GROUNDWATER RISK MANAGEMENT FOR GROWTH AND DEVELOPMENT (GRo for GooD)

Stakeholder workshop
Diani, Kwale County, Kenya

MARCH 23rd, 2015

NERC SCIENCE OF THE ENVIRONMENT
UPGro Unlocking the Potential of Groundwater for the Poor
E·S·R·C ECONOMIC & SOCIAL RESEARCH COUNCIL
UKaid from the British people

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Project Partners

introduction

Improved understanding of groundwater risks and institutional responses against competing growth and development goals is central to accelerating and sustaining Africa's development. Kwale County Government is responding to the challenges of improving water security under rapid climate, economic, environmental and political change.

The coastal aquifer system in southern Kwale faces a unique set of challenges to balance the demands of irrigated agriculture and mining with existing demands from tourism and community water supplies.

Since 2013 an international team of researchers led by Oxford University has worked with partners from Kwale County Government, the Water Resources Management Authority (WRMA), Water Services Regulatory Board (WASREB), Rural Focus Ltd., Jomo Kenyatta University of Agriculture and Technology, University of Nairobi, Base Titanium Ltd. and Kwale International Sugar Company (KISCOL) and Universitat Politècnica de Catalunya (Spain) to improve the understanding and governance of the groundwater resources to promote growth and development whilst conserving the resource base. The research aims to provide evidence of new approaches to promote water security, growth and development.

This report describes a one-day stakeholder workshop held at the Leopard Beach Hotel, Diani, Kwale County, on Monday 23rd March 2015 to present results of earlier research under the DfID supported project Unlocking Potential of Groundwater for Poor (UPGro) and to explore partnerships for the future phase of research under the Groundwater Risk Management for Growth and Development (GRo for GooD) project.

workshop objectives

The Workshop objectives were to:

- Share results from the UPGro and Handpump Sustainability Projects first phase of research and implementation (with stakeholders);
- Outline the focus of future research and activities;
- Discuss stakeholder collaboration.

The Workshop was attended by participants ranging from Government agencies to a broad range of NGOs, resident's associations, actors in water resources management and key investors in the County (see Annex 1).

The Workshop was opened by His Excellency the Governor of Kwale County, Salim Mvurya. His opening remarks stand as a suitable foreword to this Workshop report.

opening speech, H.E. Governor, Kwale

H.E. the Governor opened his remarks by welcoming attendees to Kwale County and, acknowledging the importance and usefulness of the Workshop, he stressed the importance of sharing knowledge.

"Groundwater and water in general is a subject which is of great interest and importance to the County Government. As such, the workshop contributes to Kwale Government development objectives. Achieving sustainable water management is not only of benefit to Kwale, it is important to all Kenyans and is a constitutional right. So this workshop is not simply an academic exercise, it should help strengthen the capacity of the Government of Kwale to support water supply provision.

"At present, water supply coverage in Kwale is at 50% of the population, which is not very good. In Kwale County the lower coast area boasts plenty of aquifers, some of which are fresh and some producing saline water; inland, the Mzima pipeline also supplies water. The County is actively looking at resources that will enhance water supply provision, and in this light the rehabilitation of the Mzima and Marere pipelines are being considered; these systems date from the 1950s and 1980s and their lifespans have expired. Dams are another possible resource. However, of greater importance to this workshop is the drilling of boreholes across the county, and to speed this, the County has purchased a drilling rig.

"Most aquifers in the County are served by handpumps, which break down frequently. Water service provision is currently regulated by the Water Act 2002, and enacted by Water Service Boards and Water Service Providers; companies formerly run by the County Councils and now run by the County Governments. Although there are sector regulators and key infrastructure providers, there are currently some conflicts between sector players. With time we have come to understand where the boundaries are, and the Coast Water Service Board, the Kwale Water and Sewerage Company and the County are now working together and the different mandates are more clearly understood.

"The National Government is working on a new Water Bill; in my opinion and in the opinion of the Council of Governors, this should not hamper devolution; we are concerned that the Bill is inconsistent with the Constitution and the spirit of devolution. Our efforts must be supported by suitable legislation, and in this regard we recognise the roles of the Water Resources Management Authority and other institutions. However, we must be aware that we have two layers of management. We recognise the investments of the Kwale International Sugar Company and Base Titanium Ltd. in our County, whose activities require large volumes of water for irrigation and mining; but the people's needs must come first and investment should respect this primacy. To this end, we expect the National Environment Management Authority and related organisations to stand firm in the support of water for the people.

"In identifying threats and risks to water resources, I expect this Workshop to look at what we have now and what we need in the future, so we can move comfortably forward and serve the people. I do not want to delay the start of this workshop, but I want to emphasise that we support the research project in its entirety."

With those remarks, he declared this workshop open and thanked the participants.

workshop programme

Session 1: Findings from the latest groundwater and poverty research. This included four presentations:

- Groundwater; overview of issues and management in Kenya
- South Coast Groundwater
- Rural Water Sustainability
- Groundwater and Poverty in Kwale

Session 2: Discussion of future research and the way forward, covering two presentations:

- Groundwater Risk Management Tool
- Rural Water Sustainability – monitoring and finance

Session 3: Breakout sessions with working groups of stakeholders discussing the way forward in respect of:

- Sustainable Finance for Rural Water Sustainability
- Groundwater risk management tool

Session 4: Plenary discussion and workshop close.

The presentations for each session are presented in Annexe 2.

Questions and answers for Sessions 1 and 2 are presented below followed by a summary of the discussions during the breakout sessions.

sessions 1 and 2: questions and answers

During the presentations there were question and answer sessions during which both the Groundwater Risk Management Tool and the Handpump Maintenance Service were discussed*.

Groundwater Risk Management Tool

Given the focus on water services, a number of delegates asked if the proposed risk management tool would consider environmental factors and wider catchment management. It was explained that the tool would be designed to consider environmental flows and ecosystem requirements as well, as the aim of the project is to consider both services and resources: "No resource, no service". The hydrological model would include calculations of surface water flows and groundwater seepage into mangroves, for example: like all data, these would be passed on to relevant stakeholders.

Issues of seasonality were raised, including the important question of re-use by the large abstractors. While figures for re-use were not available, it was noted that Base Titanium returns the majority of the water it uses back into the system. Likewise the project has data on seasonal variations in handpump usage through 2014 and into 2015.

One delegate asked if the tool would generate water quality or water quantity advisories to communities. This is something that would be developed in the Groundwater Risk Management Tool, such that, for example, during droughts we could advise on declining water levels in shallow aquifers. Similarly water quality advice that could be disseminated, for example the need to chlorinate water after certain events.

Handpump Maintenance Service

The issue of community buy-in being essential to the sustainability of any service scheme was brought up, using the example of Waa Location in Matuga: while 17 boreholes have been vandalized, nothing has been done about it. However, the same residents may pay up to 20 Ksh per 20 litre jerry can when no other options are available. Therefore absolute poverty and inability to pay is often not the issue.

There was a clarification to the presentation: the 500 handpumps was not the number in Kwale county, but figure to demonstrate the scale at which the proposed handpump maintenance service would operate and the likely costs. Likewise, the figure of 200 users per pump was indicative and these figures do not take into account the different distances people have to travel to the handpump.

**For presentations slides, see Annexe 2*

session 3 and 4

outcome of breakout sessions

A - Summary of Discussions in Working Group on "Sustainable Finance for Rural Water Sustainability"

Participants

Representatives of UNICEF, KMFRI, WASREB, Rural Focus Ltd., Kwale County Government, WRUAs, GIZ/IWaSP, Oxford University.

