

# PAYMENT FOR WATER ECOSYSTEM SERVICES AT KIKUYU ESCARPMENT FOREST INITIATIVE



## EXECUTIVE SUMMARY

Water which form part of earth's ecosystem service is critical to all forms of life and since inception many nations have continued depending in one way or another on earth's ecosystem to fulfill basic needs like food and water, the upholding of healthy crops as well as climate regulation and even disease control. This earth's ecosystem has also provided spiritual fulfillment and aesthetic enjoyment to millions around the world.

Increasing consumption per capita by a growing human population is putting enormous pressure on many of this earth's ecosystem which has continued rapidly changing. For sure most of these ecosystems no longer provide sufficient resources to sustain previously stable human population and cultures.

The deprivation in the health of some of these ecosystems is so harsh that they are approaching a point where an alarm to the global actors is vital as the current trends must be reversed.

The global actors on the payment for ecosystem service especially water continue to develop (PWES) tools for guiding and supporting its application in community context. ERMIS Africa has increasingly continued to develop community mapping tools and practices that are progressively being used to support PWES processes in Africa.

The technical support was mainly done by ERMIS Africa (Environmental Research, Mapping & Information Systems in Africa) in development of payment for water ecosystem services (PWES) tools, towards implementation of PWES in Kikuyu Escarpment Forest which specifically targets Kinale, Kereita, Kamae and Kieni blocks. The facilitation was under Kijabe Environment Volunteers (KENVO), with funding from Critical Ecosystem Partnership Fund (CEPF).

The project aims at establishing a Payment for Ecosystem Services Scheme where communities involved in the management, conservation and protection of the watershed can receive payment from the beneficiaries of the services received from the watershed as a result of their action. It thus aims at establishing a business relationship between the service providers i.e. Sellers and the beneficiaries i.e. the Buyers, for mutual benefit.

## DEFINITION OF TERMS

### **Hotspots**

An area where intervention can be done in order to restore the catchment, Areas of water abstraction like dams or catchments under threats

### **Forest Stakeholder**

Any person, group of persons, or institution who for cultural, religious, economic, social or investment reasons is involved in, or associated with, management, research and exploitation of the products or services from a forest area.

### **Community Forest Association**

A group of persons who are registered as an association under the Societies Act (Cap 108) and who are resident in an area close to the specified forest.

### **Forest Community**

A group of persons who (a) have a traditional association with a forest for purposes of livelihood, culture or religion; (b) are registered as a Forest Association or other organization engaged in forest conservation.

### **WRUA**

This is an association of water users, riparian land owners, or other stakeholders who have formally and voluntarily associated for the purposes of cooperatively sharing, managing and conserving a common water resource.

### **Sustainable use**

Present use of the environment or natural resources which does not compromise the ability to use the same by future generations or degrade the carrying capacity of these ecosystems.

### **User group**

Any group of individuals formal or informal who; collects, harvests or utilizes any part or product from a forest for subsistence or commercial purposes.

### **Community Based Organization**

A community based organization, public or private nonprofit (including a church or religious entity) that is representative of a community or a significant segment of a community, and is engaged in meeting human, educational, environmental, or public safety community needs.

## ACRONYMS AND ABBREVIATIONS

CFA	Community Forest Association
WRUA	Water resource Users Association
CBO	Community Based Organization
KENVO	Kijabe Environment Volunteers
KFS	Kenya Forest Services
ERMIS Africa	Environmental Research, Mapping and Information System In Africa
MOA	Ministry of Agriculture
WRMA	Water Resource Management Authority
KWS	Kenya Wildlife Service
ODK	Open Data Kit
PWES	Payment for Water Ecosystem Service
WSB	Water Service Board
GPS	Global Position System
PES	Payment for Ecosystem Services
GIS	Geographic Information System
CEPF	Critical Ecosystem Partnership Fund
MENR	Ministry of Environment and Natural Resources
LWSC	Limuru Water and Sewerage Company
GWSC	Gatundu Water and Sewerage Company
QGIS	Quantum Geographic Information System

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# 1. INTRODUCTION

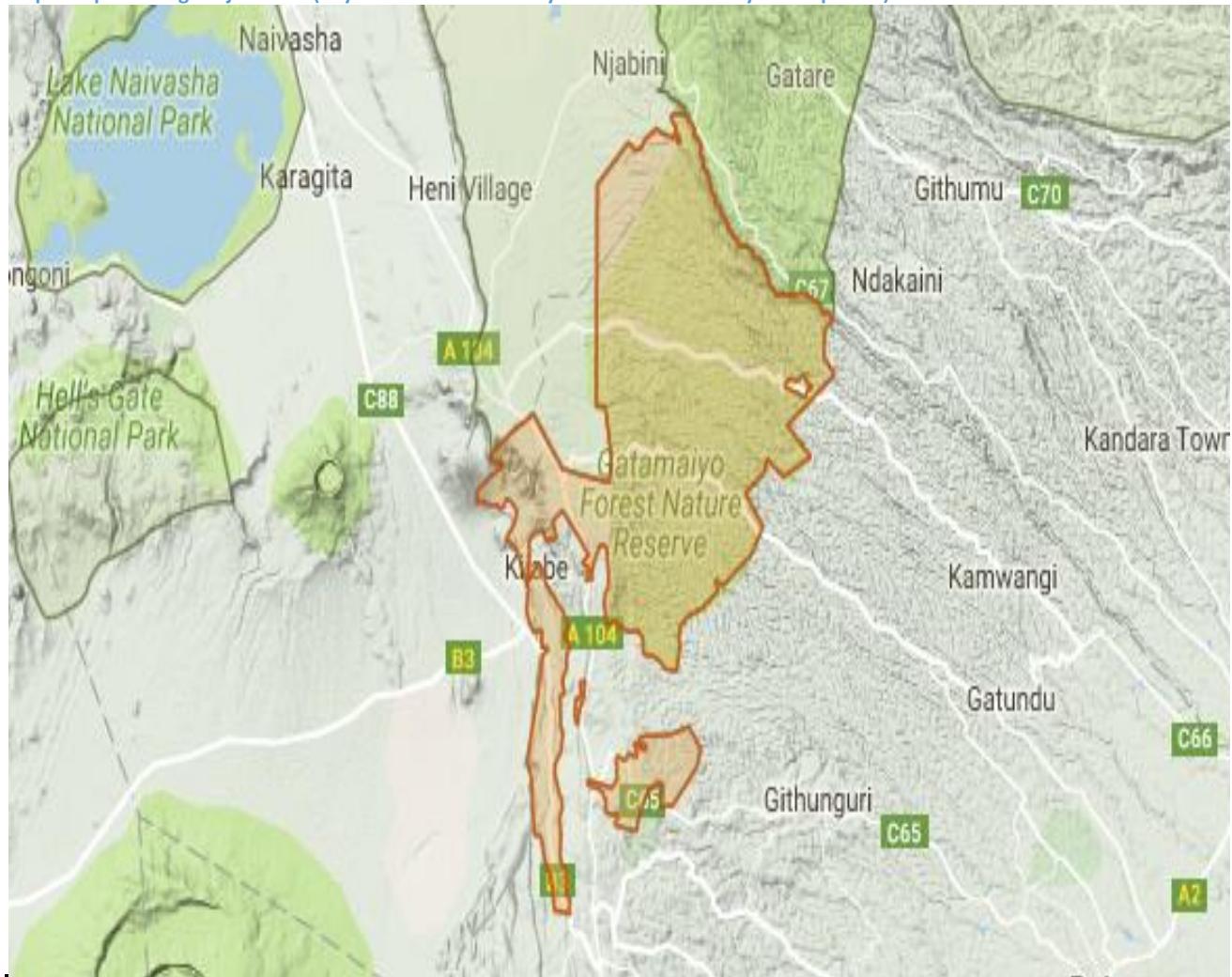
## 1.1 Description of Kikuyu Escarpment Forest

### 1.1.1 Location

Kikuyu escarpment form the water catchment area for Athi River basin and is on the southern slopes of Aberdare forest reserve which plays a critical role in water catchment functions for the country and is one of the five “water towers” in Kenya.

Kikuyu escarpment forest is located 35km Northwest of Nairobi city in Kikuyu Sub-county, Kiambu County and lies between Latitude: - 0.872186, Longitude:36.680164, decimal degrees Altitude: 1,800 - 2,700m. In terms of forest management the forest is located within the Central Highlands Conservancy.

**Map i Map showing Project area (Payment for Water Ecosystem Service in Kikuyu Escarpment)**



## 2 ABOUT THE PROJECT

### 2.1. What is Payment for Water Ecosystem Services (PWES)

The definition of payment for ecosystem services (PWES) varies widely, from narrow market-based definitions with direct transactions between providers and beneficiaries (including schemes where private buyers and sellers arrange voluntary and conditional transactions for the delivery of ecosystem services water), to broader schemes in which those who benefit from the ecosystem services pay (usually indirectly) those who provide the services.

### 2.2. Primary aim of the project

The primary aim of PWES project is to establish a Payment for Ecosystem Services Scheme where communities involved in the management, conservation and protection of the watershed can receive payment from the beneficiaries of the services received from the watershed as a result of their action. It thus aims at establishing a business relationship between the service providers i.e. Sellers and the beneficiaries i.e. the Buyers, for mutual benefit.

In order to successfully implement the project, KENVO tasked ERMIS Africa with specify objective as shown in eight fold:

- Conduct mapping and develop watershed hydrological maps
- Identify key hotspots within the watershed that requires conservation action.
- Conduct hydrological studies to establish water quality and quantity at different points in the catchment.
- Identify and show linkages between the upstream farmers / Sellers and downstream users (Buyers).
- Train project team on GIS and how to populate data on the digital monitoring tool.
- Establish a digital monitoring tool for the project (via mobile phone application).
- Provide both physical and digital hydrological watershed maps.
- Technical support in managing the digital monitoring tool.

### 3 METHODOLOGY, TOOLS and ACTIVITIES

Various methodologies were employed for gathering the required information and data for the entire survey on payment for water ecosystem services (PWES) in Kikuyu escarpment forest initiative. Similarly, appropriate tools to enable information /data gathering were developed and utilized. To ensure that all the requirements and information needed as per TORs were captured, the mapping exercise was planned and executed in phases.

#### 3.1. Inception phase

The inception phase comprised the period after the communication from KENVO of the award to implement the Payment for Water Ecosystem Services at Kikuyu Escarpment Forest Initiative through assignment on GIS mapping of project site and development of watershed hydrological maps showing hotspots and areas of intervention to the official signing of the contract. Discussions were held with the client in order to clarify some of the issues highlighted in the TORs for the purpose of developing a common understanding. This was conducted through a meeting between team from ERMIS Africa, AGRI ECOTECH, KENVO and other individual stakeholders. During the same time, the responsibilities and roles of each party were identified and elaborated, an exercise that culminated with the signing of the contract between different stakeholders and KENVO giving the latter the mandate to implement the project.

For any work to be successful, planning is very crucial which led to a number of action plan to be derived as shown in the table below.

Table i **Action Plan for PWES Survey**

1	<i>Planning meeting 001:</i> Awarding a GIS mapping of project site and development of watershed hydrological maps showing hotspots and areas of intervention	
2	<i>Planning meeting 002 :</i> Presentation of an initial comprehensive draft of hydrological watershed map	23 <sup>rd</sup> August 2016
3	Designing a Survey Recording Form for Mapping of Prospective Buyers	25 <sup>th</sup> August and 6 <sup>th</sup> September 2016.
4	Programming a Mobile tool for Mapping of Prospective Buyers	7 <sup>th</sup> and 8 <sup>th</sup> September 2016
5	Setup a web-based cloud server for data storage	9 <sup>th</sup> September 2016
6	Configuration of data collection smart phones	12 <sup>th</sup> September 2016
7	Testing and refining of the mobile PWES data collection tool	13 <sup>th</sup> September 2016
8	Development of data collection training manual	14 <sup>th</sup> September 2016
9	Field data collection	October / November, 2016
10	Data uploading to web-based cloud server for storage	

### 3.2. Preparatory Phase

The preparatory phase involved gathering thematic information to guide the whole process of GIS mapping of project site and development of watershed hydrological maps showing hotspots and areas of intervention. Effort to reach Kenya forest services (KFS) was also made with an aim of getting spatial boundaries of the forests within the project area. Water resource users associations (WRUA) from different watersheds and community forest association (CFA) were also consulted to guide through distribution of hotspots in the area.

Some visits were made to water resource management authority (WRMA) with an intention of gathering in-depth spatial data about abstractors who are referred by our write up as potential buyers. Initial field visits were also made to view some critical areas where a number of some of the challenges affecting water services were highlighted. Similarly, during the preparatory phase the necessary materials were sourced and field data gathering tools generated in agreement to attribute information highlighted by client. The data collection instrument (questionnaire) as annexed was programmed to a mobile tool and used in final data collection process. Initial data collected by client was requested in order to incorporate it in the final findings.

### 3.3. Data Collection Instrument (Questionnaires)

In order to achieve the entire project's objective on geographic information system (GIS) mapping of project site and development of watershed hydrological maps showing hotspots and areas of intervention, the following instruments were developed.

- Data collection on Locality of prospective buyers (Utilities, Commercial entities and Community projects) in addition to tributaries within each river.
- Hotspots and user groups' activities

### 3.4. Data collection Instrument (Mobile data collection Kit )

The above instruments were programmed in order to be used on a smartphone and be able to utilize features on a mobile phone like camera, WIFI, global position system (GPS) and open data kit (ODK) among other features.

Why did we decide to use mobile phone in comparison with traditional paper questionnaire?

- Mobile data collection provide data in a real time manner
- Mobile data collection include multi-attribute data and description

- Data collected via mobile is easier to share with partner and stakeholders
- Mobile data collection eliminate data entry as is done in traditional data collection using paper work
- Data collecting using mobile phone has a multi data storage i.e offline and online
- Enable tracking of error easily as data can be monitored by relevant data consumers
- It is easier to visualize your data on a map and follow an event
- Collect form data with GPS coordinates, and view your field data collection activities on a map, for real-time tracking.
- Mobile data can be collected in offline mode and later be synchronized or submitted when an open internet connection is available thus promoting data dissemination.

After programming of a data collection instrument into a mobile phone was done as annexed, a web-based fusion table based on a cloud which utilizes google resources was setup. The data collecting mobile phones are then configured and loaded with questionnaire. Testing is also done in order to access the performance of the tool against the expected indicators and if there is any gap, refining of the tool is done prior to the actual mobile data collection.

#### **3.4.1. Training Manual for Mobile Data collection Kit**

In order for the data collection using smartphone to be easier now and in future, a step by step manual is compiled for both beginners and advance users as annexed. The manual covers the following crucial areas:- external and internal features of a smartphone, how to adjust, enable and disable the mapping features, about installation of open data kit, how to configure your mobile phone to communicate with web-based crowd server, getting blank form for data entries, editing data in a record, how to save collected data and submit to a cloud server.

### **3.5. DATA COLLECTION**

The smart phone mobile tool was utilized to enable collecting of data as structured inform of a questionnaire. The tool managed to capture prospective buyers who's their locality is at downstream. These buyers were identified in three categories viz community projects, utilities and commercial entities. During data collection processes data was collected, saved and submitted on a web-based cloud server where the data was later downloaded for analysis.

During data collection, we also utilized geographic information system (GIS) tool like google globe, The WebGL Globe for visualizing geographic data and identification of river tributaries, Arc Scene, Quantum Geographic Information System (QGIS) for spatial analysis.

## 4 KEY FINDINGS

### 4.1 Summaries of Results, Analyses and deliverable

During this PWES baseline survey conducted for a period of two weeks, with utilization of a number of human labor who were equipped with a smartphone PWES tool, a total of eighty one abstraction points were gathered across different rivers, streams and tributaries, uploaded to a web-based fusion table of cloud server, downloaded for statistical and spatial analysis in order to draw a clearer intervention in payment of water ecosystem service in Kikuyu escarpment forest.

This survey is aimed at identifying key potential buyers in the ecosystem like utilities or water service providers, owners of community water projects and commercial entities like factories, learning institutions, farms estates and industries; development of a watershed hydrological map equipped with hotspots and areas of intervention for the project.

