WATER SECTOR DESK REVIEW

SAMBURU AND TURKANA COUNTIES

September 2021

Water Sector Desk Review: Samburu and Turkana Counties

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Matthew Nims, Agreement Officer

ATTN: Kathleen Hartin
Agreement Officer's Representative
khartin@usaid.gov

Prepared by: Mercy Corps Nawiri Consortium

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Acronyms

ASALs	Arid and Semi-Arid Lands
FAO	Food and Agriculture Organization
FEWS NET	Famine Early Warning Systems Network
GDP	Gross National Product
GCP	Gross County Product
GoK	Government of Kenya
GPS	Global Positioning System
HDI	Human Development Index
IWMI	International Water Management Institute
KNBS	Kenya National Bureau of Statistics
OCHA	Office for the Coordination of Humanitarian Affairs
O&M	operations and maintenance
MEL	Monitoring Evaluation and Learning
MSD	Market Systems Development
NDMA	National Drought Management Agency
PAM	Persistent Acute Malnutrition
SDG	Sustainable Development Goals
TAHMO	Trans-African Hydro-Meteorological Observatory
TSU	Technical Support Unit
UN	United Nations
UNDP	United Nations Development Program
UNEP	United Nations Environment
USAID	United States Agency for International Development
USD	United States Dollar
WASHBAT	WASH Bottleneck Analysis Tool
WASREB	Water Services Regulatory Board
WFP	World Food Program
WRA	Water Resource Authority
WRM	Water Resources Management
WSP	Water Service Provider
WWDA	Water Works Development Agency

Executive Summary

In the Arid and Semi Arid Lands in northern Kenya, the daily struggle to access water is emblematic of the entwined challenges of poverty, insufficient infrastructure and inadequate governance. Mostly rural and deeply remote, the pastoralist communities in Samburu and Turkana counties are suffering under the increasing burden of climate change, with consequences that include longer dry seasons, deeper droughts and dwindling supplies of the surface water that are relied upon for household and productive use.

The scarcity of water resources in these areas makes the provision of Water, Sanitation and Hygiene services a difficult proposition, which in turn is contributing to the under-development of these communities and is a causal factor for the persistent and acute malnutrition that routinely afflicts some 35% of the children under age five among them. Such scarcity is putting Sustainable Development Goal 6 far beyond the reach of the country as a whole, even as there is some degree of improvement nationwide in that 59% of Kenyans are meant to have at least basic access to drinking water.

The burdens of gender norms and tradition add to the weight of the women of these counties who can spend up to eight hours per day in search of water that then is used not for domestic purposes but for livestock. Water distribution in the ASAL remains among the most pervasively inequitable elements of pastoral life, ignoring or misinterpreting the needs of women in favor of those of men.

Governance and management of water -- be it the limited seasonal rainfall, or supplemental groundwater sources -- is badly underdeveloped due to shortcomings in the legislative and policy structures that have accompanied devolution and the handing over of water management to the county governments. A lack of funds for investing in infrastructure, building technical skills or developing system-wide master plans makes it difficult for county government officials to adequately address water security or water productivity needs.

A systemic and long-standing lack of data and evidence including historical trends in rainfall and groundwater recharge only compounds the problem. So, too, does the failure to invest in longer-term development-oriented solutions that are owned, operated and maintained by local structures, either at the community or county level.

Improving governance will be critical to developing sustainable solutions to the problems confronting the sector to address supply, demand and reallocation deficiencies. Too often rural water system projects fail to bring such sustainable benefits and services to the people who need them because they fail to consider the drivers, externalities and linkages to other challenges that emerge in the hunt for a regular water supply.

Understanding the causal pathways to PAM in the target counties requires a nuanced and detailed comprehension of the context-specific local drivers of access to water, underscoring the need for a more coordinated, multisectoral approach underpinned by policy coherence to the persistent development challenges in the ASAL.

The USAID Nawiri Theory of Change requires the underlying drivers of PAM to be addressed systematically and simultaneously, in order to transform the necessary systems that strengthen the capacity of individuals, communities and institutions to absorb, anticipate and adapt to risk.

Findings and learning from this desk review of the water sector in the two counties are a first step in understanding one of the critical structural drivers of PAM.

Climate change

While localized and historic information on weather, and therefore climate, was found to be largely absent or poorly assessed, it is clear that climate change, coupled with continued land degradation, will have adverse consequences for water resources and water supply, with hotter temperatures, increasing intensity and erratic distribution of rainfall, as well as increased frequency of droughts. The direction of future annual rainfall totals is uncertain and thus expected to remain the same. Climate change seems likely to put additional pressure on rainfed rangelands and reduce their carrying capacity, with adverse consequences for household incomes going forward.

Information on drivers of water supply and demand, as well as data and maps with respect to specific water sources and infrastructure (dams, boreholes, etc.) was found in the literature and is available to USAID Nawiri as a starting point for investigating likely geographies for implementation though it would likely need to be verified or updated prior to engaging in specific geographies. Efforts to document historic vegetation conditions are rather more reliable and useful. There is a clear need to rebuild weather station capacity to provide data for short-term weather forecasting and to track climate change over the longer term.

Without future investment in water resource management measures that address the impacts of climate change, surface water sources used by livestock for drinking are also likely to decline in availability with climate change.

Gender

Women have little agency in water development and management issues. Their roles in monitoring and regulating water systems and services are negligible as they are only engaged in the lowest level of decision-making around water, namely at household level.

The time burden (and stress) of water collection falling on women and children is considerable, particularly during the dry season and diverts women from other household chores, caring for others and leisure activities. For children, water collection can take away from time spent at school.

The decision to pay for water, whether from an improved source or not, is a complex decision made by women that reflects a careful weighing of the cost of water versus the benefits of not having to trek for water, which include the time to complete other chores, care for other household members and to rest or engage in leisure activities. Of course, this decision is moot if there is no cash available, if the cash is needed for some other expenditure, or if the cooperation of the husband in obtaining the case is not secured, though there was no evidence in the surveys that this latter point was a problem or limiting factor.

Despite a lack of empirical evidence, anecdotal evidence and historical understanding of the chronic challenges confronting the women in these communities demonstrate that where household water insecurity is high and variable, identifying ways to make things easier for women is the surest way to improve both WASH outcomes and reduce PAM.

Governance

Kenya's 2016 Water Act along with the 2010 devolution of authority to counties sets up a relatively modern framework for governing water. Turkana County has passed a Water Act and is looking to undertake a Water Master Plan. Samburu is interested in both, but at present has neither.

In the absence of sufficient institutional capacity – staffing, equipment and funds – the result is less than desired as there are not the necessary resources to coordinate across functions and departments, much less the ability to carry off investment projects at the pace and scale needed to address water needs in the counties.

Low numbers do not reflect inequitable shares of national revenue assigned for government expenditure, or unfavorable allocations of budget within county government between water and other purposes, rather that the economic output and incomes at the county are too low to meet all needs, including that for improved water services. Either income levels, county prioritization of funding, or resource mobilization will need to change to markedly affect the current trajectory.

A key limiting factor for the improvement of well-being and income potential in rural, pastoralist societies is water insecurity. Focusing additional donor resources on water security – in the presence of a clear theory of change for sustained access to improved water sources and sustainable water resource management – is advised given the high benefit-cost relationship observed for water investments at the early stages of economic development.

USAID Nawiri intends to use this research to identify areas of support for gender responsive good water governance practices to support county governments and their efforts to improve and sustain local water resources and develop sustainable water service delivery systems. The ultimate goal of these efforts is to inform actions that enhance water security and improve the productivity of water for livelihoods and nutrition in the Samburu and Turkana Counties.

Introduction

Access to adequate water, sanitation and hygiene is critical for children to survive and thrive. And while substantial progress has been made to increase access to water and sanitation, billions of people -- mostly in rural areas and in informal urban settlements -- still lack these basic services.

The arid and semi-arid counties of Turkana and Samburu in northern Kenya are consistently confronting challenges with access to water for both the human populations and the livestock upon which they predominantly base their livelihoods.

For Kenya to make any significant progress toward its own objectives under Vision 2030 or the global Sustainable Development agenda, the country must understand the pathways that link water insecurity, gender norms, and under-nutrition. A policy-oriented research agenda co-created by Kenya's development partners and technical actors in its devolved system of governance would begin to fill the evidence gap that provides understanding of the connections between water insecurity and persistent acute malnutrition.

Current estimates from the UN's Joint Monitoring Program suggest that 59% of the country's nearly 60 million people have "at least basic" access to drinking water, 20% to sanitation facilities, and 25% to hygiene – e.g., soap and water (WHO & UNICEF 2020). The rate of improvement in these metrics in order to achieve SDG 6 is less than 1% per year, putting the goal decidedly out of reach.

In the rural and remote parts of the country, including the ASALs, the scarcity of water resources not only makes WASH provision challenging, but also constrains the availability of water for productive uses: water for livestock and, where feasible, limited cultivation of crops and kitchen gardens. Water distribution in these areas is enormously inequitable, due to cultural norms that mean that women's needs are excluded or misinterpreted, or subsumed by those of men.

Improving the governance and management of water resources and water services provision is integral to USAID Nawiri's approach to identifying and challenging the structural drivers of persistent acute malnutrition in Samburu and Turkana counties. This desk review is one in a series of research and learning activities in the area of water governance intended to identify, prototype and scale implementation interventions.

The review seeks to compile, organize and analyze available information on conditions, recent trends and future forecasts in the water sector in the two counties, with particular attention to geographic, institutional, socio-economic and cultural variations.

Relevant governance arrangements, including national and county water legislation, policies and regulations will be reviewed and progress in their implementation gathered. The desk review will be supplemented by WASH bottleneck analyses conducted in both counties.

Water Governance and Management for Livelihoods and Improved Nutrition

Conceptual Framework for Water Governance and Management

Water Management

Globally, the water crisis is painted as a crisis of governance more than one of supply and demand. In regions like the ASALs of northern Kenya, however, the imbalance between supply and demand is critical due to pervasive physical water scarcity and limited financial and technological resources.

Improved governance requires improved water resource management to alleviate physical water scarcity matched by enhanced technical skills in the provision of sustainable urban/rural water services to local populations. This section provides the conceptual framework necessary to identify how improved governance and management of water and water services can be critical enablers of improved nutrition.

A recent systemic review of comparative studies of water governance selected the following as definitions:

Water governance: the social function that regulates development and management of water resources and provisions of water services at different levels of society, and

Water management: the activities of analyzing and monitoring, developing and implementing measures, with governance/management having the shared objective of guiding/keeping the state of water resources within desirable bounds and away from an undesirable state.

Sources: (Özerol et al. 2018; Pahl-Wostl 2009; 2015)

Figure 3.1 in Annex 3 depicts the layers of state-run water governance to achieve end-stage use through public water service providers. Typically, public water governance and management facilities use a combination of strategies to manage water: Figure 3.2 depicts these supply, demand, or reallocation strategies.

The limited governance capacity and scarcity of water supply in northern Kenya heavily emphasizes supply development and service provision; moreover, tapping into "new" sources of water through rainwater harvesting, sand dams and managed aquifer recharge is increasingly important due to the impacts of climate change on groundwater recharge.

For this region, encouraging and incentivizing water use efficiency through demand management measures is critical to improving water productivity should the opportunity arise.

Northern Kenya's rural context

Rural water systems face perennial difficulties in bringing sustainable water supply the communities they seek to serve (World Bank 2017; Foster 2013; Dentz et al. No date). Despite gains globally in the number of people with access to a basic improved source – such as a borehole for domestic uses – population increases mean that even improved supply is not enough to meet demand.

Sustained water system access remains beyond the means of the majority of those residing in Turkana and Samburu counties, either because of reluctance or inability to pay for water. Many choose to use traditional surface water sources or hand-dug wells rather than pay for sustainable access, meaning that a better understanding of the interplay between water governance and management and household behavior is critical.

Maintaining physical infrastructure of water supply is becoming more of a long-term strategy for water sector providers, amid significant constraints that are both technical and managerial. There has been some degree of innovation in rural water service delivery models (Lockwood 2019; Sustainable WASH SLP 2021), including in Turkana county, where the Fundifix and Caritas "insurance-based" models for maintenance service are being tested. Financial constraints – at both community or higher levels – will, however, limit the extent to which such techno-managerial solutions can be replicated and scaled.

The USAID Nawiri Theory of Change: Water, Livelihoods and Nutrition

The USAID Nawiri Theory of Change (ToC) posits that transforming systems to improve adaptation to risk at individual, household and community level is necessary to achieving sustained reductions in persistent acute malnutrition.

A lack of adequate access to WASH is most directly linked to undernutrition via the ingestion of fecal pathogens and diarrheal disease (J. Brown, Cairncross, and Ensink 2013; Dodos et al. 2017; Mills and Cumming 2016). WASH has been linked to all four "pillars" of the food and nutrition security framework – availability, access, utilization and stability – as immediate and more distant causes (Pritchard, Ortiz, and Shekar 2016; Cumming and Cairncross 2016).

Broadening the water supply component of WASH to include agricultural production and household income (Cumming and Cairncross 2016) is necessary to address persistent acute malnutrition, and relies on improved capacity not only at individual, household or community levels but also within the context of the larger ecosystem of public and private actors that govern and manage water resources and that engage directly in water provision (urban and rural) to communities and households.

The weakness of systems, or individual elements within such systems, can undermine sustainable water service delivery and water resources management (Tillett et al. 2020). Strong systems provide a solid foundation for providing sustainable water services at scale. Therefore identifying what elements of a strong system could be integrated into the approach to improved sustainable water service delivery, could support innovations in the design of 'transformative' water services delivery and water resources management interventions.

As water resource management is identified as a structural driver of PAM, the ToC applies in this way:

- **IF** there is improved governance and management of water resources and urban/rural water systems
- **AND** these responses can enhance formal institutions to monitor, learn and adapt to more effectively manage and scale interventions to prevent and respond to acute malnutrition while mitigating the influence of external climate factors such as drought
- **THEN** poor and food insecure households in rural and urban communities will have access to adequate water of the required quality and at an affordable cost to meet their household and productive needs to sustainable reduce acute malnutrition

Research Objectives and Methods

USAID Nawiri has developed a broad-based and multi-dimensional research and learning agenda to:

1. Identify areas of support for gender-responsive good water governance practices to support county governments and their efforts to improve and sustain local water resources and develop sustainable water service delivery systems.
2. Identify action research aimed at strengthening inclusive water resource management approaches and increasing the availability and productivity of water.
3. To identify critical evidence gaps that need to be addressed to inform piloting or the need for additional field research for primary data collection and water sustainability assessments.
4. Contribute to other USAID Nawiri research and learning activities in exploring the most critical aspects of water governance and management to determine which activities have the optimal impact on reducing persistent acute malnutrition including: water insecurity, women's time poverty, water productivity for livelihoods and nutrition and water governance.

These efforts ultimately will inform actions to enhance water security and improve the productivity of water for livelihoods and nutrition in both counties. Our working hypothesis is that improved governance and management of water resources in Turkana and Samburu can serve to:

- ensure sufficient availability and quality of surface and groundwater supplies;
- safeguard the resource in the face of competition over water supplies;
- respond to a changing climate, availability and sustainability of water resources;
- promote access to, and the equitable allocation of, water sources to poor and food insecure households in urban and rural communities, particularly during dry seasons;
- alleviate community and household-level conflict related to water scarcity; and
- have a positive effect on women's workload, psychosocial wellbeing, time away from the home, enabling improved self-care and care of infants and young children with a resultant effect on improved nutrition of women and children.

Methodology

The desk review relies primarily on published and grey literature, as well as documents sourced from relevant ongoing projects in Kenya and the two counties specifically. Effort was also made to obtain existing data sets, models or analysis that examine linkages between water resources and production and/or that build water budgets for local geographies and water productivity models for characterization of water management strategies.

The desk study will be supplemented with field visits, as feasible, to gather additional perspectives and evidence on water resource management, WASH systems and productive water uses. More details are available in **Appendix 1**.

Key Informant Interviews held to explore particular technical areas of potential interest to USAID Nawiri included:

- USGS
- Acacia Water
- Millennium Water Alliance – HQ
- TAHMO
- SweetSense

Additional engagements were conducted as part of the June 2021 WASH Bottleneck Analysis, for which reporting is available separately.