Discussion over whether rural water users should carry the full cost of operation

This is a feasibility and coordination challenge, with most countries failing to achieve full cost recovery in terms of O&M. Three main challenges in maintaining handpumps at the community level were identified by the working group:

-Institutional challenge: lack of adequate mechanisms to collect and store funds (insecurity of collected payments)
-Economic inability of communities when ad hoc payments are requested for immediate repairs
-Lack of local-level technical know-how and spare parts.

Discussion of a county-wide "maintenance service provider" with a linked "Kwale Water Fund"

-The role of the Kwale Water Fund would include
  a.Supervision
  b.Coordination
  c.Subsidies
  d.Capacity-building
-Communities would be empowered, as they have the choice to opt in or out of the system
-Communities would also play an important role in collecting handpump user payments
-Transparent allocation and management of funds would avoid inefficiency and corruption
-User fees and community tariffs would be ring-fenced from taxes and transfers
-The coordination of rural water sector activities would be through the Kwale WASH Forum. (The WASH Forum comprises 35 entities and representatives from inter alia CBOs, NGOs and the private sector.)

Financing

The Kwale County Government offered to contribute a budget of around Ksh 2 -3 million annually to set the fund up and keep it running.

session 4

outcome of breakout sessions

B - Summary of Discussion and in Working Group on "Groundwater Risk Management Tool"

Group participants were drawn from the following stakeholders: representatives of WRMA, WRUAs, KMFRI, Kenya Meteorological Services, SCRA, Rural Focus Ltd., Kwale County Government, Base Titanium Ltd., KISCOL, Plan International, JKUAT, UoN, UPC and Oxford University.

Collaboration and coordination

The GRo for GooD project members emphasized their interest in participating in existing appropriate county government coordination forums. It was established that the forums that are currently operational, which the project could participate in to report to stakeholders on an ongoing basis were:

-WASH Forum. The WASH forum has approximately 35 organisational members drawn from county government departments, government agencies, and civil society operational in the areas of water, sanitation and hygiene. The WASH forum is a successor to the WESCOORD forum that had a strong drought management and humanitarian response focus. The WASH forum is seen as a broader platform to share information and coordinate activities. The WASH forum is chaired by the County Government.
-Kwale Natural Resources Network. KNRN draws in organizational and individual members interested in environmental conservation within Kwale County. KNRN would provide a suitable platform to share project activities and findings with stakeholders.
-WRUAs. The Water Resource User Associations have membership drawn from local stakeholders in each sub-catchment. The WRUA meetings would provide appropriate opportunities for discussing project activities and findings.

It was further established that the project quarterly reports could be shared with stakeholders through the UPGro Website and if appropriate, through the Kwale County Government website.

Data management

The project environmental monitoring network to complement those of WRMA, KMD, Base Titanium and KISCOL. Other stakeholders were invited to state what other relevant data they have and would be willing to contribute. GRo for GooD project members reinforced the point that the release of data would be consistent with individual MOUs drawn up with the respective organizations. The project environmental monitoring data would be held in a project database which would be located in the local project office.

Stakeholder Level of Engagement

It emerged from the discussion that various stakeholders would be closely involved with the project activities, namely WRMA, County Government, Base Titanium Ltd. and KISCOL. Other stakeholders would be consulted in detail during the development of the risk management tool. These stakeholders included SCRA, WRUAs, KMD, and KMFRI.

Annexe 1: participant contacts

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Annexe 2: presentation slides

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

Leopard Beach Hotel, Diani
Kwale County, Kenya
23rd March 2015

Unlocking the Potential of Groundwater for the Poor

Workshop opening, aim and objectives

Official Opening – Kwale County Governor, HE Governor Salim Mvurya
Introductions
Workshop Aim : To improve groundwater management in Kwale County

Session 1 (9-1030am) - Presentations
1. Findings from the latest groundwater and poverty research

Session 2 (11-1230am) – Discussion
2.1 Achieving Rural Water Sustainability
2.2 Groundwater Risk Management Tool

Session 3 (2-330pm) – Working Groups
3.1 Sustainable Finance for Rural Water Sustainability
3.2 Groundwater risk management tool

Session 4 (4-430pm)
4. Plenary and workshop close

Session 1 – what we've done

1. **Groundwater – overview of issues and management in Kenya**
   Professor Dan Olago (University of Nairobi)
2. **South Coast Groundwater**
   Mike Lane (Rural Focus Ltd., Kenya)
3. **Rural Water Sustainability**
   Professor Rob Hope (Oxford University, UK)
4. **Groundwater and Poverty in Kwale**
   Jacob Katuva (PhD student, Oxford University, UK)

Session 2 – what we're doing next

1. **Groundwater Risk Management Tool**
   Eng. Mike Thomas, Rural Focus Ltd., Kenya

2. **Rural Water Sustainability – monitoring and finance**
   Patrick Thomson, Oxford University, UK

GROUNDWATER – AN OVERVIEW OF ISSUES AND MANAGEMENT IN KENYA

Prof. Daniel O. Olago

Institute for Climate Change & Adaptation (ICCA) and Department of Geology,
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Nairobi, Kenya

Email: Dolago@uonbi.ac.ke

Fellow: Geological Society of Kenya
Member: Kenya National Academy of Sciences

Africa Water Vision

Africa Water Vision for the Year 2025 and MDG water and sanitation targets

- “An Africa where there is an equitable and sustainable use and management of water resources for poverty alleviation, socio-economic development, regional cooperation, and the environment.”

Targets

- 75% reduction of the populations having no access to a hygienic and suitable system of drinking water-supply and sanitation before 2015.
- 95% of the populations having access to a hygienic and suitable system of drinking water-supply and sanitation before 2025.

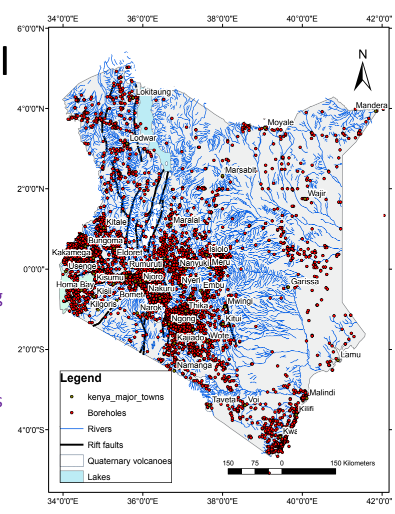
Context

- Over 300 million Africans don’t have access to safe drinking water
- About 14 African countries are under the distress of acute water shortage.
- 35 of the 55 countries around the globe where people have access to less than 50 litres per person per day are located in Africa.
- Almost 50% of the continent’s population suffers from one out of the six main water-related diseases.
- (+) less than four percent of Africa’s renewable water resources are withdrawn for agriculture, domestic supply and sanitation and industry

Water links Africa’s economic fortunes and climate change challenges.

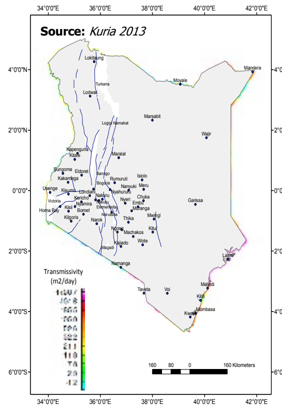
Picture courtesy nhm.ac.uk
Women and children collecting water for domestic use around Lake Victoria

- Kenya already experiencing water scarcity.
- Rapidly increasing demand for water (population growth, urbanisation, tourism, industry, agriculture)
- Groundwater aquifers are being increasing exploited due to scarcity of fresh surface water.
- Great (inter-annual) variation and unpredictability in amounts and distribution of rains in Kenya reflects in variable groundwater potential.



