Groundwater Risk Management for Growth and Development (Gro for GooD)

Leopard Beach Hotel, Diani
Kwale County, Kenya
26th February 2016

NERC SCIENCE OF THE ENVIRONMENT
UP Gro Unlocking the Potential of Groundwater for the Poor
Gro for GooD
E·S·R·C ECONOMIC & SOCIAL RESEARCH COUNCIL
UKaid from the British people
Research jointly supported by the ESRC and DFID

Hon. H. Mwabudzo,
Kwale County Minister for Water,
welcomed 50 delegates to
a stakeholder meeting at
Leopard Beach Hotel on
Friday 26th February.

The Minister encouraged the government, private sector and civil society groups to collaborate in the Groundwater Risk Management for Growth and Development (Gro for GooD) to deliver sustainable benefits for communities, businesses and the environment.

He re-affirmed the County's support and commitment to the research which is producing novel scientific insights to support government policy and investments.

Participants at the Workshop

Base Titanium – Georgina Jones (Manager, Environment)
Community – Amina Mwakutwaa
CWSB – Linus Njoghola (Geologist)
JKUAT – Prof. Bancy Mati (Director WARREC), Prof. John Gathanya (Hydrologist)
KALRO – Benard Madegwa (Research Office)
KCG – Hemed Mwabuzo (CEC Water), Munyao Muthku (Chief/Water), Amol Josphat , Kubushi Daniel
KMFRI – Carolina Wangari (Member), Ann Wanjiru (Research Officer)
KISCOL – Clive Okioma (Field Technical Manager), Mathias Okwemba (Groundwater Engineer)
KMS – Dominic Mbindio (County Director)
KWAWASCO – Saum Ramadhan, Zohra Chapu
KWS – Bernard Ochieng (Research Officer)
Kinondo Ward – Hamisi Mwakoja
Mombasa Technical University – Kagiri Moses (PhD student)
Msambweni Hospital – Dr. Kelvin Duhiu (Director of Health)
Oxford University – Dr. Rob Hope, Farah Colchester, Heloise Greef, Jacob Katuva, Johanna Koehler, Patrick Thomson (Researchers)
NDMA – Bakari M. Mwachakure (CDRO)
Plan International – Hernest Ondigo (Programme Manager)
Pwani University – Dr. Okeyo Benards (Dean Environmental Science)
Rural Focus Ltd – Calvince Wara (Project Manager), Fauzia Swaleh (Office Administrator), Mike Thomas (Researcher), Mike Lane (Hydrogeologist), Said Banje (Project Manager), Suleiman Mwakurya (Project Assistant), Willy Sasaka (Assistant Hydrogeologist)
University of Nairobi – Prof. Daniel Olago (Researcher), Julius Odida (Student)
Grupo de Hidrología Subterrénea (UPC-CSIC) – Albert Folch, Núria Ferrer Ramos (Researchers)
WASREB – Richard Cheruiyot (Inspectorate Manager)
WRMA – Canute Mwakamba (ATCM Groundwater), David Shokut (GWO – Mombasa),
Josphat Mwagongo (ATCM-GW R – Machakos)
WRUAs – Sopai Abdallah, Gedion Muli (Mkurumudzi River), Juma Mboma (Ramisi River), Mohammed Shaban (Ramisi River), Mohamed Jumadari (Mkurudzi River)

Workshop Programme

09h00	Registration
09h30	Welcome & Introductions
10h00	Environmental Monitoring
11h00	Poverty and Rural Water Sustainability
12h00	Discussion & Close
12h30	Lunch and informal discussions

Rationale and Objectives

The workshop provides an opportunity to:

- Present progress on the Environmental Monitoring, Welfare Analysis and Rural Water Sustainability
- Discuss shared goals and interests from stakeholders

Introduction

Background

- Vision 2030 provides pathway to middle income status
- Economic growth and improved services contingent on availability & management of the water resources
- Institutional ability to address the challenges constrained by lack of data, tools & uncertain futures
- Coastal part of Kwale brings issue into focus given:
  - New large scale investments in mining & irrigated sugar
  - Rural people highly dependent on groundwater
  - Changing governance framework with new constitution

Gro for GooD Project

Partners	Oxford University, Kwale County Government, WRMA, University of Nairobi, JKUAT, UPC (Spain), Rural Focus Ltd., Base Titanium Ltd., KISCOL
Timeframe	4 years March 2015 – Feb 2019
Outputs	• A new Groundwater Risk Management Tool which is transferable and sustainable in Africa. • An automated, daily monitoring network for shallow groundwater levels – the first system of its kind and replicable at scale. • New epidemiological insights into the health impacts of faulty or intermittent water supplies. • Improved theory and evidence of groundwater governance and poverty pathways

Environmental Monitoring Strategy

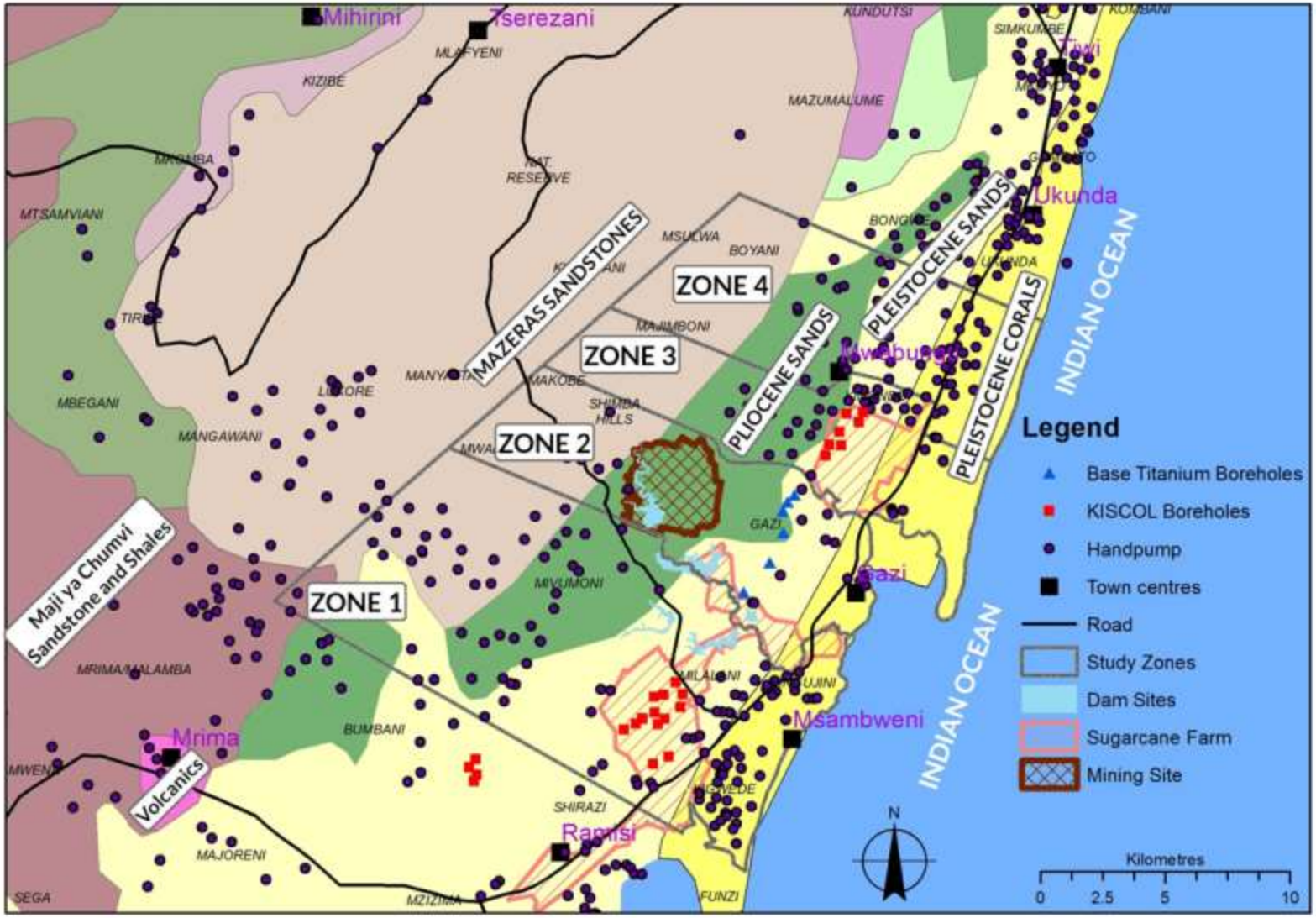
Objectives:

Provide a coherent rationale and program of work to support the co-development and future use of a groundwater risk management tool by key stakeholders