During Spatial data analysis tools like Quantum GIS (QGIS), Google Earth and ArcGIS were used to analyse the collected data after downloading from the server.

Absolute totals, percentages and correlations area analyzed using pivot tables and bar / pie charts in excel and SPSS

## 4.2 Sample plates of water abstraction point



Plate 1 Water abstraction by Gatundu Water and Sewerage company at River Theta



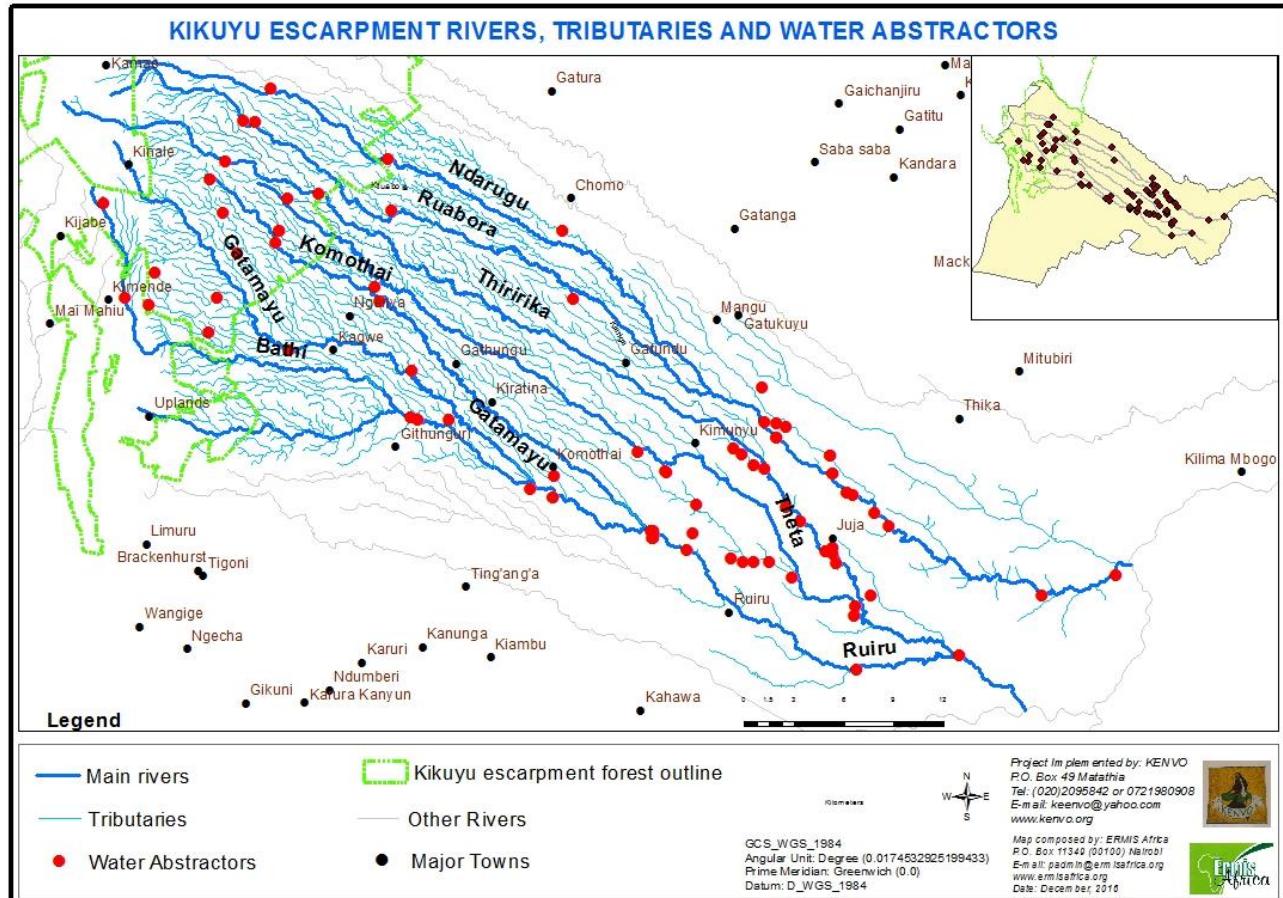
Plate 2 Water abstraction at Bathi River



Plate 3 Water abstraction at Ndarugu River

#### 4.3 Spatial View Distribution of Potential Buyers in the catchments

The spatial analysis tool achieved and distributed a total of sixty probable buyers in Kikuyu forest escarpment catchment see map ii.



Map ii Spatial view of Rivers, Tributaries and abstractors in Kikuyu Escarpment forest

**Table ii percentage of water abstractors in the major rivers**

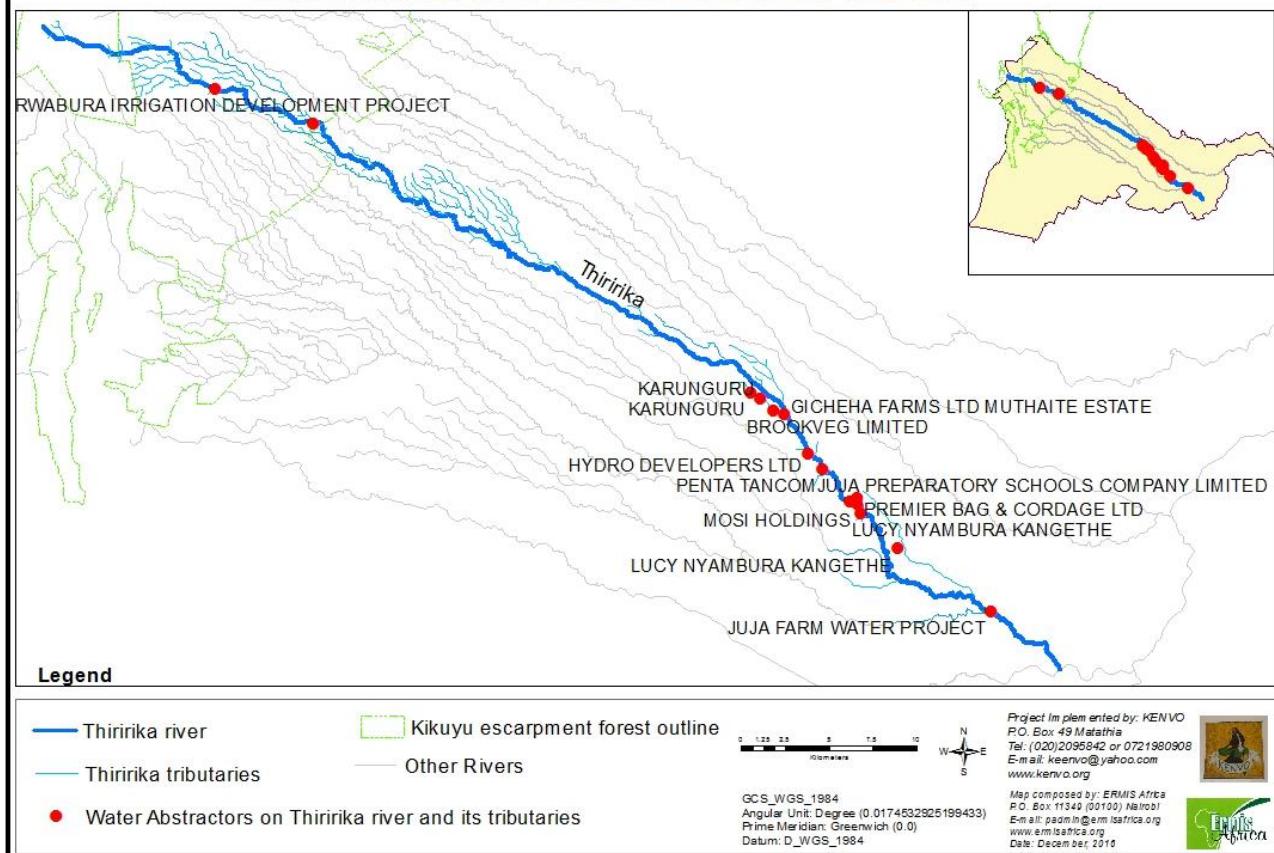
River name	Percentage (%)	
• Thiririka	17.28	14
• Ruiru	14.81	12
• Ndarugu	13.58	11
• Theta	9.87	8
• Gatamayiu	3.7	3
• Bathi	2.47	2
• Ruabora	3.7	3

#### 4.4 Major Rivers, Tributaries and Water Abstractors

All the water abstractors who are referred as potential buyers were overlayed on individual major rivers like Thiririka, Ruiru, Ndarugu, Ruabora, Gatamayiu, Bathi and Theta and shaped a number of different maps see map iii to map ix.

##### ***1.1.1.1 Spatial View of Thiririka River, Tributaries and Water Abstractors***

### THIRIRIKA RIVER; TRIBUTARIES AND WATER ABSTRACTORS



Map iii Distribution of Potential buyers along Thiririka River and its tributaries

During our mapping and spatial analysis, Thiririka which is one of the major highlighted rivers in the catchment attained 26% percent of the total number of water abstractors from major rivers in the catchment see figure ii.

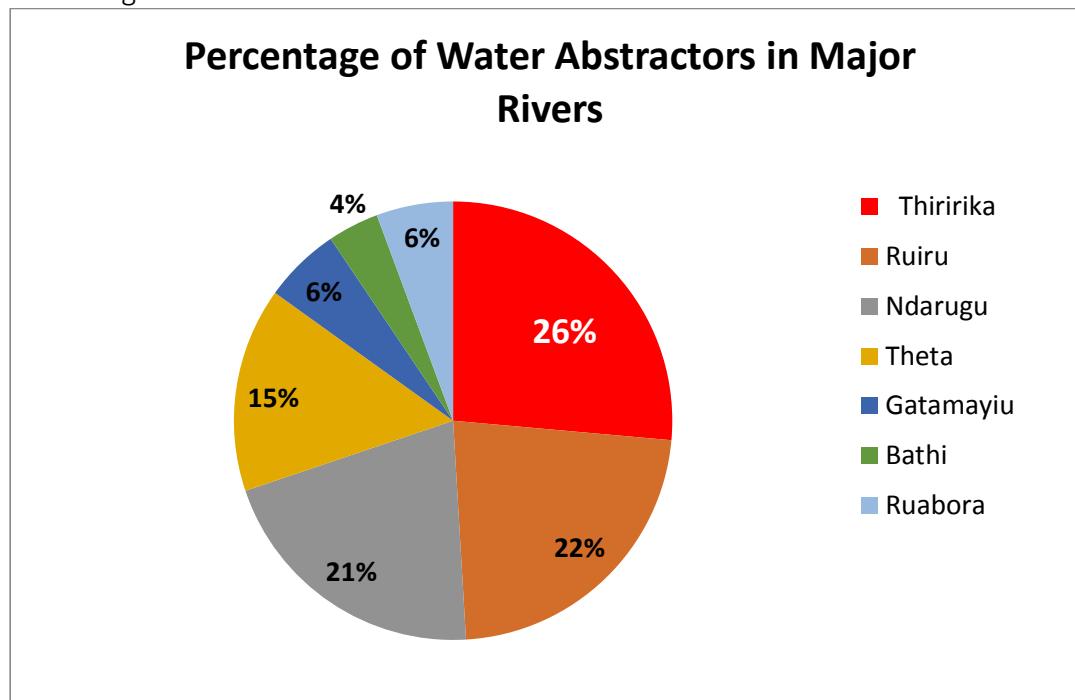


Figure i Percentage of water abstractors in the major rivers

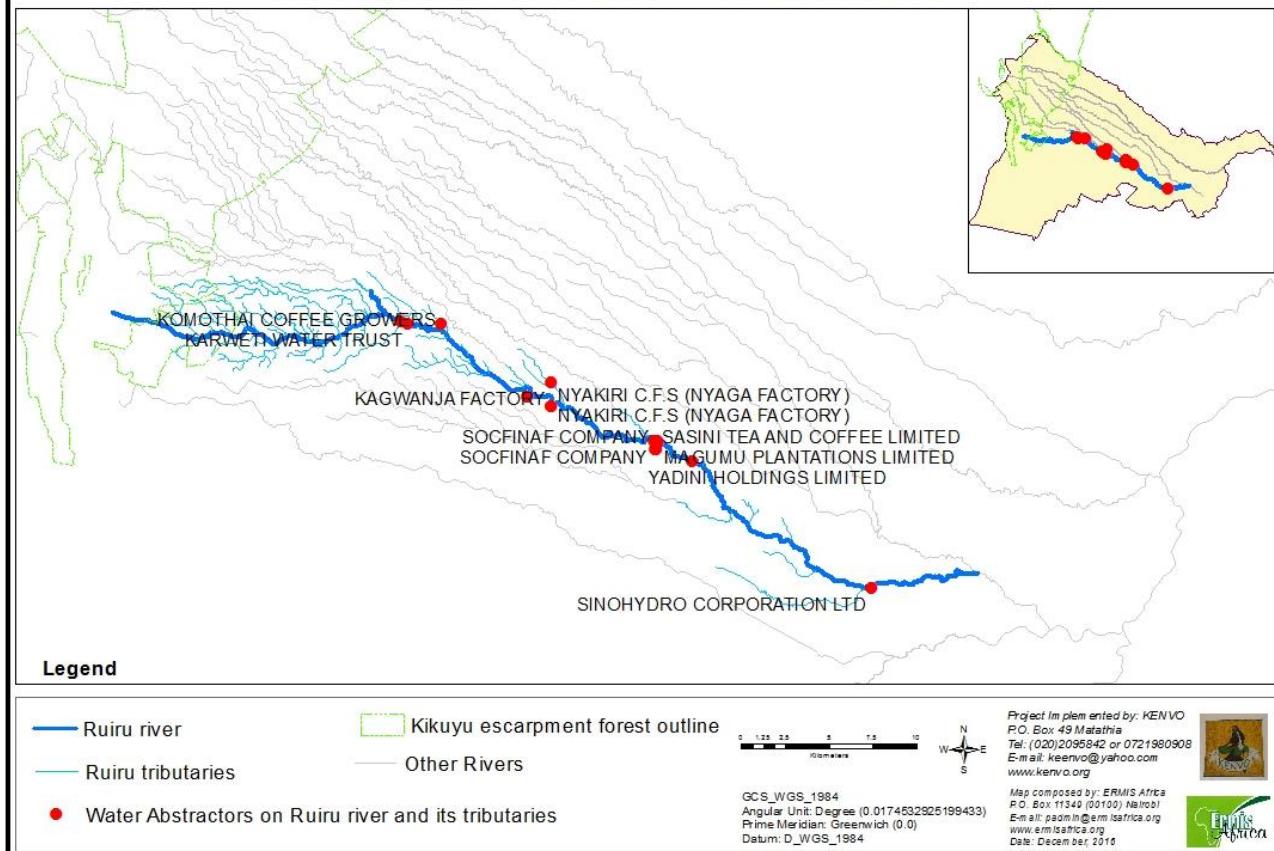
See the table below gives summaries of water uses by various abstractors along Thiririka River and its tributaries

**Table iii Water uses by water abstractors from Thiririka River**

Abstractor name	Water uses
KARUNGURU	Water for domestic, pulping of coffee, irrigation
GATUNDU WATER AND SANITATION COMPANY	Water for public use
HYDRO DEVELOPERS LTD	Water for construction
JUJA FARM WATER PROJECT	Water for public use
JUJA PREPARATORY SCHOOLS COMPANY LIMITED	Water for irrigation, livestock and fish pond
KARUNGURU	Commercial irrigation
LUCY NYAMBURA KANGETHE	Public use
LUCY NYAMBURA KANGETHE	Water for subsistence irrigation
MOSI HOLDINGS	Commercial use
PENTA TANCOM	Water for domestic & commercial irrigation
PREMIER BAG & CORDAGE LTD	Domestic use
RWABURA IRRIGATION DEVELOPMENT PROJECT	Commercial irrigation
GATUNDU WATER AND SANITATION COMPANY	Public use
GICHEHA FARMS LTD MUTHAITE ESTATE	Commercial coffee farming, washing & pulping