Kuria 2013

- Overabstraction, e.g. in Lake Naivasha area, one model suggests that abstraction in the mid-1990s exceeded by three to four times the considered 'safe' yield
- Falling water levels have led to increased pumping costs, estimated to be 860 million shillings/yr in Nairobi.
- In Daadab, the electrical conductivity of the water in boreholes has doubled since they were first drilled.
- Water-related conflicts are likely to rise with increasing water scarcity.



Groundwater has been accorded a very low profile, partly because it is a largely invisible resource, and yet it is heavily exploited particularly during drought periods.

Challenges

- Groundwater development has proceeded without an adequate scientific evidence base
- Distribution of groundwater not well known in many cases
- There is currently no rational allocation of water, for example:
  - there are no water balance studies upon which one can base a rational allocation of water.
  - Inadequate groundwater information database
  - low understanding of how to use groundwater sustainably (e.g. case of salinisation in Dadaab area)

Subsector	2010 (a)	2030 (b)	(b)/(a)	2050 (c)	(c)/(a)
	(MCM/year)	(MCM/year)	(%)	(MCM/year)	(%)
Domestic	1,186	2,561	216	3,657	308
Industrial	125	280	224	613	490
Irrigation	1,602	18,048	1,127	18,048	1,127
Livestock	255	497	195	710	278
Wildlife	8	8	100	8	100
Fisheries	42	74	176	105	250
Total	3,218	21,468	667	23,141	719

Source: JICA Study Team (Ref. Main Report Part A, Section 6.10 and Sectoral Report (G), Sub-section 3.3.1 (3))

Challenges (cont.)

- Partnering with political leadership – high influence at grassroots through to national level
- Evidence based policy – how do scientists and policy makers interact?
- Advocacy for wise and efficient use and conservation of the water resource – who does this? How are they coordinated?
- Management of water resources is sector based, not holistic
- Water resources information is typically fragmented, unreliable and out-of-date
- Social and ecosystem issues/needs often ignored for economic gain, or "we know best" attitude when designing and building water infrastructure – contributes to low success/adoption rates
- Low "water awareness" amongst the communities
- Lack of adequate finance to roll out programmes - financing for the water sector has been on an increase, but the portion going to groundwater is still quite deficient.

What can be done to promote innovative research and outreach?

- Partnering with policy makers through e.g. project embedding
- Partnering with industry – joint projects, student attachments;
- Partnering with Civil Society, NGOs and Community Based Organisations
- Recognition of actions required at different scales and setting up of coordinated networks and institutions to address the issues at appropriate scales
- Build and harmonise solutions-oriented databases
- Provision of adequate funding through Public-Private Partnerships (PPPs)

Conclusions

1. Provide an adequate and sharable knowledge base within which we can embed practical, low cost and sustainable solutions
2. Harness coordinated funding to tackle the issues, problems and risks at relevant scales
3. Grow institutions to coordinate and network at appropriate scale
4. Effectively pool together all stakeholders – policy and decision makers, innovators, practitioners, end-users and local communities to collectively address their specific water needs
5. Grow critical mass in and through academic and research institutions
6. Plan ahead.

SOUTH COAST GROUNDWATER

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Introduction

- Geology of the study area
- Aquifer types – deep aquifers
- Shallow aquifers
- Uncertainties – groundwater risk
- Uncertainties – how much groundwater is available?
- Groundwater for development
- Where next?

Geology of the Study Area (Map 1)

Aquifer types – deep aquifers

Deep aquifers are confined and occur in
- Triassic sediments (Maji ya Chumvi and Mariakani); west of the Shimba Hills.
- Jurassic sediments (Mazeras, Kambe and Mtomkuu); the Shimba Hills and to the east and south east of the Shimba.
- Pleistocene sands (Kilindini Formation); the Tiwi aquifer system between Bixa and Ngombeni.

Deep groundwaters may also occur occasionally in Pleistocene age corals (Kilindini Formation) along the Coastal Strip (e.g. Vingujini, Msambweni area), uncertain.

Significant deep aquifers

1

Aquifer types – shallow aquifers

Shallow aquifers are unconfined and occur in
- Pliocene sands (Magarini Formation); the range of sandy hills between the Shimba Hills and the Coastal Plain.
- Pleistocene sands (Kilindini Formation); between the sand hills and the Lunga Lunga to Likoni Road.
- Pleistocene age corals (Kilindini Formation) along the Coastal Strip.

We have yet to review shallow aquifer tests, but of 252 SIDA-constructed boreholes, the highest test discharge rate was 20m^3/hr and the average was 2.5m^3/hr.

19

Shallow aquifer distribution

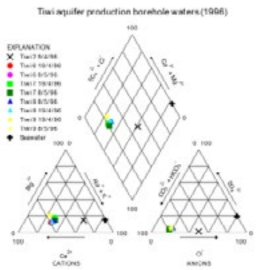
2

Uncertainties – Groundwater Risk

Although groundwaters are usually safe, aquifers in the South Coast are at risk from a number of potential hazards:

- Shallow aquifers face contamination from pit latrines and wastewater; this is known to have occurred already.
- Over pumping from shallow aquifers close to the sea risks saltwater intrusion, which has already occurred in the Diani area.

Intensive abstraction from the deep aquifer system might influence water levels or water quality in the shallow aquifer system in the long term and could induce saltwater intrusion.



Uncertainties – how much groundwater is available?

The next study phase will use a variety of methods to determine recharge and safe yields from different aquifers, building on current understandings:

- Marere springs: current abstraction 12,000m^3/day
- Tiwi aquifer: current abstraction is 13,000m^3/day, groundwater potential 20,000m^3/day (? "safe")
- 'Msambweni aquifer system' current abstraction uncertain, groundwater potential 30,000m^3/day or more (? "safe").

The renewable shallow aquifer resource across the entire South Coast is unknown, but is of the order 50,000m^3/d. This needs to be refined.

RURAL WATER SUSTAINABILITY

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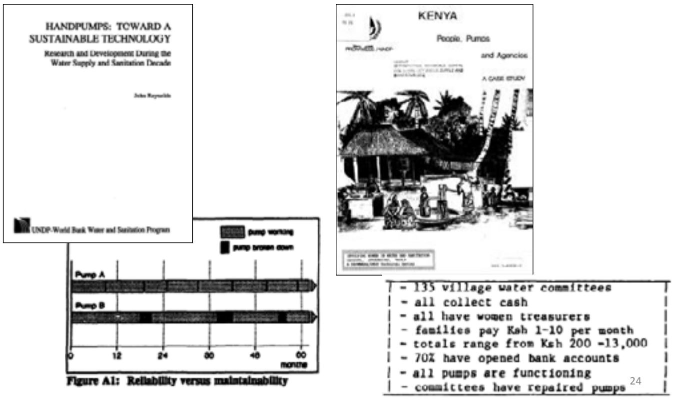
1. Kwale's Handpump Legacy
- A history of innovation but elusive sustainability



What's changed in the last 25 years?

