REACH

Improving water
security for the poor

Country diagnostic report

Kenya

Contents

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Executive summary

Kenya is one of Africa's most dynamic and entrepreneurial economies, but one with increasing water security risks. Kenya's implementation of decentralisation from 2010 reflects its commitment to reduce enduring inequalities by establishing 47 county governments in 2013. With a clear mandate, county governments offer a new institutional architecture to address a portfolio of growth and development challenges, including water security for the poor.

Current income poverty and multidimensional welfare monitoring do not capture the impact and implications of water shocks or long-term human exposure to water risks. Periodic surveys provide snapshots which weakly relate to major flood or drought shocks, chronic exposure to poor water quality or exclusion from basic water resources or services. Vulnerable individuals (children, urban poor, elderly, ill) are merged into household data and are thus largely invisible or ignored.

With increasing water security risks there is a need for 'climate services', whereby scientists work with decision makers to explore the resilience of their decisions to climate variability and change. Current gaps include lack of data about rainfall variability, extremes and future changes, which are relevant both for short-term operational decisions and for long-term strategic planning. These data needs to be presented considering impact-relevant water security metrics with user defined thresholds and decision-relevant spatial scales. This knowledge will help establish whether strategies put in place for current water security will survive the near-term manifestation of climate change.

Kenya's advances in mobile ecosystems are one response to its water security and poverty challenges. Mobile technologies offer 'accidental infrastructure' to provide high quality, low cost and remote data to support decision-making. Mobile platforms narrow the distance between data and decision-making. Political accountability can be enhanced with electoral cycles and physical proximity recalibrating decision-making processes and priorities.

The University of Oxford is building science-practitioner partnerships with county governments, the Ministry of Water and Irrigation, the Water Services Regulatory Board, UNICEF, the University of Nairobi to **establish Water Security Observatories for 'small towns and fragile lands' in Turkana County and 'build water secure institutions' in Kitui County**. Impacts and implications of the work will support wider regional initiatives to improve water security for millions of poor people.

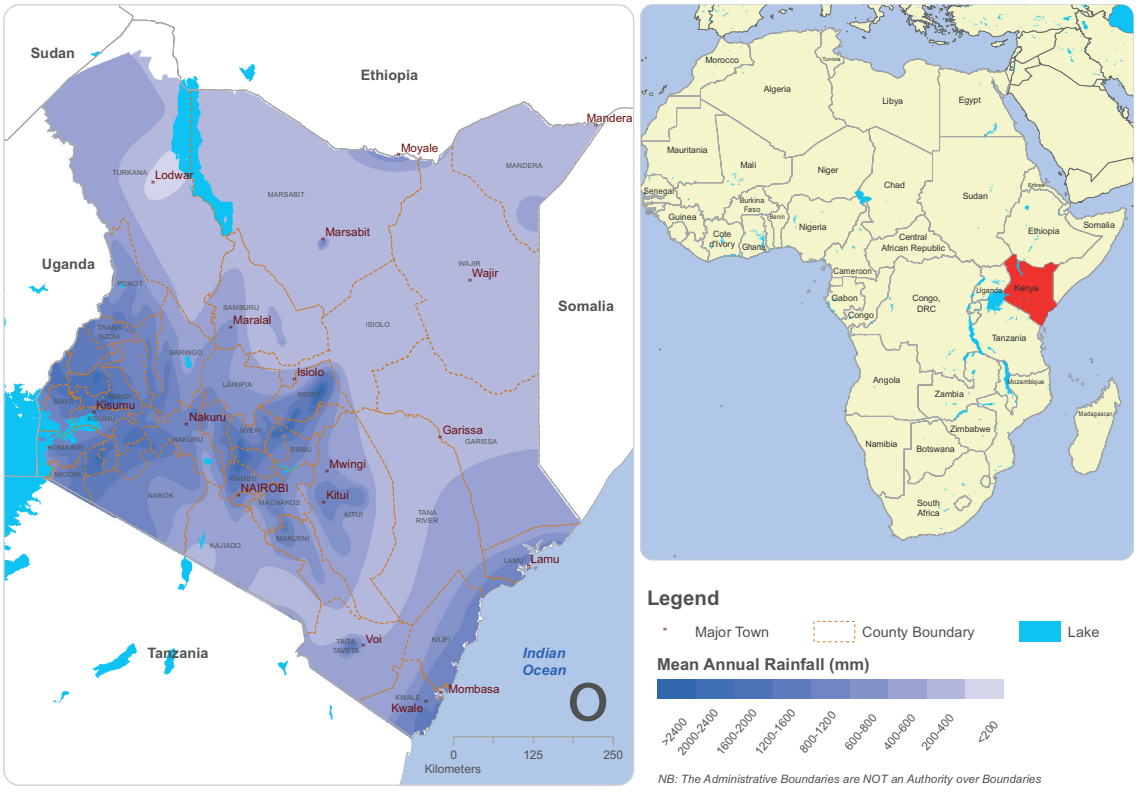
1 Improving water security for the poor in Kenya

1.1 Kenya – profile and progress

Kenya's 44 million people live in a physically and socially diverse landscape. Forty two ethnic groups are dispersed across the Great Rift Valley, running from Ethiopia to Tanzania, around Mount Kenya in the central highlands, and along the shores of Lake Victoria and the Indian Ocean. Four fifths of the land is arid or semi-arid with extremely variable rainfall supporting half the nation's livestock and around a third of its people. Kenya remains a lower middle income country with high levels of inequality, a headcount poverty rate of 45% (2005), and ranking 147th out of 187 countries in the low, human development category (2013)[1].

Four significant but uncertain developments will interact to determine Kenya's progress to achieve its target of middle-income status by 2030 and improve water security for 17 million poor people: (1) the impacts of decentralisation, (2) resilience to climate shocks, (3) reducing inequality, and (4) harnessing mobile ecosystems.

Figure 1: Map of Kenya by county boundaries, highlighting the variability in average annual rainfall across the country.



1.2 Decentralisation – bringing power to the people?

Decentralisation became a 'revolutionary megatrend' in the 1980s and 1990s – defined as a process in which central governments cede power to lower levels in political, administrative and territorial systems.[2,3] However, in practice, the extent of these decentralisation reforms varied strongly and is often limited to administrative deconcentration.[4] Over 80% of developing countries have adopted some form of decentralisation due to widespread international support and the expectation of measurable development impacts.[5] Many African countries, including Tanzania, Uganda, Zambia, and South Africa, have followed different institutional transitions with varying impacts on service delivery and development. In states with strong marginalised groups decentralisation can be a policy response to state fragility. Three components of state fragility are often identified[6]: (1) failure of authority (i.e. authority to protect the citizens from violence); (2) failure of legitimacy (if the state enjoys only limited support by the people); and (3) failure of comprehensive basic service provision. While the first two are central pillars of any political system, the latter links stabilisation measures such as decentralisation to service delivery, including in the water sector. It is important to understand a state's rationale for introducing decentralisation as the effects on determination and political will are expected to be significant, depending on the impact on the voters.

Kenya's post-election violence of 2007/08 gave rise to a process of reform including the Constitution of 2010 and the present process of decentralisation. It has set Kenya on a new trajectory, which resulted in the establishment of 47 county governments in 2013. Together with the national government, they pursue the objectives of social and economic development, participation and 'proximate, easily accessible services throughout Kenya'.[7] The introduction of democratically elected, sub-national governments takes into account tension between national citizenship and ethno-regional identification. Decentralisation has gone further in Kenya than in other sub-Saharan African countries with a strong capacity of county governments to resist attempts of the national government to interfere in decision-making.[8]

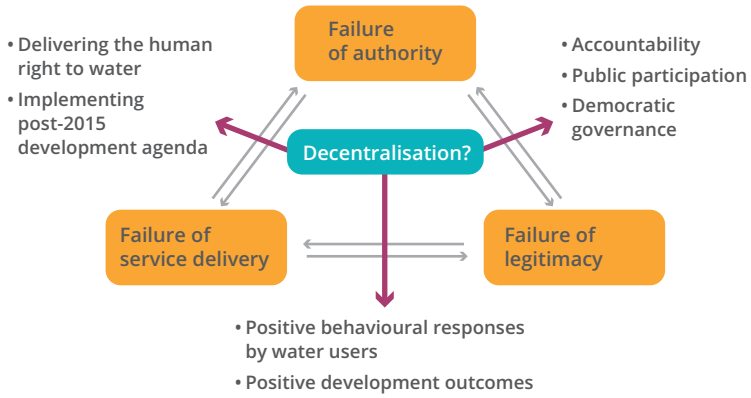


Figure 2: Decentralisation and State Fragility, highlighting the links to water supply. Adapted from Stewart and Brown, 2010.[6]