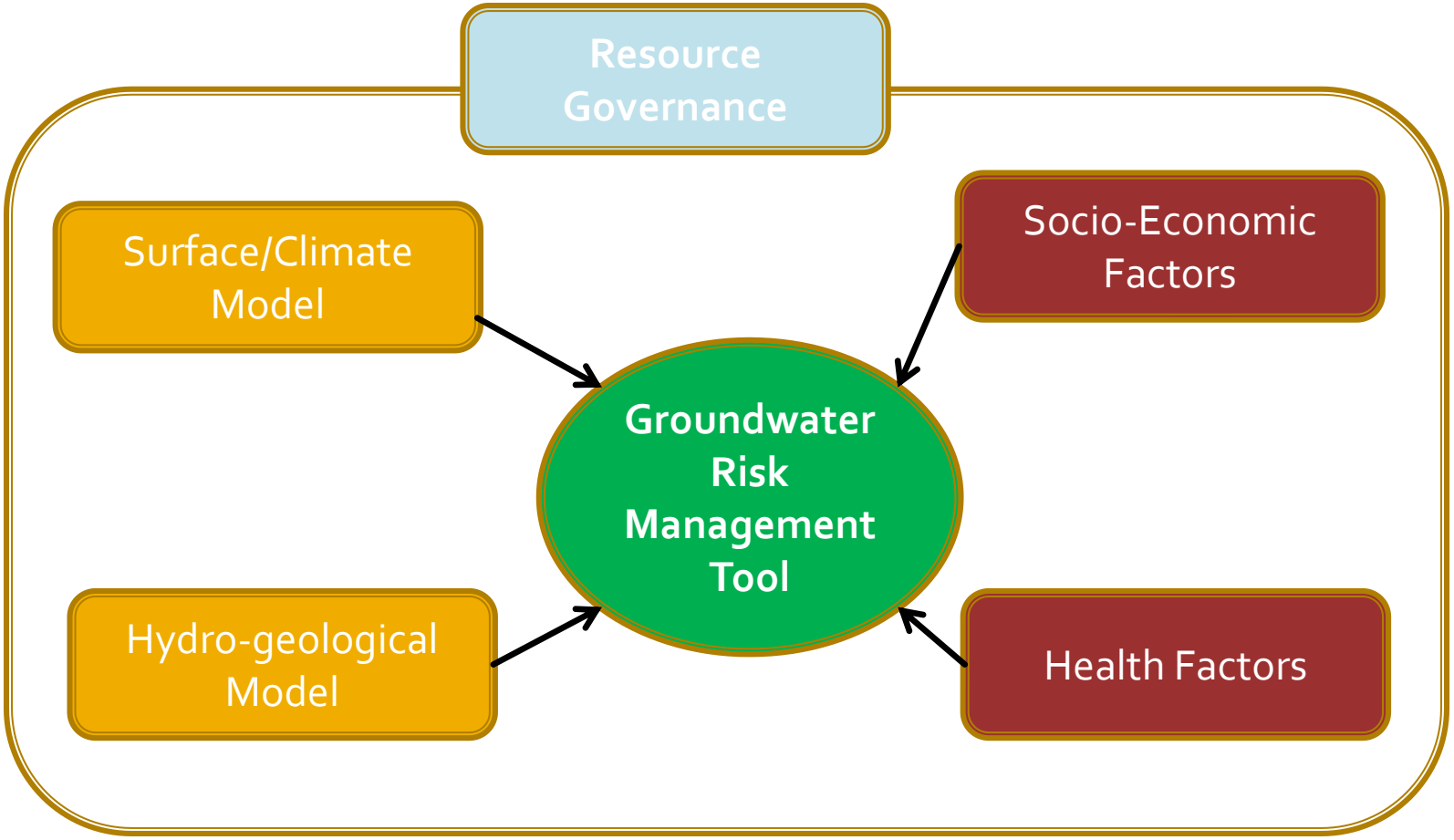
Environmental Monitoring Strategy provides:

1) Design of environmental monitoring network that builds on existing data & networks
2) Delivers data required to characterize and model hydro-geological systems under existing & future change scenarios
3) Builds stakeholder engagement to identify risks associated with uncertain future scenarios
4) Continuity strategy for data collection beyond the project timeframe

Complex Environment



Groundwater Risk Management Tool



REPLICABLE AND SCALABLE TOOL (MODEL) that provides the ability to examine groundwater risks to water supply and economic productivity

Environmental Monitoring

- Geophysics (Prof. Dan Olago, UoN)
- Hydrochemistry (Dr. Albert Folch, UPC)
- Surface Water (Prof. John Gathenya, JKUAT)

Characterising the Msambweni Aquifer Hydrogeophysics

Prepared By:

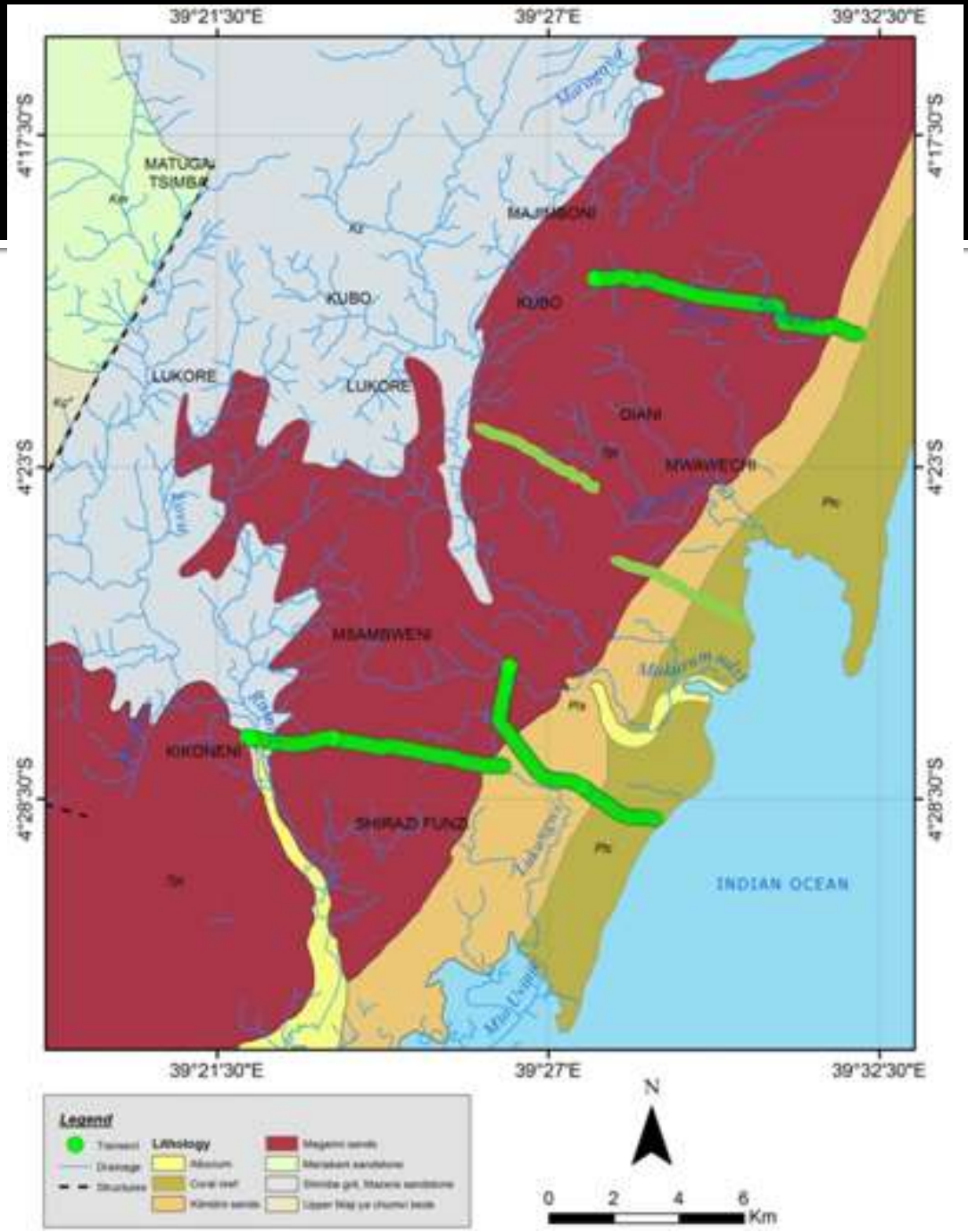
Prof. Daniel O. Olago
Mr. Julius Odida

University of Nairobi

Geology

- after Casewell (1953)

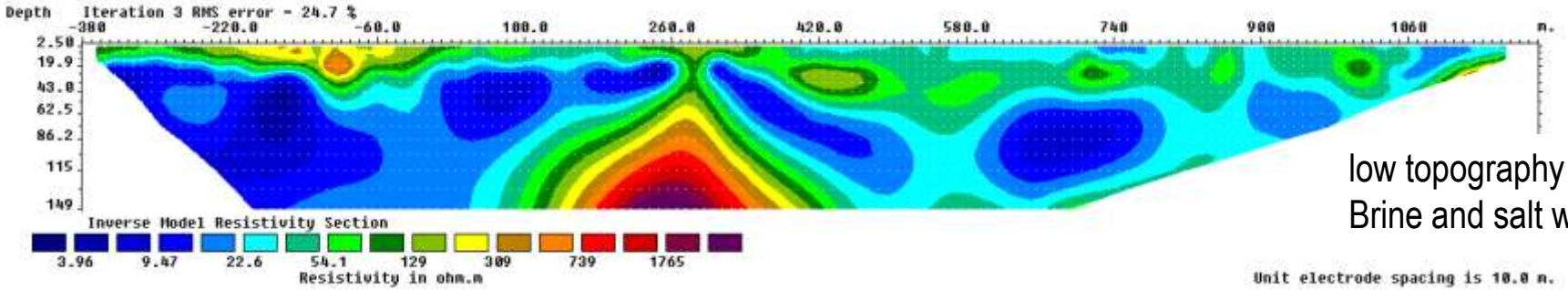
- *MMB* - Gneisses and Schists
- *Permo-Triassic (Karoo)* - Duruma sandstones
- *Jurassic* - Shales, limestones, Mazeras sandstones
- *Lower Cretaceous* – Shales, Coral & limestone
- *Pliocene* - Magarini sands (derived from Duruma sandstone)
- *Middle Pleistocene -* Back reef , Lagoonal Kilindini sands (reworked Magarini sands)
- *Upper Pleistocene* - Raised beaches, red windblown sands, coral reef
- *Recent* - Beach sands, alluvial and soils