- the challenge and opportunity for Kwale County Government

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135 village water committees
all collect cash
all have women treasurers
families pay Ksh 1-10 per month
totals range from Ksh 200 -13,000
70% have opened bank accounts
all pumps are functioning
committees have repaired pumps
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World Bank (1988)

rpoint mapping (2013)

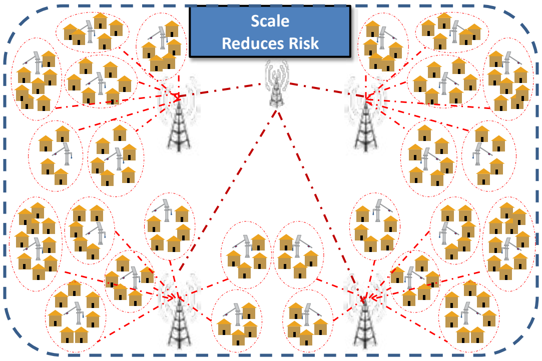
- 50% of working handpumps have committees
- 90% of wells are boreholes (57% are SIDA installations)
- 28% don't collect any fees
- Of fee paying, average per family is Ksh46 per month
- 49% women members on committee
- 4% store money in a bank account
- 30% of pumps are functioning
- 37% have fundi in community

2. Study Design

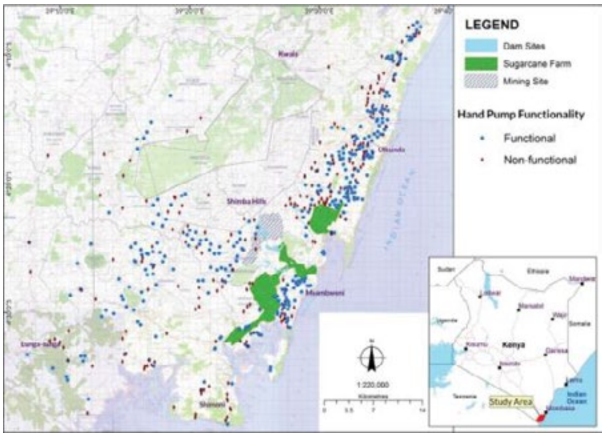
a) Waterpoint mapping (n=549, Oct 2013);
b) Installation of 303 (smart) transmitters (Feb 2014);
c) Household surveys to monitor impacts (1st round 2014; 2nd round 2015)
d) Environmental monitoring system

Of 303 functioning Afridev handpumps, **300 have transmitters installed**.

213 receive repairs from the project mechanics to evaluate the new maintenance model compared to **87 which continue with community management.**



Waterpoint mapping and institutional analysis (Oct, 2013)



Building capacity and generating new employment for Kwale County

New company

- Kwale Handpump Services Ltd.

Local Project Staff:

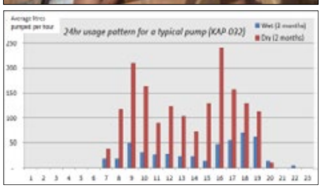
- Manager based in Bomani
- Mechanics in Msambweni and Ukunda

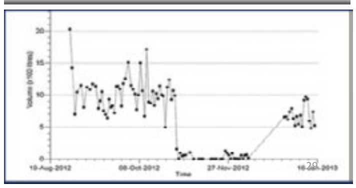
Part-time Staff:

- 21 x enumerators from across the county
- 2 x team leaders

3. What is a smart handpump?

A smart handpump has a GSM transmitter securely fitted in the handle of the pump. The transmitter automatically sends data on handpump water use via SMS over the mobile network. A user interface provides immediate performance metrics. The transmitter is small and robust with no moving parts. Installation is simple, enabling it to be retrofitted to existing pumps in the field or built into new pumps prior to deployment.





Why install transmitters?

1. **Measurement** of handpump usage and associated volumetric water use to monitor service delivery;
2. **Surveillance** of maintenance service delivery and down-time to guide performance-based contracts;
3. **Accountable** and objective data that can improve infrastructure planning and investment, and promote sector accountability.

4. Results

- what is the profile of households (n=3,401)?

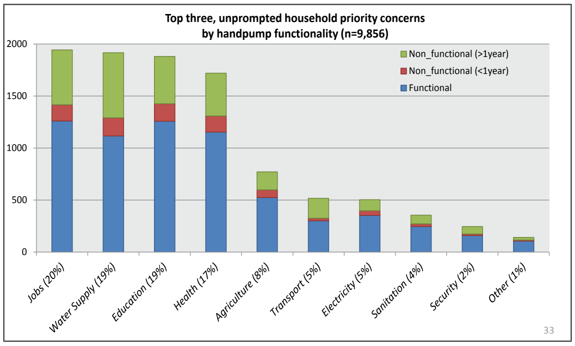
- Many with no income (46%) and limited education (no schooling, 31%)
- High mobile ownership (84%) but low access to electricity (7%)
- Unimproved (bush/field=45%) or low (pit with slab, 46%) sanitation access

Water access seems high (>80%) until affordability, reliability, quality and proximity are considered

- the poor have 3-5 times worse service delivery than the wealthy

		Water user assessment		Global metric (JMP)	
		Dry season	Wet season	Dry season	Wet season
Improved		(n=2,778)	(n=2,827)	(n=2,778)	(n=2,827)
	Accessible (“close”)	63.6%	65.3%	81.7%	83.1%
	Affordable	13.9%	14.5%		
	Reliable	31.5%	30.4%		
	Safe to drink	44.8%	45.8%		
Unimproved		(n=622)	(n=574)	(n=622)	(n=574)
	Accessible (“close”)	27.0%	35.0%	18.3%	16.9%
	Affordable	1.6%	1.0%		
	Reliable	27.3%	29.1%		
	Safe to drink	8.5%	8.7%		

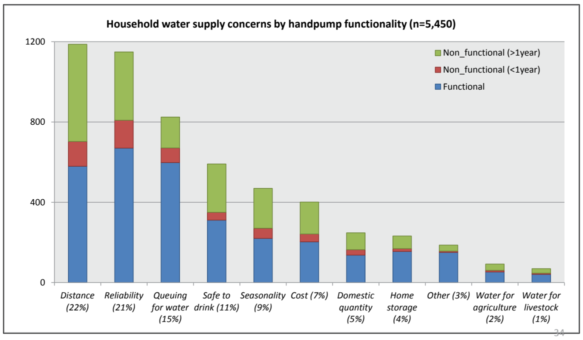
Unprompted concerns for households prioritise jobs, water supply, education and health



Major water concerns with distance, reliability and queuing

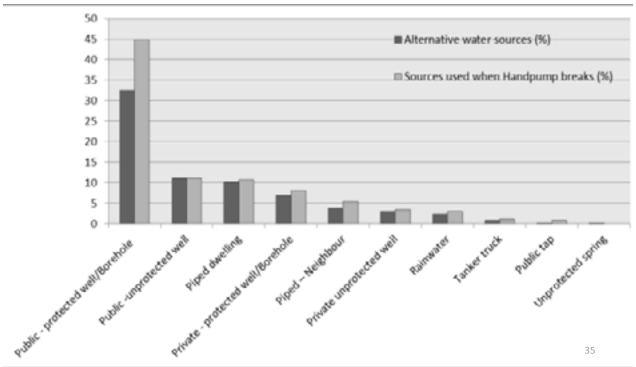
– reliability main concern for functioning handpumps

– distance main concern where handpumps are broken

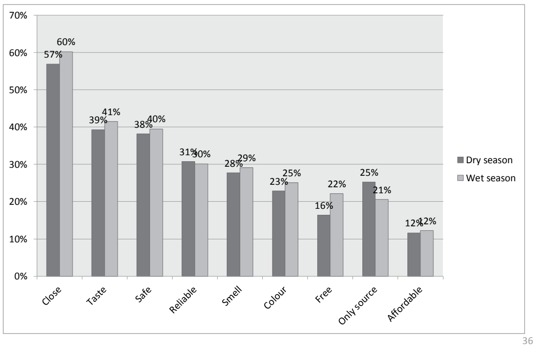


Kwale communities depend on handpumps for:

(a) households main water source, (b) main alternative source and (c) the main source when handpumps break