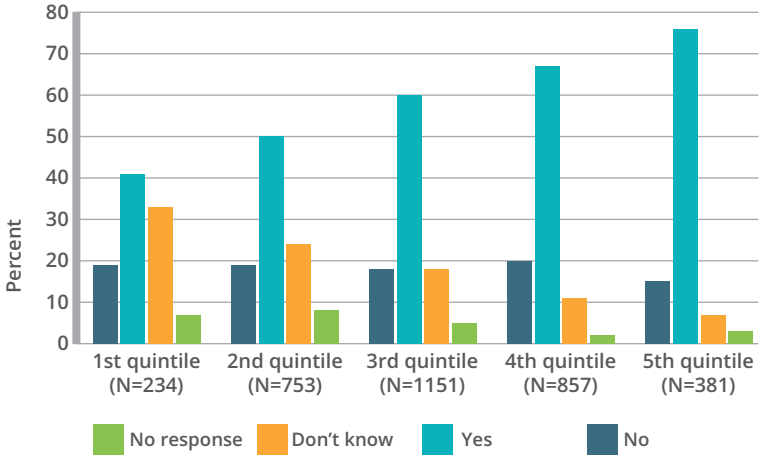


Figure 3: Support for devolution by wealth quintiles in Kwale County (1st quintile/low welfare, 5th quintile/high welfare).[9]

Two-thirds of voters approved the Constitution which included devolution alongside a new Supreme Court and Bill of Rights. In 2015, a study in Kwale County found that 60% of 3,376 households still support devolution, the transfer of certain functions, including that of water service delivery, to the county level.[9] The main reason for supporting devolution is the expectation that it will lead to faster access to services (37%), both in the water and health sectors, followed by the expectation of a more equitable distribution of resources (34%). The main reason for households not supporting devolution is 'too much politics' (19%). Relative welfare appears to be one determinant for supporting devolution; less than half of the lowest welfare quintile supports devolution, with higher levels of uncertainty about the process, whereas there is majority support (over 70%) from the highest welfare quintile.

Decentralisation is also motivated by addressing corruption in Kenya which affects the lives of the very poorest. Corruption manifests itself in many forms in Kenya and has been associated with high-level institutional corruption in the legislature and the police. Another example is the Constituency Development Fund which is a financial instrument to bring national funds closer to the people. Evidence in 2014 indicated 13% of funds dispersed between 2007 and 2009 could not be accounted for.[10] Other cases of corruption relate to transport, health and education. Often the country's poorest citizens are denied access to basic services, including water services. There is growing evidence that corruption is rapidly spreading within the new county governments, with negative impacts for service provision and the financial sustainability of devolution.

Tackling corruption will be a central challenge for promoting political accountability with important implications for improving water security for the poor. The 47 county governments now have the constitutional obligation to provide every person with clean and safe water in adequate quantities. This is both a question of service delivery and water resources management. Kenya's Water Act 2002 introduced decentralisation of functions to lower-level state organs. However, it did not go as far as fully devolving them to lower-level entities. Ultimate decision-making remained centralised. What the constitutional provisions of 2010 mean for the water sector, is expected to be clarified in the Water Bill, 2014 – currently before the Senate. It retains the key pillars of separation of water resources management from services provision, and separation of policy making from regulation and service delivery.

County governments will need to rapidly respond to the challenges of improving water security for the poor posed by explosive urban growth, and persistent rural neglect, as well as adverse localised climate and human impacts on water resources. Urban growth in Kenya is characterised by three major trends: (1) the rapid increase in the urban population in aggregate and percentage terms, (2) the decreasing share of Nairobi as a percentage of the total urban population, and (3) the steady annual growth in the number of urban centres, particularly small towns. In 2009, 31% of the recognised towns or municipalities had less than 100,000 people, with 68% with less than 500,000 people.

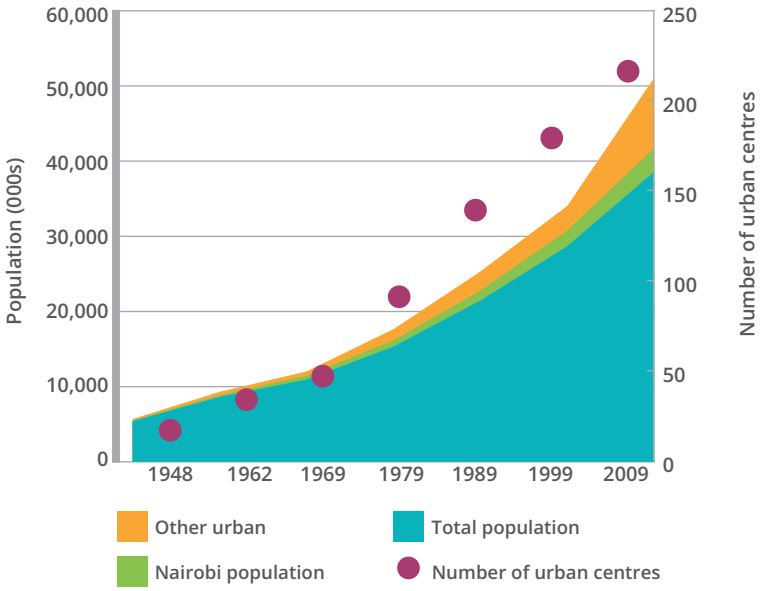


Figure 4: Going to town, but not Nairobi.[11,12]

Explosive urban growth has created significant stress on the delivery of basic services, particularly for the poor. The increasing strain on water services is reflected in a study of 10 urban sites in East Africa where waiting times increased from 27 minutes in 1967 to 92 minutes in 1997.[13] In Kenya, urban piped water access has fallen from 55% in 1990 to 45% in 2015, with unimproved water use, including surface water, increasing from 8% to 18% in the same period.[14] The poor are vulnerable to failing urban water systems relying on unregulated supplies that impose quality-related and cost-related 'poverty penalties'.[15] In Nairobi unregulated water vendors charge up to six times higher than the official water kiosk rate, which translates into a 'poverty premium' of up to 51 times more than for a private, piped water connection, available to wealthier households. Poverty penalties for water supplies are amplified by water supply deficit with high non-revenue water, low collection efficiency, high connection charges and unreliable supplies allowing predatory market conditions to emerge, and for the poor to be penalised.

Rural water neglect is an equally daunting challenge for county governments. Four out of five Kenyans without improved water access live in rural areas.[16]

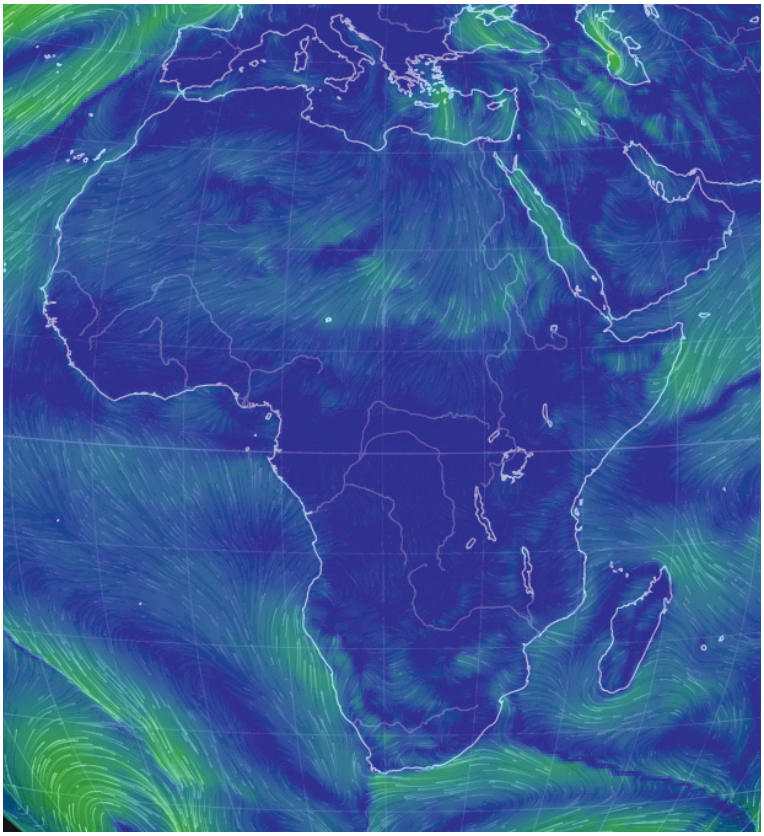


Figure 5: Winds over Africa (at 850hPa) with contours of total precipitable water, forecast for Thursday 4 December, 2015 at 19.00 UTC.[19]

County electoral cycles and political proximity will likely make this majority group of Kenyans a more vocal constituency in the future. Existing and unsatisfactory models for rural water sustainability need to be re-examined and effectively monitored to identify and reduce risks at scale against operational, financial and institutional performance criteria. This includes the impact of climate variability and shocks on surface and groundwater systems which are critical to the water security of all Kenyans.