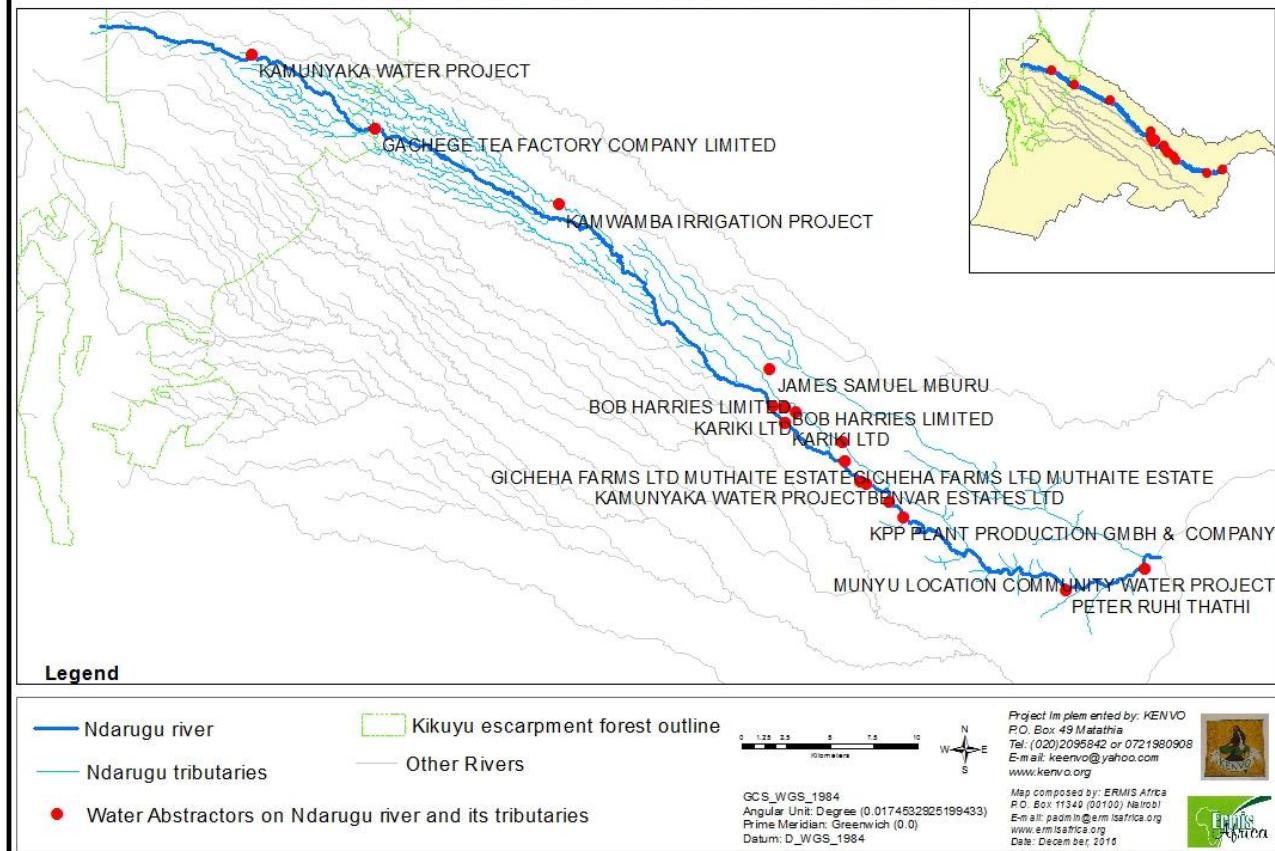
#### **1.1.1.2 Spatial View of Ruiru River, Tributaries and Water Abstractors**

### RUIRU RIVER; TRIBUTARIES AND WATER ABSTRACTORS



#### 1.1.1.3 Spatial View of Ndarugu River, Tributaries and Water Abstractors

## NDARUGU RIVER; TRIBUTARIES AND WATER ABSTRACTORS



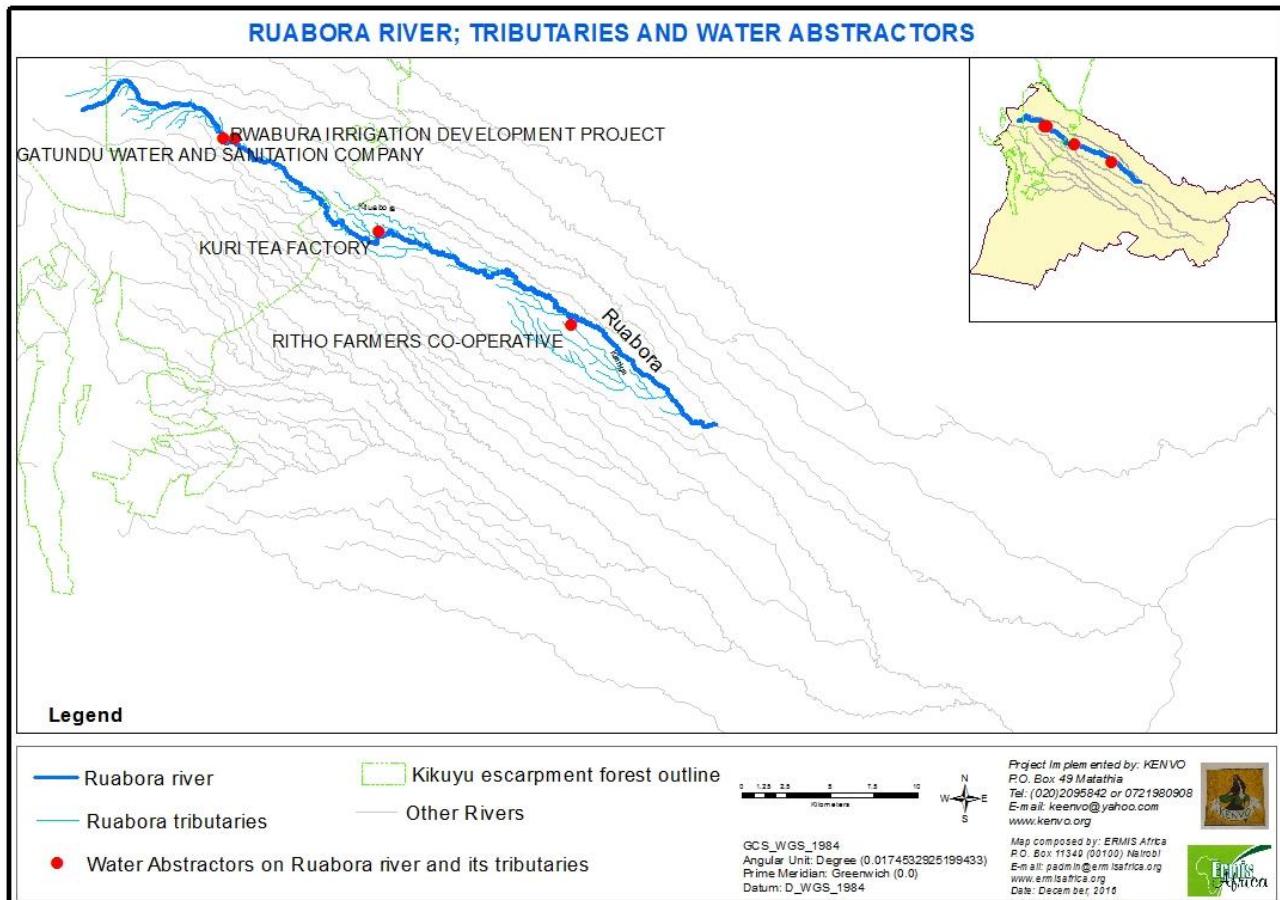
**Map v Distribution of Potential buyers along Ndarugu River and its tributaries**

See the table below gives summaries of water uses by various abstractors along Ndarugu River and its tributaries

**Table v Water uses by water abstractors from Ndarugu River**

Abstractor name	Water uses
BOB HARRIES LIMITED	domestic and commercial irrigation
GACHEGE TEA FACTORY COMPANY LIMITED	water for domestic & commercial irrigation
GICHEHA FARMS LTD MUTHAITE ESTATE	commercial irrigation
GICHEHA FARMS LTD MUTHAITE ESTATE	commercial irrigation
JOMO KENYATTA UNIVERSITY OF AGRICULTURE & TECHNOLOGY	water for domestic use
KARIKI LTD	commercial irrigation
KPP PLANT PRODUCTION GMBH & COMPANY	commercial use
MUNYU LOCATION COMMUNITY WATER PROJECT	public use
PENTA TANCOM LTD T/A PENTA FLOWERS (NDARUGU FARM)	commercial irrigation
PETER RUHI THATHI	commercial irrigation
BENVAR ESTATES LTD	commercial irrigation

#### 1.1.1.4 Spatial View of Ruabora River, Tributaries and Water Abstractors



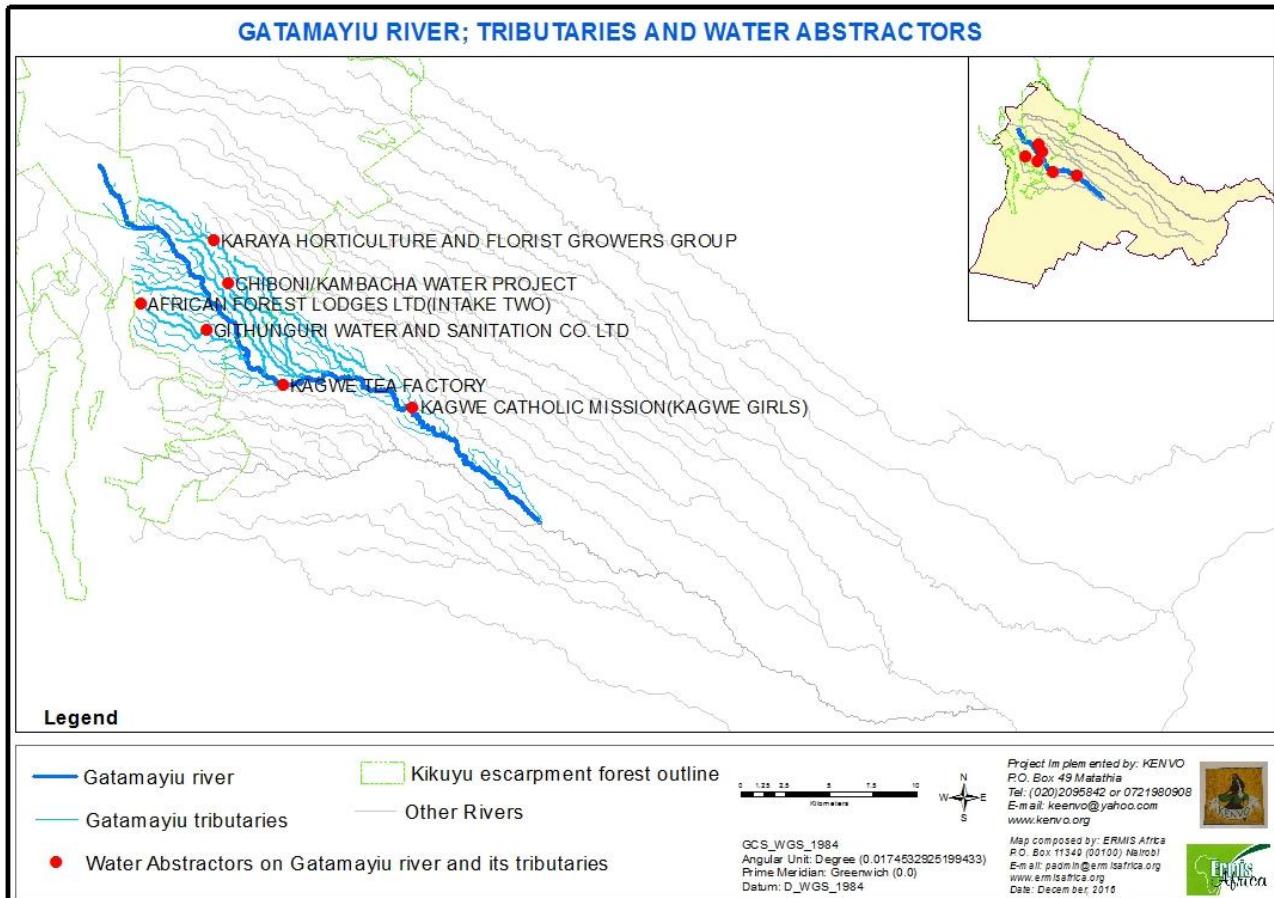
Map vi Distribution of Potential buyers along Ruabora River and its tributaries

See the table below gives summaries of water uses by various abstractors along Ruabora River and its tributaries

Table vi Water uses by water abstractors from Ruabora River

Abstractor name	Water uses
GATUNDU WATER AND SANITATION COMPANY	water public water supply
KURI TEA FACTORY	domestic and industrial
RITHO FARMERS CO-OPERATIVE	industry and commercial use

### 1.1.1.5 Spatial View of Gatamaiyu River, Tributaries and Water Abstractors



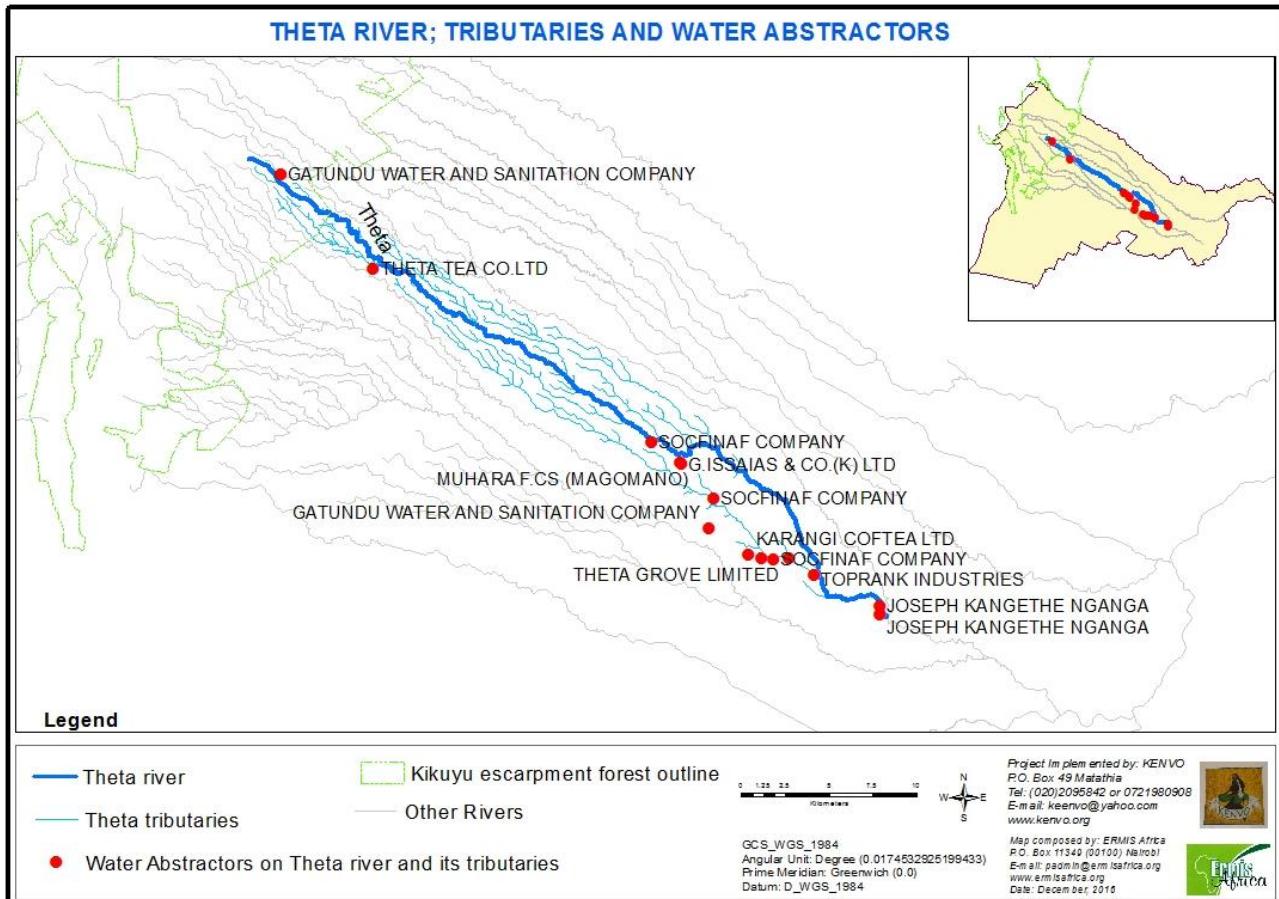
**Map vii Distribution of Potential buyers along Gatamaiyu River and its tributaries**