Reasons for choosing main drinking water source - proximity, taste, safety & reliability



Drinking water sources used in dry season: handpump failures lead to *32% fall in safe water access*

WHEN HANDPUMP FUNCTIONAL

Source	% HHs
Improved	**93.4%**
REFERENCE_HANDPUMP	82.6%
Other_handpump	2.8%
Piped_to_neighbour_s_yard	2.1%
Public_tap_Kiosk	1.7%
Piped_to_yard_dwelling	1.3%
Submersible_pump_PRIVATE_	1.2%
Protected_well_PRIVATE_	0.5%
Protected_well_PUBLIC_	0.4%
Submersible_pump_PUBLIC_	0.3%
Rainwater_collection	0.3%
Bottled_water	0.1%
Unimproved	**6.6%**
Surface_water	2.6%
Unprotected_well_PUBLIC_	2.5%
Unprotected_well_PRIVATE_	0.9%
Cart/bicycle_with_tanks/drums/jerricans	0.6%
Tanker_truck	0.0%

WHEN HANDPUMP NON-FUNCTIONAL

Source	% HHs
Improved	**61.1%**
Other_handpump	25.0%
Piped_to_neighbour_s_yard	10.9%
Submersible_pump_PRIVATE_	7.1%
Public_tap_Kiosk	5.3%
Protected_well_PRIVATE_	3.0%
REFERENCE_HANDPUMP	2.7%
Protected_well_PUBLIC_	2.5%
Piped_to_yard_dwelling	2.0%
Submersible_pump_PUBLIC_	1.7%
Rainwater_collection	0.5%
Bottled_water	0.2%
N/A – Repaired immediately	0.2%
Unimproved	**38.9%**
Unprotected_well_PUBLIC_	**17.3%**
Surface_water	**13.1%**
Unprotected_well_PRIVATE_	**6.6%**
Cart_bicycle_with_tanks_drums_jerricans	2.0%
Tanker_truck	0.0%

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Drinking water sources used in wet season: handpump failures lead to *30% fall in safe water access*

WHEN HANDPUMP FUNCTIONAL

Source	% HHs
Improved	**94.4%**
REFERENCE_HANDPUMP	80.7%
Rainwater_collection	4.5%
Other_handpump	2.3%
Piped_to_neighbour_s_yard	2.0%
Public_tap_kiosk	1.7%
Piped_to_yard_dwelling	1.2%
Submersible_pump_PRIVATE_	1.0%
Protected_well_PRIVATE_	0.4%
Submersible_pump_PUBLIC_	0.4%
Protected_well_PUBLIC_	0.4%
Bottled_water	0.1%
Unimproved	**5.6%**
Surface_water	2.4%
Unprotected_well_PUBLIC_	1.8%
Unprotected_well_PRIVATE_	0.8%
Cart_bicycle_with_tanks_drums_jerricans	0.6%
Tanker_truck	0.0%

WHEN HANDPUMP NON-FUNCTIONAL

Source	% HHs
Improved	**64.5%**
Other_handpump	22.8%
Piped_to_neighbour_s_yard	10.8%
Rainwater_collection	7.7%
Submersible_pump_PRIVATE_	6.9%
Public_tap_kiosk	5.2%
Protected_well_PRIVATE_	2.7%
REFERENCE_HANDPUMP	2.6%
Protected_well_PUBLIC_	2.2%
Piped_to_yard_dwelling	1.8%
Submersible_pump_PUBLIC_	1.4%
Bottled_water	0.2%
N/A – Repaired immediately	0.1%
Unimproved	**35.5%**
Unprotected_well_PUBLIC_	**15.1%**
Surface_water	**12.4%**
Unprotected_well_PRIVATE_	**6.4%**
Cart_bicycle_with_tanks_drums_jerricans	1.7%
Tanker_truck	0.0%

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Handpump use, collection, user perceptions of water safety, quality & treatment practices

Handpump use

Use	DRY SEASON	WET SEASON
Cooking/Washing/Bathing	71.7%	66.5%
Irrrigation	4.9%	0.5%
Livestock	16.0%	7.0%
Ave trips to HP per day	**3.0**	**2.0**
No. of jerricans per day	**5.9**	**3.7**

User perception of HP water

Attribute	DRY SEASON	WET SEASON
Good Taste	62.8%	66.0%
Good Colour	85.8%	87.3%
Good Smell	87.1%	88.3%

Water collection responsibilities

Main water collector	% HHs
Adult_female	86.9%
Adult_male	9.1%
Female_child <15_years	2.5%
Male_child <15_years	1.5%

Water collection – by time of day

Person	Before 8am	8am-4pm	After 4pm
Adult_female	76.3%	32.3%	61.1%
Adult_male	6.5%	2.1%	5.7%
Female_child <15_years	4.6%	1.3%	10.9%
Male_child <15_years	1.9%	0.5%	4.8%

Percentage of users describing water as safe to drink

DRINKING WATER SOURCE	DRY SEASON	WET SEASON
Piped_to_yard_dwelling	98%	100%
Submersible_pump_PUBLIC_	97%	100%
Bottled_water	100%	100%
Submersible_pump_PRIVATE_	98%	99%
Public_tap_Kiosk	98%	99%
Piped_to_neighbour_s_yard	99%	99%
Other_handpump	96%	95%
Protected_well_PRIVATE_	93%	92%
REFERENCE_handpump	85%	92%
Rainwater_collection	91%	88%
Cart_bicycle_with_tanks/drums/jerricans	84%	88%
Protected_well_PUBLIC_	91%	83%
Unprotected_well_PRIVATE_	**68%**	**72%**
Unprotected_well_PUBLIC_	**62%**	**61%**
Surface_water	**42%**	**37%**

Water treated?

Is water treated?	% HHs
No	83.6%
Yes – both wet & dry season	14.9%
Yes – Wet season only	1.0%
Yes – Dry season only	0.5%

Treatment types used

Treatment type	% HHs
Chlorine	14.2%
Boil	2.4%
Strain	0.2%
Stand and settle	0.1%

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Handpump finances: who, when and where

HOW OFTEN ARE FEES PAID

Payment frequency	DRY SEASON	WET SEASON
per jerrican / bucket	51.6%	51.7%
per month	35.1%	34.8%
per week	10.9%	10.9%
per year	1.2%	1.4%
free	1.2%	1.2%

WHO IN HH PAYS FEES

Person	% HHs
Female_adult	51.4%
Male_adult	47.5%
Female_child_15_years_	0.5%
Male_child_15_years_	0.4%
Other	0.2%

WHO COLLECTS FEES

Collector	% HHs
Water_committee_treasurer	71.2%
Handpump_attendant_caretaker	25.1%
Owner_of_handpump	2.5%
Other_water_committee_member	1.3%

WHERE ARE FUNDS STORED

Location	% HHs
Home_of_the_treasurer	75.8%
Home_of_handpump_attendant	14.4%
Bank_account	4.2%
Home_of_handpump_owner	2.4%
Other	2.1%
Home_of_other_committee_member	0.9%
Rotating_savings_and_credit_assn	0.2%

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Speed of handpump repairs drivers user satisfaction

USER SATISFACTION WITH HANDPUMP MAINTENANCE

Satisfaction level	Functional Handpump	Non-Functional Handpump (<1 yr)	Non-Functional Handpump (>1 yr)	Total
Very_satisfied	24.4%	1.4%	1.3%	**16.7%**
Satisfied	50.9%	18.9%	7.6%	**37.3%**
Neither_satisfied_or_dissatisfied	7.4%	7.9%	8.5%	**7.7%**
Dissatisfied	14.8%	52.1%	46.8%	**26.0%**
Very_dissatisfied	2.5%	19.6%	35.8%	**12.3%**