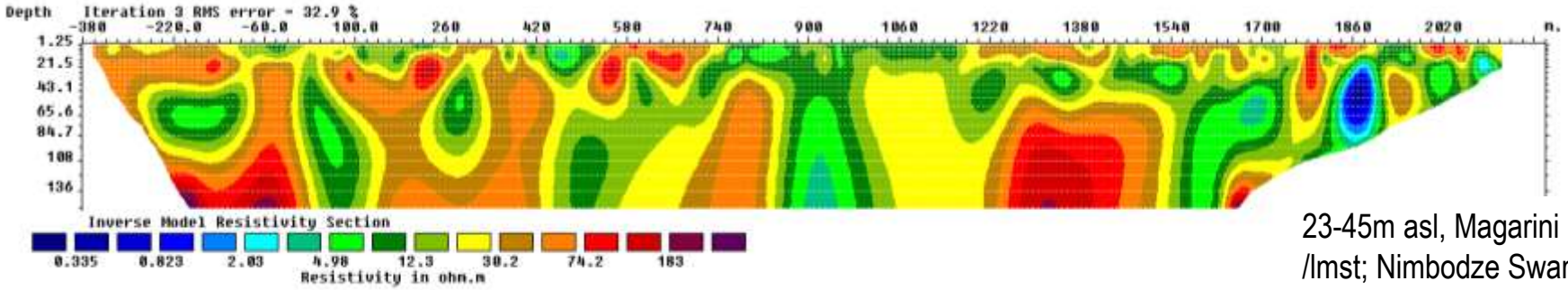
Tomography - Materials & Methods

- Tomography system:
  - Terrameter, Source of power, Switch box, Electrodes, Take-outs, Cables
- Methods:
  - Reconnaissance in Nov 2015, 1st phase in Dec 2015, 2nd phase in Jan 2016
  - Measurements in E-W orientation: Southern (8km), Central (6km & 8km) & Northern Transect (8km)
  - Inversion methods: Ergraph-converts s4k to .dat files readable by RES2DINV
  - Finite-element modelling
  - Data presented in tomographs with colour codes depicting varying resistivities

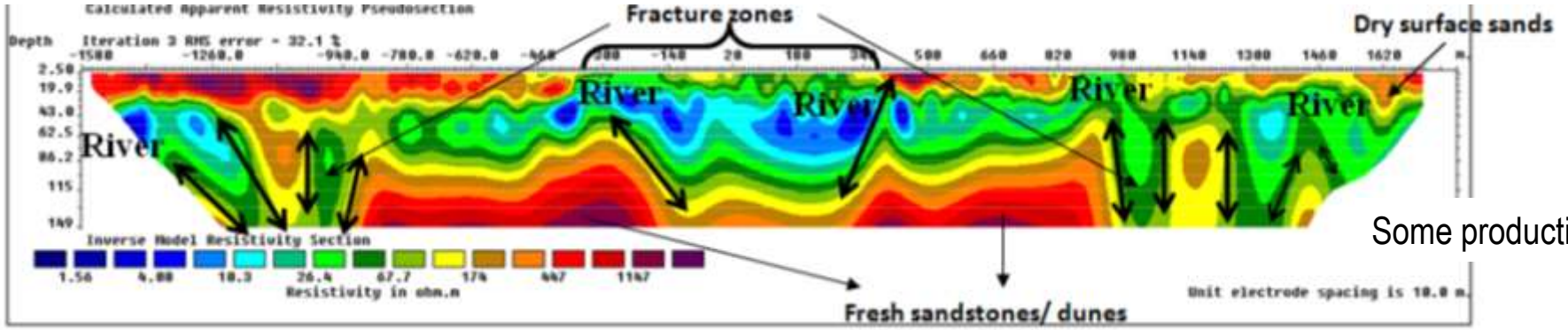
Results & Interpretation: Transect 1



low topography <5m,
Brine and salt water

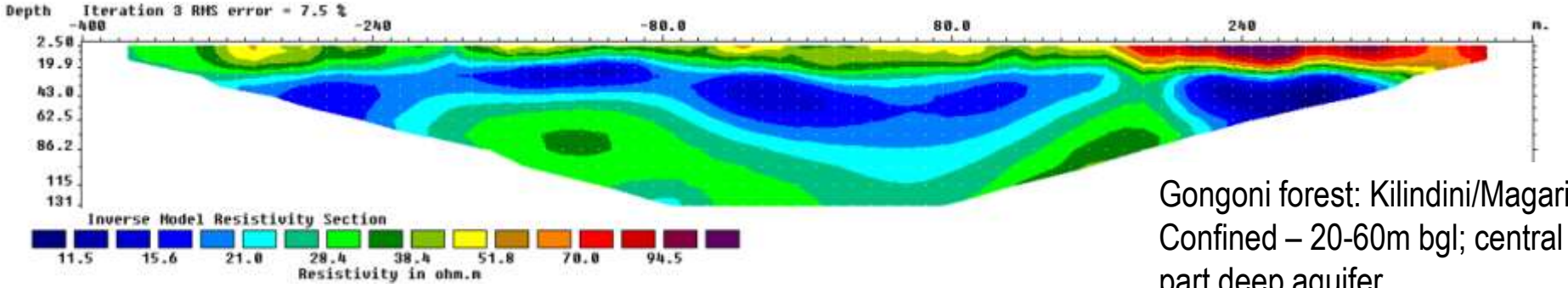


23-45m asl, Magarini Sands
/lmst; Nimbodze Swamp

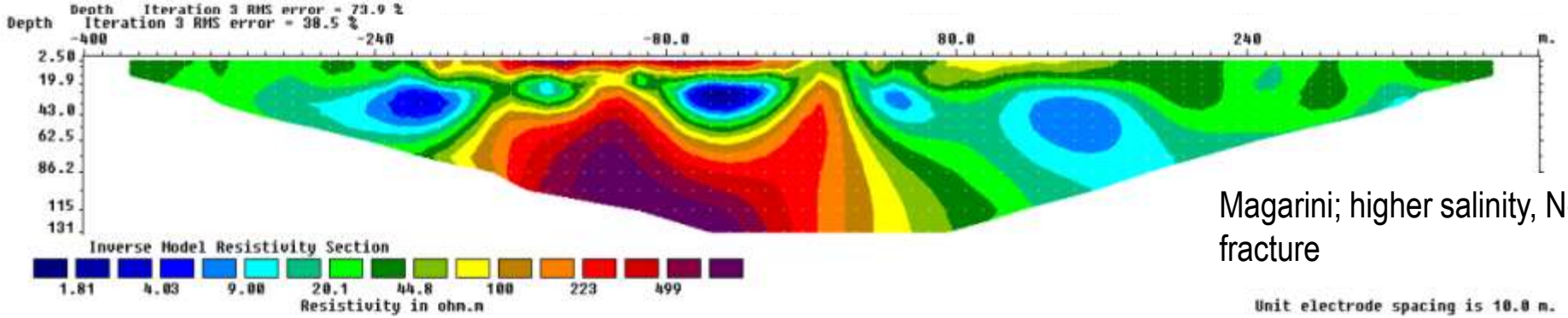


Some productive BHs

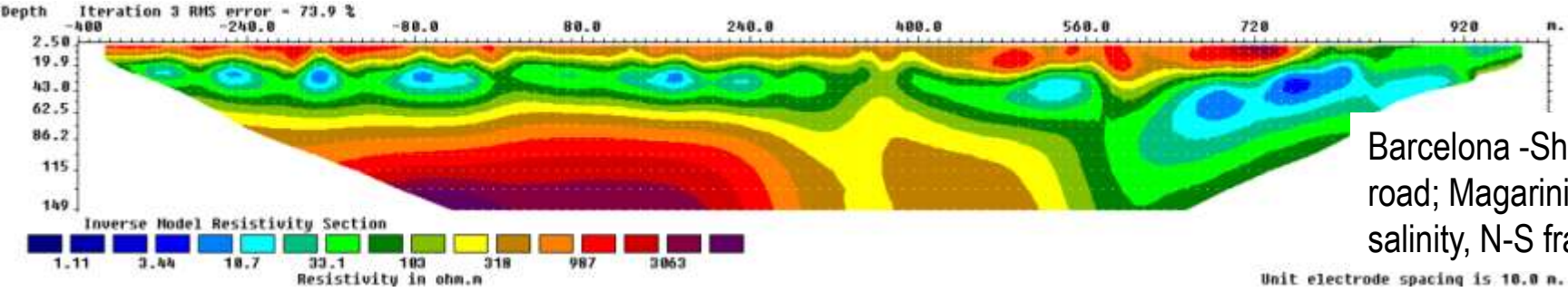
Transect 2: Gongoni-Shimba Hills



Gongoni forest: Kilindini/Magarini; Confined – 20-60m bgl; central part deep aquifer