See the table below gives summaries of water uses by various abstractors along Gatamaiyu River and its tributaries

**Table vii Water uses by water abstractors from Gatamaiyu River**

Abstractor name	Water uses
GITHUNGURI WATER AND SANITATION CO. LTD	diversion by dam, pump and pipeline for public use
KAGWE CATHOLIC MISSION(KAGWE GIRLS)	institutional water abstraction for domestic purpose
KAGWE TEA FACTORY	domestic and industrial

#### 1.1.1.6 Spatial View of Theta River, Tributaries and Water Abstractors



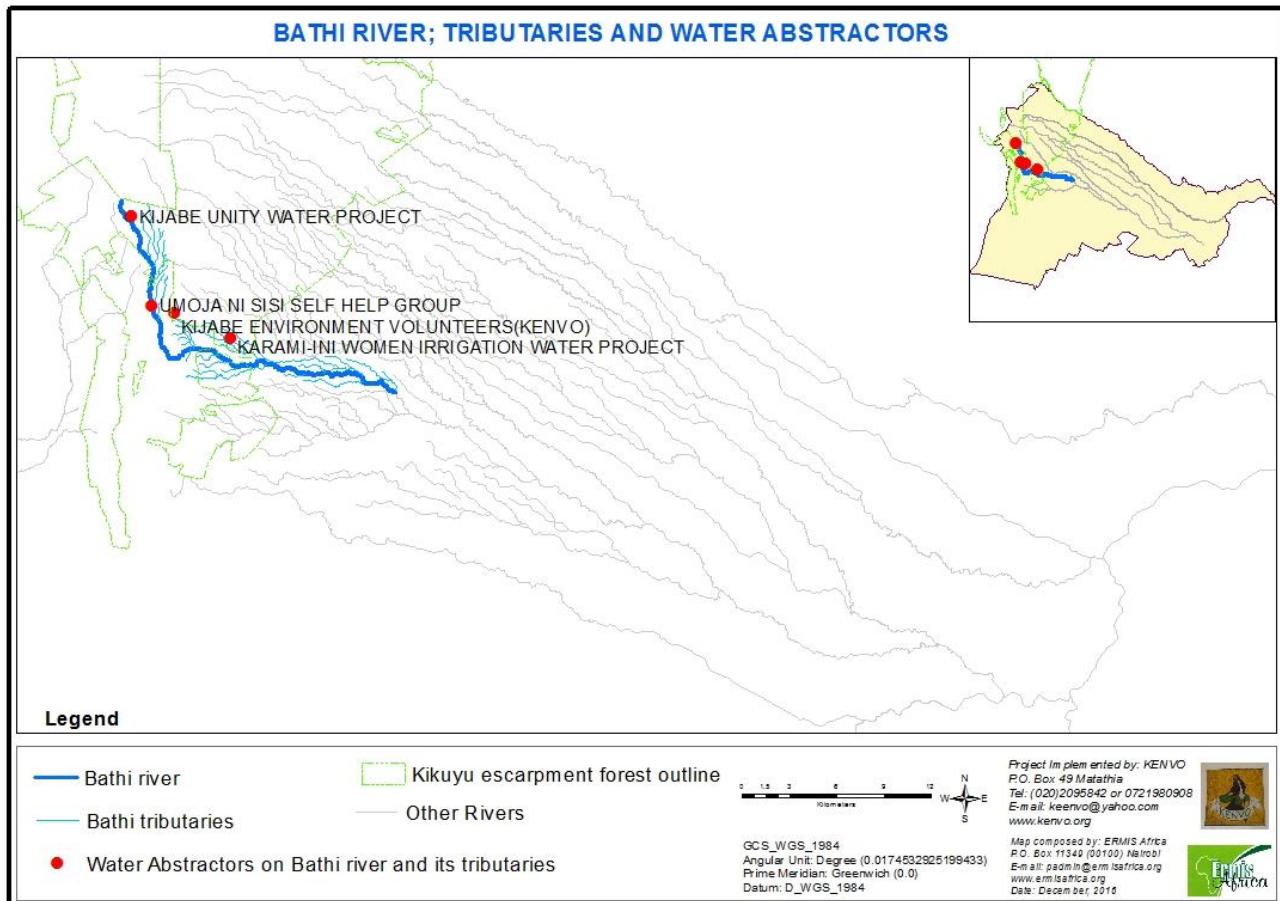
Map viii Distribution of Potential buyers along Theta River and its tributaries

See the table below gives summaries of water uses by various abstractors along Theta River and its tributaries

Table viii Water uses by water abstractors from Theta River

Abstractor name	Water uses
SOCFINAF COMPANY	domestic and irrigation
AQUAPONICS KENYA LIMITED	livestock and fish rearing
G.ISSAIAS & CO. (K) LTD	domestic use & road construction
GATUNDU WATER AND SANITATION COMPANY	dam 17 m high and gravity pipeline 3.8 km long for public use
JOSEPH KANGETHE NGANGA	public use
JOSEPH KANGETHE NGANGA	water for subsistence irrigation
THETA TEA CO.LTD	domestic and industrial
TOPRANK INDUSTRIES	water for industrial use

### 1.1.1.7 Spatial View of Bathi River, Tributaries and Water Abstractors



**Map ix Distribution of Potential buyers along Bathi River and its tributaries**

See the table below gives summaries of water uses by various abstractors along Bathi River and its tributaries

**Table ix Water uses by water abstractors from Theta River**

Abstractor name	Water uses
KIJABE UNITY WATER PROJECT	Water for domestic use
UMOJA NI SISI SELF HELP GROUP	Water for domestic use

#### 4.5 Summaries of Potential buyers per river

The water abstractors acquired during mapping of probable buyers in kikuyu forest escarpment catchment survey were drawn from all the twenty four rivers in the project area. The number of abstraction point per river derives the proportion in percentage and hierarchy view of the total number of the abstractors per river as shown in the table and chart respectively.

**Table x Proportion of abstraction points per river**

River name	Proportion (%)
• Thiririka	17.28
• Ruiru	14.81
• Ndarugu	13.58
• Theta	9.77
• Karakuta	4.94
• Komothai	3.70
• Marigoti	2.47
• Bathi	• Gatamaiyu
• Wambete	• Ruabora
• Gachie	• Ithagana
• Githobokoni	• Komo
• Kibii	• Githoito
• Nyanduma	• Kamugu
	• Kiruiru
	• Kono
	• Ngewa
	1.23

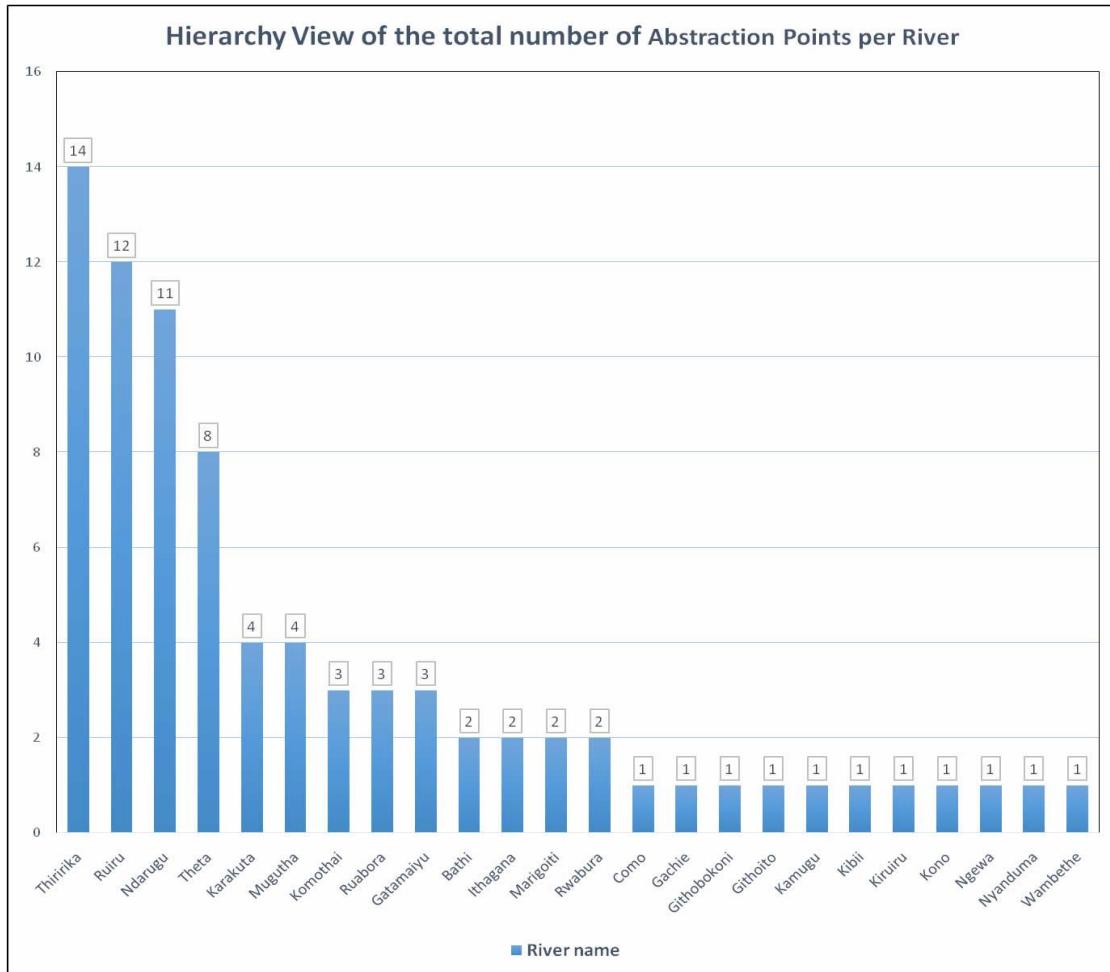


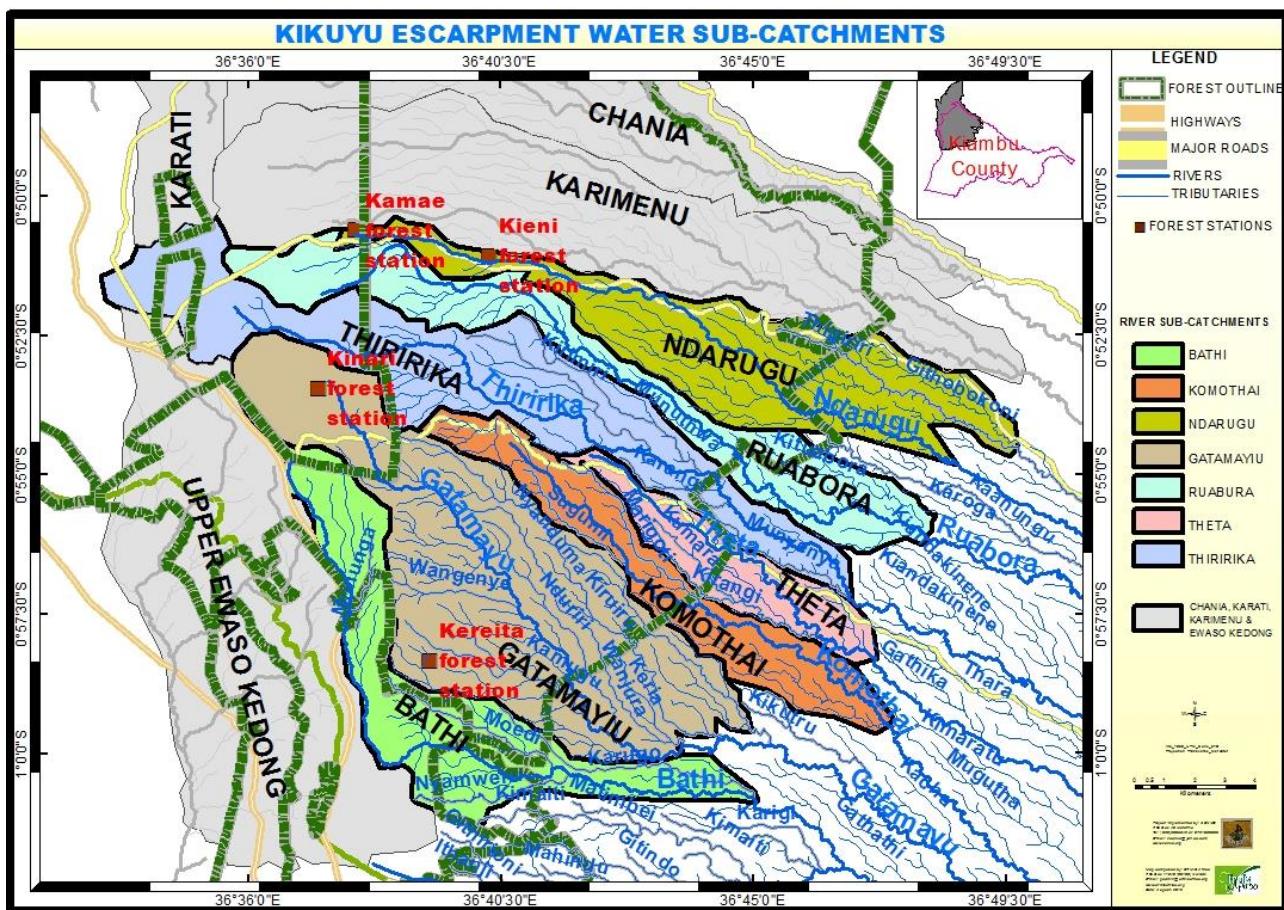
Figure ii Hierarchy view of the total number of abstraction points per river

Abstractor (Potential buyer)	Abstracted River
KARUNGURU	THIRIRIKA (LOWER PUMP)
GATUNDU WATER AND SANITATION COMPANY	THIRIRIKA
HYDRO DEVELOPERS LTD	THIRIRIKA
JUJA FARM WATER PROJECT	THIRIRIKA
JUJA PREPARATORY SCHOOLS COMPANY LIMITED	THIRIRIKA
KARUNGURU	THIRIRIKA
LUCY NYAMBURA KANGETHE	THIRIRIKA
LUCY NYAMBURA KANGETHE	THIRIRIKA
MOSI HOLDINGS	THIRIRIKA
PENTA TANCOM	THIRIRIKA
PREMIER BAG & CORDAGE LTD	THIRIRIKA
RWABURA IRRIGATION DEVELOPMENT PROJECT	THIRIRIKA
GICHEHA FARMS LTD MUTHAITE ESTATE	THIRIRIKA ( UPPER )
GITHUNGURI DAIRY FARMERS	RUIRU
MAGUMU PLANTATIONS LIMITED	RUIRU
NYAKIRI C.F.S (NYAGA FACTORY)	RUIRU