DRIVERS OF SATISFACTION

Driver	Cause of satisfaction	Cause of dissatisfaction
Frequency of breakdown	23.3%	11.0%
Cost of repairs	11.7%	16.4%
Speed of repairs	33.6%	23.8%

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Financial sustainability

- 1 in 5 communities keep payment records and manage handpump access improving sustinability

Characteristics	Records available (n=100)	Records unavailable (n=376)	All[a] (n=476)	p-value[b,c]
Functional (% waterpoints)	97.0	48.7	58.8	<0.001
pH ≥ 6.5 (% waterpoints)[d]	70.3	70.7	70.6	0.951
Distance to spare parts (km)	25.3	23.1	23.5	0.196
Mechanic in community (% waterpoints)	50.0	41.8	43.5	0.139
Electrical conductivity (uS/cm)[d]	1150	1171	1164	0.873
Locks (% waterpoints)	77.8	43.7	51.4	<0.001
Attendants (% waterpoints)	50.5	32.7	36.7	0.001
Bank account (% waterpoints)	13.0	2.4	4.6	<0.001
Education higher than primary (% households)	44.6	37.2	38.9	0.007
Grass/makuti roof (% dwellings)	58.9	71.4	68.5	<0.001
Electricity within 1km (% waterpoints)	65.0	59.6	60.7	0.323
Years of waterpoint management	23.6	20.3	21.1	<0.001
Distance between households and waterpoint (m)	166.9	133.3	141.0	0.004
Alternative water source available (% waterpoints)	82.0	85.6	84.9	0.367

Source: *Foster et al., forthcoming*

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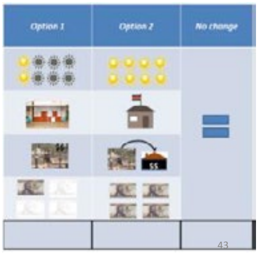
Improving payment behaviour is contingent on significant improvements in repair times

	Attributes	Model 1 coeff.	Model 1 std.error
Payment level	Household payment per month	0.000	0.000
	Pay - Ksh50 (USD0.54) per month	-0.050	0.097
	Pay - Ksh100 (USD1.08) per month	-0.101	0.104
	Pay - Ksh150 (USD1.61) per month	-0.572*	0.098
	Pay - Ksh200 (USD2.16) per month	-0.489*	0.090
Payment mode	Community treasurer	-1.236*	0.079
	Cash to bank	-0.878*	0.085
	MPesa to bank	-1.211*	0.076
Service level	Days to repair handpump	-0.002*	0.000
	2 days to repair	0.180*	0.057
	4 days to repair	0.133**	0.061
	6 days to repair	-0.163**	0.078
	8 days to repair	-0.900*	0.100
Private sector maintenance provider		-0.095**	0.048

Choice Experiment analysis (n=1,570)
Hope et al., forthcoming



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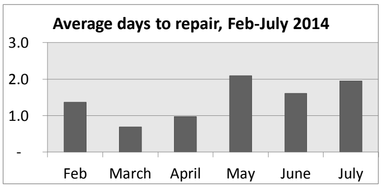
Successful pilot of handpump maintenance model

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

- Pilot period: February 2014 – March 2015
- Two local mechanics performing over 25 repairs per month
- Most pumps in treatment group (213/300) have received a repair visit
- Average days to repair is < 3 days (most repairs <2 days)



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GROUNDWATER RISK AND POVERTY

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Introduction

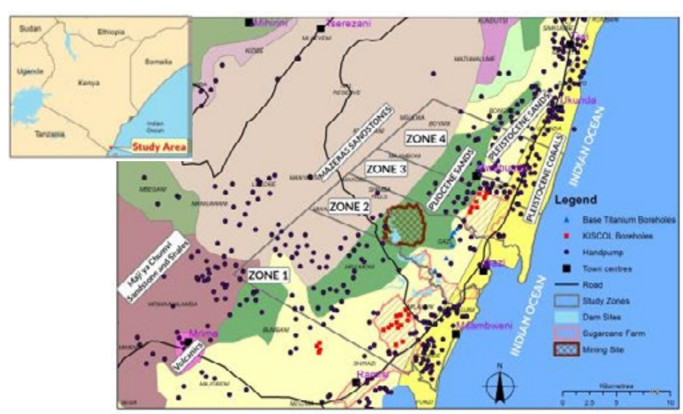
A one year, UPGRo Catalyst Grant funded by UK research councils and DFID explored baseline conditions with the support of national (WRMA, WASREB) and County government, Base Titanium Ltd., and KISCOL from Sept 13 – August 14.

Key activities in catalyst gran

- ❑ **Hydrogeology**
- ➢ Conceptual aquifer model developed.
- ➢ Network of water level monitoring.
- ➢ Weekly field chemistry monitoring at 36 points.
- ➢ Dry and wet season water chemistry analyses.
- ❑ **Groundwater poverty**
- ➢ 3,401 household survey.
- ➢ A multi-dimensional welfare index with 27 indicators constructed.
- ❑ **Groundwater governance**
- ➢ Institutional transformations in the Kenyan water sector assessed through stakeholder interviews.
- ➢ Focus group discussions were conducted with Water Resources User Associations in Kwale County.

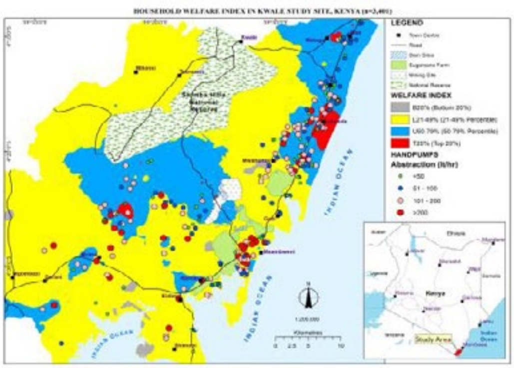
Why Kwale?

- interactions and unknown impacts between large scale groundwater abstractors and over 300 handpumps serving over 50,000 rural water users



Multidimensional poverty

- sample of 3,401 households using 534 handpumps (next round March 2015)
- comparing different poverty metrics with handpump usage



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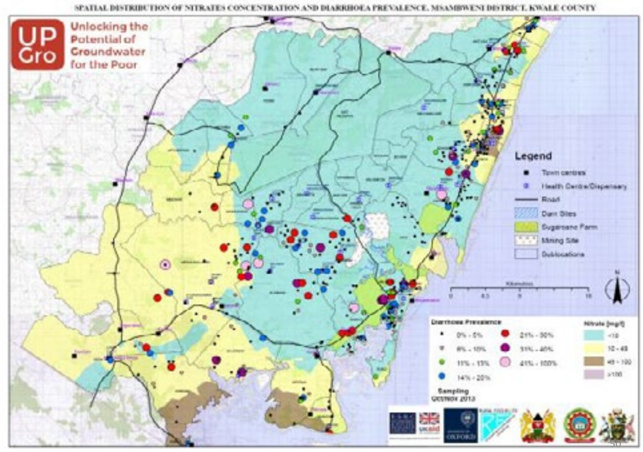
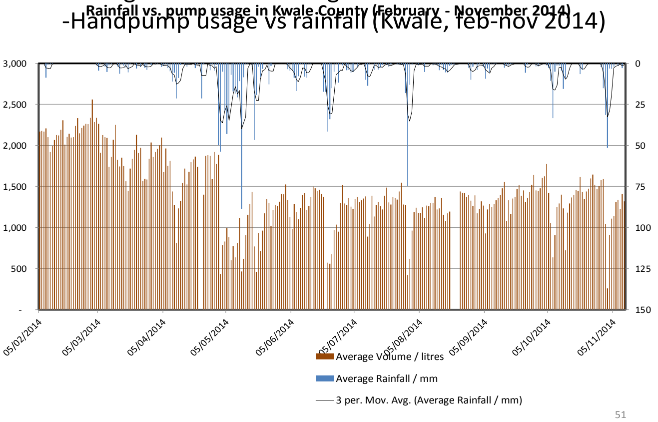