1.3 Reducing vulnerabilities to climate shocks

The vulnerability of the Greater Horn of Africa to climate shocks is widely recognised. In 2011, drought struck Ethiopia, Kenya, Somalia, and Djibouti. Over 13 million people were affected, and in Somalia widespread famine displaced one third of the population with thousands registered in refugee camps in northern Kenya.[17] In 2005/06, drought affected 3.5 million people, particularly in north east Kenya where an estimated 70% of cattle died.[18] In 2015, one of the strongest El Niño events in the last 50 years is well underway, and climate variability is once again threatening water security in East Africa. While Kenya is being affected by heavy rainfall in November, the national government had already allocated USD 50 million to county governments in September, for mitigation and recovery.

Climate shocks are costly. The World Bank estimates the 1997/98 El Niño floods cost Ksh 70 billion (c. USD 1.1 billion).[20] Damages included water systems, roads, communications, and buildings; costs of treatment for waterborne diseases; and crop loss. The 1998–2000 drought caused by La Niña, brought at least Ksh 220 billion (c. USD 3.1 billion) in crop losses, livestock loss, forest fires, fisheries damage, reduced hydropower, reduced industrial production, and increases in the cost of accessing water. These figures represent about 11% of Kenya's GDP in 1998/99 and 16% of the GDP in 2000. Long-term, climate-related costs to the annual Kenya economy are estimated to be 2.4% of GDP.

Since the 1990s two thirds of Kenya's refugees and asylum seekers have fled from Somalia and South Sudan due to general insecurity issues with climate shocks an unclear, contributing factor. Turkana and Garissa County Governments will now have increased responsibilities for refugee populations in the existing Dadaab and Kakuma camps, including the likely emergence of a new refugee facility in Turkana in the near term. Sustainable delivery of basic services to the refugees, including water, will be an important priority along with the existing deficit for local citizens.

In a region with such large variability in rainfall from year to year, and where livelihoods are so closely bound to fluctuations in the weather, it is important that interventions to improve water security take into account climate risks. Understanding how global climate influences local realities is not straightforward. It is difficult to predict how human induced climate change will interact with natural variability, including oscillations such as El Niño. Whilst scientists can make confident statements about changing patterns of global and regional temperatures, there are large uncertainties about rainfall at regional scales,[21] which is vital for decisions about investments for poverty reduction and economic growth.[22]

Uncertainty in the influence of climate change on rainfall is particularly large in East Africa, which has experienced a greater number of droughts in recent decades, but for which climate models project an increase in rainfall.[23] This "East Africa Climate Paradox"[24] creates a confusing picture for decision makers, and has the potential to lead to maladaptation if the information is not handled carefully. For example, it would be unwise to plan agricultural expansion or shallow-aquifer based drinking water supplies based on model predictions of wetter futures, when observations suggest a drying trend unless the current drying trend could, for example, be shown to be driven by processes independent from those causing climate change.

Some uncertainty in future climate is inevitable: we can never know exactly how much rain will fall next year, or in thirty years. However, it should be possible to provide more useful information for planners, in a way that allows them to build uncertainty into their decision making. Similarly, knowledge of the size of uncertainty itself can prove helpful. Such improvement requires scientific analysis which is sensitive to user needs.

Increasingly, it is recognised that improved data provision is not sufficient to generate better societal outcomes. There is a need for "climate services", whereby scientists work with decision makers to explore the resilience of their decisions to climate variability and change by converting climate data into knowledge. Current gaps include lack of data and knowledge about rainfall variability, extremes and future changes, which are relevant both for short-term operational decisions and for long-term strategic planning. This data needs to be presented considering impact-relevant water security metrics, with user-defined thresholds and decision-relevant spatial scales. This knowledge will help establish whether strategies put in place for current water security will survive near-term climate change.

1.4 Inequality and poverty

Future strategies shaped by better science should contribute to reducing existing inequalities. Geography, governance and gender are key factors in social inequalities determining where the poor live and why they remain poor in Kenya.[25] A legacy of structural inequalities and weak social distribution has meant healthy economic growth often bypasses the poor. Infrequent socio-economic surveys also means no one firmly understands what reproduces inequalities and how better to act to reduce poverty. The Government of Kenya is responding with the 2015, national Kenya Household Integrated Budget Survey (KHIBS) to compare with the 2005/06 KHIBS survey. But this will represent two data

points in the last decade. Occasionally measuring poverty by household income or expenditure provides important, but partial insights. Kenya has long recognised inequalities in human welfare are more than income metrics, with attention to multidimensional welfare assessments and increasing recognition of the views of individual people, particularly vulnerable women, children and the infirm.[25,26] However, since 1964 income inequality, as measured by the Gini coefficient, has remained stubbornly high (Figure 6).

1.5 Mobile ecosystems

Kenya has led the world in transforming political accountability, financial inclusion, agricultural services, disaster response and water security through mobile technologies and data.[29,30,31,32,33] Harnessing the convergence of an expanding mobile network coverage, mobile handset ownership, mobile payment systems and smart metering systems has created a new mobile citizenry with an ecosystem of services that are rapid, secure and inclusive. For example, 6% of Africa's GDP flows through mobile money systems with 61 million active mobile money accounts, which is twice as high as the next nearest region (South Asia, 22 million).[29]

In 2006 more Africans owned a mobile phone than had access to a piped water connection.[33] A glib statement but one that plays out in the astonishing growth and financial inclusion of Africa's unbanked. For example, in Kenya in 2014, 59% of the adult population (26 million adults) used mobile money services and transacted an average of USD 2.2 billion per month.[29] Payment behaviours have expanded to include cash transfers, retail, government, loans, insurance and bills, including water services. A regional analysis of urban water payment behaviours in Kenya, Uganda, Tanzania and Zambia identified uneven adoption profiles despite potentially large benefits accruing to water users, water service providers and mobile network operators.[32] Recent evidence from Kenya describes the first pre-paid, mobile payment system for rural water users based on a rapid and guaranteed maintenance service for handpumps.[31] Given an estimated USD 485 million annual cost for operation and maintenance for rural handpumps in Africa this results-based payment model may offer a new approach to unlock matching funding from government and donors to make the sector more financially sustainable to contribute to the new Sustainable Development Goal of universal drinking water services.

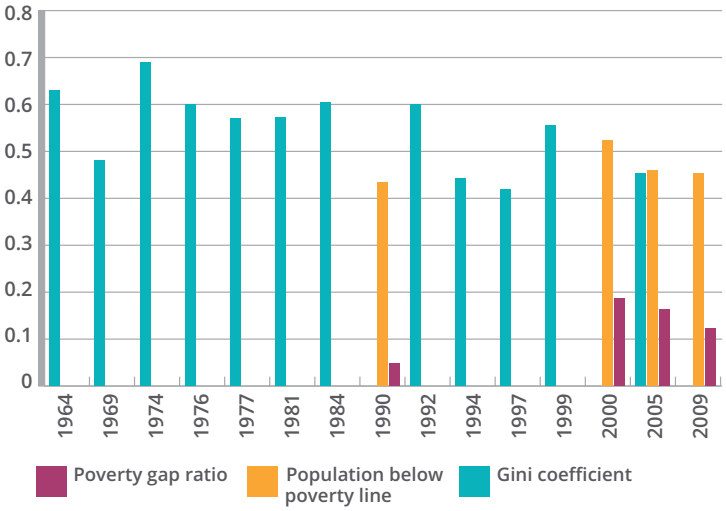


Figure 6: Mind the Gap--Income Inequality in Kenya 1964–2009.[27,28]

Since 2012 Kenya has made rural handpumps 'smart' with mobile-enabled transmitters. Four streams of mobile data offer improvements for water security:[30] (1) estimated daily water use to monitor service delivery to the hard-to-reach, (2) using (1) to inform a rapid maintenance response when handpumps fail, (3) providing evidence of accountability to national regulators and investors, and (4) using the accelerometry data to remotely measure aquifer depth. Results provide new insights of relevance for Africa's 200 million rural water users depending on one million handpumps as their main water source. First, information improves institutional design with handpump downtime reduced from a month or more to a few days with benefits for the poor, particularly women and girls. Second, rural water use is found to be heavily influenced by rainfall events with implications for health and future climate variability and extremes (Figure 7). Third, proof-of-principle research indicates shallow-aquifer depth can be accurately and remotely estimated to provide 'accidental infrastructure' in exploiting rural handpumps as a distributed, network for real-time groundwater monitoring.