Human Geography

Administrative Divisions

County Integrated Development Plans detail the following administrative and political units:

- Samburu – three sub-counties, 15 wards and 108 villages
- Turkana – six sub-counties, 30 wards and 156 villages

Kibish is a seventh administrative unit within Turkana. Maps of the counties, sub-counties and wards are provided in Figures 3.4 and 3.5. This desk review uses the county administrative units to group and present data and associated analyses.

Population

Kenya has conducted a census every ten years since 1969, and participates in the multi-country periodic Demographic Health Survey (DHS). Historic census data is available from IPUMS; DHS data is available directly from DHS or through IPUMS.

Population data for the two counties is summarized in Table 3.6 to demonstrate where population growth could drive demand for water usage. Ten- and thirty-year population increases are projected based on increments observed between the 2009 and 2019 censuses. Turkana County, with over 900,000 people, has three times the land area and three times the population of Samburu County, meaning that they have comparable population densities at 14/km^2 and 15/km^2 respectively.

During the census interval, Kenya's population grew by an annualized rate of 2.1%. Samburu grew faster than the national average at 3.2%, while Turkana was below the average at 0.8%. Population growth was driven by surges in the county seats of Lodwar in Turkana Central at 3.1% to 83,000 people, and Maralal in Samburu East at 4.6% to 31,000 people.

Turkana's northwestern counties of Turkana North, Turkana West and Loima saw population declines of some 10%, or 50,000 people, over this 10-year period – due in part to insecurity and refugee populations fleeing regional conflicts.

Should Samburu county maintain its current population growth rate, the county could add another 115,000 people and increase population density to 20 people/km^2 by 2030. Commensurately, Turkana would add some 40,000 people in the same time frame, leaving population density at 14/km^2. This assumes relatively static total fertility rates in both counties, even though the exceed the national average of 3.9 births per woman at 6.3 births per woman in Samburu and 6.9 births per woman in Turkana, according to 2014 DHS data (DHS 2014). These rates approximate the national rate in the early 1990s (DHS 1989, 1994).

Economy, Poverty and Inequality

Improved water services, as with other public services, are provided according to allocations from national resources and commensurate with the level of economic development in a given administrative division.

Funding for the capital and operational expenditures of boreholes and other water services is sourced from the federal budget and payments made by households. Understanding how government and households pay for water services is important to understanding what services are likely to be affordable and, perhaps as significantly, sustainable over time.

Economic Output

These data represent a first attempt in 2019 by KNBS at computing gross county product (GCP), which provides a picture of the economic structure and relative size of the economy in each county, as well as sectoral contributions and per capita income at the county level (KNBS 2019). Both current and constant (real or inflation adjusted figures) are provided as well as per capita figures. Given that the census revealed lower population growth than expected in Turkana, the per capita figures in the KNBS report are overly pessimistic about growth in Turkana. The data were calculated for the five-year period from 2013-2017. For 2017 a sectoral breakdown of GCP is provided for each county.

Summaries of relevant data for Samburu, Turkana and Kenya are shown in Figure 3.7, Table 3.8 and Table 3.9. The figures included here are derived from market transactions, and as such do not reflect the full extent of economic activity in these counties. In particular, so-called “own production” meaning food and other household inputs produced and consumed within the household are not reflected.

Samburu ranks next to last in terms of economic output among Kenya counties, with KSh 26.5 trillion (USD 250 m) in GCP in 2017, or roughly KSh 90,000 per capita (USD 870/capita or USD 2.39/c/day).

While the economy grew larger in current prices of goods and services over the period, once the figures are adjusted for inflation, the county economy grew at a modest 1.7% over the period. Significant swings are observed on a year-to-year basis with 2015 and 2017 recording negative per capita growth. The population growth rate assumed by KNBS is 3.6% as opposed to the 3.2% observed during the census period, thereby understating per capita figures slightly. Rural productive activities including agriculture represent 41% of the formal economy, with government services making up another 20%. The remainder comes from private sector activities. Water supply and waste collection represent 0.7% of county economic activity (KSh 180 m or USD1.7 m).

Turkana’s economy is three times larger than that of Samburu: of comparable size in per capita terms. In 2017, GCP was KSh 78 trillion (USD 750 m). Due to the overestimation of population growth by KNBS

– at 3.9% instead of the observed figure of 0.8% -- there is therefore little difference between the two counties with Turkana returning a KSh 86,000 per capita GCP (USD 845.10 or USD 2.32/c/day).

Agriculture and other rural productive activities make up 53% of the economic activity with 15% from government and the remainder from the private sector. Water and waste make up 0.6% and electricity production 2.6% (KSh 2 trillion or USD 20 million) presumably due to the hydropower project on the Turkwel river.

With rather erratic economic growth, therefore, at 4% (Turkana) and 5% (Samburu) this implies – particularly in Samburu – both a limited improvement in living standards and limited resources to spend on basic needs – including the delivery of even basic rural water services.

Areal Extent, Land and Agricultural Land

Land is classified inconsistently across the two counties, with little consensus on what constitutes arable land. Disaggregation of data was not found for Turkana; the most recent figures for Samburu came from county government data (County Government of Samburu 2018).

Tables 3.10-3.12 depict the different classifications; taken together, they suggest that the classification of 36% of land in Turkana as arable must also include some category of rangeland as just 120 km2 of the county receives enough rainfall to be classified as high-potential agricultural land.

Most land in Samburu is considered communal land, representing some 8,000 km2. Close behind is 7,000 km2 of land without a clear designation.

As part of the Kenya RAPID program, Acacia Water conducted detailed biophysical and hydro-meteorological assessments in five ASAL counties, including Turkana (but not Samburu). The land use and land cover maps from this effort for Turkana are shown in Figure 3.13. To note that these maps failed to include a legend, but it can be inferred that the light green color is grasslands, and the darker green color (which correlates to higher altitudes) is likely to be woodlands. Floodplains in the north of Turkana viewed on Google Earth appear to be a large wash that drains the eastern slopes of the mountains running north/south to a low point or pan just across the border in South Sudan, rather than to Lake Turkana, as is the case to the south in Turkana.

Agriculture and Livestock

Agriculture and livestock drive rural livelihoods in the two counties, and require significant and consistent water to remain viable. Data sources were inconsistent, and efforts were made to cross-reference yields and prices imputed. In some cases, missing data was improvised using external reference or imputed data, so for example value of meat production was calculated using FAOSTAT data and prices for hides found in Turkana data were used to impute hide value in Samburu.

Data that remain unclear, erroneous or missing are noted in the discussion and highlighted in tables 3.14-3.17.

Livestock is the predominant form of agricultural production in Samburu, generating 75% of the total production value of KSh 1,108m (USD 12.6m as per 2014 forex). Meat production is four times the size of milk production, with animal hides of negligible value. Cultivation of 3,800 ha of cereal crops of maize and wheat generated KSh 261 m (USD 3.0 m) in that year, with a gross return of KSh 68,000/ha (USD 780/ha).

For Turkana County, total production value could not be reliably calculated as the KNBS estimates for meat production appeared low and other estimates from the 2013-2017 CIDP were excessively high. Using the data as provided, total production in 2013 was valued at KSh 6,600 m (USD 76 m). Value from cereal crops – primarily millet and sorghum – were roughly three times higher than in Samburu, due to a larger area under production and a higher price per kg for millet. Value generated in crop and horticulture per hectare is double that of Samburu County at KSh 140,000 (USD 1,600/ha), most likely due to the presence of irrigated lands in this mix of production data. This is at the low end of gross returns per hectare for data from four irrigation schemes in Kenya for the 2014/15 season that are provided by KNBS (http://knbs.or.ke/visualizations/?page_id=3786).

While these data are not year-on-year comparisons and represent different levels of economic output, they do diverge substantially – by 80-85% -- from the Country Gross Capital Product figures provided by KNBS. This may be attributable to low valuation of livestock. Another possibility is that the Gross Capital Product values reflect the import and slaughter of animals from outside the counties and are thus not counted as part of county agricultural production.

Meat production in Turkana was substantially lower than in Samburu, which seems odd given that stock numbers in Turkana are much higher – at roughly five times the size of Samburu's stock numbers. On the other hand, reported milk production is significantly higher than in Samburu. Neither set of figures was consistent with reported data in the 2013-2017 CIDP for the county, even though the stock numbers were largely identical. Further time and effort would be needed to confirm or correct the KNBS data from 2013 and 2014.

Climate and Water Resources

The assessment of water insecurity in terms of supply and demand for water resources was conducted in two parts: historical observation, and trends in climate projections, derived from both regional information and limited local meteorological data. The limitations on local data are historical and current because of the small number of weather stations able to provide comprehensive data. A review of drought and vegetation conditions in both counties is also provided.

Climate Trends and Projections

Data Availability and Validity

Low-resourced countries like Kenya are unable to count on the same sophisticated gridded infrastructure to track trends in precipitation and other climate data as their industrialized counterparts. Instead, they make do with satellite data to make up the distance between two weather stations to generate a reasonable estimate of the spread of precipitation. However, this does not always translate into complete and longitudinal data that measures trends. One needs only to look at the 2020 Global Precipitation Climatology Centre's initiative pulling 67 years of precipitation data from more than 135,000 weather stations worldwide; the African continent is nearly unrepresented in the global trend analysis due to a lack of data to interpolate. For reference, the two northern Kenyan counties, with a combined surface area of nearly 90,000 km2, boast just a single weather station: at Lodwar, in Turkana.

Figures 3.18-3.20 illustrate these implications across the continent as well as locally within the two counties.

That Kenya and its neighbors are facing such challenges in measuring past rainfall, the situation bodes ill for predicting and forecasting future precipitation for modeling as well, even as the consequences of climate change accelerate. Were there to be an area for considered investment in innovative and low-cost technology, it would be in building an alternative to the physical infrastructure of weather stations.

This profound lack of infrastructure prevents any meaningful, data-driven investigation of the implications of climate change for the people of the region – both within the micro-region of the ASAL of northern Kenya but more broadly, for the African continent of more than one billion people whose population is expected to double in the next 30 years.

Trends and Projections in Temperature and Precipitation

Temperature trend data across East Africa as a function of the consequences of the climate crisis have showed steady and consistent warming, with a mean temperature increase between 0.7°C to 1°C over the 40-year period from 1973 to 2013. Temperature increases vary with the seasons, but overall the net implication has yielded warmer nights, warmer days, longer periods of warmer temperatures and warmer temperatures during the summer months. The greatest increases are found in the northern and central regions.

Ballpark projections suggest that temperature increases will rise from a low end of another 1-2°C increase in the far future (for a total from pre-industrial levels of 2-3°C) and a high-end increase of another 3-5°C (total of 4-6°C). The highest increases will be found in the northern and central regions, with steady increases in the magnitude and frequency of heat extremes.

Consistent declines in the period from March to May known as the long rains have been associated with repeated and compounded droughts, which have doubled in frequency to one in three years and are becoming more severe. The ASAL region has been flattened by several prolonged droughts over the last 30 years, many of which have been accompanied by massive invasions of locusts. The short rains, extending from October to December have been wetter even amid changing large-scale circulation patterns that have produced the drying trend by causing later onset and earlier cessation of the rains.

Climate change is projected to have an even greater impact on precipitation cycles over the next generation. Extreme climate change consequences would (RCP8.5) yield increases in rainfall during the short rains (October-December) of up to 100 mm on average, with later onset but delayed cessation. For the long rains, there is little redundancy among existing models, with no significant trend emerging.

However, there is general consensus about the likely increase in extreme rainfall events expected under moderate and high emissions scenarios as well as more intense and more frequent droughts, with overall greater aridity in the ASAL region.

Separately, an MSc student team from Wageningen University undertook an analysis of climate change in Turkana County and the four other ASAL counties for Acacia Water (Jessica Brown et al. 2015). This effort involved examining 2006 to 2015 trends as a baseline and then using RCP 4.5 and 8.5 to examine monthly and yearly trends through 2050. Their analysis confirms the increase in the short rains but found a stronger increase in precipitation through the period during the long rains under both models. As the paper is not peer reviewed, these results are noted but the AR6 results will be assumed to be more accurate.

Local Conditions and Trends in Samburu and Turkana

A study at the Lodwar weather station used 1950 to 2012 data for rainfall and 1979 to 2012 data for temperature (Opiyo et al. 2014) to demonstrate that the analysis of seasonal trends confirm the upwards trend in temperature. However, a closer reading suggests that the results were somewhat mixed, with the analysis of monthly data showing a statistically significant increase in the maximum temperature only in three months and a declining minimum temperature in three months. A decrease in rainfall from March to May during the long rains was noted by the authors, as well as a slight increase in October to December, consistent with regional trends noted above. Results from the single, longstanding station at Lodwar are shown in Figures 3.21-3.24.

Water Resources (aquifers, groundwater, lakes and rivers)

Regional and National Trends in Surface Water and Groundwater

A study of 75 years of flow data from the Tana River Basin in Kenya, located to the southeast of Samburu County (Figure 3.25) showed increasing river flows linked to increasing rainfall in the highlands (Langat, Kumar, and Koech 2017). Also to the south of the area of study, the shallow lakes of the Eastern Rift Valley have been rising since 2010 in part due to changes in rainfall and land use (Onywere et al. 2013; Olago et al. 2021). And in western Kenya, analysis of the Nyando River, which drains into Lake Victoria, show significant variability in rainfall and river discharge, attributable to climate variability, while deforestation and land use change – has led to increased peak flows, soil erosion and sediment levels (Kitheka, Okoyo, and Mboya 2021).

Much has been written of late about groundwater in Africa, often due to an interest in understanding groundwater level, behavior and potential alongside the question of whether or not to promote an increase in its usage south of the Sahara (R. C. Taylor, Koussis, and Tindimugaya 2009; Carter and Parker 2009; Altchenko and Villholth 2014; Murray-Rust and Fakhruddin 2014; Kundzewicz and Doll 2009; MacDonald et al. 2009; Mahe 2009; IAEA 2017; Bonsor and MacDonald 2011; Cobbing and Hiller 2019).

While many of these are continent-wide or regional efforts and, thus, provide only a limited degree of resolution on what is ultimately a local issue, they do raise the question of groundwater sustainability: both in terms of stock and rate of recharge. Generally, recharge is high during mid-intensity rain events; during low intensity events most precipitation goes to evapotranspiration. During high-intensity events most of it runs off (Carter and Parker 2009).

Water Resources in Samburu and Turkana

Samburu and Turkana counties differ in available water resources – as well as in available data on those resources. Turkana borders a large freshwater lake that provides an ample fishery. Samburu has no lakes but instead ephemeral pans that collect water during the rainy seasons but are often dry in dry seasons. Both the Turkwel and Kerio rivers in Turkana run year-round and provide for irrigation on their banks as well as in a couple of smaller formal irrigation schemes. The Turkwel River is also tapped for hydroelectric power production: a major regional source of hydropower. At the same time the future of Lake Turkana, a World Heritage site and terminus lake, is threatened due to the Gibe III dam and prospective irrigation projects upstream in Ethiopia on the Omo River, the primary source of water for the lake.

Samburu lies largely within the Ewaso-Ng'iro Basin (Figure 3.25) and the Ewaso-Ng'iro River forms the southern boundary of Samburu East County. Due to limited rainfall and high aridity Samburu has limited perennial streams and no surface-fed irrigation schemes. Where perennial streams (or *laggas*) exist, for example as tributaries to the Ewaso-Ng'iro and the Seiya River in the Meibae Conservancy, these are important water sources for local communities (Rural Focus Ltd 2019). The flow of the Ewaso-Ng'iro River is potentially under threat from the Isiolo or Crocodile Jaws Dam, proposed upstream on the river within Isiolo County (CAS Consultants 2016). Estimates are that flows below the dam will vary from 15-38% of their normal range once the dam is built, potentially leading to the drying of the river downstream, for example as it reaches the Lorian Swamps downstream from Samburu County (Vilela and Bruner 2017).