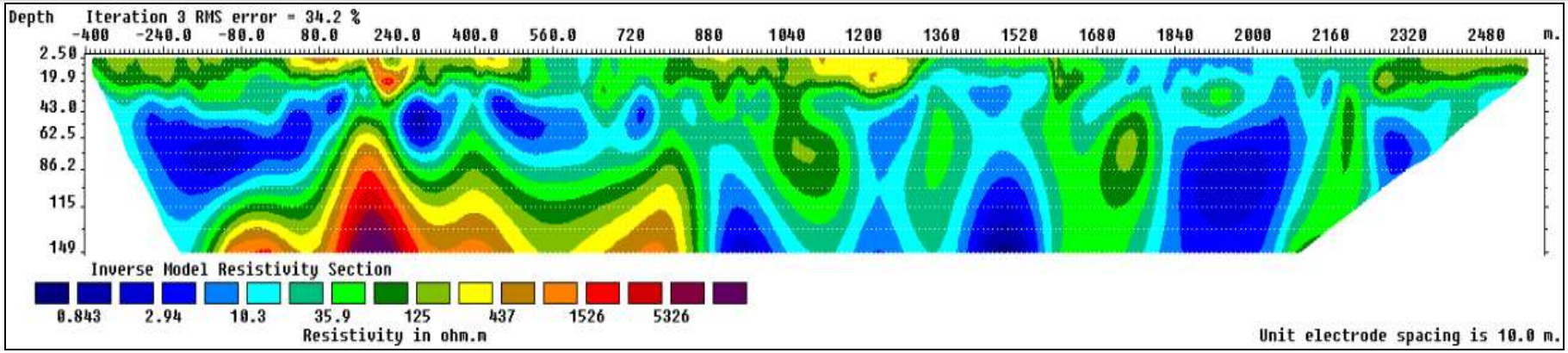


Magarini; higher salinity, N-S fracture

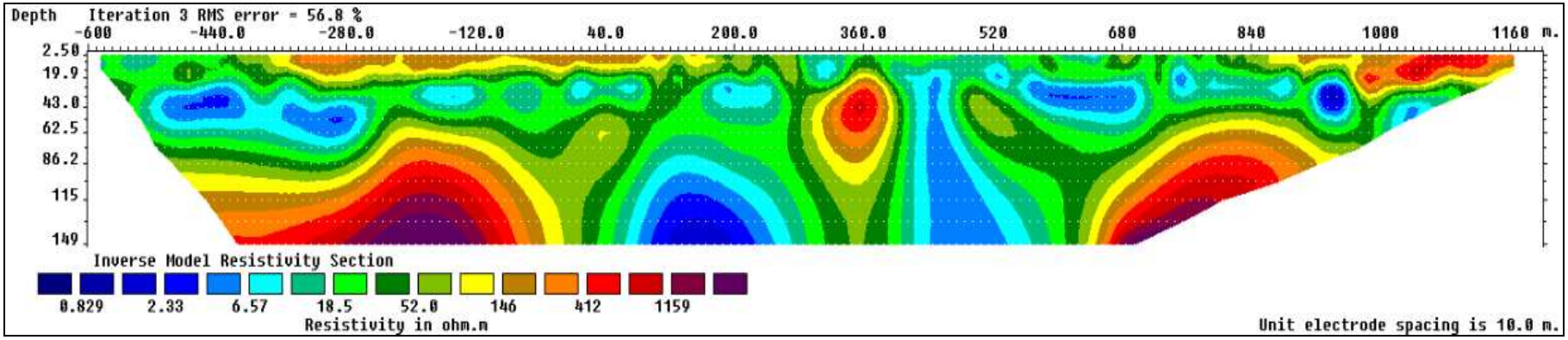


Barcelona -Shimba Hills road; Magarini; higher salinity, N-S fracture

Transect 3: Mwabungo-Mwapala



Calcarous sands/corals (1.4 km, 115m depth) to Kilindini . High salinity covers the remaining part of the profile.
Major structural feature (1.6km) separating different geology-Corals and Kilindini Sands.



Muhaka-Mwapala road, Magarini Sands.
Aquifers interconnected, curvilinear dune shapes.
600m long fracture (0.6-1.2km) evident. Dry sands barrier at 0.96km. River Mtawa saline and G/W also saline.

Next Steps

Future plans

- Complete East - West transects
- Go further west to characterise western boundary
- Establish points for VES (Vertical Electrical Sounding) – deep probe to 500 m below ground level
- Run a North - South ERT transect

Thanks to

- WRMA - Athi Catchment
- County Government of Kwale

Groundwater System

Prepared By:

Dr. Albert Folch
Ms. Núria Ferrer Ramos
Hydrogeology Group (UPC-CSIC)

What we are doing?

Characterization of the Groundwater system to:

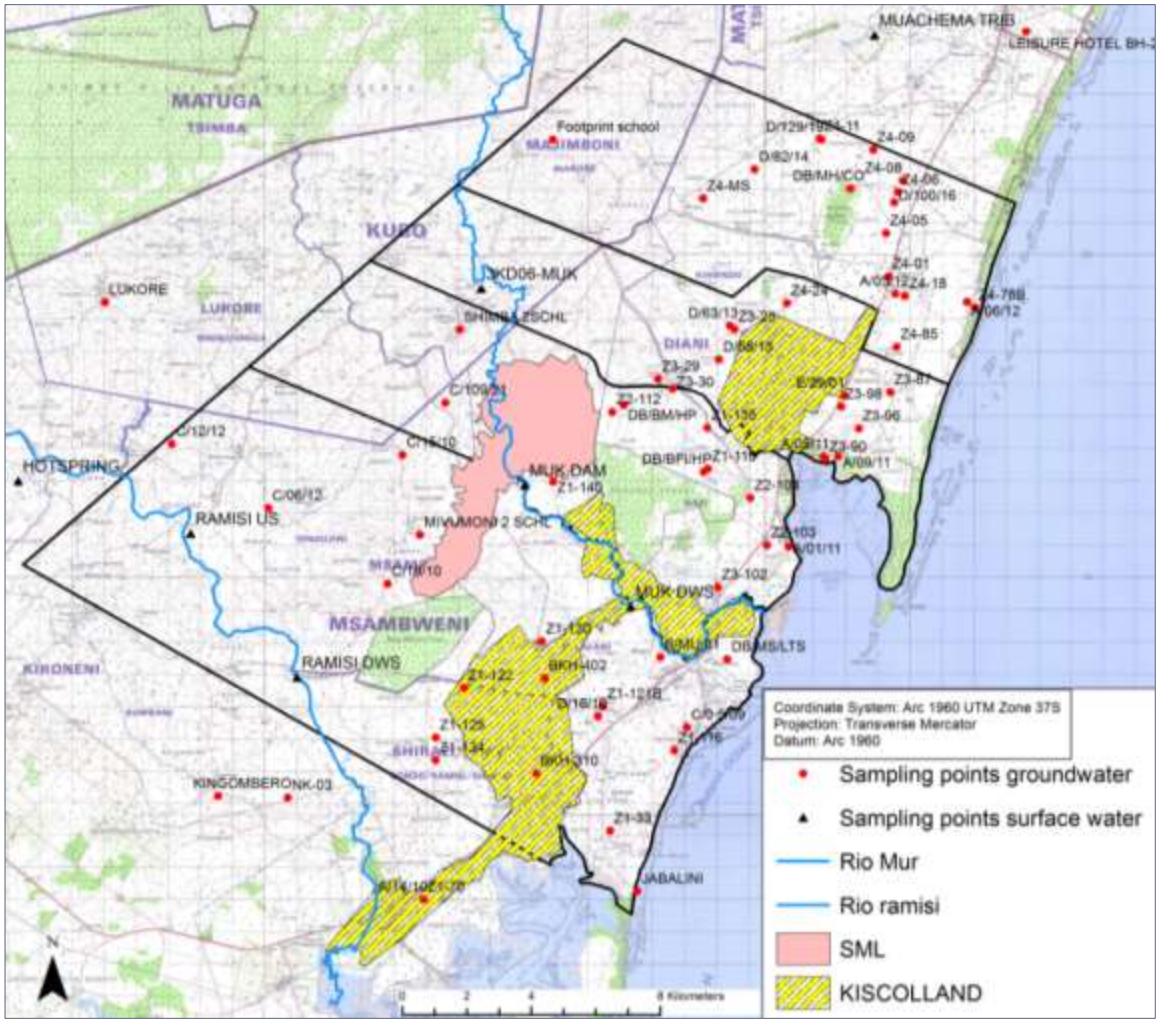
- Define the conceptual model and the mass balance of the aquifer including surface water
- Identify the main quality issues
- Understand interactions with the socio-economic system

Inputs for the **Groundwater Risk Management Tool**

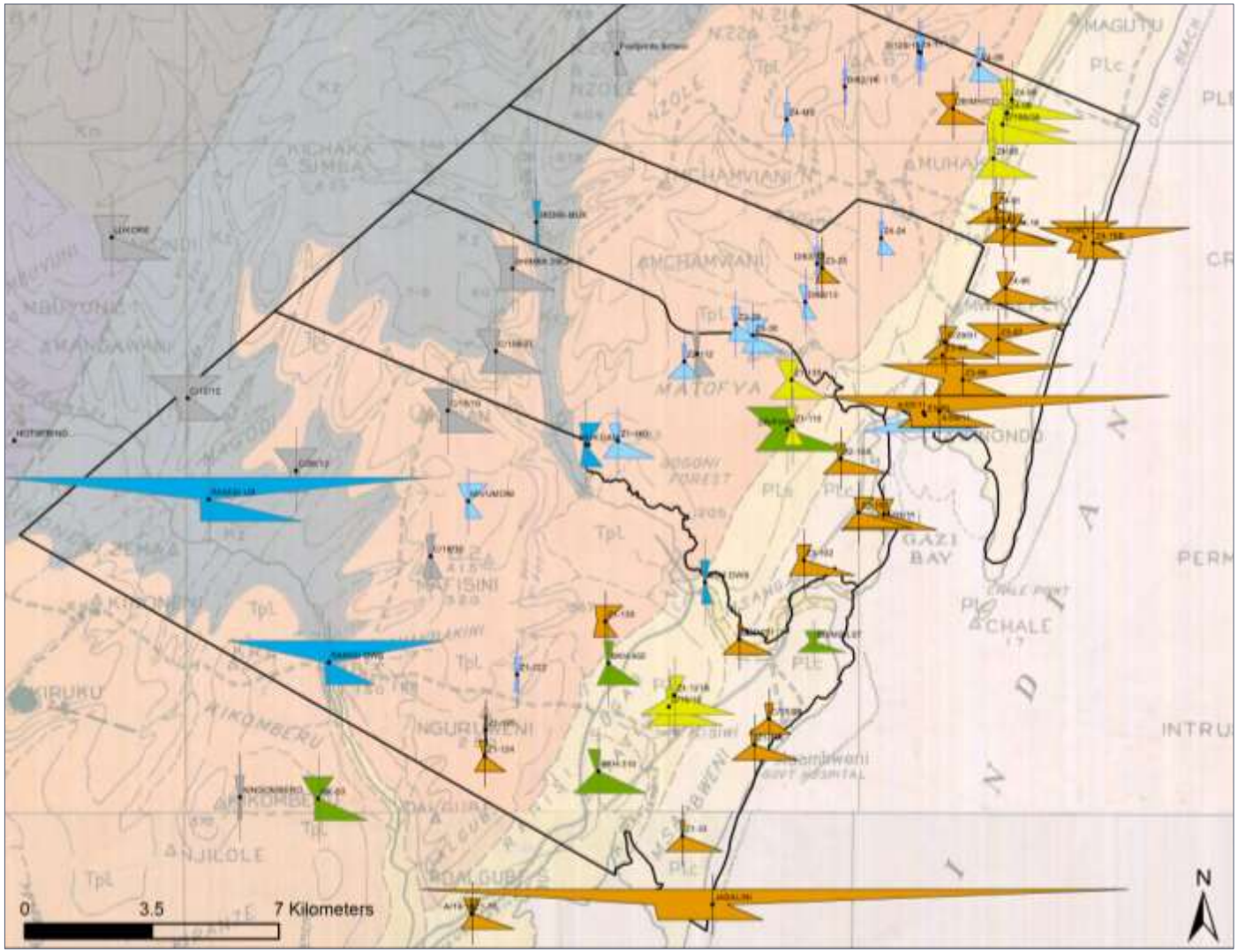
September 2015 Field Survey

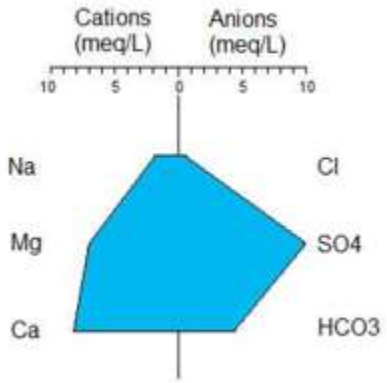
Sampling 77 points:

- Field parameters (Electrical Conductivity, Temperature, pH, alkalinity)
- Major anions and cations (Ca, Mg, Cl, etc.)
- Trace element (Sr, Li, Ba, etc.)
- Faecal Bacteria
- Water Isotopes (Deuterium, Oxygen-18)
- Groundwater level when available (40 points)



Major anions and cations

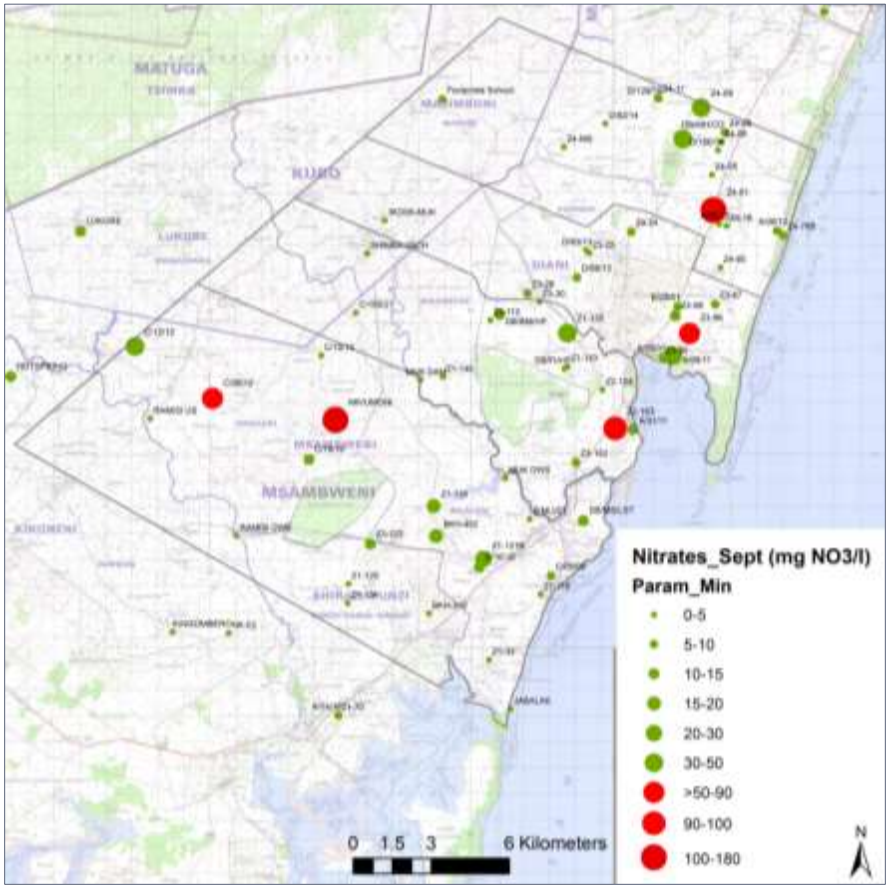


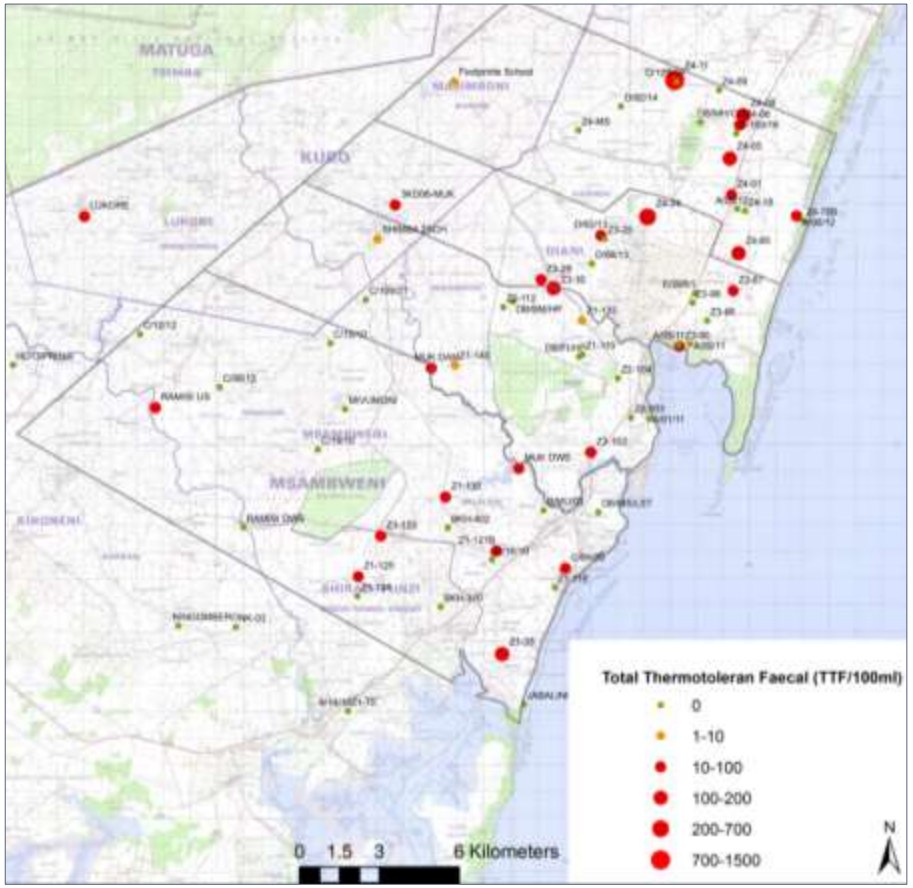


Legend

- Pleistocene Sands
- Deep Aquifer
- Surface Water
- Mazeras Sandstones
- Pleistocene Corals
- Pliocene Sands

Chemical and Bacteriological Groundwater Quality





Monitoring network

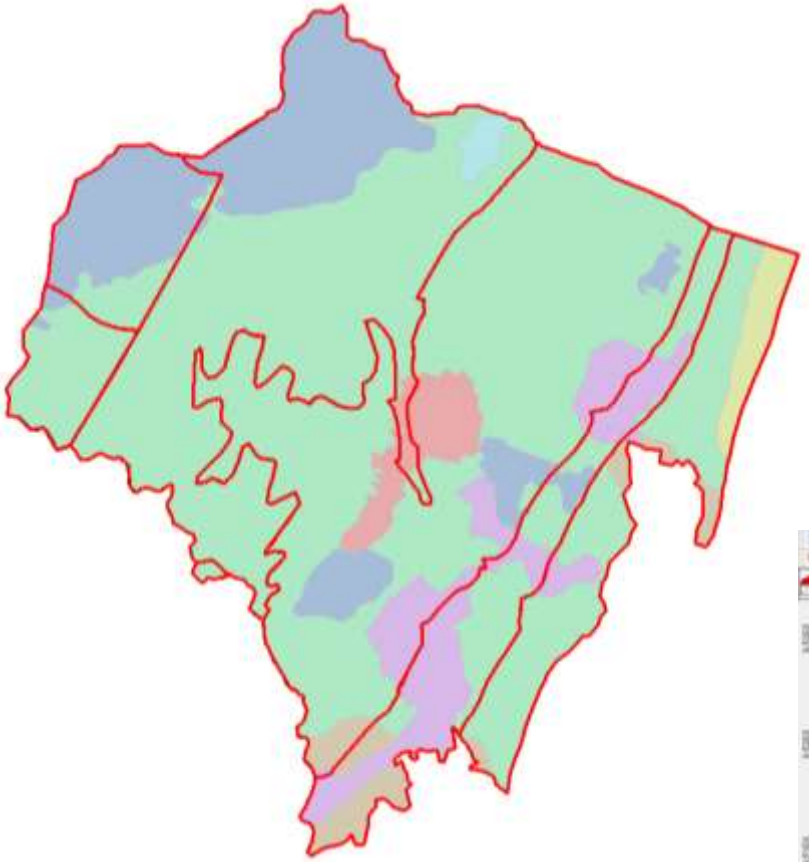
35 groundwater points have been monitored since 2013 to 2015:

- Quality: Electrical Conductivity, Temperature, pH
- Quantity: Groundwater level

After the September field survey a new monitoring network of 49 points has been defined:

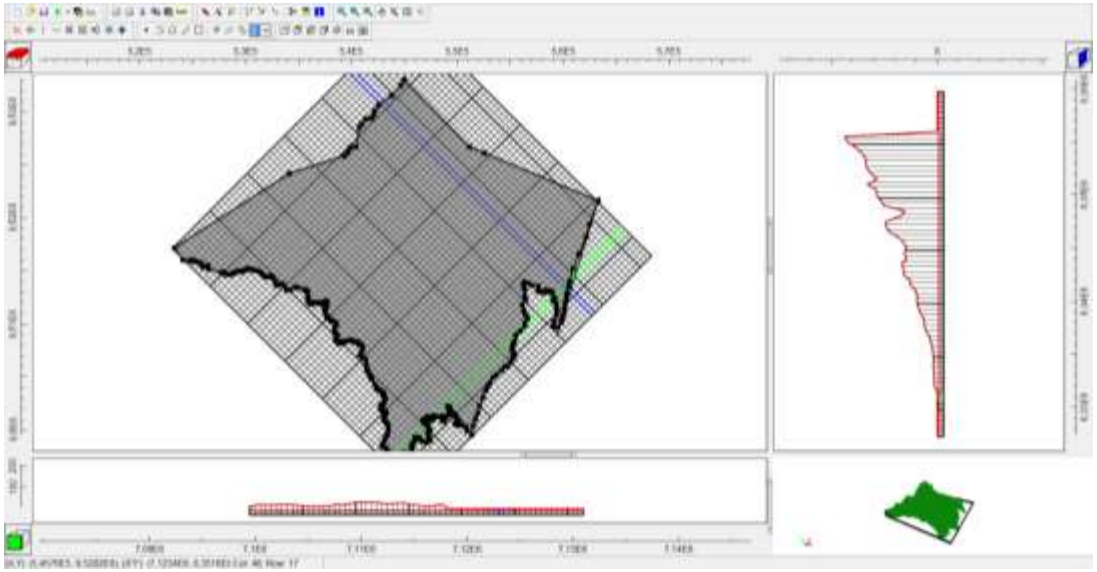
- 6 points surface water
- 34 points Quality and Quantity
- 5 points only water quality
- 4 points only water level