New insights into water usage to inform better decisions
-Handpump usage vs rainfall (Kwale, feb-nov 2014)



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GROUNDWATER RISK MANAGEMENT TOOL

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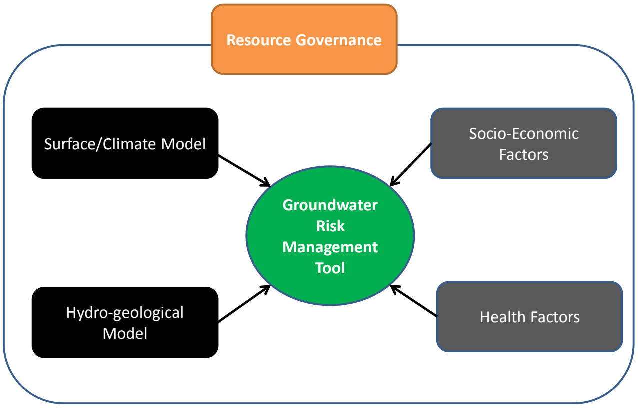
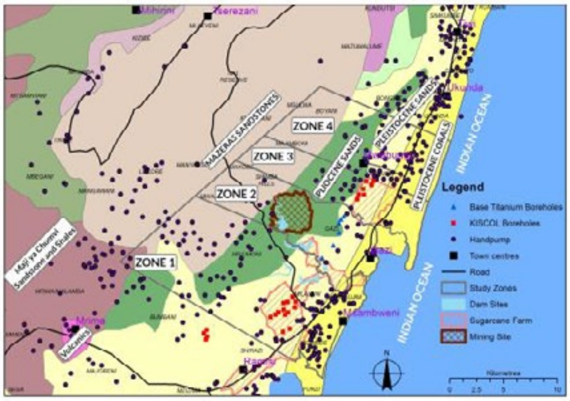


REPLICABLE AND SCALABLE TOOL (MODEL) that provides the ability to examine groundwater risks to water supply and economic productivity

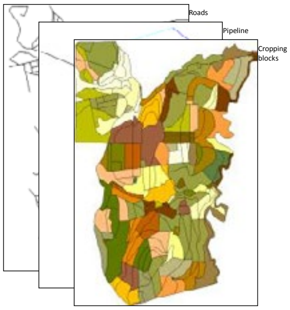
Complex Environment



SPATIAL DATABASE

Components

1. Topography
2. Drainage networks – rivers, lakes, water features
3. Land use
4. Geology
5. Land cover/vegetation
6. Administrative units
7. Population
8. Socio-economic data
9. Boreholes & other water supply features



ARC-GIS Platform

Surface/Climate Component

A. Environmental Monitoring Network

- Complement existing networks (WRMA, KMD, BASE, KISCOL , Project)

1. **Rainfall & Climate**
   - 2 (new) automatic weather stations, 18 daily rain gauges & rainfall chemistry (Cl, isotopes) (sampled 2x)
2. **Streamflow**
   - Existing river gauging stations
   - 2No. automatic water level recorders
   - River water chemistry – Mkurumudzi, Ramisi, Mtawa, Mwaweche)
3. **Water Levels** – reservoir levels (BASE, KISCOL)
4. **Abstraction**
   - Support User, WRUA & WRMA data collection systems

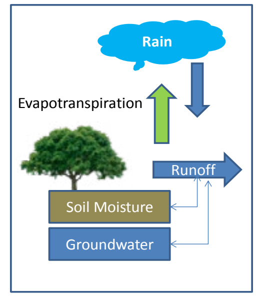
Map of Surface Water/Climate Monitoring Network

Surface / Climate Component

B. Surface – Climate Modeling

1. Catchment Rainfall
2. Evapotranspiration
3. Streamflow analysis & baseflow separation
4. Rainfall-runoff modeling (NAM/Mike 11)
5. Reservoir simulation (Mike Basin)
6. Water balance model

►Ability to determine water balance at different points in catchment



Hydro-geological Component

A. Environmental Monitoring

1) Shallow Aquifer – distributed across 4 zones

- 70+ shallow wells sampled weekly/bi-weekly/quarterly for depth & field water chemistry (T, EC, pH)
- 42 sites project sites to be sampled seasonally (wet/dry) for physical, isotopic & bacteriological analysis
- 5 loggers available for shallow water level time series
- 2No. Conductivity-Temperature-Depth (CTD) Loggers for saltwater intrusion monitoring
- Pump testing (simple pumping tests)
- Abstraction
  - estimated from Smart Handpump Data (300 wells)
  - Flow meters on pumped wells/BH

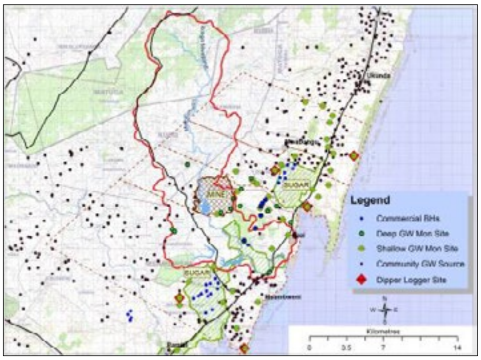
Hydro-geological Component

A. Environmental Monitoring

2) Deep Aquifer
– distributed across 4 zones

- 13 sites (Project, BASE, KISCOL) to be sampled weekly for depth (or logged) & water chemistry sampled seasonally (wet/dry) for physical, isotopic, & bacteriological
- Pump testing data/analysis available
- Abstraction estimated from data submitted to WRMA

Map of Groundwater Monitoring Network



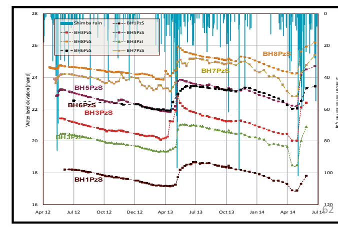
Understanding Resource System

B. Hydro-geological Modeling

i. Improving understanding of geology
   - 2D geophysics (3 transects – total 50km)

ii. Abstraction – recharge relationship (shallow & deep aquifers)

iii. Recharge, water quality & depth (shallow aquifer)
   - pH changes
   - Saline intrusion
   - Nitrate pollution



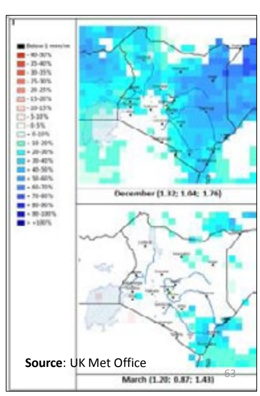
Future Trends

Rainfall, Near Future (2025)

Scenario Analysis

1. Climate Change
- Using trends drawn from local historical data sets
- Using results from downscaled global climate models (1960 – 2100)

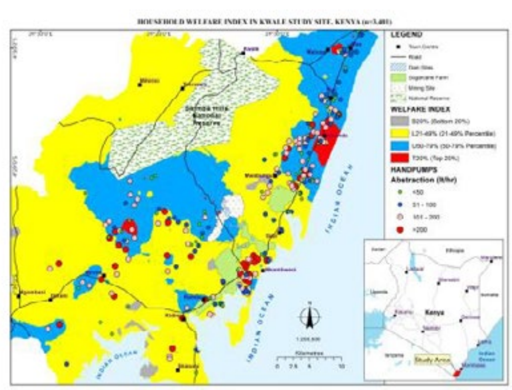
2. Changes in Water Demand
- Increase in domestic and urban demand
- Expansion of irrigated agriculture
- Change in water use efficiency
- Change in mining activity



Source: UK Met Office

Multidimensional poverty

Sample of 3,401 households using 534 handpumps (2 repeat surveys 2016, 2017)
Comparing different poverty metrics with handpump usage
Exploring Water-health relationships



Building Groundwater Risk Management Tool

- Linking bio-physical data with socio-economic data
- Co-develop tool with government, corporate, academic & community
  - Build utility & ownership of tool
- Define data reduction options & demands on monitoring systems
- Test scenarios for future trends
- Explore options for wider applications beyond Kwale

Q1: Which part of Kwale county would benefit most with piped water?