Turkana has a series of vast and underground aquifers that provide the lure of fossil groundwater, which requires treatment. Hydraulic connections between aquifers and between aquifers and surface waters in the Turkwel River Basin mean that excess groundwater pumping may draw pollutants from one aquifer into another and may reduce river flows (Tanui et al. 2020). Samburu has yet to explore its aquifers and groundwater potential as Turkana has and thus appears to be limited to existing shallow aquifers, which can run dry. Lineaments found in Samburu are promising for groundwater recharge.

Despite the more significant presence of water resources in Turkana, the overall impression is that for most communities in both counties, the situation is one of water scarcity and during dry periods and droughts, water insecurity for households and pastoralists.

The physical and economic distance from the rivers, lakes and aquifers are of little consequence to most inhabitants of Turkana; rather, they rely on available water stored on the surface or underground, using wells or mechanized boreholes to access the groundwater. Water security in this context requires an understanding of how these water sources behave as they are recharged and as water is withdrawn. Equally, the impacts of population growth and climate change figure worryingly.

There are three primary information sources on Turkana water resources, including mapping, datasets, models and documentation:

1. JICA's project on Community Based Drought Management in Turkana and Marsabit counties as completed in 2015 includes an Annex on Turkana Water prepared by Japanese consultants (JICA n.d.; Nippon Koie Co. Ltd. 2015).
2. USAID's Kenya RAPID project employed Acacia Water, a Netherlands-based consulting firm, to produce a series of map products, water supply and demand tools and assessments of the 3Rs (retain, reuse and recharge) (Acacia Water n.d.).
3. Oxford University's REACH program completed a WEAP model and assessment of climate risks for water resources in the Turkwel River Basin (Hirpa et al. 2018).

The USGS has had a long-term research program aimed at increasing understanding of aquifers and the hydrogeology in the Turkana area, but these reports have yet to be completed. In any event, this effort is aiming at increasing the “hit rate” for well drilling, rather than assessing water scarcity or insecurity.

Acacia Water provides a large series of maps for Turkana County Including:

- Land-related maps: land cover, land use, DEM (digital elevation model), protected areas, topography, soils, slope, slope-change in NDVIA
- Groundwater related maps: aquifer productivity, geology, groundwater potential, groundwater potential and borehole density, known aquifers, water points, water quality
- Hydro-meteorological maps: evapotranspiration, NDVI average, NDVI variance, Net precipitation, precipitation, recharge as % of precipitation
- Water Demand: livestock density, livestock water demand, minimal water demand 2035, minimum water demand 2015, optimal water demand 2015, optimal water demand 2035
- 3 R maps: 3R potential, 3R potential plus groundwater, 3R potential plus groundwater plus boreholes.

Maps of the hydro-meteorological variables showing precipitation, evapotranspiration, and net precipitation (precipitation less evapotranspiration) are shown in Figure 3.26. The maps show net precipitation ranging from 300 mms in the highland areas to close to zero in large areas of the plains, with a few isolated areas of negative net precipitation, presumably due to irrigation and other water uses. The time frame for the data used to derive the maps is not noted on the maps. Acacia Water’s water supply and demand tool suggests average precipitation of 302 mm/yr and evapotranspiration of 421 mm/yr for Turkana County, for a net draw on surface and groundwater of 120 mm/yr. However, there is considerable variability noted with the surplus in a “wet” year at 238 mm/yr and deficit in a dry year at 278 mm/yr.

The net precipitation figures are indicative only and should not be taken as representing recharge. Acacia Water, in a series of maps for five counties included in a national RAPID survey produced a recharge map that estimated recharge in Turkana at 10mm per year or less. (Kenya RAPID Figure 3.27). Given the 70,000 sq kms of land in the county this would amount to about 700 million m^3 of recharge at 10 mm/yr. Subtracting from this recharge the amount that might be consumed for environmental purposes, including going to streamflow, would leave a rough estimate of the rate at which groundwater might be extracted sustainably, assuming they are consistent rather than from extreme rainfall events.

The JICA team suggests that recharge rates in Kenya vary from 4%-22% (Nippon Koie Co. Ltd. 2015). Based on estimates from studies in ASALs of other countries the team provides a range of 1% to 18% for these conditions. Using 361 mm/yr for Turkana County and a figure of 8 mm/yr for renewable groundwater recharge, or 2.2% of precipitation, they calculate 547 m m^3 of annual recharge. The JICA team further deploys a rather general estimate from a USGS publication that 10% of recharge is representative of sustainable yield to arrive at a figure of 55 m m^3 for sustainable yield. They then calculate that at the time the total maximum pumping rate in the county was just 7 m m^3/yr or 12% of the sustainable yield. These simple estimates are applied to sub-basins in the country to arrive at the extent to which the sustainable yield is developed for pumping (Figure 3.28).

The draft on sustainable yield as defined by the JICA team varies but is under 50% in all locations and quite low in some. Such calculations are very gross estimates derived from a rainfall mapping exercise, which is in itself a tenuous proposition in the county. Setting the sustainable yield at 10% therefore, is a conservative estimate in comparison to a continent-wide mapping of groundwater potential by the International Water Management Institute that used a range of from 30% to 70% for this parameter in their mapping exercise (Altchenko and Villholth 2014).

Water Supply and Demand Estimates for Turkana County

Both Acacia Water and IRC have developed spreadsheet water supply and demand models for the USAID KALDRR and RAPID projects. The Acacia Water tool is available for download and includes data at county and sub-county levels for Turkana and the other ASALs (Acacia Water n.d.). The IRC effort is included as part of a Water Master Plan exercise for two sub-locations on the Turkwel River, in Kalemgorok and Katilu (Carrasco 2014), incorporating similar models simulating water use on irrigated land and by livestock plus wildlife rangeland use. The monthly (Acacia Water) and annual (IRC) demand for ground and surface water – so-called "blue" water – is calculated based on observed or assumed rates of use per person, animal or per crop.

Irrigation changes any assessment of current water use and likely recharge. The Oxford Reach program developed a Water Evaluation and Planning (WEAP) model to simulate water supply and demand on the Turkwel river in the presence of climate change (Hirpa et al. 2018). The modeling showed that in over half of the 34 years of hydrology observed, precipitation deficits would likely lead to severe risk of water scarcity. The authors then simulated moving from the existing 1,800 hectares to 10,000 hectares and even 25,000 hectares of irrigation. Both irrigation and population growth were found to aggravate the impacts of climate variability, even with limitations including inconsistent hydroclimatic data, from the lone weather station in Lodwar, and the uncertainty of climate projections for rainfall. The model predicted that by 2030, the probability of severe risks and high rates of groundwater depletion will increase threefold, from 16% to 49%.

Extending these models into Samburu would be a valuable consideration for USAID Nawiri's investment in long-term, county-owned planning against continued persistent acute malnutrition.

Investigations conducted by JICA in Turkana include:

- Detailed survey, mapping and investigation of surface water pans, to identify potential sites for increased capacity or new construction
- Estimation of groundwater potential including a Total Groundwater Development Potential map (Table 3.29, Figure 3.30)

- Development of a MODLFOW groundwater model with 2km grid cell sizes, depth at -1,000 meters (deep enough to incorporate the newly found deep aquifers), "Worldclim" rainfall, 5% of rainfall as recharge, with calibration to 24 boreholes
- Extensive water quality testing for 30 wells and boreholes
- Hearing surveys in 43 communities
- Proposed sites for 50 new boreholes
- Mapping to include detailed topography and slope, geology, rainfall, temperature, map of rainfall and surface water features (rock catchments, water pans, sub-surface dams), groundwater sources (spring, borehole, and wells), rainfall and water pans, slope and water pans, water pans and laggas, boreholes classed by water quality, grazing areas, and more.

Drought and Vegetation Condition

The JICA team developed maps tracking drought recurrence based on rainfall records (Figure 3. 31). These are limited, however, to meteorological drought and do not measure impacts to grazing and agriculture. Meanwhile spatially explicit rainfall estimates from satellite observations are subject to their own limitations (Klisch and Atzberger 2016).

NDMA has engaged the University of Natural Resources and Life Sciences Vienna (BOKU) to prepare VCI maps on a monthly basis for each county that is monitored, including Samburu and Turkana counties (Klisch and Atzberger 2016). The BOKU approach uses Moderate Resolution Imaging Spectroradiometer (MODIS) satellite data with a resolution of 250 meters. While the MODIS resolution is far less than the LandSat imagery (30 meters), MODIS is better at "seeing through" cloud cover and, thus, has advantages in tracking NDVI through wet periods. Data is acquired and processing undertaken on a weekly basis and made available on a near real-time basis. This is an advantage over the FEWSNET product, which is available only with a time lag. The BOKU team assessed FEWSNET vs BOKU data and found they provide effectively the same results (a coefficient of determination or R^2 of 0.89), with some seasonal differences being more marked (Klisch and Atzberger 2016). The fidelity between the two datasets had the lowest degree of variance in the case of the ASAL counties. When compared to assessments by the Kenya Food Security Steering Group, the BOKU approach performs particularly well during drought periods. However, the authors conclude that ideally the VCI should be compared to actual field measurements to confirm the accuracy of the approach.

While the work with NDMA by BOKU to create the index began in 2014, the analysis is hindcasted through to the year 2001 using MODIS. The VCI is available as a one-month or three-month VCI. The cumulative three-month VCI results for the two counties up through 2021, as found in the NDMA drought bulletins, are shown in Figure 3.31-3.32.

A visual scan of the two figures suggests that the two counties do not experience drought conditions in lockstep; the 2004 drought hit Samburu harder and in 2015, Turkana fared worse.

Water Use and Resource Management

Data compared between the 2019 Census and KNBS 2015/26 household surveys found that local, primarily rural pastoral communities rely typically on surface water for their household needs. Only the communities along the Turkwell river have access to large infrastructure including dams and irrigation schemes. It was noted that the survey data tended to overstate the extent of improved sources in both counties. Presumably, this reflects the higher level of effort in the census to reach pastoralist households.

Water Sources

A snapshot of the water sources used by households shows that in Samburu, only 35% have access to improved sources: well off the 55% nationwide (Figure 3.33, Table 3.34). Households in Turkana have the same improved portion as rural households generally but with higher levels of piped supply. Despite the apparent lack of large rivers in Samburu, fully 35% of households say river water is their primary source (30% in Turkana). Borehole coverage is 16% and 13% for Samburu and Turkana respectively, suggesting that improved coverage is very low in rural areas.

Data from the Meibae Conservancy on water sources provides a picture of water use in rural Samburu: eight boreholes, four of which would be capable of producing sufficient water (10l/c/d) to reach the human population if they were close enough to reach, and one in disrepair (Rural Focus Ltd 2019).

As a result, 50% of households use surface water, mostly pans and sand dams, and another 27% rely on wells, springs, and rock catchments. At 77%, this exceeds the reliance across the county on unimproved sources, at 63%. Competition for water can be dangerous for women collecting from sources also used by livestock and wildlife, including carnivores, particularly in the dry season (Rural Focus Ltd 2019).

The shrinkage of available domestic water access in the Conservancy is shown in Figure 3.35.

Over 40% of households in Samburu and Turkana must travel for more than 30 minutes to fetch water (Figure 3.36). Only 10% of households have on-premises access. Together these figures demonstrate just how far behind these counties are from the national average, and how much investment is needed to even bring them within reach.

NDMA reports provide data from transect surveys in the two counties and report much longer fetching times; in Turkana, during January and May, women are making round trips of between 6-8km to fetch water. The average in Samburu is 5km, with livestock distances double this.

Depending on walking speed these distances convert into fetching times of from 45 minutes to 100 minutes. A survey of urban and rural households in Samburu found 56% of pastoralist households (whether urban or rural) taking more than two hours to fetch water and another 34% taking between 30 minutes and two hours (Balfour and Mutuku 2018).

In the Meibae Conservancy in East Samburu Sub-County it is reported that 37% and 61% of households trek two hours or more a day to fetch water in the wet season and dry season respectively (Balfour, Obando, and Gohil 2020). A study in a Turkana community, Locher Edoot, revealed that before a handpump was installed, women would take 6-9 hours to fetch water from local rivers every other day during the dry season (R. Fischer 2015).

This has an impact on everything from access to education to health care to opportunities to participate in governance processes.

Household Water Usage

The 2015/16 KNBS survey also asked households to pin their monthly water usage within categories bounded by 1,000-liter intervals. Water usage by households in Samburu and Turkana are considerably lower than in other rural areas in Kenya; 95% of households in Samburu and 65% in Turkana fail to meet the minimum threshold of 20 l/c/d established by WHO (Figure 3.37 and 3.39 and Table 3.38) .

Total county household water usage, therefore, works out to roughly 1.0 m m^3/yr for Samburu and 2.0 m m^3/yr for Turkana. These figures concur with those cited earlier from the Acacia Water supply and demand tool. These amounts do not represent a large draw on surface water or groundwater sources available and, certainly, represent only a portion of the animal use of water in the two counties. It is also critical to note projections of what the implications could be if both counties progressed to the WHO standards for water consumed under basic, intermediate, and optimal access (noting that even optimal access remains a small portion of household water use in developed countries). Even at the optimal access, water use would remain a portion – a significant portion at that level – of current animal use. For Turkana, this amount if sourced entirely from groundwater would still not exceed the very conservative sustainable yield put forward by the JICA team, as reported above (Nippon Koie Co. Ltd. 2015).

Water Supply Infrastructure

A number of projects have compiled lists and maps of water supply infrastructure in the two counties. For Samburu the REACH program provides a spreadsheet of boreholes and their status to generate summary statistics on functionality of water points in Samburu County (Table 3.39); at the time of production, 69% of sources were considered functional.

These figures compare to national studies that suggest between 20-30% of improved water supplies are non-functional at any given time. A recent report measures the sustainability of water and sanitation investments as only 44% and 56% for Turkana and Samburu respectively (Maji Insights, n.d.). Further data on water point functionality exists and can be reviewed prior to implementation (Brooklyn Economic Consulting Ltd 2020; Otieno 2019). REACH maps by sub-county are also available; the Samburu West map is shown in Figure 3.40. Further information on functionality is sometimes found in the Samburu NDMA bulletins.

The JICA team's approach in Turkana, although now somewhat dated, is the most comprehensive as they surveyed boreholes, wells, springs, sub-surface dams and water pans (Figures 3.41-3.43). Acacia Water also provides maps of boreholes and other sources, but this information is now also dated.

To ensure appropriate prototyping and implementation of interventions, timely assessment of water data should be a priority of USAID Nawiri's collaboration with county governments. Additionally, while all of the investments in water resource management align around a specific objective – to improve the planning of infrastructure -- there is little follow-up to determine whether projects are completed – or even funded.

Water Supply, Gender Roles and Water Insecurity

Statistics of average water use hide the dysfunctions and unreliability in existing water supplies and systems. For the ASAL, many of those dysfunctions are a result of the access and travel time fluctuations during the dry season. According to June 2018 SMART Surveys only 20% of households in Turkana and 15.7% in Samburu access the minimum amount of water recommended for humanitarian purposes of 15 l/c/d, even in the wet season: a generous finding as compared to the KNBS 2015/16 household survey data.

Hydro-climatic and socio-ecological disruptions are increasing water security risks for vulnerable households, sedentary pastoralists, women, and children in particular (Balfour and Mutuku 2018). A 2018 mixed-methods study, employing a Household Water Insecurity Scale in rural and urban Samburu, found that almost all rural households (92%) were water insecure during the dry season (Balfour 2019). This figure dropped to 73% in the wet season, with the most pronounced change being that only 6%, instead of 38%, were highly insecure.

This pattern of seasonality in water insecurity, and the severe nature of insecurity during the dry season, is also observed among pastoralists who have opted out of rural areas and have settled in and near urban areas hoping for improved livelihood options. Urban pastoralists appear to be better off in the wet season as compared to their rural compatriots, who face insecurity year-round (Figure 3.44).

Traditional gender norms dictate that women are responsible for domestic water security while men and male youth maintain water sources and water livestock herds, except for sick and young animals who are left at the homestead as the responsibility of the women (CHC 2018).

These gendered responsibilities are emblematic of the relative disempowerment of women and intersect with the socio-cultural and economic value of livestock that influences key household decisions on where to migrate or settle, or community decisions on location of a new water point.