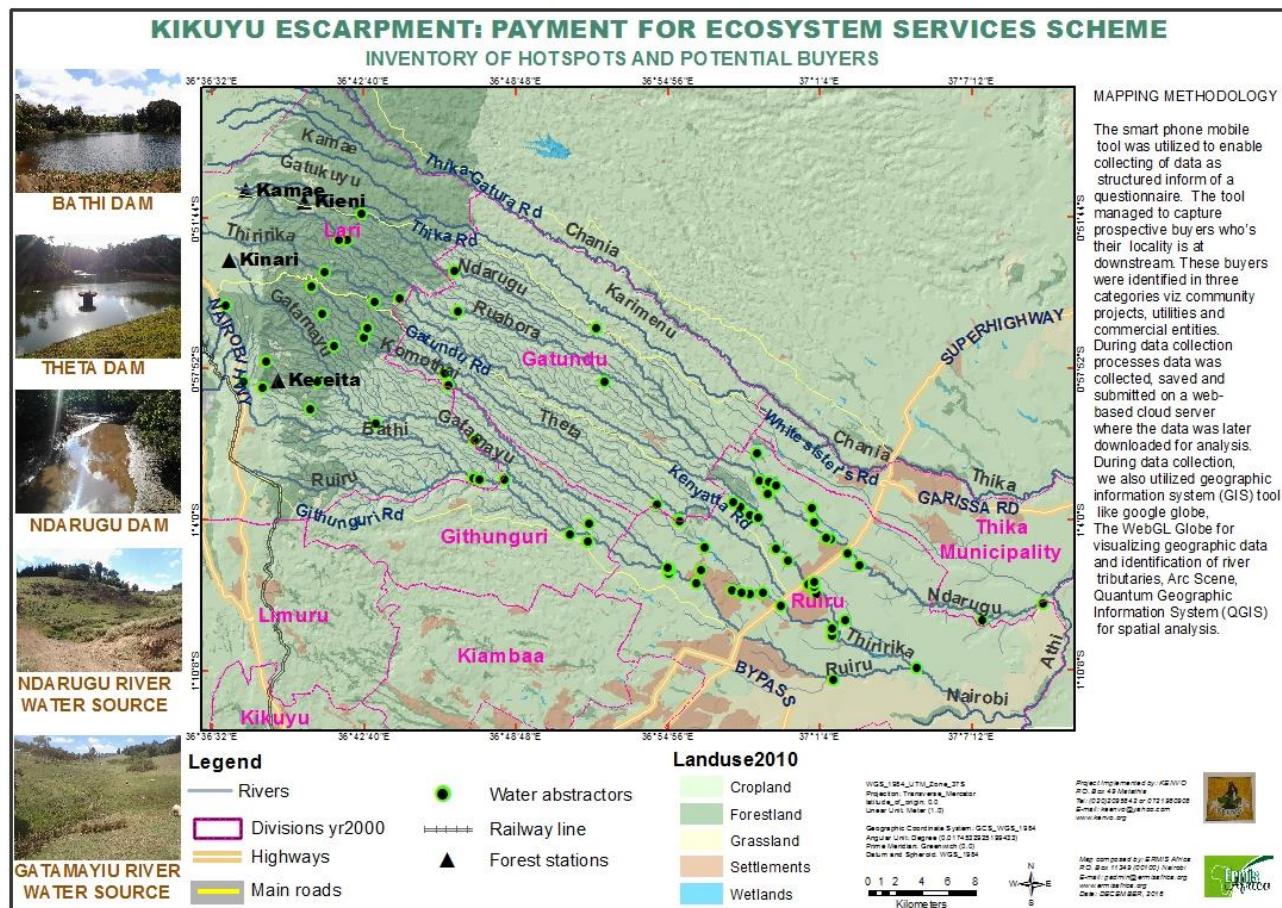
SASINI TEA AND COFFEE LIMITED	RUIRU
SASINI TEA AND COFFEE LIMITED	RUIRU
SINOHYDRO CORPORATION LTD	RUIRU
KAGWANJA FACTORY	RUIRU
KOMOTHAI COFFEE GROWERS	RUIRU
JAMES SAMUEL MBURU	RUIRU
SOCFINAF COMPANY	RUIRU
SOCFINAF COMPANY	RUIRU
YADINI HOLDINGS LIMITED	RUIRU
BOB HARRIES LIMITED	NDARAGU
GACHEGE TEA FACTORY COMPANY LIMITED	NDARUGU
JOMO KENYATTA UNIVERSITY OF AGRICULTURE & TECHNOLOGY	NDARUGU
KARIKI LTD	NDARUGU
KPP PLANT PRODUCTION GMBH & COMPANY	NDARUGU
MUNYU LOCATION COMMUNITY WATER PROJECT	NDARUGU
GICHEHA FARMS LTD MUTHAITE ESTATE	NDARUGU
GICHEHA FARMS LTD MUTHAITE ESTATE	NDARUGU
PENTA TANCOM LTD T/A PENTA FLOWERS (NDARUGU FARM)	NDARUGU
PETER RUHI THATHI	NDARUGU
BENVAR ESTATES LTD	NDARUGU (UPPER)
SOCFINAF COMPANY	THETA
G.ISSAIAS & CO. (K) LTD	THETA
GATUNDU WATER AND SANITATION COMPANY	THETA
JOSEPH KANGETHE NGANGA	THETA
JOSEPH KANGETHE NGANGA	THETA
THETA TEA CO.LTD	THETA
TOPRANK INDUSTRIES	THETA
AQUAPONICS KENYA LIMITED	THETA TWIGA DAM
BOB HARRIES LIMITED	KARAKUTA
BENVAR ESTATES LTD	KARAKUTA RIVER (MIRURI DAM)
BENVAR ESTATES LTD	KARAKUTA TRIB OF NDARUGU (WANJIRU DAM)
KARIKI LTD	KARUKUTA RIVER(KARAMAINI DAM)
KARANGI COFTEA LTD	MUGUTHA
SOCFINAF COMPANY	MUGUTHA
SOCFINAF COMPANY	MUGUTHA
THETA GROVE LIMITED	MUGUTHA
KAMUKA FARMERS WATER PROJECT	KOMOTHAI
KARIGUINI S.H.G WATER PROJECT	KOMOTHAI
KIAMERU KIRATINA KOMOTHAI WATER PROJECT	KOMOTHAI
GATUNDU WATER AND SANITATION COMPANY	RUABORA
KURI TEA FACTORY	RUABORA
RITHO FARMERS CO-OPERATIVE	RUABORA
KAGWE CATHOLIC MISSION (KAGWE GIRLS)	GATAMAIYU
GITHUNGURI WATER AND SANITATION CO. LTD	GATAMAIYU

KAGWE TEA FACTORY	GATAMAIYU
KIJABE UNITY WATER PROJECT	BATHI
UMOJA NI SISI SELF HELP GROUP	BATHI
MUHARA F.CS (MAGOMANO)	RWABURA
RWABURA IRRIGATION DEVELOPMENT PROJECT	RWABURA
MAGAWA IRRIGATION WATER PROJECT	MARIGOITI
MAGAWA IRRIGATION WATER PROJECT	MARIGOITI
KAMUNYAKA WATER PROJECT	ITHAGANA
KAMUNYAKA WATER PROJECT	ITHAGANA
JAMES SAMUEL MBURU	COMO
KARWETI WATER TRUST	GACHIE STREAM TRIBUTARY OF RUIRU
KAMWAMBA IRRIGATION PROJECT	GITHOBOKONI RIVER
KIJABE ENVIRONMENT VOLUNTEERS (KENVO)	GITHOITO
AFRICAN FOREST LODGES LTD (INTAKE TWO)	KAMUGU
BROOKVEG LIMITED	KIBII TRIBUTARY OF THIRIRIKA
KARAYA HORTICULTURE AND FLORIST GROWERS GROUP	KIRUIRU
A.I.R HARRIES AND SONS LTD	KONO
NYAKIRI C.F.S (NYAGA FACTORY)	NGEWA
CHIBONI / KAMBACHA WATER PROJECT	NYANDUMA OF KIRUIRU
KARAMI-INI WOMEN IRRIGATION WATER PROJECT	WAMBETHE SPRING TRIBUTARY OF BATHI

### 1.1.2 Watershed hydrological map



### 1.1.3 Inventory of hotspots and potential buyers



## 5 Appendices

### 5.1 Questionnaire

#### Survey Recording Form on Locality of Prospective Buyers

---

1. Entry Date \_\_\_\_ / \_\_\_\_ / \_\_\_\_

2. Location name.....

3. Name of water abstractor

.....

4. Photo of abstraction point.....

5. Source of water

River

Dam

Other

6. Other specify.....

7. River name.....

8. Name of Dam.....

a. Tributary name.....

b. Tributary name.....

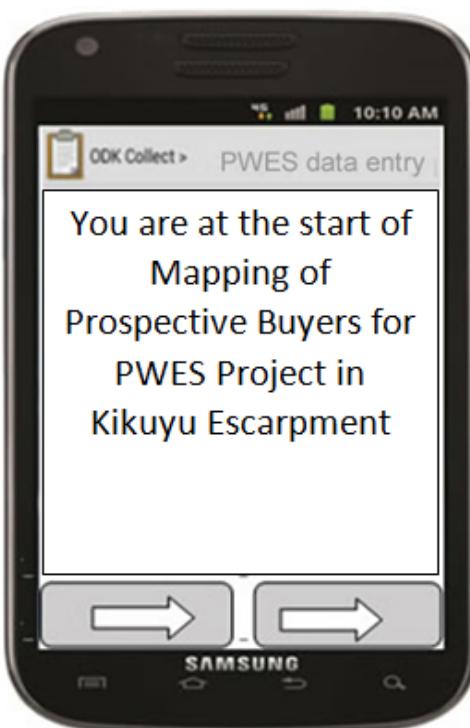
c. Tributary name.....

d. Tributary name.....

e. Tributary name.....

## 5.2 Mobile Data collection tool Kit

Mobile tool for data collection on Locality of Prospective Buyers



OOK Collect > PWES data entry

Source of water

River  
 Dam  
 Other



OOK Collect > PWES data entry

Other Specify

If selected river, Enter its name



OOK Collect > PWES data entry

If selected Dam, Enter its name

Enter River and tributaries that feed the dam



OOK Collect > PWES data entry

Additional Information



### 5.3 PWES Questionnaire

1. General Questions	
Code	
	Entry date.....
	Name of Potential (entity) buyer.....
	Interviewee Name.....
	Interviewee Phone.....
	Position Held / title.....
	GPS.....
	Photo.....
	Village / Area .....
	Sub-location.....
	Ward.....
	Sub-County.....
	Ward.....
2. Community Water Projects	
	Name of Project.....
	Date of construction / Rehabilitation.....
	<p>Who Manages?</p> <p><input type="checkbox"/> Community Group <input type="checkbox"/> Government <input type="checkbox"/> Partners <input type="checkbox"/> Other</p> <p>Specify other.....</p>
	<p>Water Sources</p> <p><input type="checkbox"/> River <input type="checkbox"/> Borehole <input type="checkbox"/> Dam <input type="checkbox"/> Other</p> <p>Specify other.....</p>
	<ul style="list-style-type: none"> <li>• Name of river.....</li> <li>• Annual proportion (specify % tage from river) .....</li> <li>• Water quantitative in field assessment  <input type="checkbox"/> Safe <input type="checkbox"/> unsafe</li> <li>• Water qualitative in field assessment  <input type="checkbox"/> crisp and clear <input type="checkbox"/> Colored (e.g whitish/ Brown, Green) <input type="checkbox"/> Salty <input type="checkbox"/> Fluoride (e.g Brown teeth)</li> </ul> <p>• Name of Borehole.....</p> <p>• Annual proportion (specify % tage from borehole) .....</p> <ul style="list-style-type: none"> <li>• Water quantitative in field assessment  <input type="checkbox"/> Safe <input type="checkbox"/> unsafe</li> </ul>

	<ul style="list-style-type: none"> <li>• Water qualitative in field assessment</li> </ul> <p><input type="checkbox"/> crisp and clear <input type="checkbox"/> Colored (e.g whitish/ Brown, Green) <input type="checkbox"/> Salty <input type="checkbox"/> Fluoride (e.g Brown teeth)</p> <ul style="list-style-type: none"> <li>• Name of Dam.....</li> <li>• Annual proportion (specify % tage from dam) .....</li> <li>• Water quantitative in field assessment</li> </ul> <p><input type="checkbox"/> Safe <input type="checkbox"/> unsafe</p> <ul style="list-style-type: none"> <li>• Water qualitative in field assessment</li> </ul> <p><input type="checkbox"/> crisp and clear <input type="checkbox"/> Colored (e.g whitish/ Brown, Green) <input type="checkbox"/> Salty <input type="checkbox"/> Fluoride (e.g Brown teeth)</p> <ul style="list-style-type: none"> <li>• Name of other specified.....</li> <li>• Annual proportion (specify % tage from other specified).....</li> <li>• Water quantitative in field assessment</li> </ul> <p><input type="checkbox"/> Safe <input type="checkbox"/> unsafe</p> <ul style="list-style-type: none"> <li>• Water qualitative in field assessment</li> </ul> <p><input type="checkbox"/> crisp and clear <input type="checkbox"/> Colored (e.g whitish/ Brown, Green) <input type="checkbox"/> Salty <input type="checkbox"/> Fluoride (e.g Brown teeth)</p>
	<ul style="list-style-type: none"> <li>• Extraction capacity per month in M<sup>3</sup></li> </ul>
	<ul style="list-style-type: none"> <li>• Treatment facilities in place <input type="checkbox"/> Yes <input type="checkbox"/> No</li> <li>• If Yes, indicate the monthly cost</li> <li>• The Average monthly Cost of Operation and Maintenance (O&amp;M) for the last 3 years ..... in (KES)</li> </ul>
	<ul style="list-style-type: none"> <li>• Who provide funds for maintenance?</li> </ul> <p><input type="checkbox"/> Self (Community) <input type="checkbox"/> Partners <input type="checkbox"/> Beneficiaries <input type="checkbox"/> None <input type="checkbox"/> Other</p> <ul style="list-style-type: none"> <li>• Specify other.....</li> </ul>
	<ul style="list-style-type: none"> <li>• What is water used for and how many users per category</li> </ul> <p><input type="checkbox"/> Household .....</p> <p><input type="checkbox"/> Social amenities (Schools) .....</p> <p><input type="checkbox"/> Public /Private amenities .....</p> <p><input type="checkbox"/> Firms / Factory.....</p> <p><input type="checkbox"/> Other.....</p> <p>Other specify.....</p>
	<ul style="list-style-type: none"> <li>• Which months do you experience Highest water Level.....</li> <li>• Which months do you experience Lowest water Level.....</li> </ul>
	<ul style="list-style-type: none"> <li>• Is the supply or continued existence of the resources/ water secure? <input type="checkbox"/> Yes <input type="checkbox"/> No</li> <li>• If yes give details.....</li> </ul>
<p>3. Commercial Entities ( tea, coffee estate and factories, industries, learning institutions)</p> <ul style="list-style-type: none"> <li>• Water Sources <input type="checkbox"/> River <input type="checkbox"/> Borehole <input type="checkbox"/> Dam <input type="checkbox"/> Other</li> </ul>	

	<ul style="list-style-type: none"> <li>• Specify other.....</li> </ul>
	<ul style="list-style-type: none"> <li>• Name of river.....</li> <li>• Annual proportion (specify % tage from river) .....</li> <li>• Water quantitative in field assessment  <input type="checkbox"/> Safe <input type="checkbox"/> unsafe           </li> <li>• Water qualitative in field assessment  <input type="checkbox"/> crisp and clear <input type="checkbox"/> Colored (e.g whitish/ Brown, Green)<input type="checkbox"/>Salty <input type="checkbox"/> Fluoride (e.g Brown teeth)           </li> </ul>
	<ul style="list-style-type: none"> <li>• Name of Borehole.....</li> <li>• Annual proportion (specify % tage from borehole) .....</li> <li>• Water quantitative in field assessment  <input type="checkbox"/> Safe <input type="checkbox"/> unsafe           </li> <li>• Water qualitative in field assessment  <input type="checkbox"/> crisp and clear <input type="checkbox"/> Colored (e.g whitish/ Brown, Green)<input type="checkbox"/>Salty <input type="checkbox"/> Fluoride (e.g Brown teeth)           </li> </ul>
	<ul style="list-style-type: none"> <li>• Name of Dam.....</li> <li>• Annual proportion (specify % tage from dam) .....</li> <li>• Water quantitative in field assessment  <input type="checkbox"/> Safe <input type="checkbox"/> unsafe           </li> <li>• Water qualitative in field assessment  <input type="checkbox"/> crisp and clear <input type="checkbox"/> Colored (e.g whitish/ Brown, Green)<input type="checkbox"/>Salty <input type="checkbox"/> Fluoride (e.g Brown teeth)           </li> </ul>
	<ul style="list-style-type: none"> <li>• Name of other specified.....</li> <li>• Annual proportion (specify % tage from other specified).....</li> <li>• Water quantitative in field assessment  <input type="checkbox"/> Safe <input type="checkbox"/> unsafe           </li> <li>• Water qualitative in field assessment  <input type="checkbox"/> crisp and clear <input type="checkbox"/> Colored (e.g whitish/ Brown, Green)<input type="checkbox"/>Salty <input type="checkbox"/> Fluoride (e.g Brown teeth)           </li> </ul>
	<ul style="list-style-type: none"> <li>• Extraction capacity per month in M<sup>3</sup>.....</li> </ul>
	<ul style="list-style-type: none"> <li>• Is your water metered? <input type="checkbox"/> Yes <input type="checkbox"/> No</li> </ul>
	<ul style="list-style-type: none"> <li>• Average water used per month.....(Units in Litres or M3 )</li> </ul>
	<ul style="list-style-type: none"> <li>• Which month do you experience Highest water level at source.....</li> <li>• Which month do you experience Lowest water level at source.....</li> </ul>
	<ul style="list-style-type: none"> <li>• Do you have regular supply <input type="checkbox"/> Yes <input type="checkbox"/> No</li> <li>• If no, which months.....</li> </ul>
	<ul style="list-style-type: none"> <li>• Specify the reasons for irregular water supply.....</li> </ul>
	<ul style="list-style-type: none"> <li>• Is the supply or continued existence of the resources / water secure<input type="checkbox"/> Yes <input type="checkbox"/> No</li> </ul>