Groundwater flow model



Closed trees (broadleaved evergreen) on permanentl
Closed trees with shrubs
Mining (no vegetation or scarce)
Open general trees with shrubs with rainfed hervac
Open general trees with shrubs with rainfed tree c
Open trees (broadleaved deciduous) with closed to
Sugar Cane crops

Mesh model



Future work

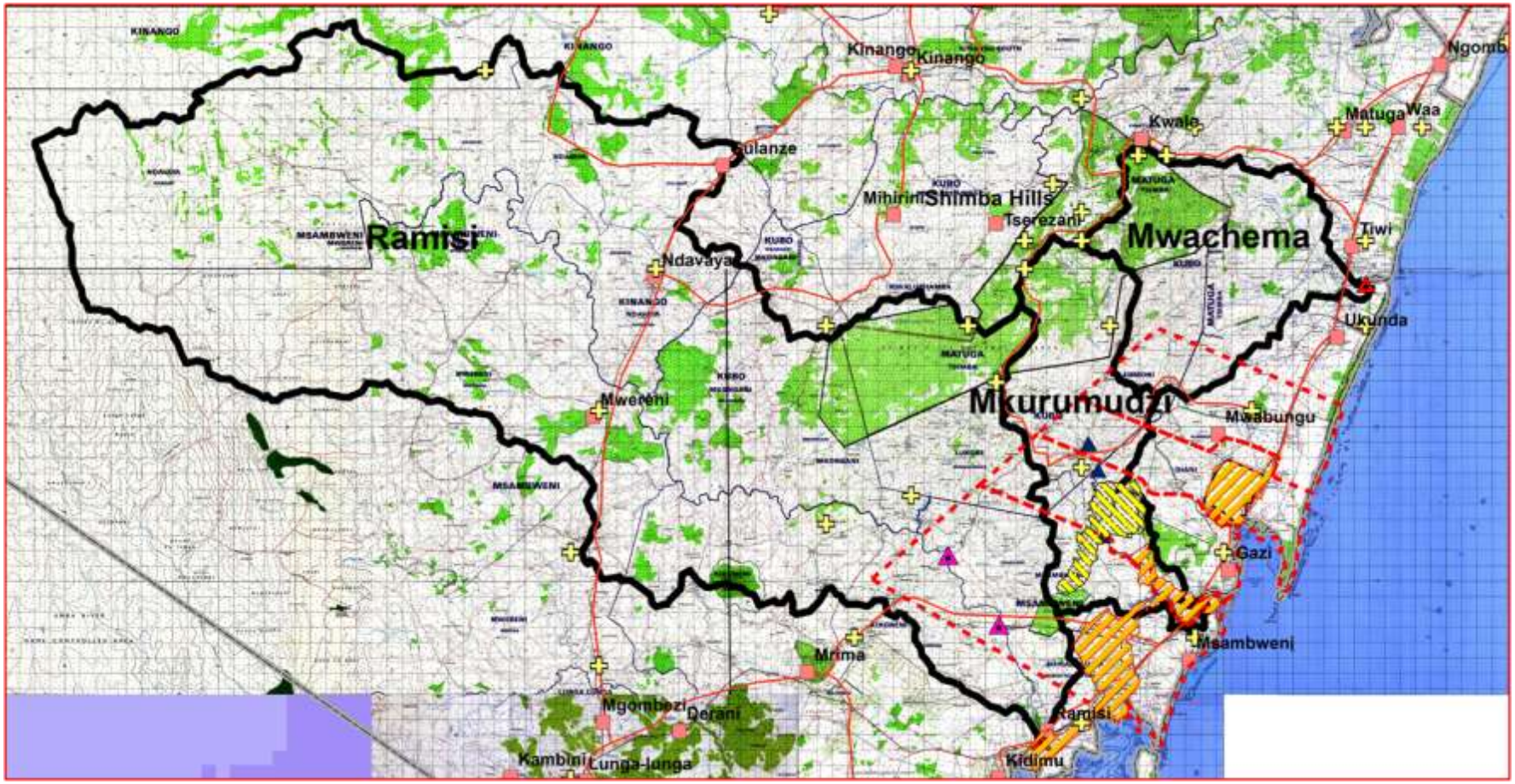
- March 2016 Field Survey (Dry Season)
- June 2016 Field Survey (Wet Season)
- Define the water balance (Recharge vs Abstraction /discharge)
- Keep integrating data and building the flow model

Climate and Surface water analysis

Prepared by

Prof. John M. Gathenya
Jomo Kenyatta University of Agriculture and Technology

Study area context



- Water demands by Kiscol, Base, Communities met from surface and groundwater sources
- Surface water and groundwater balance interactions through recharge, enhanced evaporation from irrigated/open water surface

Work Package objectives

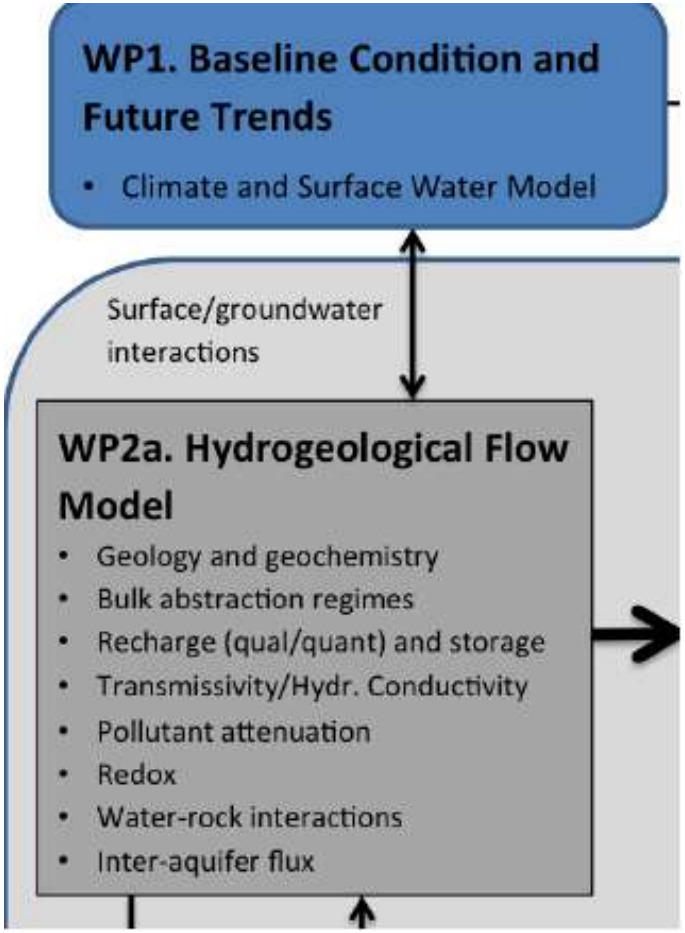
To characterize the surface water system

- Establish baseline conditions (rainfall and river flow, storage)
- Quantify interactions with groundwater system (recharge to shallow and deep aquifer)

Determine system behaviour in future

- Generate scenarios for abstraction from surface water to meet part of demand for Base Titanium Ltd., KISCO and community demands

Generate inputs for the groundwater risk management tool



Approach

Measure / collect historical data

- Rainfall
- Climate
- Stream flow in Mkurumudzi, Mwachema, Ramisi
- Water abstraction from rivers and reservoirs

(Data generated from existing Base Titanium Ltd. and KISCOL monitoring networks, WRMA RGS, KMD stations and Gro4Good environmental monitoring.)

Also compile Soil, land cover maps, topography needed for hydrological modelling

- Sensitivity of system to changes in climate conditions and changes in abstraction, water and land use.
- Hydrological modelling under different scenarios of uncertainty (climate, water demands)