Africa's advances in mobile ecosystems are responding to its enduring water security challenges. First, novel mobile technologies offer 'accidental infrastructure' to provide high quality, low cost and remote data to support decision-making. This counters the decline of environmental and poverty monitoring across Africa which provides partial, irregular and often low quality data. Anomalies and paradoxes are inevitably developing. This includes mobile survey platforms which can be selectively activated to capture socio-economic information rapidly and at scale related to shocks to improve policy design and responses. Second, Africa's people are an untapped resource with mobile penetration advancing rapidly to support citizen science approaches by farmers, school children or water collectors. Third, mobile ecosystems support open data platforms, narrowing the distance between data and decision-making. Political accountability can potentially be enhanced with electoral cycles and physical proximity recalibrating decision-making processes and priorities under newly formed county governments.

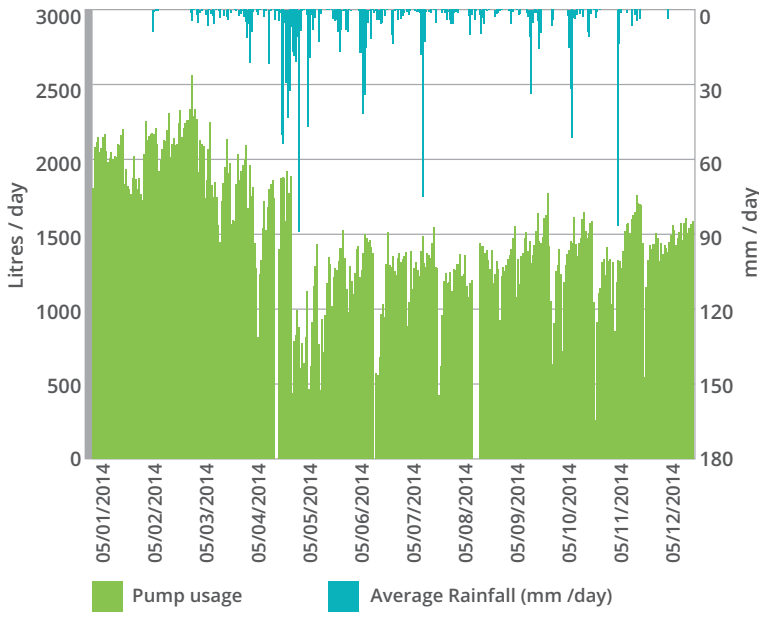


Figure 7: Handpump usage and rainfall in Kwale County, Kenya (February to November, 2014).[30]

2 Understanding the 'real nature' of poverty in Kenya

"...this review of previous attempts to address poverty are: basically a similar diagnosis of the problem and its causes has been repeated in the national development plans, coupled with a recurring inability to implement the remedies prescribed and a weak understanding of the real nature of poverty..."

National Poverty Eradication Plan, Department of Development Coordination, Office of the President, Republic of Kenya, 1999, page 8.

2.1 Poverty and welfare

Poverty is a condition of multiple deprivations for vulnerable individuals, households and communities, varying over space and time.[35,36,37] Understanding the dynamic nature of poverty has generated an extensive portfolio of metrics and methodologies. Who defines poverty and how poverty is measured influences action and outcomes. Making effective decisions can be challenging if measuring what we value is disputed or disregarded in favour of valuing what we can measure. If measurements are infrequent or inaccurate, policy will be less certain in reducing poverty. Poverty is commonly measured in four ways:

- **Income poverty**, for example the global estimate of USD1.90 per person per day at 2011 purchasing power parity (PPP);
- **Consumption poverty** in terms of the cost of basic needs such as food, energy, clothing or shelter;
- **Multidimensional welfare**, which recognises health, education, assets and other social deprivations; i.e. Human Development Index, Multidimensional Poverty Index
- **Subjective welfare** which prioritises how people self-assess their individual or household welfare.

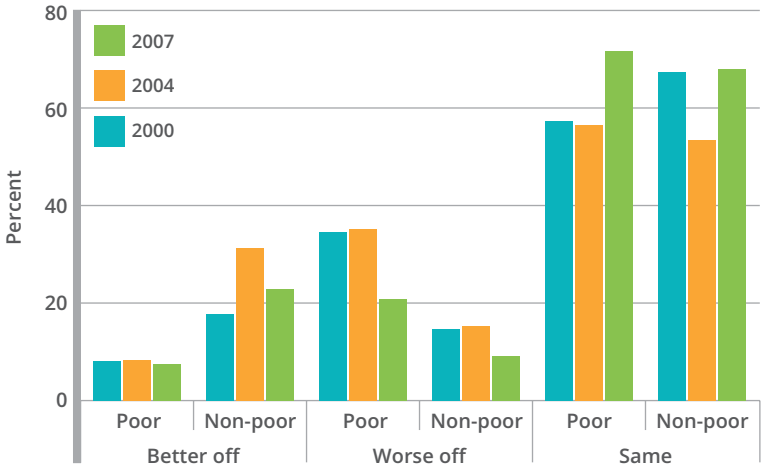
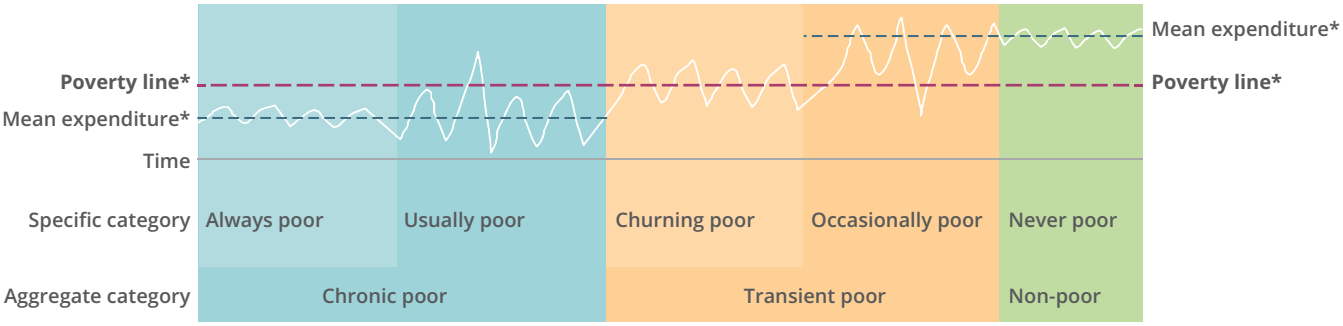


Figure 8: Comparing subjective welfare and income poverty in Kenya, 2004–07 (n=1,275). Adapted from Suri *et al.*, 2008[38]

Poverty and welfare are linked but diverge in measurement methods and policy implications. To avoid confusion we label each to distinguish between poverty metrics generated from household surveys for estimates of income or expenditure data, and welfare, which embraces a range of education, health and living standard indicators. Findings of a multi-year, panel study of 1,245 respondents in eight agro-ecological zones indicate income poverty does not align with self-evaluation of being better or worse off.[38] While imprecise and not strictly comparable, subjective studies overcome a significant barrier to externally defined measures, which may weakly reflect people's own priorities.