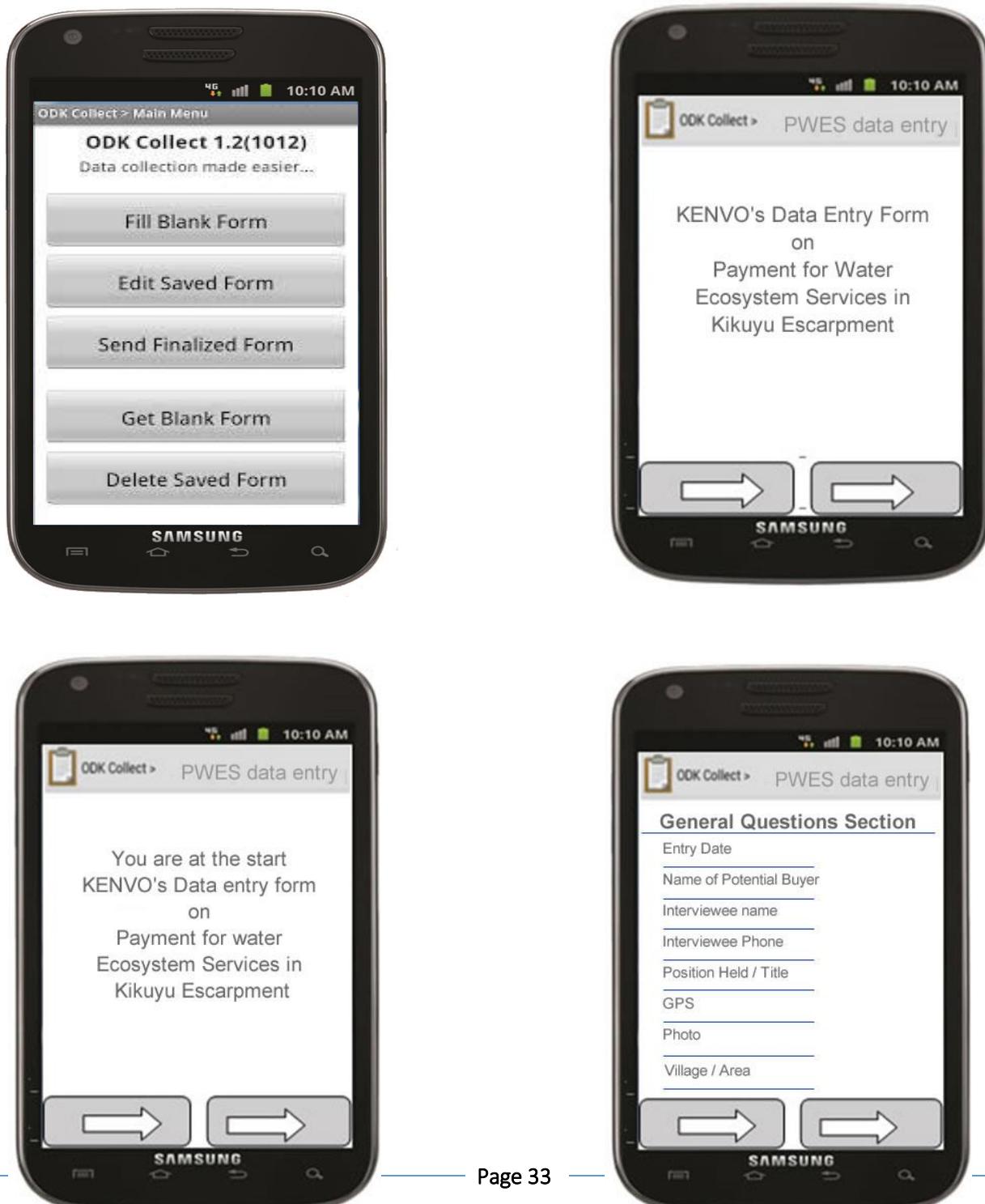
	<ul style="list-style-type: none"> <li>• If yes give details.....</li> </ul>
	<ul style="list-style-type: none"> <li>• Do you have any Corporate Social responsibility <input type="checkbox"/> Yes <input type="checkbox"/> No</li> <li>• If yes, List them.....and specify cost.....</li> </ul>
	<ul style="list-style-type: none"> <li>• How do you think environmental services (water flow, quantity and quality) can be enhanced? .....</li> </ul>
	<ul style="list-style-type: none"> <li>• Are you involved in conservation protection activities of the resource<input type="checkbox"/> Yes <input type="checkbox"/> No</li> <li>• If yes, which.....</li> </ul>
	<ul style="list-style-type: none"> <li>• How much do you put back to conservation or maintenance source at the upstream.....and who is involved.....</li> </ul>
	<ul style="list-style-type: none"> <li>• Are there agreement with those involved<input type="checkbox"/> Yes <input type="checkbox"/> No</li> </ul>
<b>4. UTILITIES ( Water Service Provider )</b>	
	<ul style="list-style-type: none"> <li>• Water Sources<input type="checkbox"/> River <input type="checkbox"/> Borehole <input type="checkbox"/> Dam <input type="checkbox"/> Other</li> <li>• Specify other.....</li> </ul>
	<ul style="list-style-type: none"> <li>• Name of river.....% of total water supply .....</li> <li>• Water quantitative in field assessment <ul style="list-style-type: none"> <li><input type="checkbox"/> Safe <input type="checkbox"/> unsafe</li> </ul> </li> <li>• Water qualitatitve in field assessment <ul style="list-style-type: none"> <li>• <input type="checkbox"/> crisp and clear <input type="checkbox"/> Colored (e.g whitish/ Brown,Green)<input type="checkbox"/> Salty<input type="checkbox"/> Fluoride (e.g Brown teeth)</li> </ul> </li> <li>• Name of river.....% of total water supply .....</li> <li>• Water quantitative in field assessment <ul style="list-style-type: none"> <li><input type="checkbox"/> Safe <input type="checkbox"/> unsafe</li> </ul> </li> <li>• Water qualitatitve in field assessment <ul style="list-style-type: none"> <li><input type="checkbox"/> crisp and clear <input type="checkbox"/> Colored (e.g whitish/ Brown,Green)<input type="checkbox"/> Salty<input type="checkbox"/> Fluoride (e.g Brown teeth)</li> </ul> </li> <li>• Name of river.....% of total water supply .....</li> <li>• Water quantitative in field assessment <ul style="list-style-type: none"> <li><input type="checkbox"/> Safe <input type="checkbox"/> unsafe</li> </ul> </li> <li>• Water qualitatitve in field assessment <ul style="list-style-type: none"> <li><input type="checkbox"/> crisp and clear <input type="checkbox"/> Colored (e.g whitish/ Brown,Green)<input type="checkbox"/> Salty<input type="checkbox"/> Fluoride (e.g Brown teeth)</li> </ul> </li> <li>• Name of river.....% of total water supply .....</li> <li>• Water quantitative in field assessment <ul style="list-style-type: none"> <li><input type="checkbox"/> Safe <input type="checkbox"/> unsafe</li> </ul> </li> <li>• Water qualitatitve in field assessment</li> </ul>

	<p><input type="checkbox"/> crisp and clear <input type="checkbox"/> Colored (e.g whitish/ Brown,Green) <input type="checkbox"/> Salty <input type="checkbox"/> Fluoride (e.g Brown teeth)</p> <ul style="list-style-type: none"> <li>● Name of river.....% of total water supply .....</li> <li>● Water quantitative in field assessment <input type="checkbox"/> Safe <input type="checkbox"/> unsafe</li> <li>● Water qualitatitve in field assessment <input type="checkbox"/> crisp and clear <input type="checkbox"/> Colored (e.g whitish/ Brown,Green) <input type="checkbox"/> Salty <input type="checkbox"/> Fluoride (e.g Brown teeth)</li> </ul>
	<ul style="list-style-type: none"> <li>● Name of borehole.....% of total water supply .....</li> <li>● Name of borehole.....% of total water supply .....</li> <li>● Name of borehole.....% of total water supply .....</li> <li>● Name of borehole.....% of total water supply .....</li> <li>● Name of borehole.....% of total water supply .....</li> </ul>
	<ul style="list-style-type: none"> <li>● Name of dam.....% of total water supply .....</li> <li>● Name of dam.....% of total water supply .....</li> <li>● Name of dam.....% of total water supply .....</li> <li>● Name of dam.....% of total water supply .....</li> <li>● Name of dam.....% of total water supply .....</li> </ul>
	<ul style="list-style-type: none"> <li>● Name of other source.....% of total water supply .....</li> <li>● Name of other source.....% of total water supply .....</li> <li>● Name of other source.....% of total water supply .....</li> <li>● Name of other source.....% of total water supply .....</li> <li>● Name of other source.....% of total water supply .....</li> </ul>
	<ul style="list-style-type: none"> <li>● Area supplied by the utility.....</li> <li>● Number of consumers / connections.....</li> </ul>
	<ul style="list-style-type: none"> <li>● Number of consumer by category <ul style="list-style-type: none"> <li><input type="checkbox"/> Household .....</li> <li><input type="checkbox"/> Social amenities (Schools) .....</li> <li><input type="checkbox"/> Public /Private amenities .....</li> <li><input type="checkbox"/> Firms / Factory.....</li> <li><input type="checkbox"/> Other.....</li> </ul> </li> <li>● Other specify.....</li> </ul>
	<ul style="list-style-type: none"> <li>● Volume of water supplied per month in M<sup>3</sup></li> </ul>
	<ul style="list-style-type: none"> <li>● Volume supplied to consumers by categories <ul style="list-style-type: none"> <li><input type="checkbox"/> Household .....</li> <li><input type="checkbox"/> Social amenities (Schools) .....</li> <li><input type="checkbox"/> Public /Private amenities .....</li> <li><input type="checkbox"/> Firms / Factory.....</li> </ul> </li> </ul>

	<p><input type="checkbox"/> Other.....</p> <ul style="list-style-type: none"> <li>● Other specify.....</li> </ul>
	<ul style="list-style-type: none"> <li>● The Average annual Cost of expansion and infrastructural development (new investments) in KES.....</li> </ul>
	<ul style="list-style-type: none"> <li>● The Average monthly Cost of Operation for the (extraction, treatment and supply cost ) in KES.....</li> </ul>
	<ul style="list-style-type: none"> <li>● The Average monthly Cost of Maintenance for the last 3 years (wear and tear, breakage ) in KES.....</li> </ul>
	<ul style="list-style-type: none"> <li>● Cost of water per M<sup>3</sup> .....</li> </ul>
	<ul style="list-style-type: none"> <li>● Is the supply or continued existence of the resources / water secure <input type="checkbox"/> Yes <input type="checkbox"/> No</li> <li>● If yes give details.....</li> </ul>
	<ul style="list-style-type: none"> <li>● What are the most significant challenges that affect the water extraction, treatment and supply?</li> <li>● .....</li> <li>● .....</li> <li>● .....</li> </ul>
	<ul style="list-style-type: none"> <li>● Do you have any Corporate Social responsibility <input type="checkbox"/> Yes <input type="checkbox"/> No</li> <li>● If yes, List them and specify cost</li> <li>● List.....cost.....</li> <li>● List.....cost.....</li> <li>● List.....cost.....</li> <li>● List.....cost.....</li> </ul>
	<ul style="list-style-type: none"> <li>● How do you think environmental services (water flow, quantity and quality) can be enhanced?</li> <li>● ..... ..... ..... .....</li> </ul>
	<ul style="list-style-type: none"> <li>● Are you involved in conservation protection activities of the resource <input type="checkbox"/> Yes <input type="checkbox"/> No</li> <li>● If yes, which..... ..... .....</li> </ul>

	<ul style="list-style-type: none"> <li>• How much do you put back to conservation or maintenance source at the upstream.....and who is involved? .....</li> </ul>
	<ul style="list-style-type: none"> <li>• Are there agreement with those involved <input type="checkbox"/> Yes <input type="checkbox"/> No</li> </ul>

## 5.4 PWES Mobile data collection Kit





10:10 AM

ODK Collect > PWES data entry

Select Category of Buyer

Community Water Projects  
 Commercial Entities  
 Water Service Providers

**SAMSUNG**

10:10 AM

ODK Collect > PWES data entry

Community Water Project

Name of project \_\_\_\_\_  
Date of Construction \_\_\_\_\_  
Management  
 Community Group  
 Government  
 Partners  
 Other  
Water Source for Project  
 River  
 Borehole  
 Dam  
 Other Other Specify \_\_\_\_\_

**SAMSUNG**

10:10 AM

ODK Collect > PWES data entry

Water treatment in place  
 Yes  
 No

Monthly cost of operation and maintenance \_\_\_\_\_

Extraction capacity per month in M3 \_\_\_\_\_

Who provide funds for maintenance  
 Self (community)  
 Partners  
 Beneficiaries  
 Other Other Specify \_\_\_\_\_

What is water used for and number of users  
 Household \_\_\_\_\_  
 Social amenities \_\_\_\_\_  
 Farms / Factory \_\_\_\_\_  
 Other \_\_\_\_\_ Other Specify \_\_\_\_\_

**SAMSUNG**

10:10 AM

ODK Collect > PWES data entry

Commercial Entities

Water source for the entity  
 river  
 Dam  
 Borehole  
 Other Other Specify \_\_\_\_\_

Extraction capacity \_\_\_\_\_

Is your water metred ?  
 Yes  
 No

Which months do you experience low water level \_\_\_\_\_

Which months do you experience high water level \_\_\_\_\_

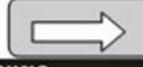
Do you have regular supply ?  
 Yes  
 No

**SAMSUNG**

10:10 AM

ODK Collect > PWES data entry

If no which month \_\_\_\_\_  
Do you have corporate social responsibility  
 Yes  
 No  
If yes List them \_\_\_\_\_  
How can environmental services be enhanced \_\_\_\_\_  
Are you involved in conservation protection or maintenance of the source ?  
 Yes  
 No  
How much do you put back to conservation or maintenance source at the upstream and who is involved \_\_\_\_\_ ?

10:10 AM

ODK Collect > PWES data entry

Are there agreement with those involved ?  
 Yes  
 No  
Which month do you experience low water level \_\_\_\_\_  
Which month do you experience high water level \_\_\_\_\_  
Is the supply or water secure?  
 Yes  
 No  
If Yes, give details \_\_\_\_\_

10:10 AM

ODK Collect > PWES data entry

**Water Service Providers**

Water Source  
 River  
 Borehole  
 Dam  
 Other

If selected by River

Name of the river % of total water supply  
i. \_\_\_\_\_ \_\_\_\_\_  
ii. \_\_\_\_\_ \_\_\_\_\_  
iii. \_\_\_\_\_ \_\_\_\_\_  
iv. \_\_\_\_\_ \_\_\_\_\_  
v. \_\_\_\_\_ \_\_\_\_\_

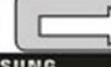
10:10 AM

ODK Collect > PWES data entry

If selected by Borehole

Name of the borehole % of total water supply  
i. \_\_\_\_\_ \_\_\_\_\_  
ii. \_\_\_\_\_ \_\_\_\_\_  
iii. \_\_\_\_\_ \_\_\_\_\_  
iv. \_\_\_\_\_ \_\_\_\_\_  
v. \_\_\_\_\_ \_\_\_\_\_

Area supplied by the utility \_\_\_\_\_  
Number of consumer / connections \_\_\_\_\_  
Volume of water supplied per month in M3 \_\_\_\_\_  
Average annual cost of expansion and infrastructure development \_\_\_\_\_

ODK Collect > PWES data entry

Specify Number of Consumer

Public amenities \_\_\_\_\_  
Firms/ Companies \_\_\_\_\_  
Households \_\_\_\_\_

Area supplied by the utility.