Q2: Which part of Kwale has seasonal contamination of water supplies and would benefit from chlorine tablets for household water treatment?

Key Issues Going Forward….

1. Collaboration & coordination
   i. Local project office (staff, logistics)
   ii. Quarterly updates emailed
   iii. Local WASH/WRM coordination structures
2. Data collection, archival and dissemination
   i. MOUs under discussion
   ii. Protocols to be developed
3. Interaction on tool development
   i. Who & scale of involvement

FINANCIAL SUSTAINABILITY FOR RURAL WATER SERVICES

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Successful maintenance service pilot project

1. 369 repairs for 213 handpumps over 12 months.
2. Average 1.7 repairs per pump per year
3. Mean days to repair <3 days.
4. Detailed information on handpump breakages and maintenance costs.
5. New data on pump and water usage generated.

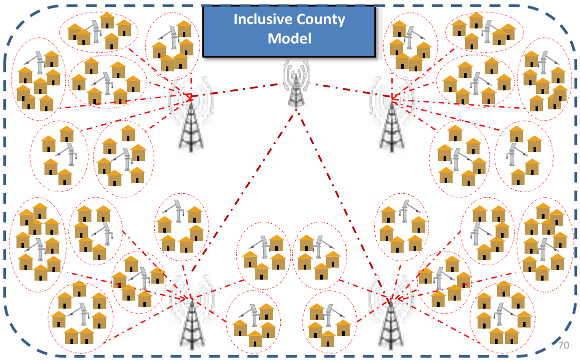
What did this service cost?

Local variable costs for maintaining 200 pumps:

Total (one year): Ksh 1,690,000
Total per handpump: Ksh 8,450
Total per household: Ksh 200

1. Labour: (35%)
2. Spare parts: (30%)
3. Transport: (15%)
4. Other costs: (20%)

Handpump maintenance and monitoring efficient only at scale – County level



Benefits of continuing the maintenance service

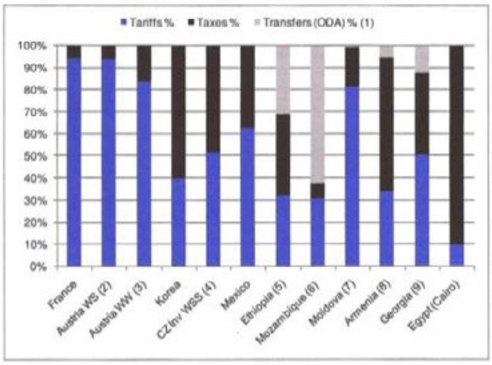
1. More reliable water services continue for ~40,000 rural water users.
2. Real-time information on handpump usage for County and national monitoring and water service regulation.
3. Better understanding of rural water use patterns.
4. Maintenance company builds local capacity and ownership.

Will handpump users pay for maintenance services?

- Pilot offered a free trial service for one year.
- Evaluation indicates future payments will be contingent on service level (i.e. fast repairs).
- Not all handpumps or users will be willing to join based on survey evidence:
  - Poorer households
  - Minority of well-run handpumps
- Globally, very few people pay for the full cost of their water.

Cost-sharing to support sustainable services – global evidence (OECD, 2009)

Figure 2.1. **Shares of official development assistance, national governments and users in water supply and sanitation finance in various countries**



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How to achieve financial sustainability?

Tariffs, Taxes and Transfers:

1. What is the breakdown of these three?
2. Where do the transfers come from?
3. How are the funds managed transparently?
4. How do we encourage long-term investment?

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How to achieve operational sustainability?

Sustainable Management:

1. How is the service provider incentivised to deliver a high quality service?
2. How are relevant stakeholders included in the decision making process?
3. How is the management structured to be cost-effective?

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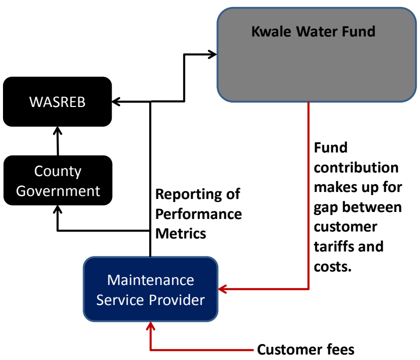
Conditions for County-level maintenance service

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

1. Agreed boundaries (County?)
2. Cooperation among all rural water partners (GoK, NGOs).
3. Accountability for service delivery.
4. Effective monitoring system.
5. Innovative finance to support rural water user payments.

Proposed Kwale Water Fund



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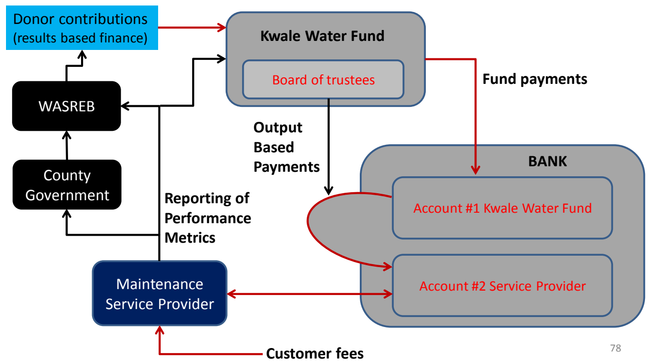
Proposed Kwale Water Fund



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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

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How much is the funding deficit?

Costs for maintaining 500 pumps: Ksh 8,025,000
(Ksh 16,050 per pump)

User tariffs per HP per month: Ksh 500
Fees per HP per year: Ksh 6,000
Annual user fees from 500 HP: Ksh 3,000,000
(user contribution ~37%)

Annual shortfall: Ksh 5,025,000
(Ksh 10,000 per pump, or Ksh ~250 per household)

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Benefits of collaboration

County Government

1. Targeted investments to meet County strategy.
2. Key role in coordination and monitoring

Payment by results

1. Donors (international agencies, NGOs, private sector) tie payments to verifiable results.

Return on Investment

1. **Ksh 50 per person** per year for sustainable and reliable rural water services for **100,000 people** using 500 handpumps.

Sessions 3 and 4

Session 3 (2-330pm) – Working Groups

3.1 Sustainable Finance for Rural Water Sustainability (Chair, Rob Hope; Rapporteur)

3.2 Groundwater Risk Management Tool (Chair, Mike Thomas; Rapporteur)

Session 4 (4-430pm)

4. Plenary – Rapporteurs, discussion and action points

Concluding comments and workshop close

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

Leopard Beach Hotel, Diani
Kwale County, Kenya
23rd March 2015

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