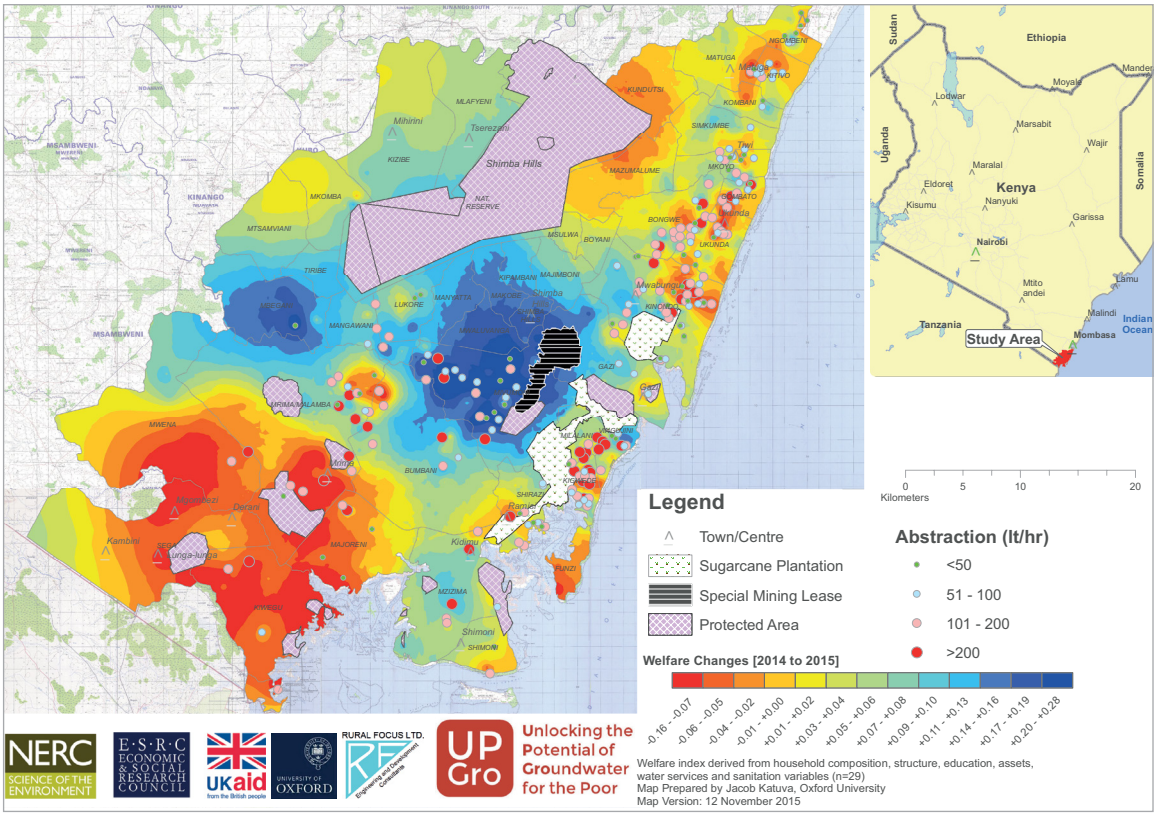
However, the poor and non-poor consistently view their status as 'the same' with transitions to 'better off' or 'worse off' picking up a weak signal based on income poverty status.

Figure 9: Poverty transitions and time.[40]



* Depending on data availability, poverty could be assessed in terms of household expenditure, income, consumption, a nutritional measure, a poverty index, a poverty score or an assessment of assets / capital

Figure 10: Household welfare changes in Kwale County, 2014-2015 (n=3,247)[41]



Assuming household data on stated income or expenditure are accurate and unbiased is a bold assumption. Welfare and poverty measures are thus not proxies for each other. Differences between measurements do not necessarily reflect 'mistakes' but reflect alternative conceptual and methodological approaches and limitations.[39] For example, weights for individual welfare indicators are often weakly grounded as current consumption is a weak measure for long-run poverty given the well-known short-term fluctuations in income faced by the poor.

The risky nature of being poor has advanced the concepts of chronic and transient poor (Figure 9). Monitoring changes in income poverty or welfare for individuals or households over time provides more detailed profiles of processes and practices in transitions between different states. Poverty dynamics can be better understood rather than an aggregate number of people 'being poor' with no evidence of who is moving in out of poverty, or why.

In Kwale County the spatial distribution of household welfare transitions between 2014 and 2015 has been estimated through a welfare index to identify areas of increasing (blue) or declining (red) welfare. Economic growth related to new mining and irrigated agriculture activities are associated with positive trends, but are far from conclusive. Households with falling welfare live near the border with Tanzania or in Ukunda where security issues have impacted the tourism industry. Of note, and in agreement with the subjective welfare data above, is the high proportion of households (62%) who indicated 'no change' from a year ago with a similar number indicating either a positive (17%) or a negative (21%) welfare change.[41] The welfare index engineers change by the choice or exclusion of indicators, which people may neither recognise nor agree with. Smart handpump data also permit estimates of daily water consumption data in 300 sites (abstraction circles), though no statistical relationship is found with welfare change.

2.2 Policy and progress

At independence in 1963, the Government of Kenya identified illiteracy, disease, ignorance and poverty as the priority challenges to be addressed. By 1999, poverty reduction through economic growth alone was dismissed by the National Poverty Eradication Plan stating "Poverty is multidimensional; it includes shortage of income and deprivation in other aspects, for example in knowledge, in life-expectancy and in the standard and quality of life experienced." The poor were identified in various social groups, including the landless, the handicapped, female headed households, low education, living in drought prone areas, unskilled labourers, AIDS orphans, street children and beggars. The Plan identified a broad range of specific targets for progressive delivery across health, education, agricultural extension, and achieving universal and safe water access by 2010.

Poverty Reduction Strategy Papers released in 200042 set out further poverty-reducing objectives to: (1) assess and monitor improvements in governance and security; (2) facilitate sustained and rapid economic growth; (3) enhance the ability of the poor to raise their incomes; (4) improve the quality of life of the poor and, (5) increase equity and participation of the masses. Emphasis was placed on the importance of strengthening poverty analysis in order to effectively understand the causes of poverty through the strengthening of socioeconomic statistics and increased monitoring. However, progress has been slow with the 2014 strategy paper identifying: "The lack of regularly and timely data on poverty, inequality and the labour force are substantive gaps in Kenya's statistics which hamper policy and monitoring."[43]

Progress on poverty reduction based on national statistics suggests major reductions in extreme poverty in rural areas from 34.8% in 1997 to 21.9% in 2006.[44] Yet, the actual number of people living below the poverty line is estimated to have increased from 13.4 million in 1997 to 16.6 million in 2006.45 The small increase in urban poverty rates from 7.6% to 8.3% between 1997 and 2006[45] reflect increasing rural to urban migration, with increasing stress on aging and inadequate infrastructure and associated social costs as outlined above.

2.3 Risks and vulnerability

Poverty risks are weakly understood by infrequent and static measures of income or consumption.[40] Poor people often live in complex and dynamic socioenvironmental systems where vulnerability

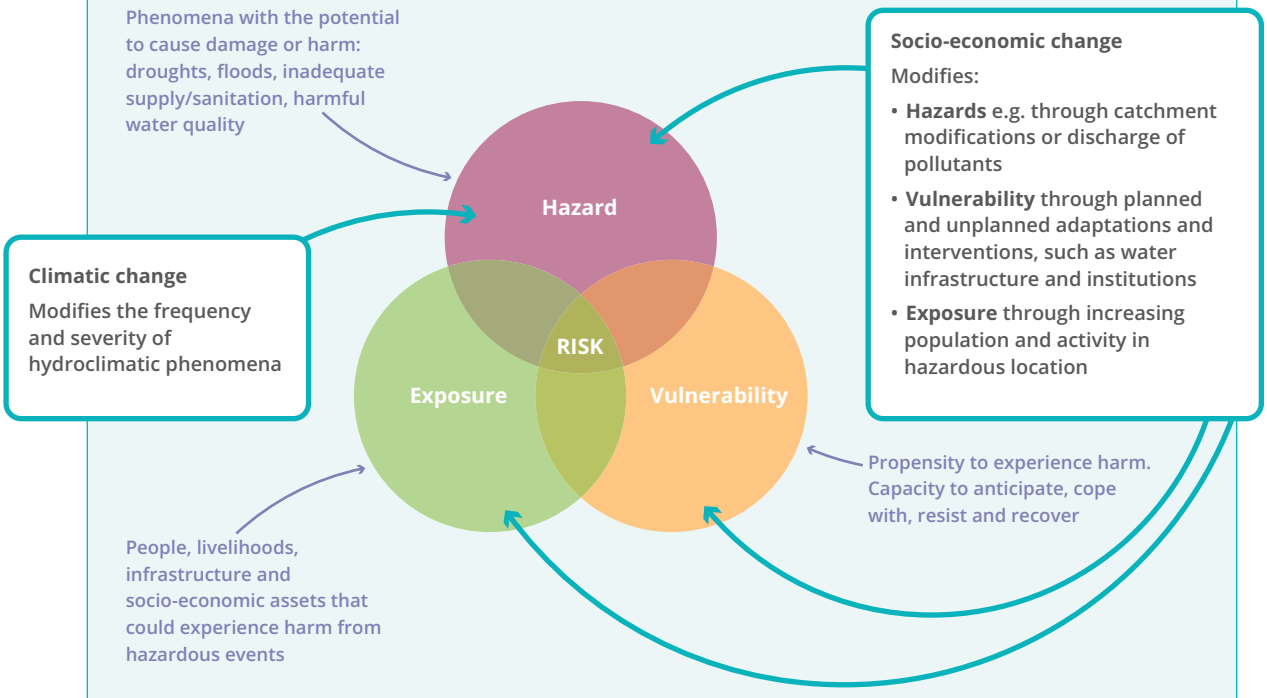
Box 1: Defining water security

Water security is defined as "the availability of an acceptable quantity and quality of water for health, livelihoods, ecosystems and production, coupled with an acceptable level of water-related risks to people, environments and economies"[46]