Volume supplied to

Public amenities \_\_\_\_\_  
Firms/ Companies \_\_\_\_\_  
Households \_\_\_\_\_

Cost of water per M3

The average monthly cost of maintenance for the last 3 years (tear and wear, breakage) \_\_\_\_\_

ODK Collect > PWES data entry

Is the supply of resource secure ?

Yes  
 No

If Yes, give details \_\_\_\_\_

Most significant challenges that affect water extraction, treatment and supply

i. \_\_\_\_\_  
ii. \_\_\_\_\_  
iii. \_\_\_\_\_

Are you involved in conservation protection activities of the resource ?

Yes  
 No

ODK Collect > PWES data entry

If Yes, which \_\_\_\_\_

Do you have any Corporate Social Responsibility?

Yes  
 No

If Yes, List them

i. \_\_\_\_\_  
ii. \_\_\_\_\_

How much do you put back to conservation or maintenance source at the upstream \_\_\_\_\_ and who is involved \_\_\_\_\_

Are there agreement with those involved ?

Yes  
 No

## 5.5 Technical Guide for Mobile Data Collection

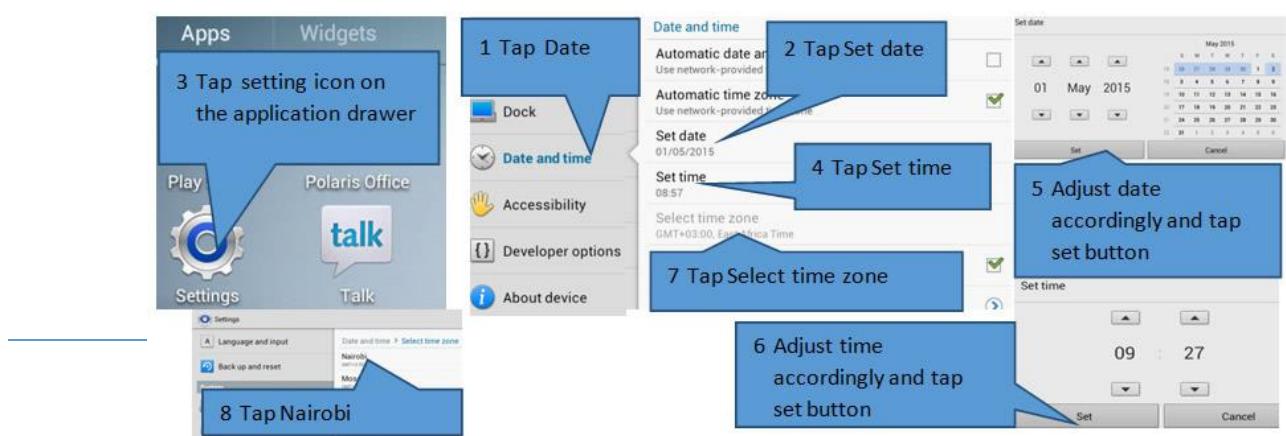
### 1. Knowing main parts of data collection Hardware

#### 1.1. Main External features of an Android Smartphone

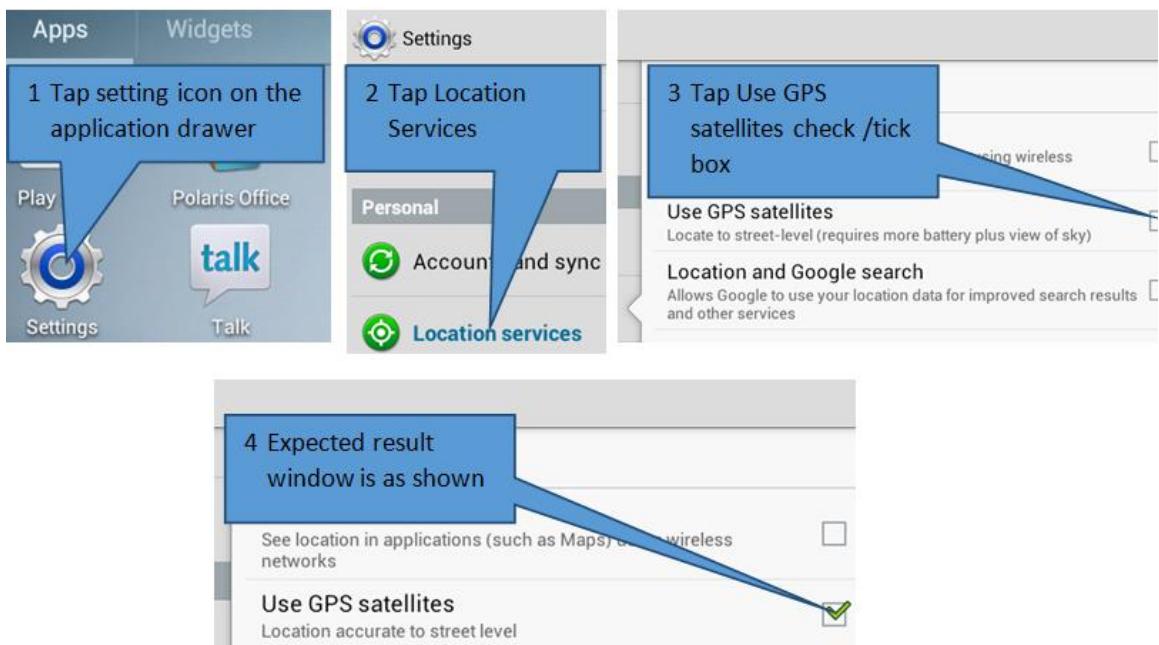


### 2. Setting up and Configuring Main Mapping Features

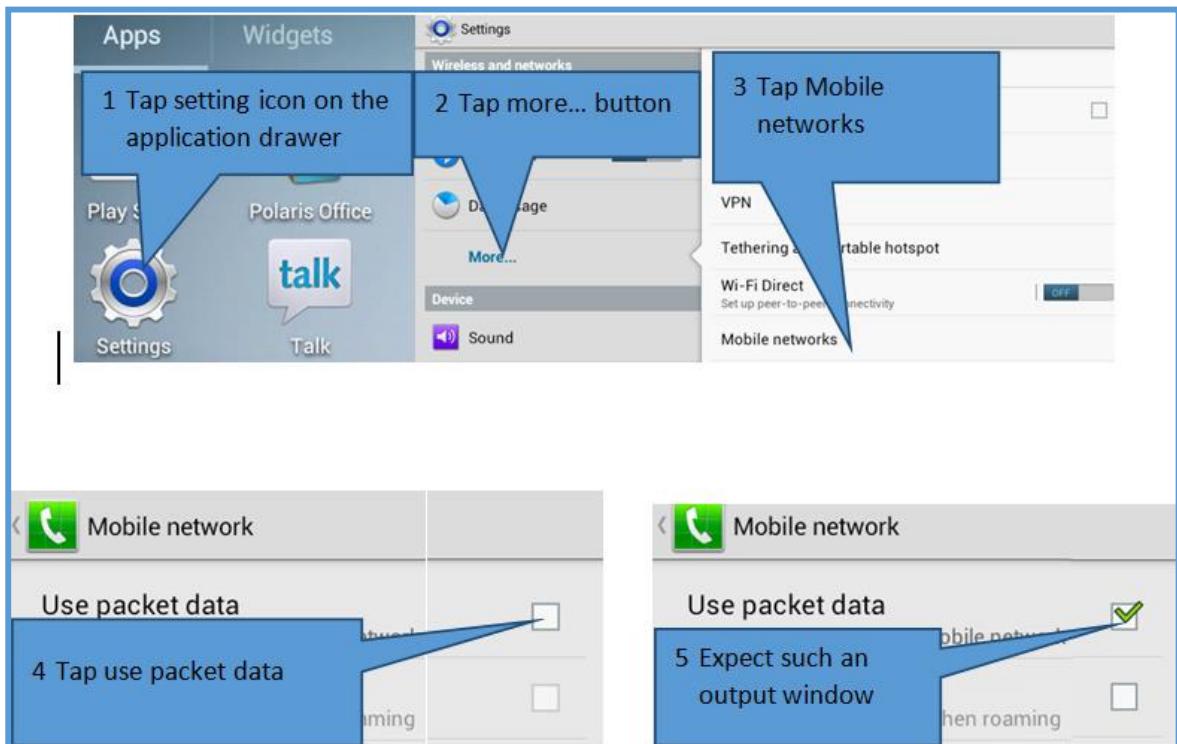
#### 2.1. Date and time



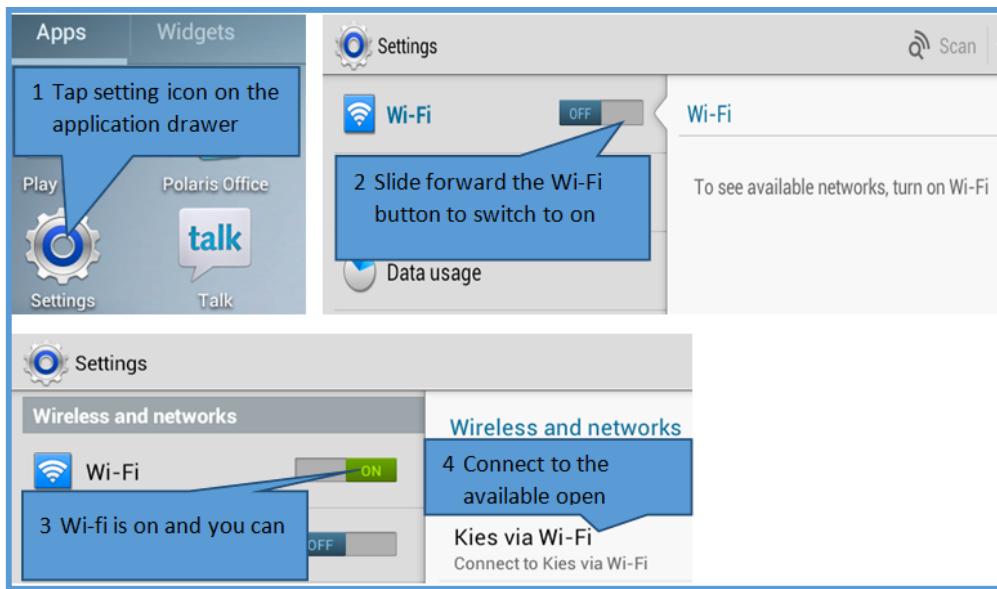
## 2.2. GPS



## 2.3. Internet access using SIM Card



## 2.4. Internet access using WIFI

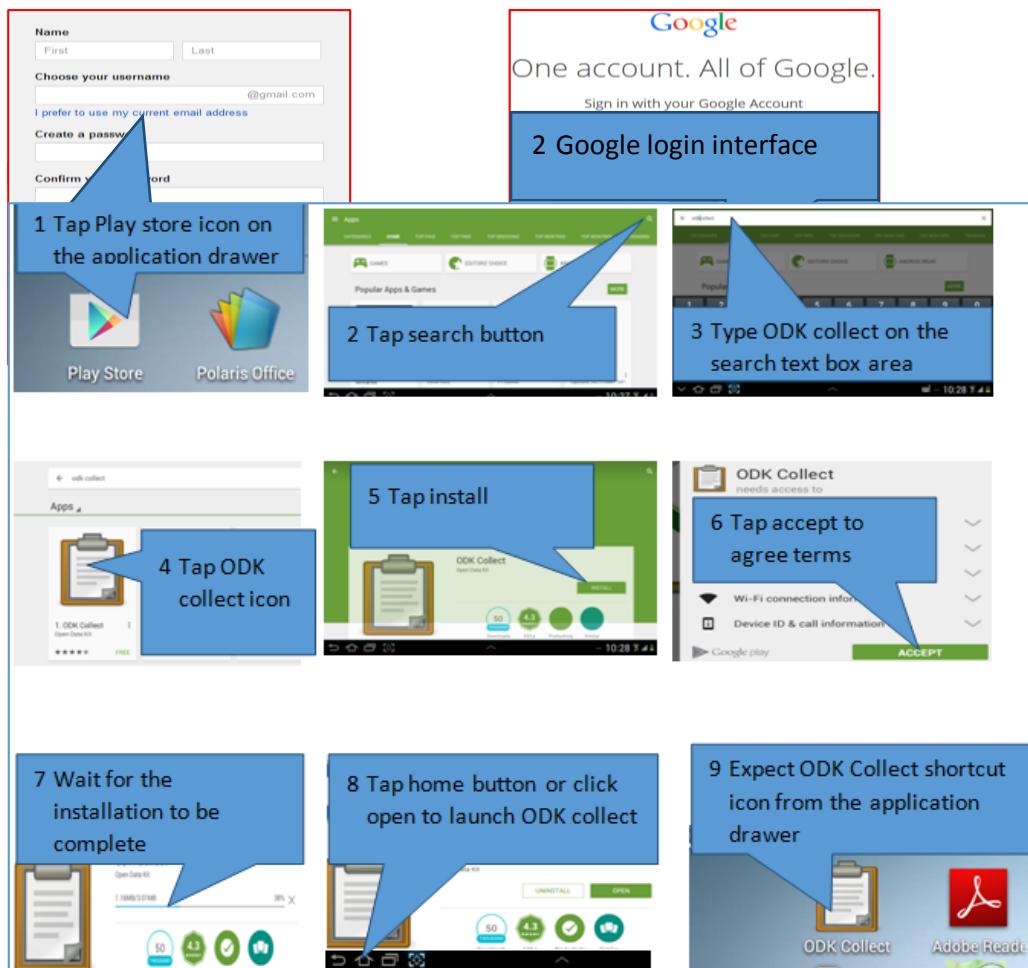


## 2.5. Additional tips

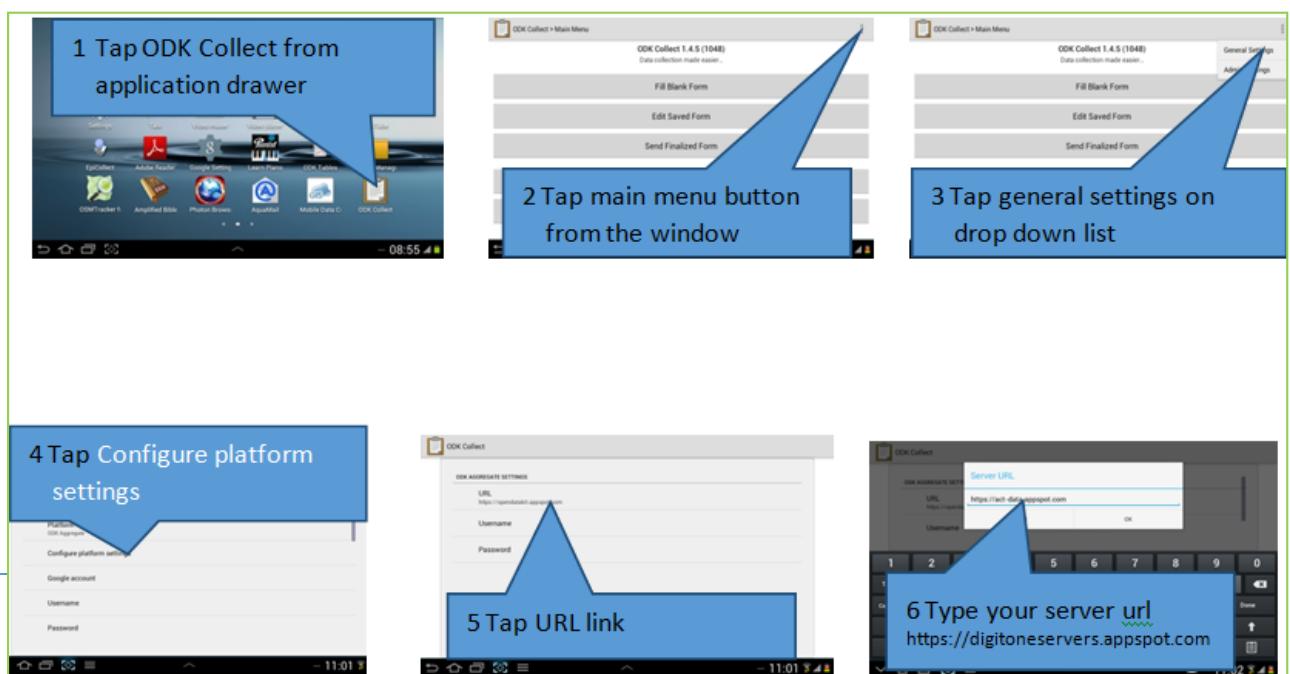
- Notice the respondent that you're to use your mobile during his / her interview
- Avoid frequent screen timeout due to disturbance while in data entry mode
- Regulate screen brightness according to the environment that you're in
- Eliminate Screen pattern / password
- Turn off automatic orientation
- Un necessary android apps installation slow down mobile phone
- Switch to Airplane mode! saves battery and also avoid disturbance during interview due to call in
- Switch off the GPS button if you don't need it
- Switch off Bluetooth
- Switch off Internet WIFI if not in use