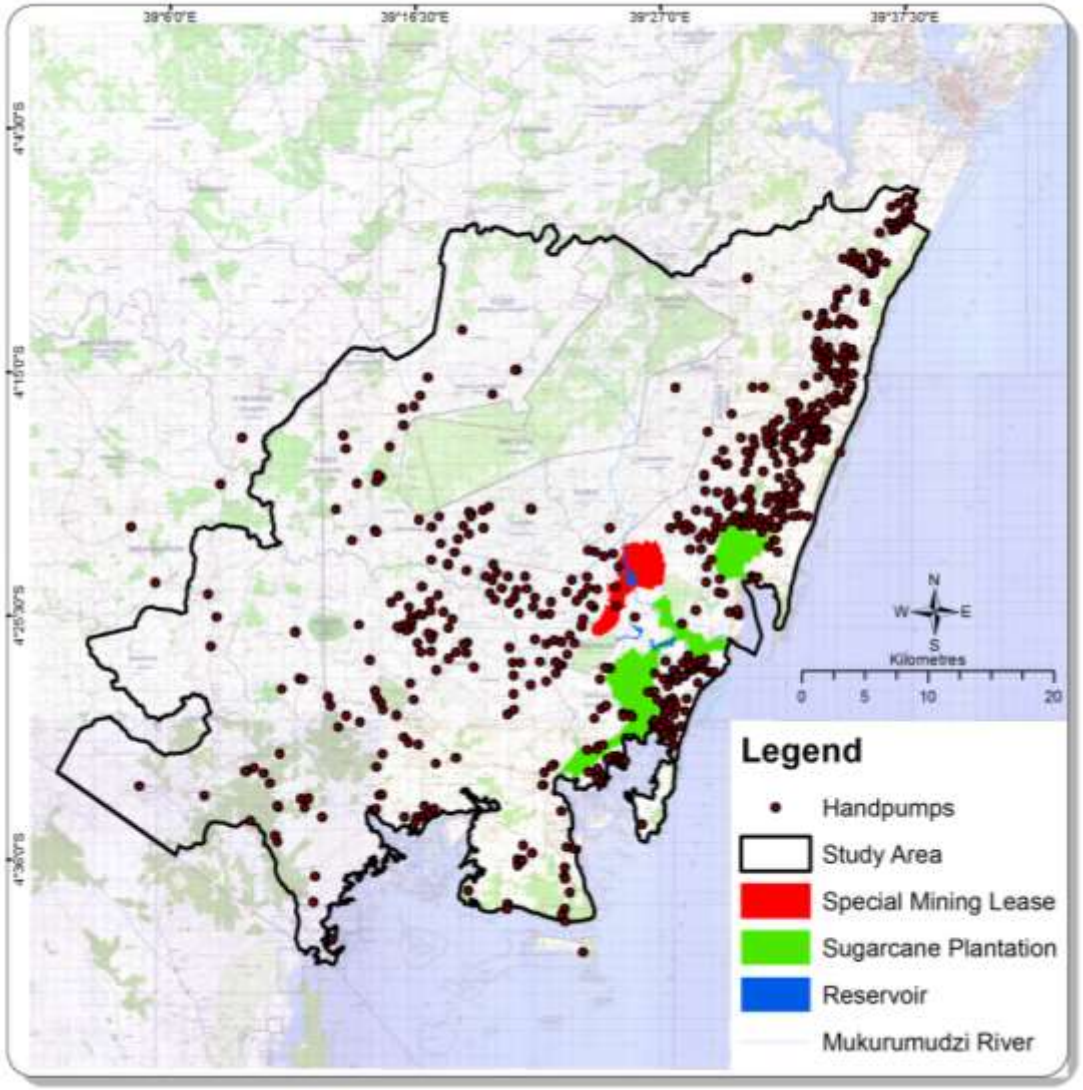
Installation of Hydromet Equipment

Poverty and Rural Water Sustainability

- Introduction (Prof. Rob Hope, Oxford)
- Welfare Mapping (Jacob Katuva, Oxford)
- Rural Water Sustainability (Eng. Patrick Thomson, Oxford)
- FundiFix Ltd. (Said Banje, FundiFix Ltd.)

Welfare Metrics

Prepared by;
Jacob Katuva and Johanna Koehler
(Oxford University)