Outcomes often favor the water-related interests of men (for livestock) over women (for domestic use), with implications for women's workload, exposure to personal risk, and caregiving capacity. In one study, a key informant stated that “Men think of livestock. They don’t think of the distances women walk”. Still, research in Samburu shows that women are the responsible party when it comes to domestic water. Women control allocation of household water so far as even being able to deny their husbands access to water collected by women. By custom, a man’s access to water within the family home is by consent, not by right. The conclusion reached is that female responsibility for domestic water is a source of some power, rather than a manifestation of complete disempowerment (CHC 2018).

Such modest concessions do little to mitigate the time burden, physical and mental stress and opportunity costs confronting women in rural areas who navigate high water insecurity, made worse during dry season drought. Research in Samburu showed that overall time spent collecting water restricted a woman’s ability to care for her children: a cornerstone of early childhood development. Limited household capacity for water storage was another major barrier to water security (CHC 2018). Moreover, the easier a woman’s access to water, the more time she spends as a caregiver, according to the same study.

Separately, a new quantitative study found that one in five Samburu women reported that time spent fetching water had prevented them from caring for their children more than 10 times in the previous 4 weeks (Balfour, Obando, and Gohil 2020). Helping women store water safely at home from water points nearer by are two design challenges that USAID Nawiri could explore as part of its package of scalable interventions.

Women routinely make tough decisions about water use, balancing a household’s diverse needs for drinking, cooking, personal and domestic hygienic, and, in some cases, watering small stock and kitchen gardens. A lack of household water security means despite knowing the benefits of handwashing (82% in Turkana and 57% in Samburu), few caregivers are able to put it into practice (16% in Turkana & 26% in Samburu) (Turkana and Samburu June 2018 SMART Surveys).

Access to improved sanitation is available only to one in ten households; the vast majority of populations – 74% in Samburu and 79% in Turkana – practice open defecation (Turkana and Samburu June 2018 SMART Surveys).

Women in Samburu are most likely to make decisions about whether to pay for water or transport (CHC 2018). Should a woman need funds to complete that transaction, it is relatively easy to obtain from the man who holds decision-making power in her household. Beyond that, however, women have little access to cash.

These findings suggest that women make calculated decisions balancing the financial cost of paying for a service – water or transport – against the opportunity cost involved in their labor to secure water (CHC 2018).

Seasonal water insecurity is a result of both the opportunity cost of finding water and the lack of a consistent income to pay to replace it. Meagre livelihood generation derived from subsistence agriculture is less possible as there is no water; moreover, the price of livestock typically declines alongside their condition during the dry season. Women are further compromised by the need of men to migrate with cattle to find better pasture; the time pressures imposed on already over-taxed women in dry season also prevent any opportunity to invest in other income generating activities. At a time when the benefits of being able to pay for water are comparatively higher, women confront a combination of factors that make it nigh unto impossible to find the funds to do so.

Adding the dimension of quality to the water in question makes these circumstances more difficult. The CHC study reports that women may assume that transported water is of higher quality than stored or sourced water. One factor that could guide further investigation by USAID Nawiri into water supply relates to the value of the social investment that is made (or not made) in developing year-round water supplies by installing and servicing boreholes that tap into reliable groundwater supplies, as perceived by various constituencies: women in particular.

Conflict, in the border areas in particular, adds yet another dimension of stress to a woman's daily search for water. Hydro-ecological conditions matter both directly, in terms of water availability, and indirectly, through interaction with socio-cultural and economic systems. In Samburu North, for example, water shortages in dry season and drought trigger violence along existing fault lines, which together with the dry season migration of young men with livestock, leaves women vulnerable as they seek to safely access water points (Rapid Assessment, February 2019).

In Turkana and Samburu, the causal links between WASH and PAM – and thus the nature of the WASH actions most likely to have an impact on PAM – are likely to vary according to differences in the wider environment. Despite a lack of empirical evidence, anecdotal evidence and historical understanding of the chronic challenges confronting the women in these communities demonstrate that where household water insecurity is high and variable, identifying ways to make things easier for women is the surest way to improve both WASH outcomes and reduce PAM.

As an example of a site-specific effort to develop a water resource management strategy it is useful to look to the Meibae Community Conservancy located in Wamba West Sub-county in Samburu. The majority of the actions involve coordination and technical items, along with action aimed more at rural water services delivery than WRM per se.

Safe, Reliable Water Supply for the People of Meibae	
Principles	**Actions**
Infrastructure Development	
Infrastructure development by all actors should follow water development priorities developed by the conservancy within this strategy (see Figure 4)	• Improve water supply access through new and rehabilitated infrastructure for priority communities • Lobby county government and other stakeholders for infrastructure plans to be included in CIDPs and other relevant plans
Strengthen Coordination and Partnerships	
County-based coordination mechanisms should have conservancy representation to reduce project duplication and inform planning for water development. Water management should become a core function of the conservancy and conservancy management should represent the community in bring water problems to the attention of key stakeholders	• Coordinate and guide the interaction and partnership between the various NGO's working within the conservancy on water issues. • Link the conservancy water development plans to sub-county water development plans • Develop links to county water coordination forum through NRT county coordinators • Develop partnership with NDMA on monitoring water resources during stress periods
Support Management of Water Supplies within the Conservancy	
The conservancy management should be able to support Water Users Associations (WUAs) and water committees to effectively and efficiently manage water supplies. The conservancy can act as an 'umbrella' organisation to cluster water supplies and harmonise approaches to management	• Improve understanding of good practice in water management and institutional arrangements for water service provision under county government • Work with WUAs (collectively and individually) to improve management systems within the conservancy • Develop a relationship with CG water department and explore opportunities for the conservancy to become a registered water service provider • Encourage women's participation and leadership in water management through exchange visits and capacity building.
Improve Household Water Safety	
Households within Meibae should have safe drinking water and practice good sanitation and hygiene to reduce disease and malnutrition	• Work with community health volunteers and health facilities to; (i) increase understanding of links between water, sanitation, hygiene and health/malnutrition, (ii) increase use of household water treatment and improve sanitation and hygiene practices • Facilitate purchase of household water storage containers (tanks) to improve water security and reduce women's work load

Source: Rural Focus Ltd. (2019)

Water Governance

Legal Framework

In Kenya, water resources are vested in the state. Water use is subject to approval and a water permit that typically defines type of use, the amount authorized, and the duration of use. Despite this legal structure, groundwater is often perceived to be a private resource that can be used by the surface property owner, which puts it at risk of being overused in the short term as a common pool resource.

Initially, national water management in Kenya focused on making potable water available to all households by the year 2000. By 1999, however, the 1999 National Water Policy shifted the responsibility for water supply to the local level and focused the national government on regulatory management. The Water Act of 2002 further separated the obligations of supply from regulation, decentralized many functions to lower levels, shifted focus to implementation, and provided a role for non-governmental entities. The Act created the Water Resources Management Authority,

Part II of the 2002 Act states that all water is vested in the state. The Minister, assisted by the Director of Water, is permitted to exercise agency over water in accordance with other provided provisions. Decisions about water must be focused on conservation and the "proper use of water." Groundwater does not have its own regulatory framework but is managed as part of water resources generally.

To assist with the goals of the Act, Part III establishes the Water Resources Management Authority, which consists of a Chairman and ten appointed members. The Authority was to regulate the ownership and control of water and make provisions for the conservation of surface and groundwater.

It was to develop guidelines and procedures for allocating water; monitor, issue and enforce permitting; protect water quality; and collect and process data. The Act dictates the process through which the WRMA should develop a national strategy to manage, protect, use, develop, conserve, and control the water. Plans should be specific to each catchment area with stated goals. A groundwater conservation area can also be created in areas when there is a need to protect public or commercial water supplies. The role of non-government entities and community groups, or water resources user associations (WRUAs) were greatly enhanced by the Act, but final decision making remains centralized.

The WRMA grants permits and ensures compliance with requirements, and provides authorization to construct boreholes and wells. Additional regulations regarding the licenses for water providers were detailed in the Water (services regulatory) rules. Unfortunately, permits are often issued without a good understanding of the aquifer or the impacts pumping would have on it.

With promulgation of the Constitution of Kenya on 27 August 2010, the water sector become a devolved function within the newly established 47 counties. Articles 21 (2) of the Constitution further obliges the State to take legislative, policy and other measures, including the setting of standards, to achieve the progressive realization of the rights guaranteed under Article 43, including the right to clean water in adequate quantities and to reasonable standards of sanitation.

The 2002 Act was superseded by the 2016 Water Act, which regulates, manages and develops water resources and water and sewerage services in line with the new Constitution. This puts water service delivery squarely in the responsibility of the counties, with authority vested to counties to manage water. The Act recognizes a shared responsibility between the national government and the county government and gives use of water for domestic purposes priority over irrigation and other uses. The Water Act continues to separate water resource management duties from water and sewage services. The Act created several new entities and redefined the roles of existing departments at national, regional and local levels.

The 2016 Water Act places oversight of policies to regulate water resources under the aegis of the Water Resources Authority (WRA) as part of a national water resource strategy. Underneath sit Basin Water Resource Committees (BWRC) at local catchment levels. Community water is managed by Water Resources Users Associations (WRUA) (Figure 3.45)

Water supply and sanitation (sewerage and non-sewer) services are delivered at county level by Water Service Providers (WSPs) regulated directly by the Water Services Regulatory Board (WASREB): a departure from the previous dispensation where WSPs were licensed as agents of Water Service Boards (WSBs). Under the Water Act of 2002, WSBs were responsible for asset development and in most instances, provision of bulk water. The 2016 act replaced WSBs with Water Works Development Agencies (WWDAs) whose main mandate is to develop cross-county water services infrastructure. The 2016 act also mandates a complete handover of assets to counties for operations, meaning a full transfer of both assets and contingent liabilities under terms and conditions developed as part of a Water Sector Transition Plan, and Transfer Plan and further backed by a National Water Policy.

The Cabinet Secretary is obligated to create or revise a National Water Resource Strategy every five years with public participation. The goal of this strategy is "to provide the Government's plans and programs for the protection, conservation, control and management of water resources" (Kenya Water Act, Section 10(2), 2016). Groundwater is not specifically listed in the description of the strategy; however, it is likely included in some of the catch-all language. Further, Article 23 recognizes that the Cabinet Secretary may need to make special measures to conserve groundwater in the public interest. For policy implementation, Article 56 states that groundwater abstraction is dictated by the Fourth Schedule of the 2010 Constitution, which defines the distribution of functions between the national and county governments. While permitting is a national obligation, counties are responsible authorities for the "implementation of specific national government policies on natural resources and environmental conservation, including…water conservation" and water services (Constitution of Kenya, Fourth Schedule, Art. 56, 2010).

Such laws have culminated in a National Water Master Plan 2030: part of the larger Kenya Vision 2030 published in 2007, which includes water targets as well as references to the 1999 water policy. It incorporates national water policy and development targets and attempts to estimate sustainable groundwater yield across several catchment areas. Unfortunately, the plan ignores surface water/groundwater interaction and makes false assumptions of uniformity across aquifers.

Much of Kenya's groundwater is shared with other countries, which compounds management challenges. At least five significant transboundary aquifer groups are shared with neighboring countries: the Rift Valley aquifers, the Elgon aquifer, the Merti aquifer, the Kilimanjaro aquifer, and the Coastal sedimentary aquifers. Despite the amount of shared water, no cooperative use or protection agreements are in place.

Governance Challenges

Governance challenges in groundwater management are related both to institutional capacity and externalities including steady population growth, which leaves too many people in both counties without basic access to water. The failure to integrate climate variability and predicted climate change uncertainties in groundwater development decisions represents another challenge.

Managing growth in withdrawals towards sustainable yield (or any other target) must consider the likelihood of longer droughts and heavier rainfall events. Critical scientific information related to recharge rates and connection to surface water needs to be grounded in a better understanding of the implications of climate change – a distant prospect in both counties.

Capacity of staff, whether in administrative, financial or technical roles, remains among the biggest obstacles to good governance and management of water resources. This is matched by a persistent resource deficit at county level, both in terms of county-driven revenues and allocations from the national treasury.

"There is inadequate capacity in the WRMA offices responsible for the NAS. Between them—two geologists are deployed to Nairobi SRO, none in Kiambu SROs—groundwater staff must manage about 4,000 groundwater permits" (Mumma, 2007). Without the ability to enforce, the aquifer is placed at the mercy of the commons.

Kenya's move away from centralized enforcement to a more localized approach utilizing aquifer-specific management plans and stakeholder/public participation, while preferable, is not effective without implementation support and consistent enforcement.

Improved local self-governance requires an understanding of existing and customary tenure systems (RRI and ELI 2019; Hodgson 2016). Kenya's context would suggest a move to a hybrid system of water rights that aligns better with its current governance and socio-economic limitations. (Schreiner and van Koppen 2020; 2018).

Rural areas remain largely beyond the oversight of the Water Resources Authority. In the Meibae Conservancy in East Samburu Sub-County, which falls under the Marsabit Sub-Region WRA office, it is reported that there are no registered Water Resource Users Associations and no water permits for the boreholes (Rural Focus Ltd 2019). Water sources are managed using traditional systems or with no management at all, and traditional systems are not very strong, and challenged by the open access nature of water sources.

Were there to be more active management, the conservancy would need to coordinate better with authorities to manage water resources more effectively. Improved sources often have Water User Committees, but these are more often considered to be weak. Tariffs and charges for improved water are largely absent in the conservancy.

Focus groups conducted by CHC in Samburu (2018) found that payments for water were more likely for the transport of water than for water itself, unless it was from a kiosk or a borehole. Costs ranged from KSh 5 to KSh 40 (roughly USD 0.30) for a 20-liter jerry can of water. The May 2021 NDMA bulletin for Samburu confirms this range within the county more broadly, including seeing prices per jerry can of KSh 20-40 in urban areas, inclusive of transport (NDMA 2021a). Similarly, the May 2021 NDMA bulletin for Turkana reports a price of KSh 20 per jerry can in urban areas, rising to KSh 30 inclusive of transport.

County Financing and Investment in Water

Funds allocated from the central government and development partner investments constitute the bulk of funding available to improve water services in the two counties. In the wake of devolution in 2010, counties could rely on a proportional share of roughly 15% of revenues collected by government. Now, this figure has doubled to 30%. In a resource-poor county like Samburu, 2019-2020 figures show (Table 3.46) this has translated to roughly KSh 7.0 billion (USD 67 million) allocated from national coffers to be spent on county development services.

Within the context of resource allocations, too, is the reality of absorption capacity by the county government. Within the water and sanitation sector, the per capita expenditure on water service provision was equivalent to USD6.80, one third of which was spent on installation/rehabilitation of 35 boreholes. This works out roughly to around 2% of household expenditure, and to Gross County Product about 0.50%: a not unreasonable number on a percentage basis if one was to ignore the additional, non-financial costs such as time, opportunity and quality as relates to these water services.

Ultimately, the ASAL counties are hamstrung in their ability to provide services that would drive populations towards achieving SDG 6 due to governance, finance and low economic activity. Meeting the water funding gap would require taking funds from other equally necessary development programs or relying on a large infusion of private or external funds.

Conclusions

More effective management and governance of water resources and water services, backed by enough resources to meet the water funding gap would contribute both to progress toward SDG 6 as re-imagined under the USAID Nawiri ToC: where rural and urban communities have access to adequate water of the required quality and at an affordable cost to meet their household and productive needs.

The absence of water remains a critical driver of persistent acute malnutrition. Yet the simple provision of more boreholes or water points to meet household or productive needs is not enough to address water insecurity. Deploying a more technically sound, data-informed strategy to govern and manage the precipitation that falls from the sky and the surface and groundwaters that move through or are resident in the counties is necessary for any meaningful change in the fortunes of the county's drought-plagued populations.

While pastoralism and rangeland management are not the focus of this review, it is worth emphasizing that the carrying capacity and hence the need to migrate in search of water and pasture (particularly for cattle) very much depends on the range condition, which in turn depends on temperature, rainfall, and soil condition. Overstocking the range can have deleterious impacts in terms of erosion and runoff, lessening groundwater recharge. At the same time long migrations have their own impacts on the household, particularly in reducing access to milk for infants and young children. Higher temperatures, more intense rainfall and more extremes, particularly in terms of drought, are not going to improve the current situation. And, as reviewed, current income levels – largely derived from pastoralism in these counties – are too low to sustain the type of investment in improved water services that are currently needed. In other words, per capita income growth is needed but seems unlikely to materialize from doubling down on pastoralism, nor is surface water available in the quantity needed to support widespread conversion of land to irrigated agriculture.

