90	97.7			4463 permit	
5	NYA/9/5	Ndemi Farm Ltd	A		22.27			9958 permit	
6	NYA/9/6	Subego Farm	A	21.15	4.50		261.12	11139 permit	H.E.P
7	NYA/9/7	Ngamini Farmers	A		40			P16266 auth.	
8	NYA/9/8	Paul Kariuki Kigima	B	9.087	72.696		81.783	P19049 auth.	H.E.P
9	NYA/9/9	Nathaniel Macharia	B		88.00			P23467 auth.	
10	NYA/9/10	Isaac Kahara Kariuki	A	0.595	8.8		10.00	Application	
11	NYA/9/11	Peter M. Kiggima	-	-	-	-			
12	NYA/9/12	Muthomi G. Njogu	A	1.4	17.6	-		P24871 auth	
13	NYA/9/13	Wendani W/Ass.	A	0.63				WRMA/ENNCA/SW/434	
14	NYA/9/14	Kirimara/Ngamini W/P	B		108.9			P29340 auth	
15.	NYA/9/15	George M. Gikanga	A	5.685				Application	
16	NYA/9/16	Murua Farm	A	6.83		10		P26421 auth	
17	NYA/9/17	Josphat K. Macharia	A	2.54				WRMA/ENNCA/SW/341	
18	NYA/9/18	Godfrey W. Karuri	A	1.89	17.6			Application	
19	NYA/9/19	James Kibunyi	A		1.8			Application	
20	NYA/9/20	Moses W. Mirie	A	2.9				P28024 auth	
21	NYA/9/21	Francis W. Ndirangu						Incomplete Application	

22	NUK/47/1	Finfran Ngorare	B	89.652	2.241			P15619 auth	
23	NUK/47/2	ADC Mutara Ranch	B	68.1525				9209 Permit	
24	NUK/47/3	ADC Mutara Ranch	A	10.904				3028 Permit	
25	NUK/47/4	ADC Mutara Ranch	A	27.3				4089 Permit	
26	NUK/47/5	Mathira K.Gitaraga Co. Ltd	A	36				10082 Permit	
27	NUK/47/6	ADC Mutara Ranch	A	0.45				7686 Permit	
28	NUK/47/7	Ukuliuma Kimariga Farmers	A	3.14				10616 Permit	
29	NUK/47/8	ADC Mutara	A	0.45				4090 Permit	
30	NUK/47/9	ADC Mutara						10018 Permit	Expired
31	NUK/47/10								
32	NUK/47/11								
33	NUK/47/12	Ben M. Gethi	A	8.96			89.65	1672 Permit	H.E.P
34	NUK/47/13	ADC Mutara							Dam
35	NUK/47/14	Kiamariga/Raya W/P	B		172.8			Application	
36	NUK/47/15	Raya Irrigation Project	B	2.25	90			Application	
37	NUK/47/16	Wangai Githinji	A	1.7	52.8			Application	
38	NUK/47/17								
39	NUK/47/18	Antony N. Theuri	A	2.1	40			Application	
40	NUK/47/19	Francis N. Muriuki	A	1.9	30			Application	
41	NUK/47/20	Ezekiel Kogi		8.75	20			Application	
42	NUK/47/21								
43	NUK/47/22	Waruguru Karigithi	B	11.77	100.0			25987 Permit	
44	NUK/47/23	Francis W Kamunya	A	1.230	20			Application	
45	NUK/47/24	Raya Water Association					0.23	Application	Cattle Dip
46	NUK/47/25	Munanda Irr. Scheme	C	59.75	759.5			26858 Permit	
47	NUK/47/26	Kiangoru S/H	B	97.10	315.0			P28804 auth.	

Annex 4: Community Water Pan for Domestic Use (without irrigation)

Size of Catchment - 498km^2
Population- 43,480 people
Volume of water pan – 200m* 170m* 3.5m (Average depth) – **119,000m^3**
Area of Pan – 34,000m^2 (3.4 Ha)

ITEM	Quantity	Unit	RATE	TOTAL
Water Demand per Day	43,480	Liters/Day	20	869,600 liters/day (869.6m^3/ day)
Water Demand in 4 Months	**869.6**	m^3	120	104, 352 m^3
Additional 20% Evaporation				20,870 m^3
Total Demand for Household				125,222m^3
Approx. Cost of Pan Construction	**125,222**	m^3	150	Ksh. 18,783,300
1mm gauge liner	36,590	m^2	400	Ksh. 14,636,000
Total				Ksh. 33,419, 300
Contingencies			10%	Ksh. 3341930
Total Cost				**Ksh. 36,761,230**

Note: A large water pan does not necessarily need a liner as the soil is compacted during construction hence reducing its porosity. The soil type of the area that is mainly vertisol is also easily compacted making it less porous.

Annex 5: Community water pan for domestic use and Irrigation (drip Irrigation)

Assuming Irrigation area per household- 40 m^2
Population – 43,480
No. of Households- 8,696
Land Size – 347,840 m^2 (35 Ha)

ITEM	Quantity	Unit	RATE	TOTAL
Population Water Demand per day	43,480	m^3/day	20	870 m^3/ day
Water Demand per Day on land	35	m^3 /day	62.5	2187.5m^3/day
Total Water Demand/ day				3057.5m^3/day
Water Demand in 4 Months	3057.5	m^3	120	366,900m^3
Additional 20% Evaporation				73,380 m^3
Total Demand for Household				440,280 m^3
Approx. Cost of Pan Construction	440,280m^3	m^3	150	Ksh. 66,042,000
1mm gauge liner	128,650	m^2	400	Ksh. 51,460,000
Total				Ksh.117,502,000
Contingencies			10%	Ksh. 11,750,200
Total Cost				**Ksh. 129,252,200**

Assuming an average depth of 3.5m
Area required is 440, 280m^3 / 3.5m = 125,794 m^2
(Including the sides the surface area is approx. = **127,000 m^2**)

Annex 6: Lined Farm Pond Material Summary and Specifications for 0.25 acres (0.1 Ha)

NO.	DESCRIPTION	QTY	UNIT	RATE	AMOUNT
1	Pan construction	750	m3	100	75,000
2	1mm gauge liner	410	m2	400	164,000

3	Solar or Pedrollo pump	1	Pc	35000	35,000
4	PVC pipes	1	sum	20000	20,000
					294,000
	Contingencies			10%	29,400
					323,400

Pan Specifications

Length	20	m
Width	15	m
Depth	3	m
Slope	2v:1h	

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