Central to this definition is the notion of water-related risks, which can be characterised as a function of hazard, vulnerability and exposure:

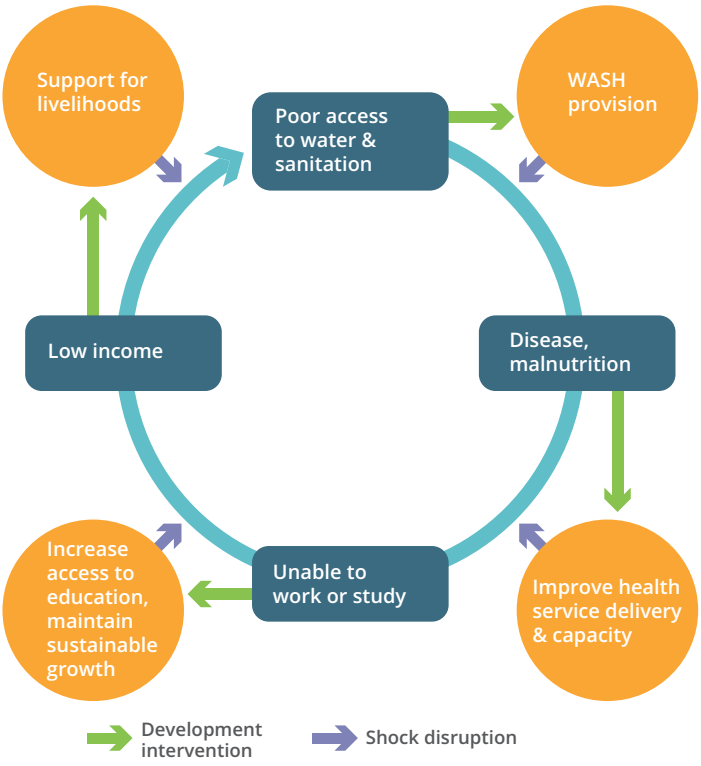
- hazard is a phenomenon with the potential to cause damage or harm;
- exposure refers to the people, assets and livelihoods that could experience harm and loss due to the hazard;
- vulnerability captures the propensity to experience harm as a dynamic function of the capacity to anticipate, cope with and recover from harmful events. Poor people have typically higher vulnerability due to lower capacity to anticipate and recover from water-related hazards.

These components can be mapped onto the well-known definition of risk combining probability and consequences, where the probability is that of the hazard materialising and the consequences are determined by exposure and vulnerability.



and exposure to hazards contribute to chronic poverty or maintains cycles of churning poverty. Poverty outcomes and water-related risks reflect the interaction of hazards, vulnerability and exposure.

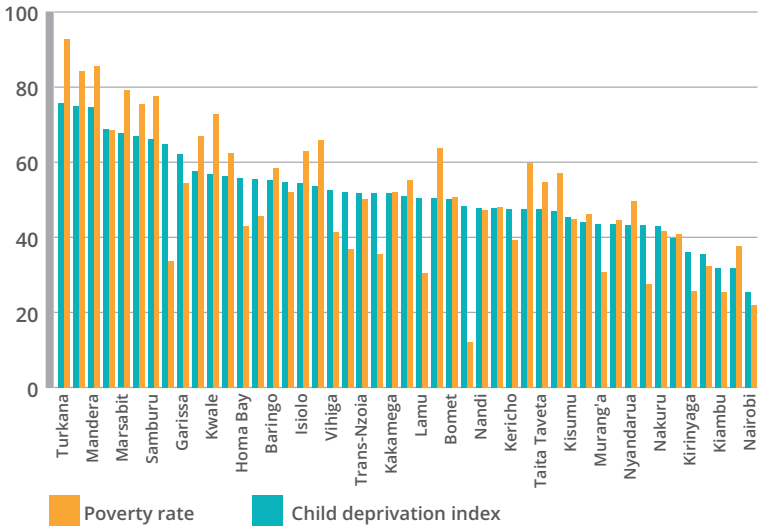
The likelihood and consequences of remaining in, or falling into, poverty as a function of water-related risks are important to determine effective policy action. Water-related risks vary and are rarely uniform across people, space or time. A drought may perversely make a minority of resilient farmers better off as a more vulnerable majority loses everything. Kenyans living in arid and semi-arid lands have the highest incidence of income poverty. Water-related hazards due to waterborne diseases do not result in the same water-related risks within communities, because children, pregnant women, the elderly and ill are often the most vulnerable.[47] Reducing vulnerability, as the capacity to anticipate, cope with and recover from water-related hazards,



can help to improve water security and break the water insecurity-poverty cycle. Social networks, remittances, savings or cash transfers may all be instruments to reduce vulnerability and risk. Interventions and shocks can disrupt poverty cycles as illustrated in the figure below.

UNICEF's Child Deprivation Index illustrates the welfare indicator applied across the counties in Kenya. The index is calculated based on dimensions of health, education, environment, and nutrition to determine the level of deprivation children face. As seen in Figure 13, children living in the north and eastern arid and semi-arid counties (Turkana, Mandera, Marsabit, Samburu, Garissa) have the highest deprivation scores compounding household poverty rates, which influence household vulnerability and exposure to harm from natural hazards.

Over the last decade, Kenya has made progress in decreasing the under-five mortality rate by 4% each year.[28] Part of this progress has been through increased focus on maternal welfare. A subsequent effect of this focus extends to maternal literacy, where higher levels are associated with reduced risk of stunting.[45,50,51] However, short-term deprivations, such as foods used to complement breastfeeding with little nutritive value, have been linked to stunting manifestations.[45] Under nutrition, and particularly stunting, which is much exacerbated by water-related diseases, remains a serious problem throughout Kenya with increasing trends among girls aged 12–23 months.



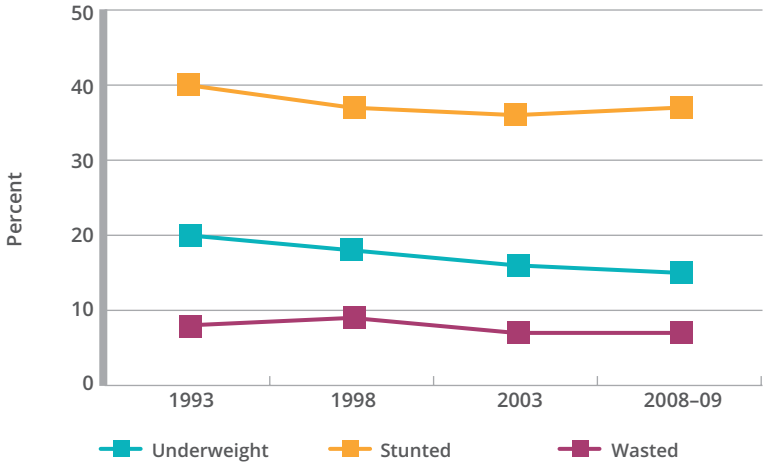


Figure 11: An example of how water-related risks relate to poverty.

Figure 12: Kenya Child Deprivation and income poverty by County.[49]

Figure 13: Wasting, Stunting and Underweight in Kenya (1993–2008/09). Adapted from Matanda *et al.*, 2014.[45]

3 Addressing water security risks to poverty in Kenya

3.1 Summary

This section identifies where the interactions between decentralisation, climate shocks and inequality are likely to be most significant and uncertain for water security risks for Kenya's poor. First, 'Small Towns in Fragile Lands' reflects regional and national trends in urban growth and climate shocks leading to increased stresses on urban water supply systems. Second, 'Building Secure Water Institutions' responds to decentralised governments' new mandate to address the historical legacy of uncoordinated infrastructure investments by using mobile ecosystems to promote financial, operational and institutional sustainability in semi-arid environments. To address these interactions, we outline the concept of 'Water Security Observatories' for scientific-practitioner partnerships. We conclude by considering the regional implications and opportunities for expanding the scope of the REACH work in Africa to deliver and sustain water security for the poor.

3.2 Water Security Observatory

A Water Security Observatory is a long-term, instrumented and interdisciplinary research location where significant but uncertain trajectories of change are predicted to emerge over a decadal or longer time span. Observatories will be designed in collaboration with practitioner partners, such as government and UNICEF, to introduce and test new concepts, models or approaches to understand the distributional impacts, particularly for the poor, and the opportunities to replicate successful interventions, or to learn from failure.