Indeed, the few studies conducted warn against drastically increasing the use of existing surface water and, to a lesser extent, groundwater for irrigation. This would simply exacerbate the existing seasonal water insecurity. Absent comprehensive information about groundwater resources, however, it is premature to reject groundwater irrigation in all locations. The one attempt in Turkana to calculate a sustainable yield suggested that current abstraction of groundwater is well within this yield. However, the pumping of shallow groundwater would likely compete with existing and future uses of water by humans and animals.

Current per capita water use is extremely low, so as groundwater is tapped to raise this amount and reduce the health risks from such low levels of consumption, the human draw on water will increase rapidly. While human use is currently small compared to livestock and wildlife in the few estimates available, this balance is likely to change going forward. Human uses are going to increase and animal uses are likely to stay the same.

Impacts of climate change, land degradation and existing management deficits suggest that the extent to which the water resource can be actively managed will drive the extent to which it is available in the quantity and quality that is desired at a given time and location. This is the essence of water resource management.

Within the counties, however, there is little understanding and experimentation of how to take steps to improve this management. USAID Nawiri must better understand the lessons learned from implementation of activities derived from formative data, studies and models (as funded by USAID and JICA) in Turkana. In Samburu, there is less evidence available. A better understanding of what is appropriate, community-level action to ensure that local surface waters – such as pans – and shallow aquifers are best supported might be an important first step in developing a co-created research agenda with county partners that would lead to greater availability of these limited resources during the dry season and for longer during drought periods.

In both counties there has been little quantitative or systematic assessment of the contribution of water resource scarcity to human water insecurity: another research opportunity for USAID Nawiri to consider.

With regard to climate change adaptation, water resources management and governance opportunities for Nawiri include:

- Anticipating potential sources of conflict to yield better understanding of how to engage in management activities,
- Engaging in mapping, field surveys and planning with communities to investigate how water is routed in and through local watersheds in order to identify opportunities for better conjunctive management of surface and groundwater, likely meaning aquifer recharge to augment water sources during the dry season.

Identifying how to expand improved water sources such as boreholes would be an ideal focus for USAID Nawiri, as it remains a top priority for county water departments. However, borehole infrastructure is expensive and the techno-managerial task of keeping these water points functioning is a significant challenge. USAID Nawiri should work with existing efforts to improve the functionality of these operations in Turkana and explore how such systems could be instituted in Samburu.

Moreover, USAID Nawiri has an ongoing opportunity with the T4D team and Cisco funds to deploy micro-sensors and satellite communications to deliver near real-time data on borehole operations and groundwater levels. Matched with weather station data, these technologies would provide useful operational data for communities, water resource managers and water service providers. It would also support a better quantification of the relationship between precipitation, recharge, groundwater, and borehole usage.

USAID Nawiri could consider working with county partners to establish and maintain such systems in a few strategic locations in order to track water levels, water usage and the impacts of water resource management interventions. At a minimum, carrying out an exercise of prioritization through surveying, mapping, site visits and evaluation would be a considerable technical exercise. It is therefore hoped that USAID Nawiri can build on prior such efforts conducted with the counties to accelerate implementation. Such efforts may involve technical advice and capacity-building to mobilize community participation and to the extent necessary market systems development and financial inclusion modalities.

The Trans-Africa Hydro-Meteorological Observatory (TAHMO) is an initiative aimed directly at this problem. TAHMO has spent the last decade building the technology and relationships to address this data deficit in Africa (van de Giesen, Hut, and Selker 2014). TAHMO provides low-cost, durable weather stations, often located at schools, as well as the cloud computing and data management to be able to provide this data out to users, including the national meteorological services. TAHMO works through a memorandum of understanding with the national meteorological services in African countries, including in Kenya. Mercy Corps is collaborating with TAHMO and held a webinar with TAHMO in early 2021 (slides are here). TAHMO has over 600 stations in operations across Africa including three weather stations in Turkana and one in Samburu since 2016.

Partnering with TAHMO to install weather stations at the required density, and doing so particularly at well-located schools, could improve short-term weather forecasting and begin tracking climate change as it proceeds.

Further elaboration on necessary next steps to build county capacity to provide water services comes from the accompanying WASHBAT work conducted with local officials and other stakeholders by USAID Nawiri.

While women's decisions are behavioral, they can also be characterized as microeconomic decisions reached within the constraints of the household time and income budget. USAID Nawiri water programming should draw from results of the longitudinal study that note that "buying" water is largely a payment to the person who transports to, and/or stores water in, the settlement. Increasing a household's capacity to store water could bring a substantial improvement and reduction in time spent trekking to water.

Addressing the affordability of storage solutions through a community-based microfinance system is one possible approach to this problem. Another approach would be to address the transport question. A market systems assessment would help to identify where market systems development might build better services between the water source, ideally improved sources like boreholes, and the community and/or household. To some extent this is a network problem between boreholes placed on the landscape and the transport routes to settlements. There may be a cost-minimization solution if it is planned in this manner.

It is said that famine can exist in the presence of abundant food. Similarly, water insecurity can persist where water is physically available, particularly if the market system is not efficient or is rife with rent-seeking behavior. To some extent the problem is one of delivering water at cost plus a reasonable profit margin for the businesses involved. Enlisting the private sector in this task, but doing so in a creative, intelligent and proactive manner, using the power and resources at the counties' disposal, may lead to better outcomes than a laissez-faire approach.

Bibliography

A bibliographic data search was undertaken using likely search terms to assess the level of scientific and other publications available on the topics of interest to this report. The search was conducted in Google Scholar and in Academic Search Premier (on EBSCOhost). Google Scholar searches the full text of publications for the search terms which makes it useful for finding documents but not for finding documents for a specific purpose. This is because it does not provide the ability to carry out keyword and title searches. As a result, a given search will turn up many publications, most of which will be unrelated to the desired topic. That said, Google Scholar is useful because it does catalog unpublished or gray literature, such as USAID reports, as well as published books. Academic Search Premier allows searching for terms and combinations of terms, across all bibliographic fields, but importantly it does not search the text of the publication. This database holds articles from around 7,500 journals.

A search was conducted of these two databases for “Turkana” and “Samburu’ as location terms, as well as likely terms of interest (as shown in Table 1). “Kenya” was used as a third location term and for comparison purpose with the counties. As expected, Google Scholar turned up many, many references, even down to 333 publications with the terms “Samburu” and “aquifer”. Meanwhile Academic Search Premier had very few references once the location term was combined with a water term. There were zero incidences of “Samburu” and “groundwater”, “borehole” or “aquifer”. So, there is scholarly work on aquifers and groundwater in or near Samburu, it’s just in books or other publications. That said the relevance of the google search tails off quickly. The eight-ranked article for the “Samburu” and “aquifer” search was entitled “Cultural perceptions of elephants by the Samburu people in northern Kenya” an unpublished master’s thesis found on the savetheelephants.org website. Effectively all the relevant pieces of work were on the first page and one technical piece of work

Table 1. Bibliographic Search Results

Search Term(s)	Google Scholar			Academic Search Premier		
	Kenya	Turkana	Samburu	Kenya	Turkana	Samburu
Location only	2.87 m	52,200	18,800	44,133	642	250
+ "water"	2.01 m	28,700	11,200	3304	98	10
+ "river"	1.1 m	21,500	7,510	803	66	5
+ "drought"	335,000	13,800	6,150	672	25	11
+ "flood"	181,000	7,260	1,830	218	16	2
+ "groundwater"	81,100	3.52	618	117	3	0
+ "borehole"	17,400	3,020	1,350	28	1	0
+ "aquifer"	18,600	1700	333	39	2	0

A more detailed list of sources for the desk review is provided below.

Data collection (tabular data from reports and online data catalog)

- Kenya National Bureau of Statistics (KNBS): http://www.knbs.or.ke
- National Irrigation Authority (NIA): http://www.irrigation.go.ke
- National Drought Management Authority (NDMA): https://www.ndma.go.ke/
- County Government of Samburu: https://www.samburu.go.ke/
- Turkana County Government: https://www.turkana.go.ke/
- Reliefweb: https://reliefweb.int/
- World Bank data repository: https://data.worldbank.org/
- Global DHS data repository: https://dhsprogram.com/data/
- IPUMS: https://international.ipums.org/international/
- Trans-African Hydro-Meteorological Observatory (TAHMO): https://tahmo.org/
  Mapping Products (with or without data extraction/download tools)
- FAO Water Productivity (WAPOR) https://wapor.apps.fao.org/home/WAPOR_2/2
- Acacia Water (Turkana): https://kenyarapid.acaciadata.com/browse
- Kenya Rapid Borehole Monitoring/eMaji Manager: https://wmaasp.mybluemix.net/dashboard

Reports and information were also collected from ongoing or past programs that engaged in either in Samburu or Turkana, as part or all of their program. These are listed in the appropriate section of the document. A number of the larger and/or more relevant programs with useful project documentation are listed here with their respective websites:

1. JICA's project on Community Based Drought Management in Turkana and Marsabit counties (ending in 2015) http://aicd-africa.org/archives/2757
2. SWS and GROWS, Oxford University's REACH program (in Kitui and Turkana counties) https://reachwater.org.uk/
3. USAID-funded Kenya RAPID in Turkana and other ASALs (ended 2020) https://www.globalwaters.org/HowWeWork/Activities/kenya-resilient-arid-lands-partnership-integrated-development
4. Centre for Humanitarian Change (CHC) research carried out in 2018 in Samburu (that collected data on governance systems and water insecurity (by season and for urban and rural communities).
5. Omo-Turkana Research Network (ongoing): https://www.canr.msu.edu/oturn/publications
6. Africa Groundwater Exploration and Assessment Program, including Turkana County (still ongoing) https://www.usgs.gov/centers/nj-water/science/africa-groundwater-exploration-and-assessment-program?qt-science_center_objects=0#qt-science_center_objects

Permission to download and use datasets was obtained as part of the research project, except that the 2019 census data is not yet available through these data portals. The datasets are quite large and are suited more to statistical software and database coding by researchers than to manipulation in Microsoft Excel by Mercy Corps Staff. To download a single variable along with the base contextual information from the 2009 census and the subnational divisions (e.g., counties) yields a 32 Megabyte file. The apparent inability to download data by county contributes to this issue. As an example of potential uses of census or DHS data, comes from Mali where the Mercy Corps TSU is working with a team from NASA and Columbia University, who are compiling the DHS wealth index from 2006, 2012 and 2018 and creating interpolated maps of wellbeing for the entire country. Should specific questions arise that could be addressed by accessing these datasets they are available to Mercy Corps. For this report only a simple review of population conditions and recent trends was attempted.

As part of the research for this review access to the TAHMO data for the following stations in Samburu (one) and Turkana (three) was requested and approved by TAHMO:

- Maralal Samburu Met Offices, from October 2017 to present
- Talent High School (near Lodwar)
- Moi High School Kalokol (at Kalokol on Lake Turkana)
- Loima Boys High School (west of Lodwar nearing the Ugandan border)

The information is available for a range of parameters at up to 5-minute intervals. A data extract was performed remotely on 6/26/21 at 20:06 UMT to demonstrate the potential use of the data. Figure 13 shows 15-minute interval precipitation data. Along with changes in onset and cessation of rainfall, changes in rainfall intensity are an important consequence of climate change. This is an important parameter in terms of the balance between infiltration and recharge, as versus overland flow and flooding during storm events.

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Annex 1: Stakeholder Consultations

Initial consultations with the Research and Learning Working Group (RLWG), formed to coordinate technical development of this line of research, have provided useful local context on the status of water resources, the demands on these resources, and the ways in which they are managed and governed in Turkana and Samburu counties. A few preliminary findings that emerge from these discussions and with regard to the supply and demand for water include:

- Limited seasonal rainfall with little natural or engineered storage creates a dependence on groundwater sources during the dry seasons.
- Seasonal rainfall - including the increasing intensity of such due to climate change - limits the ability to engage in rain fed agriculture without access to stored surface water or supplemental groundwater sources.
- Shallow groundwater sources are often depleted in the dry season, forcing households to travel long distances for water supplies.
- Shallow and deeper aquifers are often saline with fluoride contamination.
- Demands by households for water use are limited to drinking, hygiene, gardening, livestock watering, and in some cases the cultivation of crops.
- Wider demands on water exist, particularly in Turkana where hydropower, commercial/transport development, irrigation schemes and oil exploration are current/potential demands on the resource.

The two counties face multiple challenges with respect to the governance and management of water. Governance systems are relatively underdeveloped due to the recent nature of national and county legislation (or its absence and inadequacy), the lack of funds for building capacity and engaging in implementation of new rules and procedures and the lack of County Water System Master Plans. Without clear objectives, plans, staffing and finance, it is difficult for county staff to adequately address water security and water productivity needs.

- With respect to management strategies, stakeholders mentioned a number of approaches that are existing, underway, or proposed, as listed in the table in Appendix 1. These strategies face a large number of challenges, including but not limited to:
- requisite financing for capital and operational expenditures associated with improved technologies and infrastructure approaches
- issues surrounding management, ownership and cost recovery for borehole and other delivery systems
- water system or self-governance issues of how to manage access to developed water sources and trucked water during dry periods or times of drought.

Table: Water & WASH Preliminary County Characterization

Current Status	Samburu	Turkana
Water sources (Supply)	● Ewaso Nyiro River ● Reliant on rainfall/runoff and groundwater ● Natural pans for runoff during rainy season ● Aquifers are not promising due to low yield, high salinity, fluoride and other chemicals. ● Wells dry up during dry season until shallow groundwater recharges during rainy season	● Turkwel River ● Lake Turkana ● Lots of runoff during rainy seasons but no storage for dry reason ● Porous, volcanic soils prohibit use of large pans. ● Aquifers, shallow and deep, deep aquifers suffer from water quality limitations
Water uses (Demand)	● Urban/rural household uses, very important small rural centers (towns) ● Productive uses: ○ Primarily Pastoral – animal watering is a priority ○ Crops, irrigation	● Urban/rural household uses ● Crops, mostly in irrigation schemes along the Turkwel river (pastoralists switching to crops) ● Kakuma Refugee Camp and Kalobei Integrated Settlement
Water Management (technologies and practices)	● Small-scale irrigation ● Trying to use solar power for water production (changed from diesel genset). ● Rainwater harvesting (school rooftops) ● Pans and dams for runoff (for irrigation) ● Village or school boreholes (yield of >2m^3/hr), or wells (<2 m^3/hr) ● Water trucking during dry spells for domestic use	● Drip irrigation ● Solarization of water production ● In-situ micro catchments, pans for crop irrigation ● In pastoral area – large pans (100,000m^3) for livestock, can become silted ● Wells with hand pump (< 3 m^3/hr deep wells have high yielding pumps) ● Boreholes with solar/diesel pumps (> 3m^3/hr) ● Temporary water trucking where salinity/chemical issues with water (from

		Department of Water Services)
Governance /Coordination with National Ministry	● Poor water governance ● Need to train the community in good water practices ● Lack of a County Water Master Plan or County Water Act ● Department of Water working with rural water projects, tried to cluster them ● National Ministry tried to solarize facilities ● County very interested in continuing water trucking for personal financial gain and political reasons. Little political will to find permanent, sustainable solutions.	● County Water Act prepared to implement the Water Act 2016 at county level (mandate for people to demand services from government), ● Department of Water Services not ready to implement
Economics-Resources-Infrastructure	● Community accesses water for free in most boreholes - which can cause constraints on availability of funds to do operation and maintenance. ● No consistent allocation of funds ● Have lots of data and maps of water points ● Construction of tanks, pans, dams to manage water harvesting and recharge ● 5 lorries for water trucking ● County procuring and supplying plastic tanks, collapsible tanks for storage	● Water point management committees charge fees while others access it for free. ● Raw investment is limited, funding is insufficient. ● Drilling rigs are available for borehole drilling ● Investment in irrigation infrastructure for agriculture but not sustainable ● Also investment in borehole drilling for domestic water
Rural water services (boreholes, pans, river	● Rural beneficiaries depend on county, makes it hard for county manage all of the systems	● Drill permit required from WRA, areas are drilled far apart.