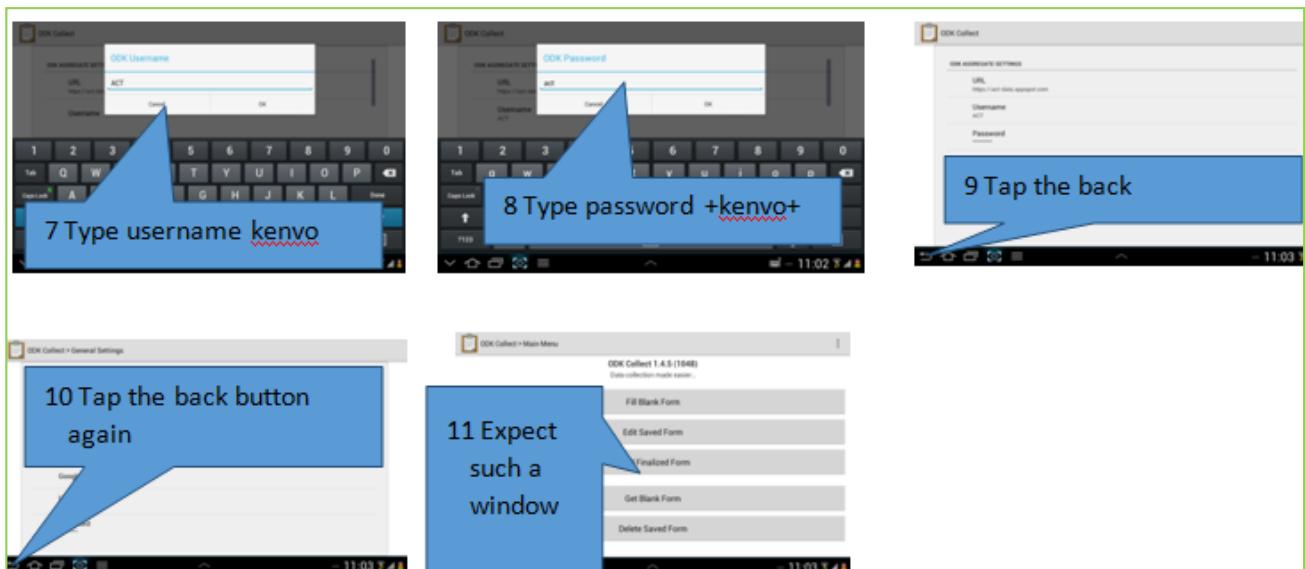
### 3. ODK collect basic configuration

#### 3.1. Google account setup



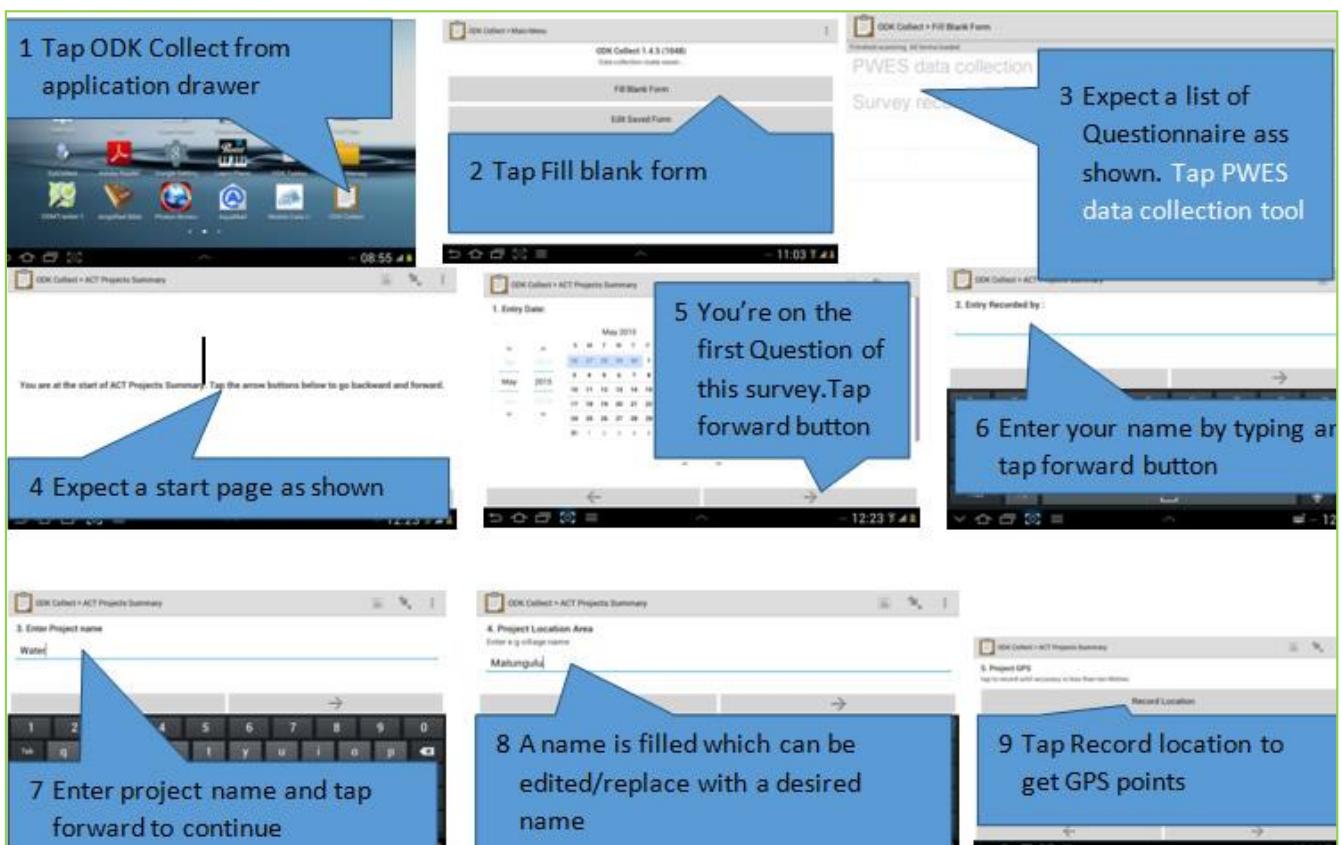
#### 3.2. Configuring ODK Collect

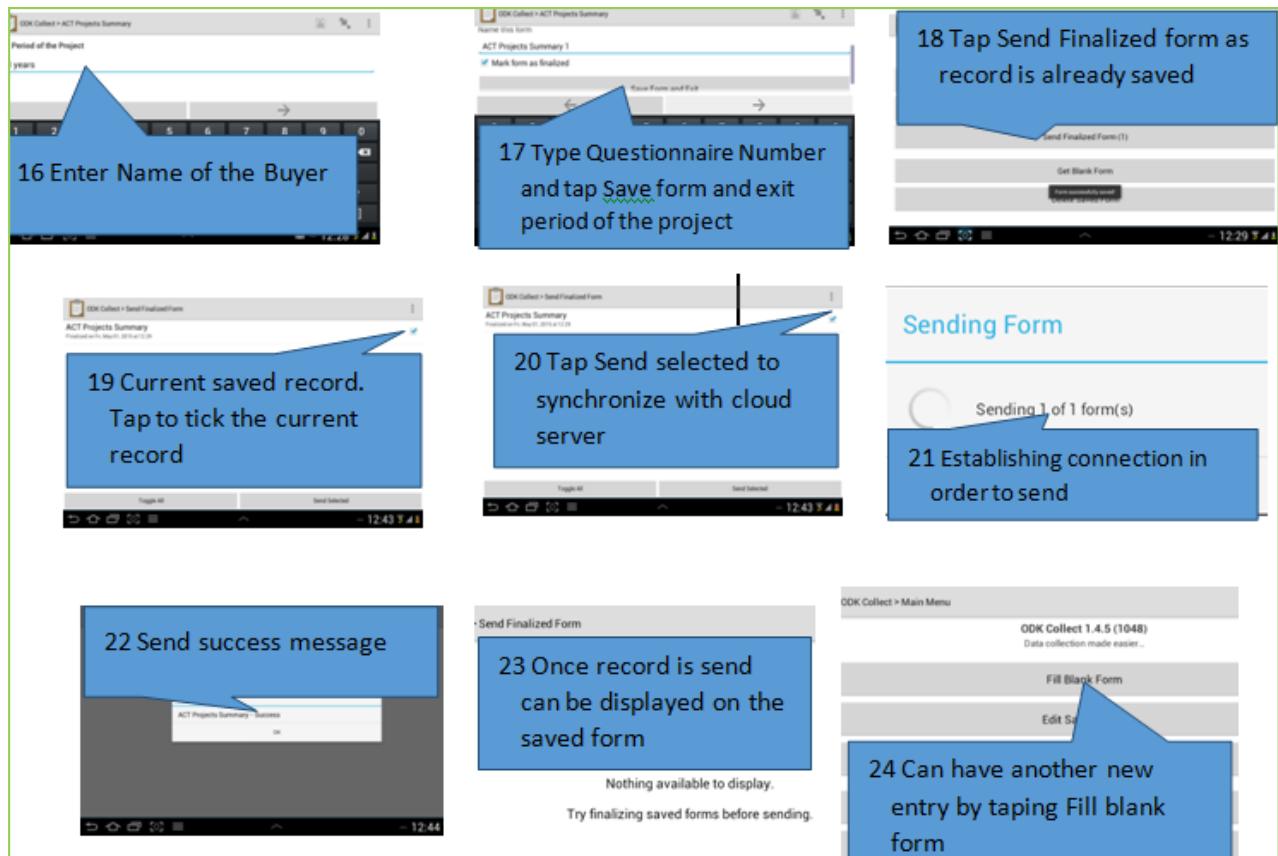
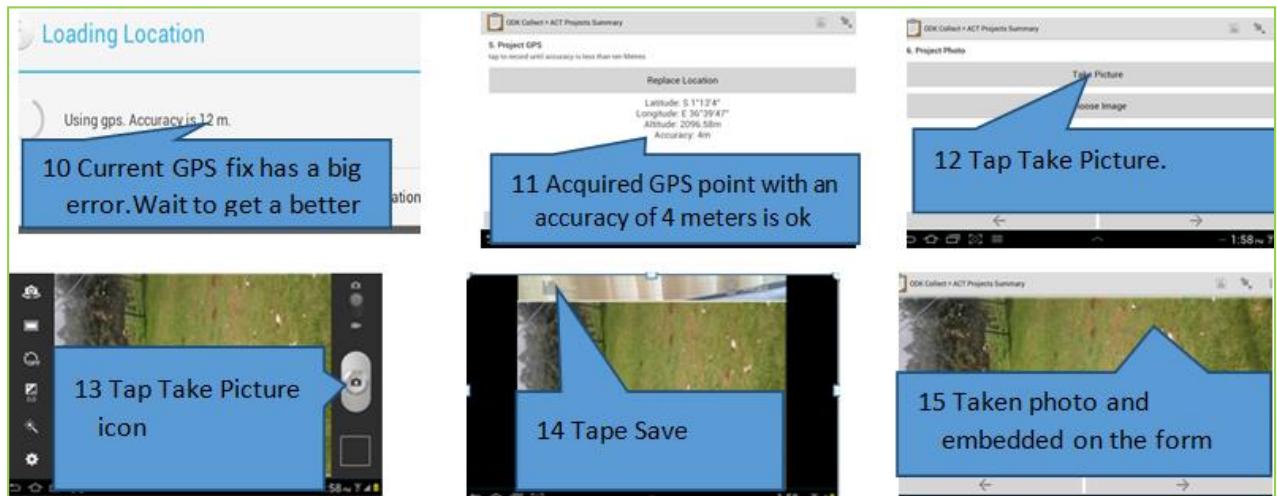




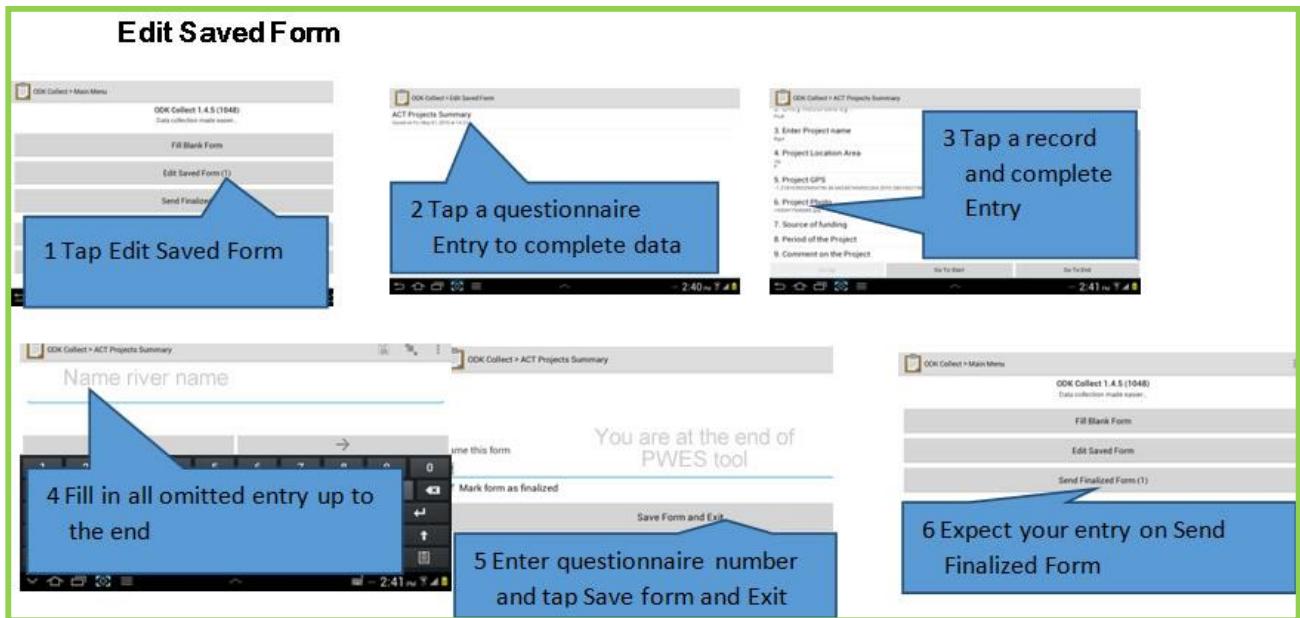
## 4. Working with ODK collect

### 4.1. Filling Blank Form





## 4.2. Edit Saved Form



## 5. Accessing Published data on web-based server