3.3 Small towns in fragile lands

Urban water service delivery in arid and semi-arid lands faces significant challenges through the intersection of high poverty rates, more variable water sources, smaller towns with lower economies of scale, and increasing climate variability and its influence on groundwater recharge and quality.[52] Declines in urban water services are linked to: falling groundwater levels as a consequence of increased water demand, increased pumping costs, increased competition, boreholes running dry, and exposure to lower quality groundwater. Lack of adequate monitoring and assessment of groundwater resources has resulted in uncertainty as to whether or not the water being consumed is safe, and poor attention being paid to groundwater planning at all levels.[53] This is particularly serious for drought-risk management in which groundwater resources should play a critical role.

In the Vision 2030 Development Strategy[54] for Northern Kenya and other arid lands, it is noted that "Isolation, insecurity, weak economic integration, limited political leverage, and a challenging natural environment combine to produce high levels of risk and vulnerability". In arid and semi-arid lands, surface water is generally an unreliable source for urban water supplies as they are mainly seasonal or ephemeral in nature, as compared to groundwater. Lodwar, together with other towns in Kenya such as Naivasha, Nakuru, Wajir, and Mandera, rely largely or exclusively on groundwater for public and private water supply. Groundwater development has advanced without adequate scientific understanding of the resource base, including the water balance, quality, quantity, and recharge. Natural groundwater contaminants such as fluoride in the Rift Valley and nitrates in sedimentary aquifers in north eastern

Kenya, as well as natural and anthropogenic heavy metal and microbiological contamination are common problems that affect groundwater quality.[55] These problems may limit their utility as water supply sources unless coupled with appropriate low-cost technologies to eliminate or reduce undesirable contaminants to acceptable levels.

Political and economic change is likely to significantly spur the growth of small towns. In the case of Turkana County, there are other developments that could result in the County registering the fastest growth of urban centres in the country despite ranking highest in income poverty (87.5%) compared to other northern Counties, such as Mandera (85.8%) or Wajir (84.2%); a poverty rate four times higher than Nairobi.[28] These include: the discovery of economic oil reserves in Lokichar area in 2012, with subsequent finds bringing the value of the estimated reserves to USD25 billion; the discovery of large groundwater aquifers in September 2013, including the Lodwar Basin Aquifer with an estimated reserve of 10 billion cubic meters and the Lotikipi Basin Aquifer with an estimated 207 billion cubic meters, though further validation is required; the development of the USD16 billion Lamu Port and South Sudan Ethiopia Transport corridor (LAPSSET) corridor which includes roads, oil pipelines, towns and Lamu Port, linking Kenya to Sudan and Ethiopia and; development of wind farms and solar energy installations. Tourism and fisheries, industries which collapsed in the 1990s are being revived.

Lodwar's strategic location, high poverty rates, low piped water service and expected population growth exemplify water security issues faced by many Kenyan small towns. Lodwar has a publicly-owned water service provider serving seven towns and ranking 27th out of 61 similar utilities reported in the 2012–13 national benchmarking report by IMPACT, produced annually by the Water Services Regulatory Board (WASREB).[56] Lodwar serves 48% of a population of 116,890 people, producing 1,060 m^3 water per year of which 24% is billed. Non-revenue water is 37% with an average consumption per capita of 13 litres per day. Lodwar falls in the bottom ten performers in six out of ten Key Performance Indicators: a) O&M cost coverage (76%), b) bacteriological quality (56%), c) non-revenue water (37%), d) water coverage (48%), e) sanitation coverage (36%), f) revenue collection efficiency (76%), and g) metering ratio (90%).

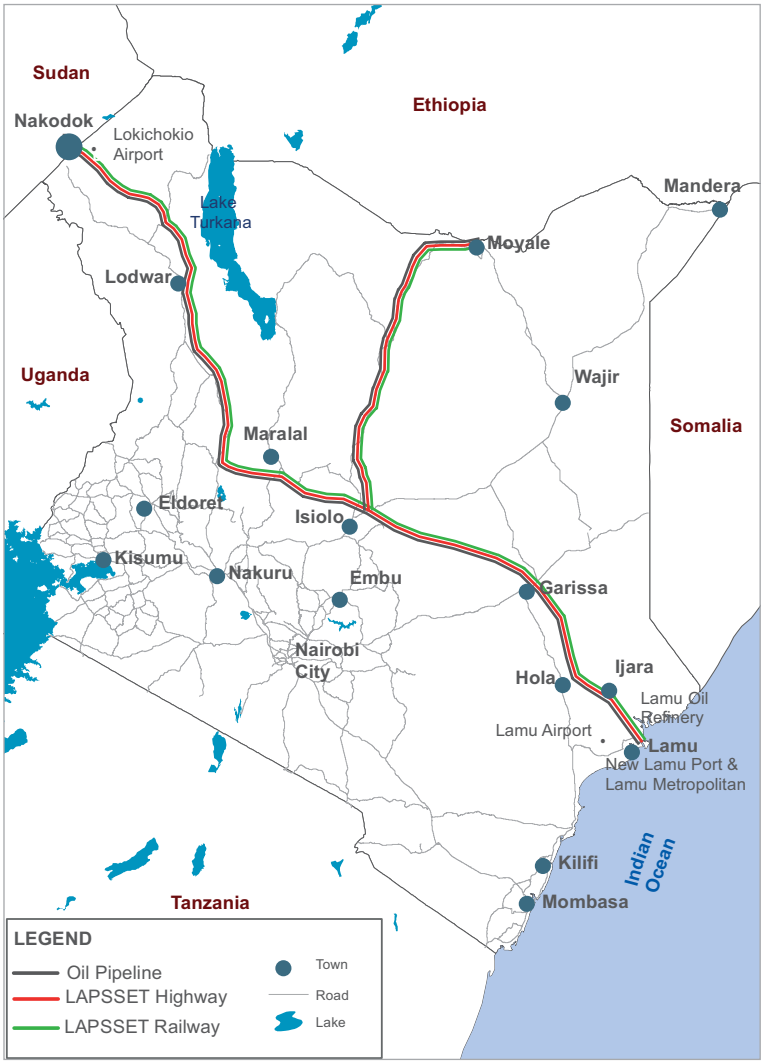


Figure 14: LAPSSET development plan for the three major transport infrastructure components (JPC & BAC, 2011).

There are three key drivers that have acted to spur urban growth in the fragile lands. An increasing trend of more frequent and severe drought, coupled with internal and cross-border insecurity issues such as cattle rustling and civil strife, as well as population growth, have pushed some nomadic pastoralists to adopt sedentary lifestyles and to seek opportunities to diversify their livelihoods. The relatively small urban centres in such regions cushion residents from such adverse exposures since state structures are better represented on the ground. For example, proximity to urban centres is an important determinant of the range of options available for income generation, and these options decrease significantly for pastoralists who live more than one day's walk away. Additionally, urban centres offer some advantages and opportunities such as free food distribution by aid agencies, employment opportunities, and markets for various products such as foodstuffs, charcoal and craft. Refugee camps such as Kakuma have flourished and could seed new urban developments.

The convergence of climate shocks, infrastructure expansion, resource mining, and refugee fluxes presents significant but uncertain risks and opportunities for the evolution of small towns in Kenya's arid and semi-arid lands and other areas of Africa. New models and approaches to promote water security for the poor will be advanced through REACH in understanding the intersections between climate shocks, groundwater systems and urban water supply systems to deliver safe, sufficient, affordable and inclusive services to all.

3.4 Building water secure institutions

Building institutions to improve water security for the rural poor must reduce risks at scale. Risks converge in social and natural systems with the intersection of climate hazards, financial flows, operational performance and institutional accountability. The increasing uncertainty but severity of hydro-climatic extremes in arid zones increases the water-related hazard to the currently poor and those in danger of falling into poverty. Maintaining reliable, safe and affordable groundwater services to the poor has proved elusive across rural Kenya and much of Africa. Well-meaning, water supply infrastructure investments from national government, donors and civil society organisations have responded periodically to support communities commonly in crisis. But with weak or absent institutional coordination and management, significant but urgent investments may duplicate existing assets and soon fail without repair in the absence of ongoing institutional support.[57]

Scale is crucial to reduce operational, financial and institutional risks. The community scale concentrates risks with those least capable to manage them. Economies of scale emerge where the institutional architecture combines water infrastructure and associated financial flows at an effective operational level across multiple communities or small towns. Networked communities combining water supply infrastructure offers a useful analogue to the logic of piped water systems in densely populated, urban centres. Determining the right scale and institutional structure is a fundamental question given the variation in population density, existing infrastructure assets, socio-economic context, environmental conditions, spatial variations in occurrence of viable water resources, and water demands in each of Kenya's 47 Counties.