abstraction, sand dams, wells)	● Self-governance/self-reliance difficult ● High cost of operations and management ● Rural water is community managed and needs to be enhanced and training provided	● Water surveys – drillers sometimes paid if only water was found.
Needs and challenges (in addition to those listed above)	● Long-term investment in and management of boreholes needed ● Salinity of groundwater on the East side - cost of reverse-osmosis is a barrier to sustainability, environmental concerns around waste disposal. ● Water sources limited during the dry season. ● Water insecurity could lead to conflict over resources on the west side - mainly disputed control over grazing areas and pastoral water sources as part of it.	● Provide sustainable water for people and livestock ● Hydrology of area must be studied ● Difficulty scaling up the small-scale sources (micro-catchments)

Annex 2: 2016 Water Act

Key changes in the legal, policy and institutional frameworks as a result of the 2016 Water Act include:

- National government has the obligation of establishing a durable system for sustainable management of water.
- Devolution of certain water sector mandates is a major change in the water sector governance framework. This requires implementing the constitutional provisions that devolve water supply and sanitation to county governments; and further, providing guidelines how counties can implement national water law and policy concerning soil and water conservation.
- The management of the relationship between the national government and institutions with county governments is important. Under the Constitution, consultation and cooperation is undertaking mandates is urged (article 6); and where necessary the establishment of joint mechanisms is promoted by the Constitution. (article 189). For this reason, the Ministry of Water and the Council of Governors have agreed on an Intergovernmental Water Sector Coordination Framework which is pending implementation.
- The delivery water supply and sanitation (sewerage and non-sewer) will be undertaken by counties through Water Service Providers (WSPs) that are county owned and regulated directly by the Water Services Regulatory Board (WASREB). This is a departure from the previous dispensation where WSPs were licensed as agents of Water Service Boards (WSBs). The WSBs were under the Water Act 2002 licensed by WASREB and were responsible for asset development and in most instances, provision of bulk water.
- The WSBs are to be replaced by Water Works Development Agencies (WWDAs) whose main mandate is development of cross-county water services infrastructure. They are also required by the Water Act to handover the completed assets to a county, several counties or a Joint Authority for operations. "Handover" in this sense means the transfer of the asset(s) and contingent liabilities to counties/joint authorities under terms and conditions that will be determined as part of the water sector reforms and clearly set out through regulations, and as part of a Water Sector Transition Plan, and Transfer Plan and further backed by a national Water policy.
- The Water Act scope includes water resources management, institutional arrangements and regulatory management tools.
- The Water Resources Management Authority (WRMA) is to transit to the Water Resources Authority (WRA). The Catchment Area Advisory Committees (CAACs) have been replaced by Basin Water Resources Management Committees (BWRCs).
- The Water Act establishes Water Resources Users Associations (WRUAs) unlike before when they were established through regulations. The mandate of BWRCs however still requires clarification through amendment of the Water Act including how to carry out their mandate.
- The Water Act has not provided the manner through which counties exercise their mandate on water resources as stipulated by the Constitution.
- Water harvesting and storage has been set out as a major priority to enhance the national water storage capacity through the establishment of the National Water Harvesting and Storage

Authority (NWHSA). NWHSA will undertake this mandate on behalf of the national government, including the provision of water during drought emergencies.

- In implementation of water sector reforms further guidance will be provided on how to enhance water harvesting and storage at small, medium and large scales including leveraging on rainwater harvesting at household level to relieve pressure on freshwater sources. This is in addition to treatment and re-use of storm and waste water for various acceptable purposes. Linkages with counties will be pursued for issuance of development permits, so that rainwater harvesting, for instance, becomes a prerequisite in provision of building permits.
- There is renewed focus on sanitation services which includes sewerage and non-sewerage services. The provision of reasonable standards of sanitation is a human right under the Constitution. In addition, the overall national coverage through conventional sewerage systems remains low and is primarily focused on urban areas. Where feasible, the water sector reforms will promote the use of affordable non-sewerage technologies, such as those that also recycle waste water for prescribed uses. Measures are to be taken to continue public investment in conventional sewerage systems.
- In the water sector reforms, the Constitution will remain as the reference guide for all actions to ensure full and complete constitutional compliance. Therefore, specific attention is being paid to mainstreaming gender considerations in all processes and decision making; and implementing affirmative action for vulnerable members of the population, and for the youth.
- The Ministry of Water has prioritized implementation of the Climate Change Act, No. 11 of 2016, which requires mandatory mainstreaming of climate change interventions for adaption and mitigation by all sectors, including water. This includes implementation of the National Climate Change Action Plan (NCCAP).
- The Ministry of Water also prioritizes water sector education; by putting in place policy directions to work with the Kenya Institute of Curriculum Development to mainstream water sector education across the nation basic education curriculum The priority is to transition the Kenya Water Institute into a Centre of Excellence for water sector professional and technical training.

Annex 3: List of figures and Tables

Figure 3.1: Governance of Water Resources and Water Services

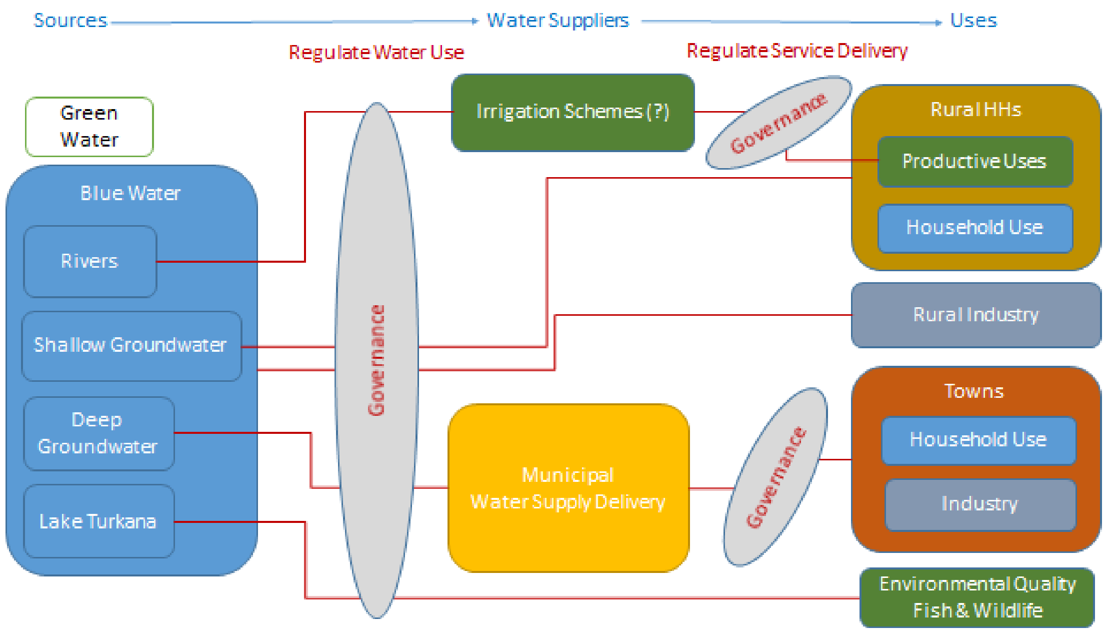


Figure 3.2: Water Resource Management Strategies

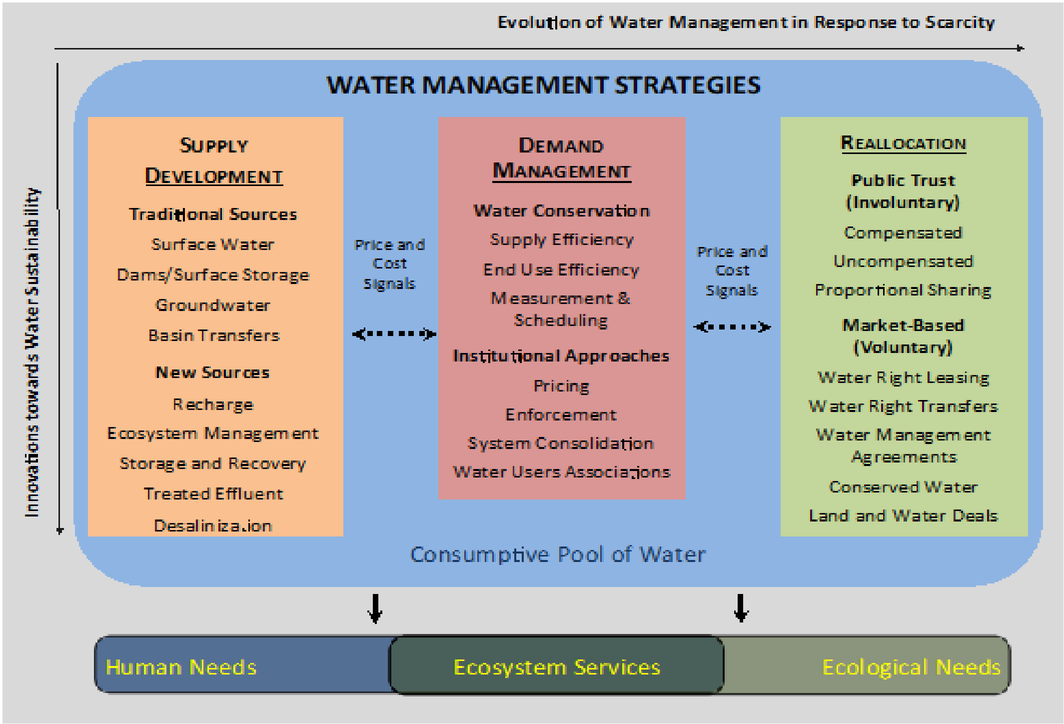


Figure 3.3. USAID Nawiri Water Governance and Management Theory of Change

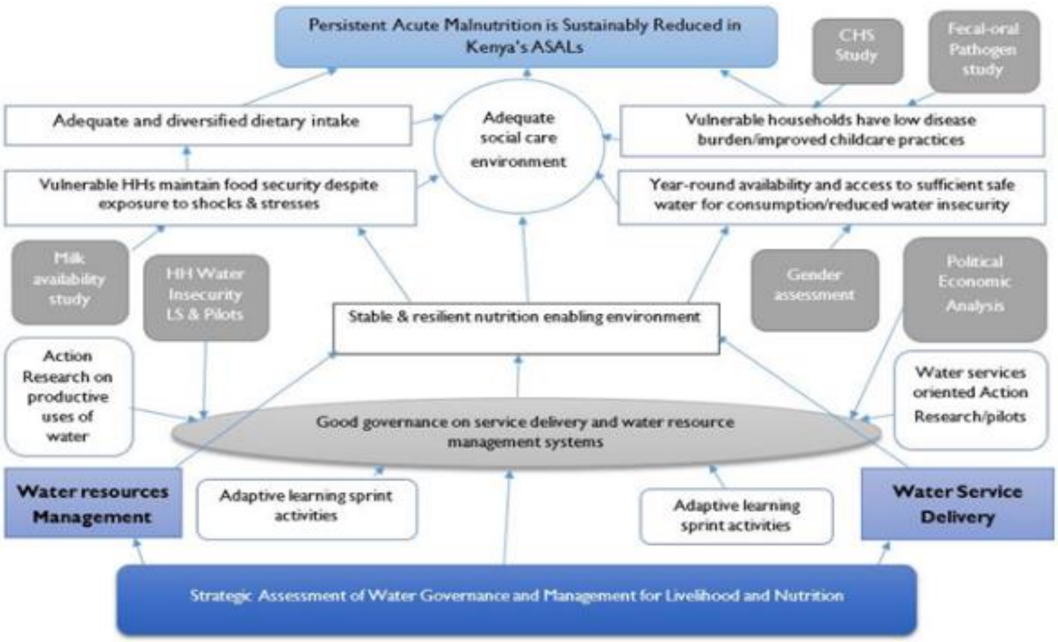
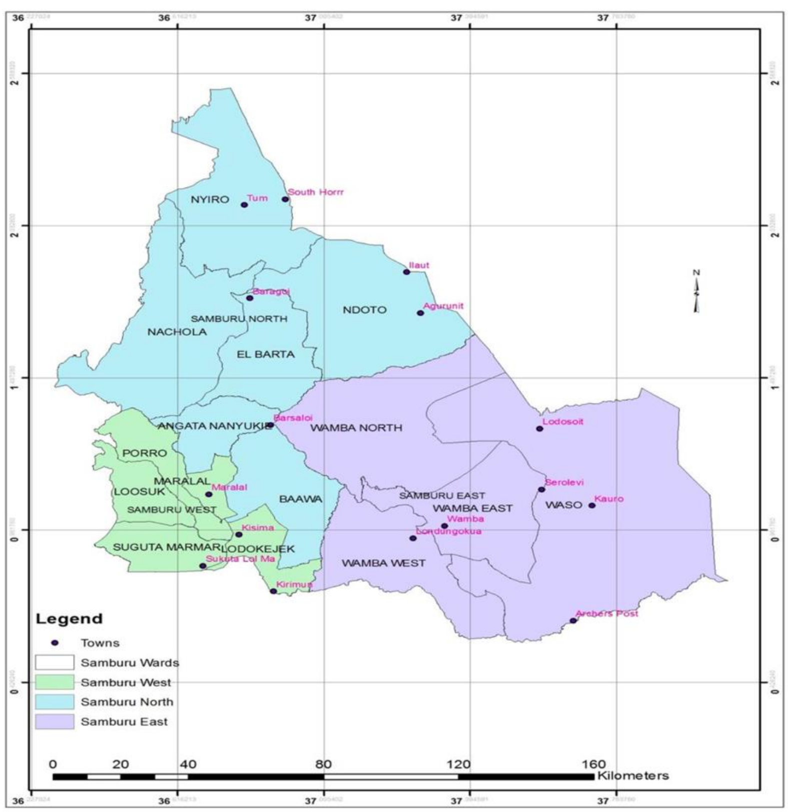
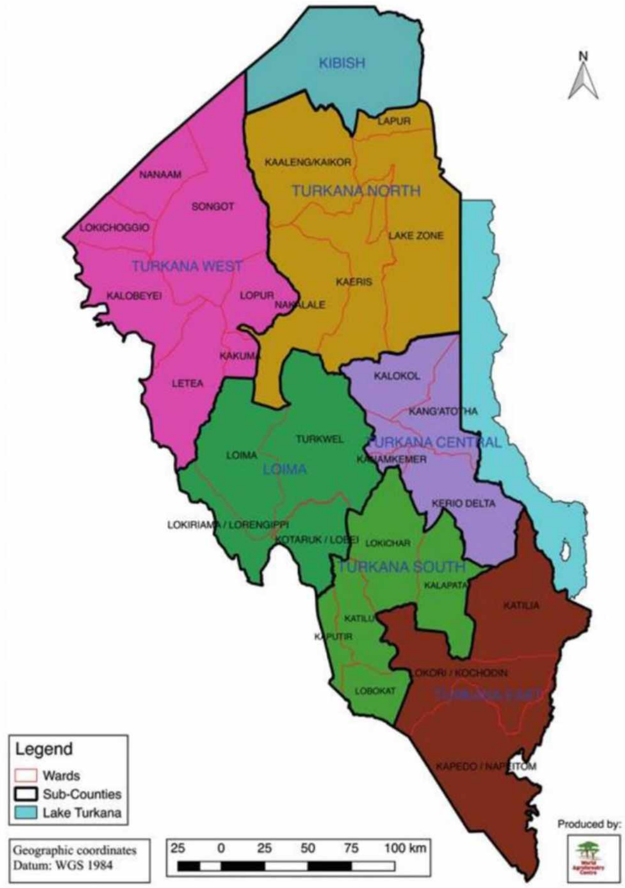