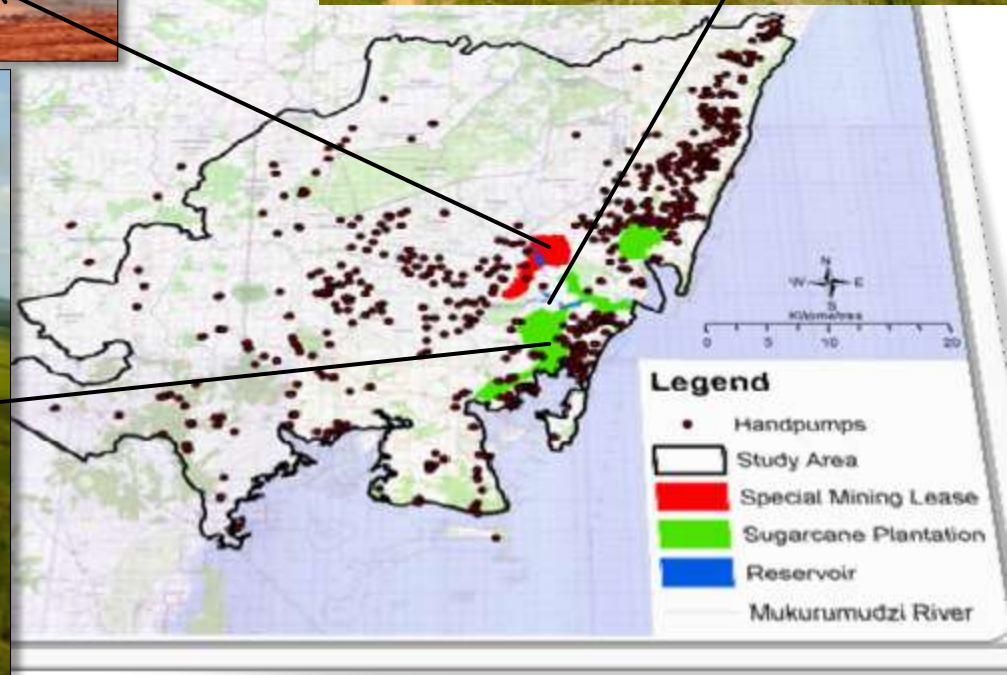


Major Investments in County

MINING OF HEAVY MINERAL SANDS

Surface Storage

SUGARCANE PLANTATIONS



Socio-Economic survey

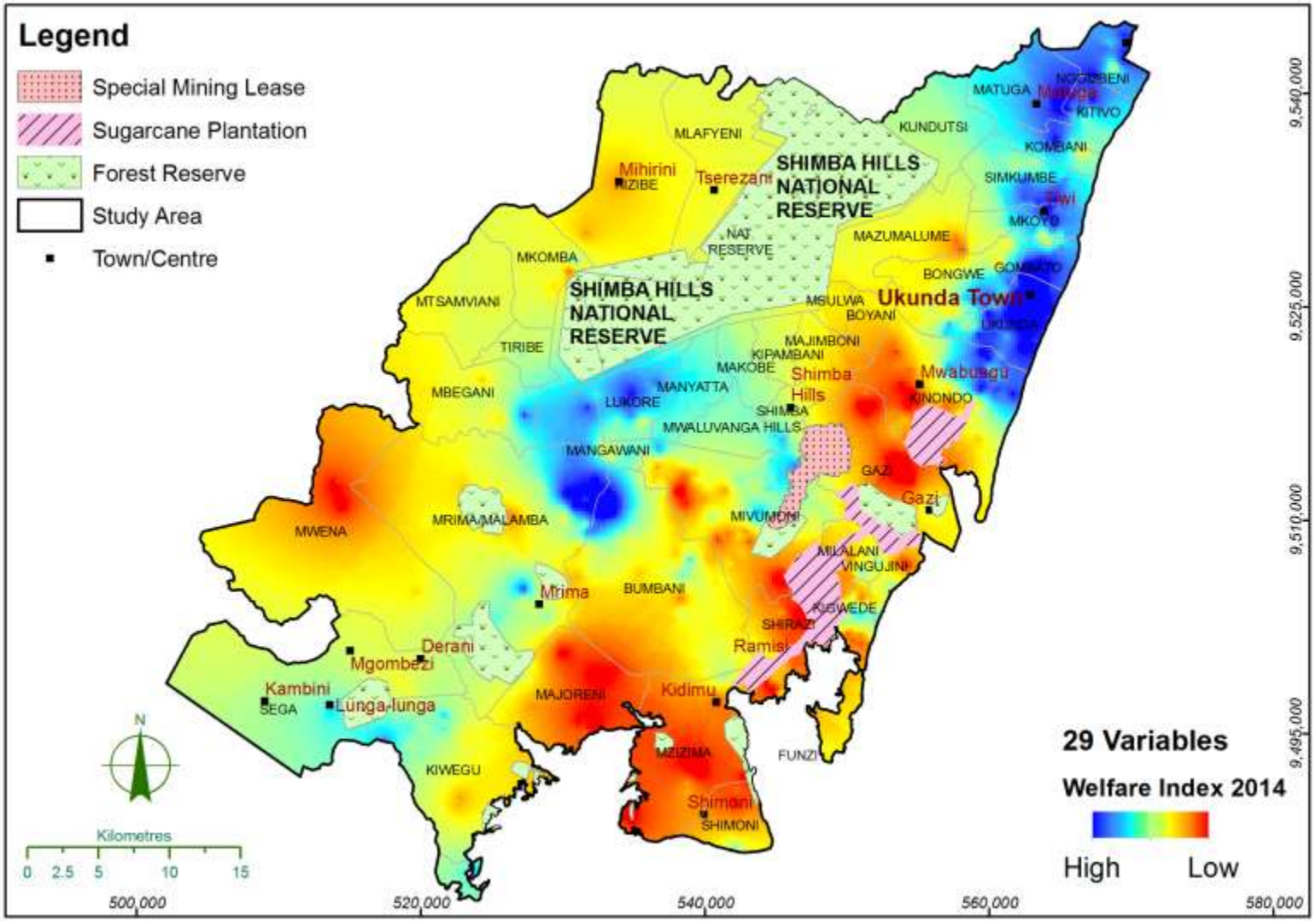
Training Field Teams

Communities and Water Usage

Household sampling and Survey

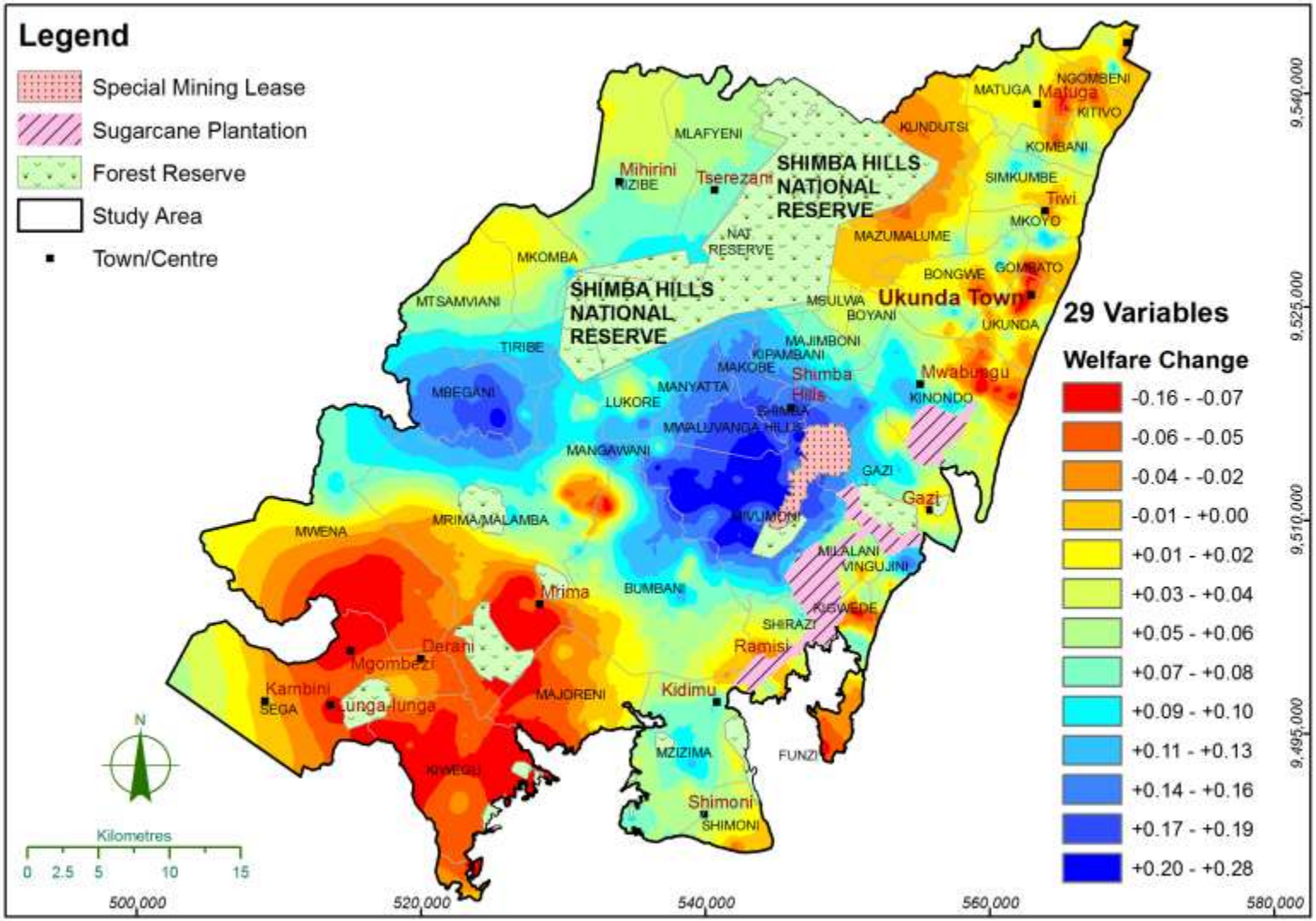
Poverty & Welfare (first round 2014, second round 2015)

- *sample of 3,229 households using 534 handpumps (next round Sep 2016)*



Poverty & Welfare (Transitions)

- *sample of 3,229 households using 534 handpumps (next round Sep 2016)*
- *Frequency of assessment; Poverty Interventions; Policy*

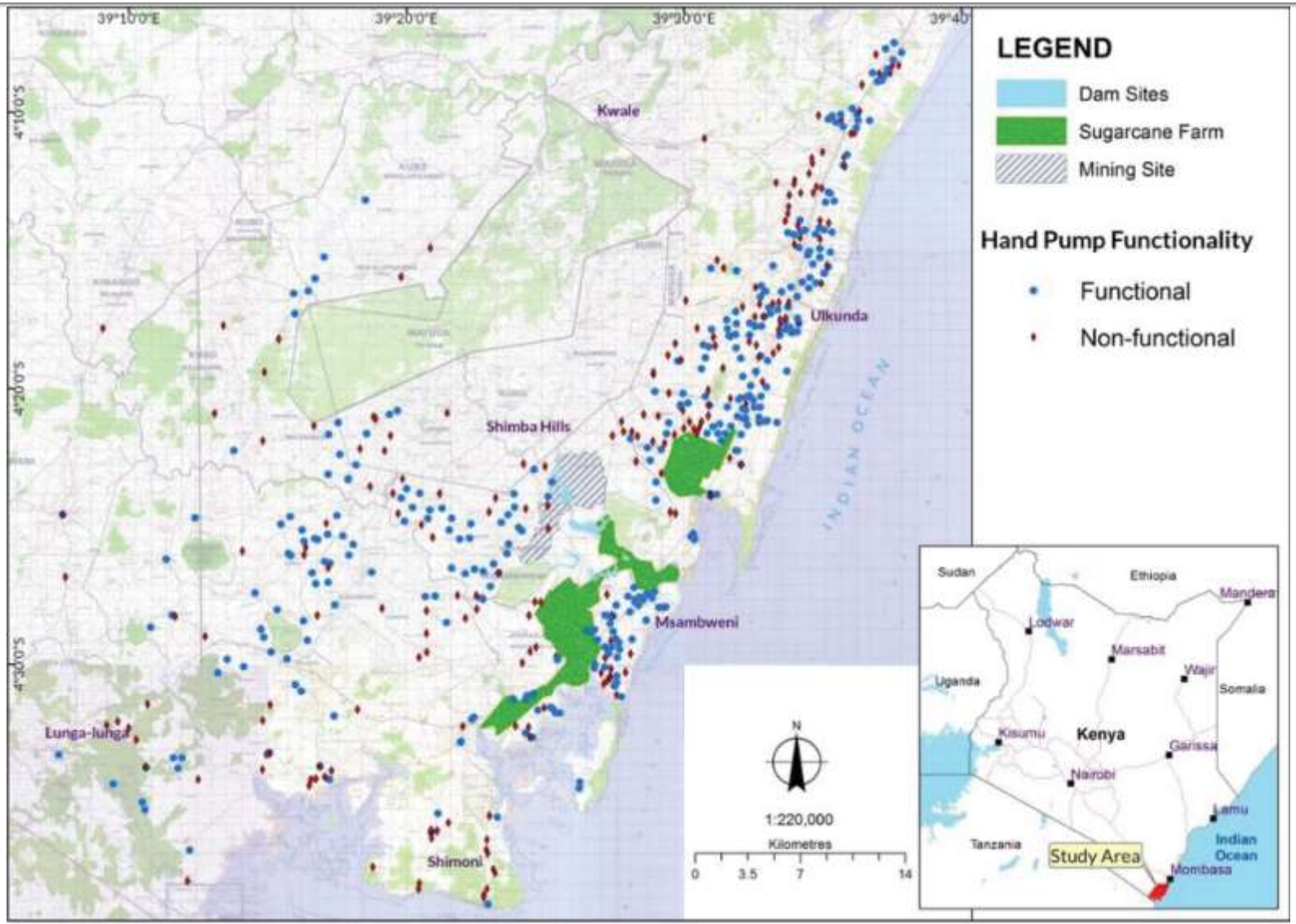


Rural Water Sustainability

Presented by

Eng. Patrick Thomson (Oxford University)
Said Banje (FundiFix, Kwale)

Waterpoint mapping and institutional analysis (October 2013)



Successful pilot of handpump maintenance model

- average down-time reduced from 37 days to < 3 days

- Initial study period: February 2014 – March 2015
- Two local mechanics performing over 25 repairs per month
- Average days to repair is < 3 days (most repairs <2 days)
- Free service extended until December 2015
- How do we make this sustainable?

Transition to community payment

- Evaluation indicates future payments will be contingent on service level (i.e. fast repairs)
- Creation of FundiFix Ltd.
- Not all handpumps or users will be willing (or able) to join based on survey evidence
- Globally, very few people pay for the full cost of their water
- How to support a maintenance service that benefits rural water users in Kwale?

How to achieve financial sustainability?

Cost-sharing (Tariffs, Taxes and Transfers):

- Communities are willing to pay a tariff
- What is the mechanism for County support (taxes)?
- Who else can support this financially (transfers)?
- Can the funds be managed transparently?
- How do we encourage long-term investment?

Conditions for County-level maintenance service

Pilot service can transition into a sustainable and inclusive locally-run service if:

1. Institutional cooperation led by County Government
2. Cooperation among all rural water partners (GoK, NGOs, SCRA, etc)
3. Accountability for service delivery
4. Effective monitoring system
5. Innovative finance to support rural water user payments

What will this service cost?

Indicative costs for maintaining 500 pumps:

(Variable cost per handpump: Ksh 8,450)

1.	Local variable costs:	Ksh 4,225,000
2.	Technical assistance:	Ksh 1,800,000
3.	Fixed costs (annualised):	Ksh 2,000,000
	Total annual cost:	**Ksh 8,025,000**
	Total cost per HP:	**Ksh 16,050**

FundiFix Kwale

FundiFix *KWALE*

Dhamira: Kutoa huduma endelevu ya utengenezaji wa maji kwa wepesi na unafuu kwa jamii za vijijini

- Huduma ya haraka (isiyozidi siku 3)
- Nambari ya usaidizi inapatikana wakati wowote
- Malipo nafuu ya kila mwezi
- Vifaa bora vinavyotolewa
- Mafundi walio na ujuzi na uzoefu
- Kampuni ya kuaminika na ya kutegemea

Kwa habari zaidi PIGA simu 0719 723000 ama TEMBELEA afisi zetu hapa Bomani

Nambari ya Pampu yako:

1000/- TU! kwa mwezi

(Mfano: 50/- kwa kila nyumba kwa nyumba 20)

Utapata manufaa gani kutokana na malipo yako?

- Huduma ya haraka isiyozidi siku 3 (au huduma ya mwezi mmoja bila malipo)
- Kubadilisha vifaa vilivyofunjika kwa vingine vipya na bora zaidi
- Mafundi walio na ujuzi na uzoefu na wanaopatikana kila wakati

Jukumu lenu ni nini?

- Kulipia huduma kwa kutumia M-PESA (kila mwezi, baada ya miezi mitatu ama kwa mwaka – vile ambavyo mtakubaliana)
- Kutoa usaidizi wakati wa marekebisho
- Kusajili nambari 10 za simu za wanajamii zitakazopokea ujumbe kila wakati wa malipo

Taarifa nyingine

- Huduma hii haitasimamia marekebisho yatakayo sababishwa na wizi wa vifaa, uharibifu ama kupungua kwa kiwango cha maji katika kisima

Discussion and Questions