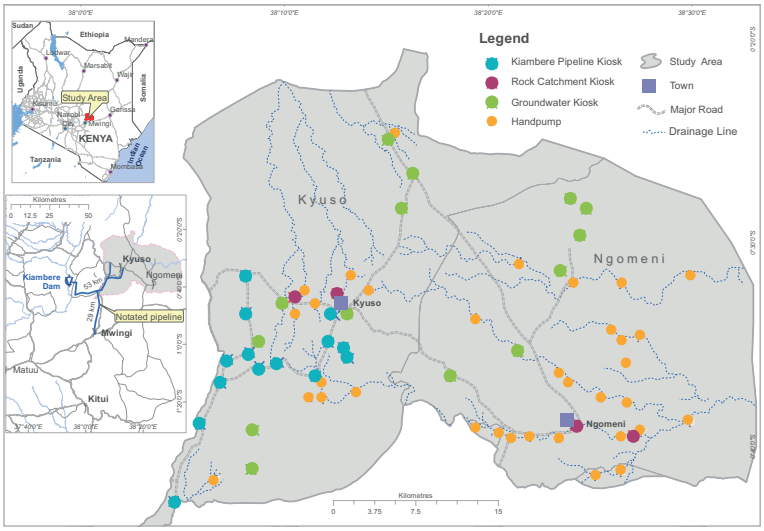
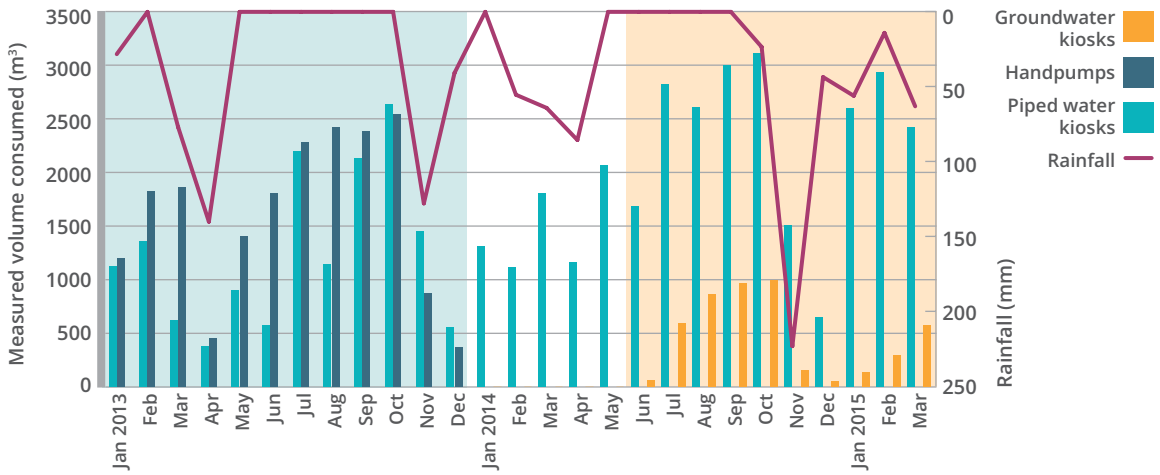


Figure 15: Water infrastructure investments in Mwingi North, Kitui County.[57]

Information flows strengthen institutional coordination and performance. Incomplete, absent or inaccurate records of basic water services' data are common across Kenya. Increasing use of low-cost, mobile-enabled devices offers one route to improve the quality, frequency and coordination of data at scale. Transparent data flows not only support monitoring service delivery but can generate opportunities to improve performance in the future and ensure policy progress is open for public scrutiny. Equally performance data can unlock new financial flows such as results-based finance, where finance is contingent upon verifiable results. Monitoring systems inevitably incur costs but these may be relatively modest and the absence of data often results in costs disproportionately born by the rural poor with limited recourse to improve performance in the future.

Kitui County reflects the key challenges of building effective water secure institutions in a semi-arid environment with high poverty, scattered populations and rainfall extremes. The County Government has responded by supporting the installation of mobile-enabled transmitters to monitor rural handpumps since 2013, followed by the establishment of a local maintenance company (FundiFix Ltd.) in 2014. Down-time of handpumps fell from an average of 27 days to less than three days. Despite major improvements in operational performance of handpumps, two thirds of communities had not joined the FundiFix model in the following year from launch. A legacy of poor installation, site locations with high levels of groundwater salinity, and limited community dependence on 'clustered' handpumps partly explains why recruitment is not higher. Results raise questions of the legacy of an infrastructure surplus, competing water supply alternatives and the seasonal nature of rural water demand. Observed water usage data from handpumps, a small piped scheme, rock catchments and groundwater kiosks during 2013–15 illustrate rural people rapidly switch to 'unimproved' water supplies (dug wells, surface water) after prolonged rains. Whether cost, convenience or taste issues influence these decisions, they are clearly observed along with the significant role of productive uses of rural water supplies, particularly for livestock.

Figure 16: Rainfall variation and consumer water usage in Kitui County (2013–2015).[57]



The implications for Kitui County Government's goals to achieve universal and safe water service delivery are characterised by:

- A historical legacy of uncoordinated infrastructure investments;
- No existing institutional structure to coordinate operational and financial systems for new and existing water infrastructure;
- Increasing climate variability and extremes influencing groundwater recharge and quality;
- Rural water demand which abandons 'improved water supplies' with higher rainfall;
- Low and variable income households who depend on precarious agro-pastoral systems; and
- Novel mobile information systems which offer real-time data and secure financial flows.

Building accountable and sustainable water institutions in Kitui County must address these challenges working at the right scale to manage infrastructure and to ensure sustainable service delivery to all. A legacy of well-meaning but failing infrastructure investments creates a significant challenge to future financial sustainability in Kitui, and across Kenya. FundiFix's community recruitment rate of one third provides an estimate of the likely infrastructure surplus from well-meaning but unrequired investments. The Kitui County Water Ministry has a key policy role in identifying 'water service areas' that do not prescriptively follow 'urban' or 'rural' typologies but consider the infrastructure portfolio and population density to promote effective and long-term management and delivery.

Delivery of services could be public, private or hybrid based on the context. Performance-based licences or contracts would be designed for delivery for the entire water service area. Service providers, whether water or maintenance, and financing mechanisms, would be regulated independent of policy interference and with power to progressively improve performance, revoke contracts or impose fines where necessary. As the infrastructure portfolio is reconciled, partner organisations (NGOs, INGOs, donors) would be registered with approved plans before infrastructure investments are made. Failure to comply would result in fines or the withdrawal of permission to operate in the County.

Institutional performance will depend on financial sustainability. This will require a coordinated and novel approach to blend the three streams of water finance from users (tariffs), government (taxes) or donors (transfers) in a County Water Fund. The Fund would need a specific mandate and ring-fence operation and maintenance costs which are commonly ignored or under-funded in existing initiatives. The constitution and mandate of the Fund would need inclusive consultation to establish a long-term and viable mechanism that exploits and leverages existing and new flows of funds in an accountable and performance-based mechanism. With the established monitoring systems this may involve the increased use of 'results-based finance' or other output based approaches where investments are contingent upon key performance indicators. Timely and reliable data are an essential component for this model.

4 Conclusion

Kenya's progress to middle income status by 2030 will be determined by balancing water security risks for growth and development. Evidence of existing relationships between water security risks and poverty are inconclusive due to infrequent and incomplete social and environmental monitoring systems limiting more effective decision-making to sequence investments in information, institutions and infrastructure. The example of Kitui County illustrates the legacy of infrastructure investments without supporting institutional and information systems. Turkana County highlights the significant but uncertain future pathways for small towns on the cusp of an unprecedented economic, environmental and social transformation.

The REACH programme in Kenya will convene National and County governments with UNICEF, the University of Nairobi and the University of Oxford in advancing a long-term, science-practitioner partnership to support development of water security outcomes that specifically meet the needs of the poor. County governments have the mandate and resources to respond to existing water insecurity challenges for the poor. In partnership with UNICEF a regional network of countries in Africa can learn and contribute to advances in building water secure institutions in rural areas and developing sustainable small towns in fragile lands to potentially benefit tens of millions of Africans. The Universities of Nairobi and Oxford provide complementary expertise to promote globally-leading science that is directed to address priority policy goals to increase water security for the poor.

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