Figure 3.4: Samburu Administrative Units



Source: Samburu CIDP 2018-2022

Figure 3.5: Turkana County Administrative Units



Source: Turkana CIDP 2018-2022

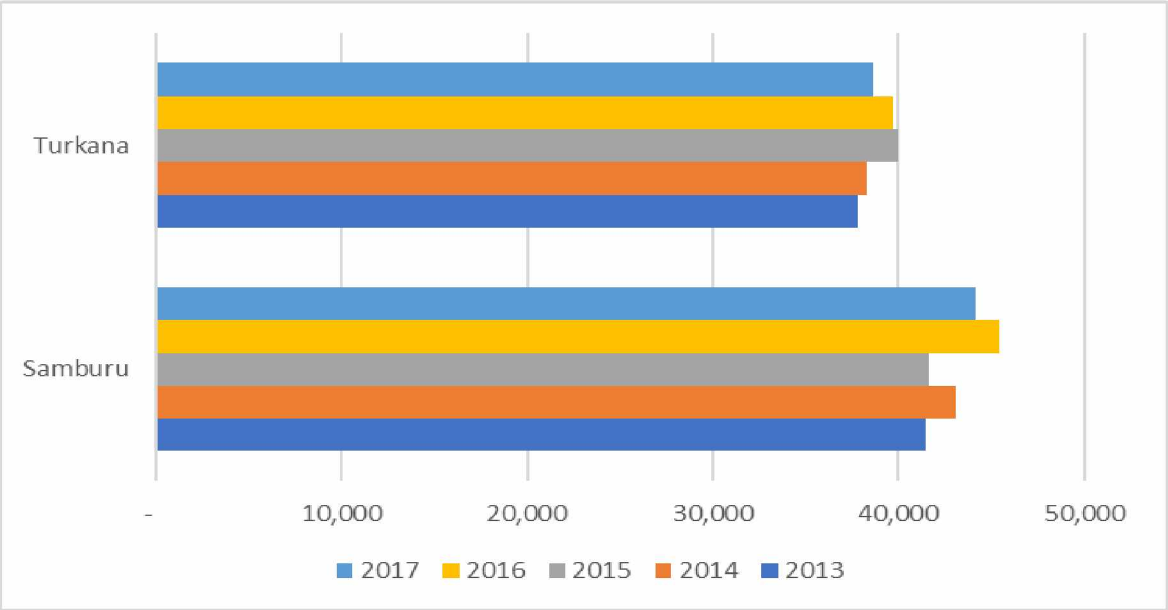
Table 3.6: Census and Projected Population and Population Density

Administrative Unit	Population					Land Area (Sq. Km)	Population Density (No. per Sq. Km.)		
	Census		Growth	Projected		Census		Projected	
	2009	2019	Rate	2029	2049	2019	2019	2029	2049
Samburu County									
Samburu West/Central	105,052	163,942	4.6%	255,845	623,086	3,674	45	70	170
Samburu North	59,801	66,879	1.1%	74,795	93,548	7,375	9	10	13
Samburu East	59,094	77,136	2.7%	100,686	171,553	10,016	8	10	17
Total - Samburu	223,947	307,957	3.2%	423,482	800,801	21,065	15	20	38
Turkana County									
Kibish		36,401	-2.4%	79,849	49,393	10,466	3	5	3
Turkana North	129,087	65,125				7,012	9		
Turkana Central	134,674	183,121	3.1%	248,996	460,364	6,415	29	39	72
Loima	119,932	106,625	-1.2%	94,794	74,926	9,113	12	10	8
Turkana South	135,913	153,350	1.2%	173,024	220,268	7,052	22	25	31
Turkana West	245,327	239,323	-0.2%	233,466	222,178	16,779	14	14	13
Turkana East	90,466	138,265	4.3%	211,319	493,620	11,396	12	19	43
Total - Turkana	855,399	922,210	0.8%	961,599	1,471,356	68,233	14	14	22
Kenya	38,610,097	47,564,296	2.1%	58,595,094	88,924,537	580,876	82	101	153

Source: KNBS (2019a; 2009) Turkana County Government, CIDP 2013-2017

Notes: Population projections carried out at 2009-2019 growth rate, Areas specified in 2009 and 2019 census' for sub-counties differ (as do those used in county CIDPs) therefore population growth rates may not account for boundary changes. Kibish and Turkana North are projected as one entity since Kibish was created out of Turkana North

Figure 3.7: Constant Per Capita County Gross Capital Product, 2013-2017



Source: (KNBS 2019c)

Table 3.8: Growth in County Gross Capital Product, 2013-2017

	GCP (curent KSh m)			GCP (constant KSh m)			GCP per capita (constant Ksh)		
Year	Samburu	Turkana	Kenya	Samburu	Turkana	Kenya	Samburu	Turkana	Kenya
2013	14,572	51,349	4,745,090	10,581	36,672	3,077,206	41,494	37,753	76,710
2014	17,076	58,064	5,402,647	11,374	38,631	3,166,946	43,038	38,277	78,817
2015	18,401	67,910	6,284,185	11,401	41,805	3,269,760	41,637	39,982	81,365
2016	23,498	73,761	7,194,147	12,879	43,020	3,373,238	45,383	39,699	83,951
2017	26,503	78,301	8,196,666	12,984	43,308	3,442,906	44,147	38,592	85,689

Source: (KNBS 2019c)

Table 3.9: Sectoral Contributions to Gross Capital Product, 2017 (current)

Sectors	Samburu		Turkana	
	KSh m	%	KSh m	%
Agriculture, forestry and fishing	10,847	41%	41,493	53%
Wholesale and retail trade; repair of motor vehicles	4,354	16%	2,581	3%
Public administration and defence	3,403	13%	3,529	5%
Education	1,703	6%	6,252	8%
Financial and insurance activities	1,386	5%	2,198	3%
Real estate activities	1,236	5%	2,537	3%
Transport and storage	1,234	5%	7,750	10%
Construction	661	2.5%	4,684	6%
Human health and social work activities	587	2.2%	1,946	2.5%
Other service activities	569	2.1%	2,172	2.8%
Water supply; waste collection	180	0.7%	487	0.6%
Information and communication	143	0.5%	366	0.5%
Accommodation and food service activities	132	0.5%	361	0.5%
Electricity supply	123	0.5%	2,066	2.6%
Mining and quarrying	47	0.2%	88	0.1%
Manufacturing	29	0.1%	65	0.1%
Professional, technical and support services	11	0.0%	16	0.0%
FISIM1	(142)		(290)	
Total	26,503		78,301	

Table 3.10: General Land Classification

Category	Samburu		Turkana	
	Sq Kms	%	Sq Kms	%
Arable (in crops, pastures, gardens)	1,500	7%	25,000	36%
Non-Arable Land	19,522	93%	43,680	64%
Water Mass	-		6,405	
Urban Area	159	1%	2,204	3%
Total Surface Area	21,022	100%	68,680	100%

Source: (KNBS 2015a; 2015b)

Table 3.11: Land Zoning, Registrations and Use

Land and Registration Status	Samburu		Turkana	
	Sq Kms	%	Sq Kms	%
Total Surface Area	21,022	100%	77,000	100%
Water Area/Lake Turkana	2	0%	6,405	8%
Registered Lands				
Game reserves	170	1%	2	0%
Gazetted Forests	3,103	15%	-	
Community Lands	8,294	39%	n/a	
Public Lands	2,678	13%	n/a	
Remaining Lands	6,775	32%	n/a	

Source: (County Government of Samburu 2018; Turkana County Government no date)

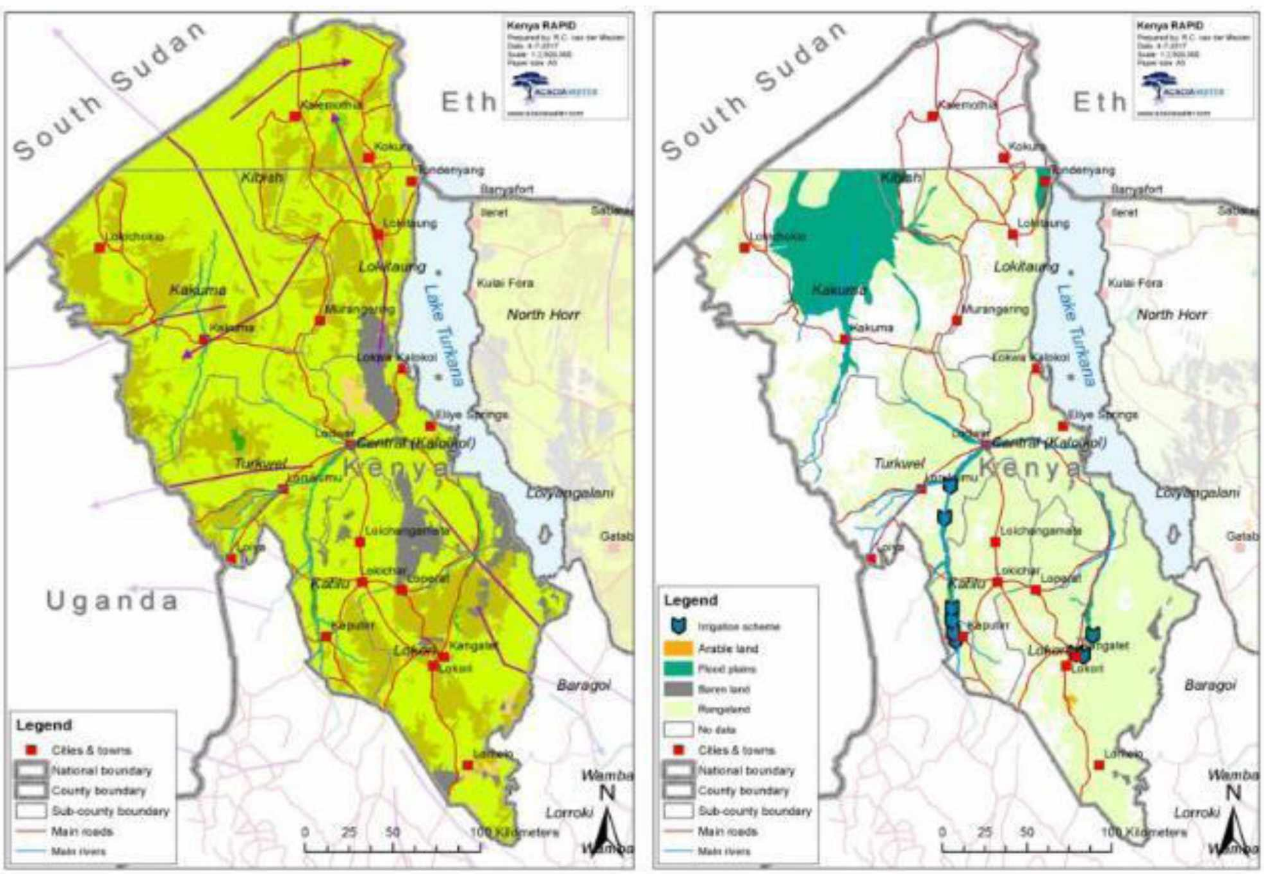
Table 3.12: Agricultural Land Classifications (as of 2013)

Classification	Samburu Sq Kms	Turkana Sq Kms
Agricultural Land		
High Potential	1,400	120
Medium Potential		
Low Potential	16,120	59,370
Total Agricultural Land	17,520	59,490
All Other	3,290	-
Total Land	20,810	59,490
Portion High Potential	7%	0%

Source: (KNBS 2020)

Note: This classification is made based simply on expected rainfall amounts

Figure 3.13: Land Cover and Land Use, Turkana



Source: Acacia Water

Table 3.14: Agricultural (including Livestock) Production Value, 2013 and 2014

Value of Production in current year million KSh	Samburu		Turkana	
	2013	2014*	2013	2014*
Crops & Horticulture	197	261	785	n/a
Livestock-Meat	n/a	681	114	111
Livestock-Milk	130	156	5,637	18,047
Livestock-Hides	5	9	15	15
Fish	-	-	425	418
Toal Value of Production	n/a	1,108	6,551	n/a

Source: See Table 11 and Table 12
*Notes: * is provisional data*

Table 3.15: Livestock Numbers, 2013, 2014 and 2018

Livestock Breed	Samburu			Turkana		
	2013	2014*	2018	2013	2014*	2018 NDMA
Cattle			202,700	1,534,612	1,534,612	1,932,108
Goats			714,000	5,741,454	5,994,859	6,033,152
Sheep			622,000	560,587	3,517,151	3,968,848
Camels			36,100	832,462	832,462	1,018,136
Donkey			10,000	558,189	558,189	748,254
Poultry				176,450	180,793	235,644

Source:(KNBS 2015a; 2015b; County Government of Samburu 2018; Turkana County Government no date; NDMA 2018)
*Notes: * are provisional figures.*

Table 3.16: Crop and Horticultural Production, 2013 and 2014

Category	Samburu		Turkana	
	2013	2014*	2013	2014*
Land In Production (Hectares)				
Rainfed Crops				
Millet	1	1	3,650	n/a
Maize	1,102	2,115	-	-
Sorghum	-	-	1,903	1,438
Wheat	1,200	1,200	-	-
Beans	305	414	-	-
Other	21	15	24	147
Total Rainfed	2,629	3,745	5,577	1,585
Irrigated Veg/Fruit	64	69	82	83
Total Land in Production	2,693	3,814	5,659	1,667
Production				
Crops				
Millet (90 kg bags/acre)	-	-	35,651	n/a
Millet (Tonnes)	-	-	7,925	n/a
Maize (Tonnes)	2,281	4,568	-	-
Sorghum (90kg/bags/acre)	-	-	27,568	15,486
Sorghum (Tonnes)	-	-	6,128	3,443
Wheat (Tonnes)	2,700	2,700	-	-
Total Crop Production (Tonnes)	4,981	7,268	5,690	n/a
Horticultural (Tonnes)				
Tomatoes	8	5	296	144
Kales	450	279	120	78
Bananas	106	72	121	74
Value (Imputed million KShs)				
Crops (using FAOSTAT prices)				
Millet	-	-	518	n/a
Maize	71	152	-	-
Sorghum	-	-	241	186
Wheat	101	94	-	-
Horticultural				
Tomatoes	0.5	0.3	18	9
Kales	23	13	6	4
Bananas	2	1	2	1
Total Agricultural Value	197	261	785	n/a

Source: KNBS 2015a; 2015b

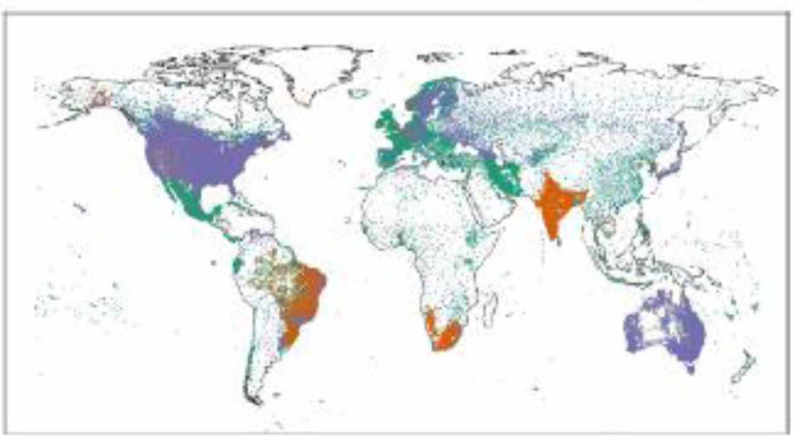
*Notes: * is provision*

Table 3.17: Livestock Production, 2013 and 2014

Category	Samburu		Turkana	
	2013	2014*	2013	2014*
Slaughter for Meat	n/a			
Number of Animals				
Cattle		3,685	249	235
Goats		34,607	4,542	4,650
Sheep		48,627	2,642	2,730
Camels		321	102	94
Quantity (kgs)				
Cattle		552,750	74,700	70,700
Goats		519,105	90,500	89,000
Sheep		729,405	52,840	54,600
Camels		57,780	30,600	28,200
Value (m KShs)				
Cattle		166	30	28
Goats		208	45	45
Sheep		292	26	27
Camels		16	12	11
Total Meat Value		681	114	111
Hides				
Quantity (Tonnes)				
Cattle/calves	5,201	14,250	4,303	4,004
Goats	32,115	56,681	162,057	169,277
Sheep	29,203	57,091	93,569	104,849
Camels	472	536	n/a	n/a
Value (m KShs)	(imputed using Turkana prices)			
Cattle/calves	1.9	3.6	1.6	1.0
Goats	1.7	3.0	8.5	9.1
Sheep	1.5	2.7	4.8	4.9
Camels				
Total Hide Value	5	9	15	15
Milk				
Quantity (million liters)				
Cattle	3.0	3.3	22	127
Goats	1.1	1.2	125	221
Sheep	-	-	41	131
Camels	0.2	0.2	n/a	111
Value (m KShs)			(using Samburu prices)	
Cattle	91	116	651	4,431
Goats	34	35	3,745	6,430
Sheep (using Goat prices)	-	-	1,241	3,810
Camels	5	6	n/a	3,376
Total Value (m KShs)	130	156	5,637	18,047
Fish				
Quantity (MT)	n/a	n/a	4,193	4,050
Value (m KShs)	n/a	n/a	425	418

*Notes: * is provision*

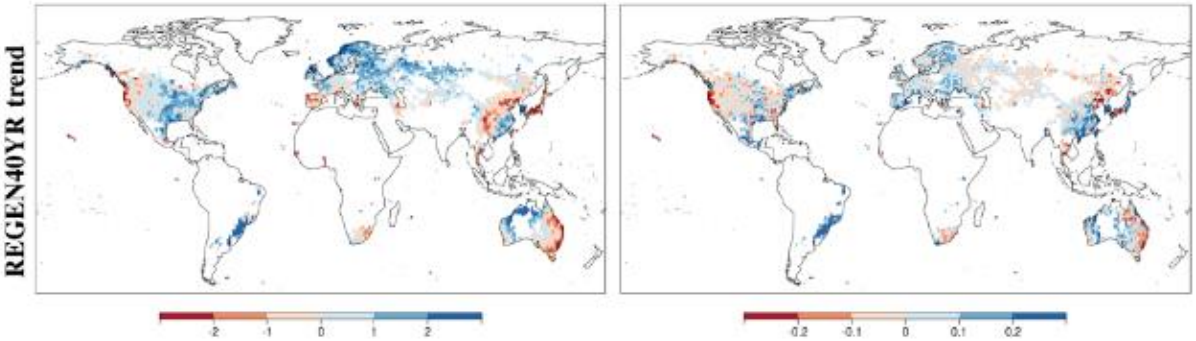
Figure 3.18: Weather Stations with data stored in the Global Precipitation Climatology Centre (GPCC) and the Global Historical Climatology Network-Daily (GHCN-Daily)



Note: each dot is a weather station; the colors refer to source of station data: GPCC (green), GHCN (orange) and mixed (purple)

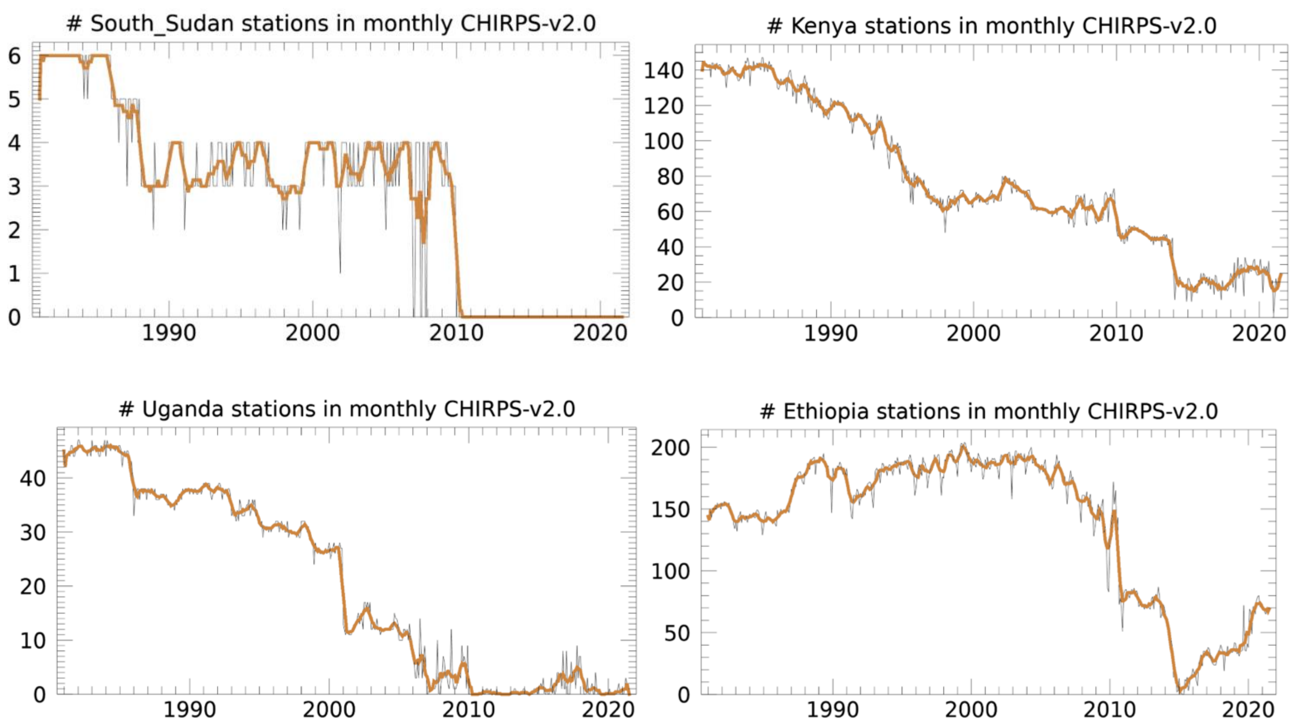
Source: Contractor et al. (2020)

Figure 3.19: Rainfall Estimates on a Gridded Network (REGEN), with weather station data from 1950 to 2016 showing trends in total annual (left panel) and annual maximum (right panel) precipitation (white areas show no trend due to lack of station data to interpolate)



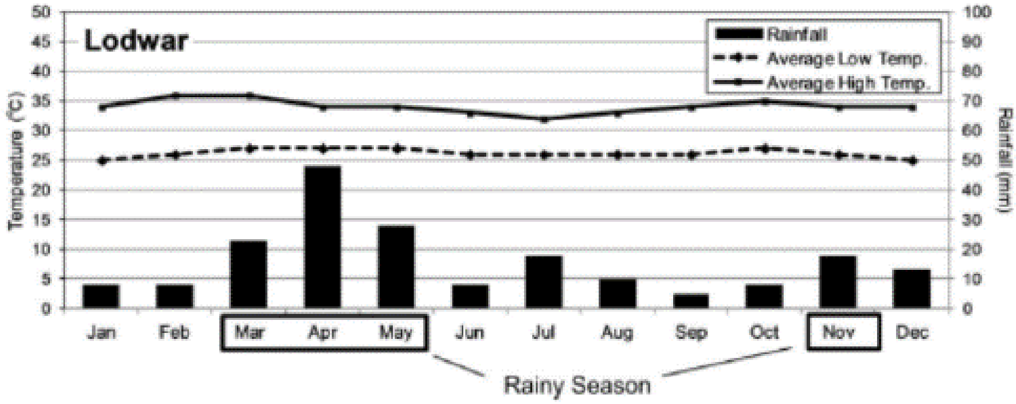
Source: Contractor et al. (2020)

Figure 3.20: Number of weather stations in Kenya and countries bordering on the Kenyan ASALs that meet requirements for inclusion in interpolated precipitation models by the Climate Hazard Group (as funded by USAID's Famine Early Warning System Network)



Source: http://data.chc.ucsb.edu/products/CHIRPS-2.0/diagnostics/stations-perMonth-byCountry/pngs/

Figure 3.21: Monthly Temperature and Rainfall at Lodwar



Source: Nippon Koie Ltd. (2015

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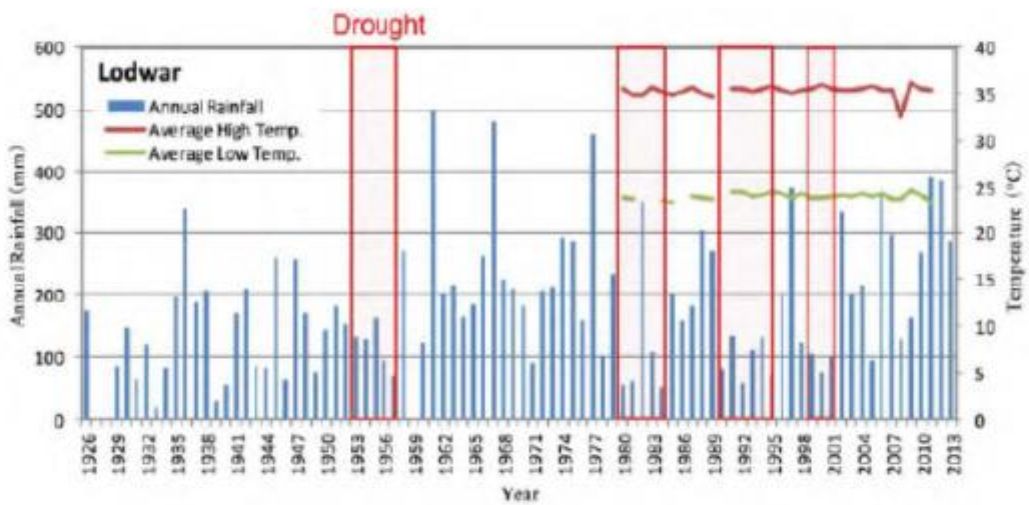
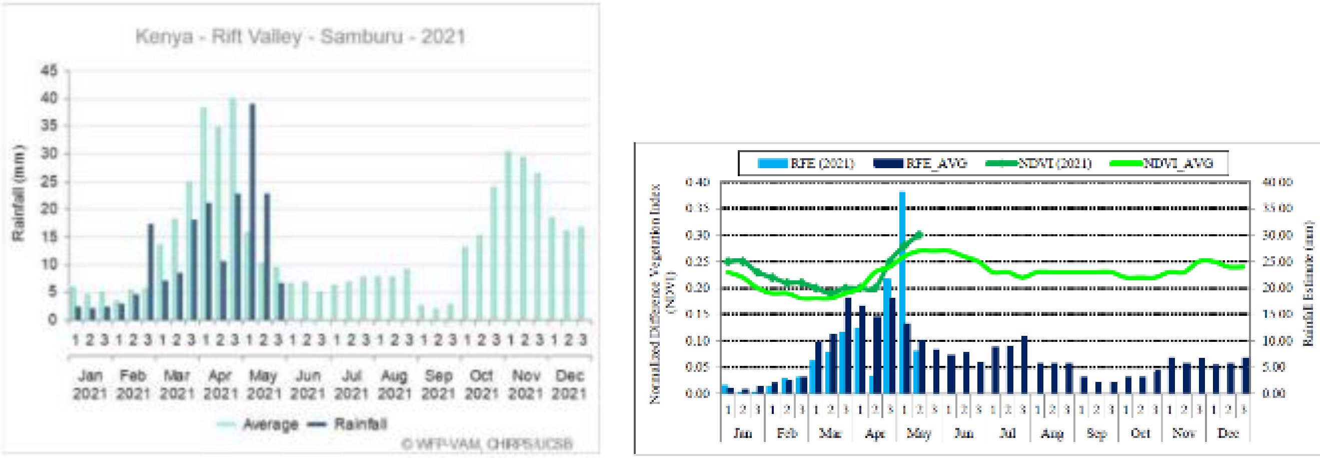
Figure 3.22: Long Term Precipitation and Drought Records at Lodwar, 1926-2013



Source: Nippon Koie Ltd. (2015)

Figure 3.23: Rainfall at TAHMO Stations, 1/1/21 00:00 to 6/26/21 19:00

Figure 3.24: NDMA Rainfall reports for May 2021, Samburu and Turkana



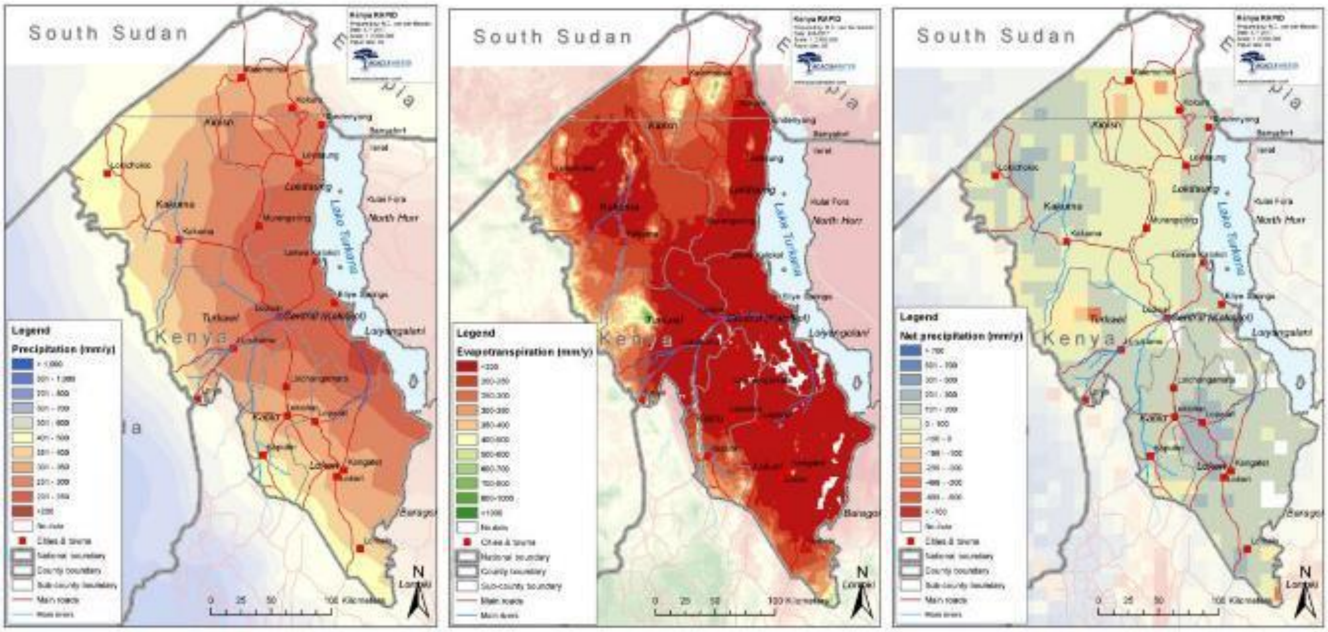
Source: NDMA

Source: Acacia Water

Figure 3.25: Basins of Kenya

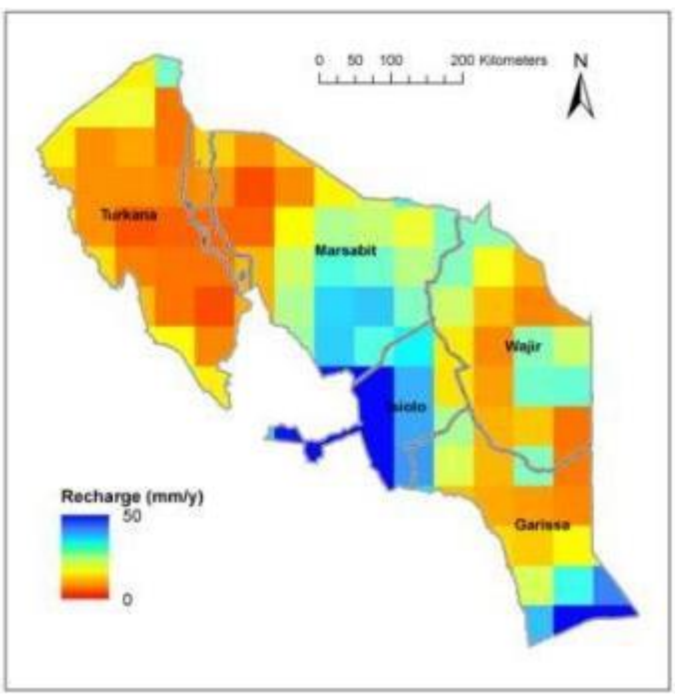
Source: NEMA (2011)

Figure 3.26: Hydro-Meteorological Maps for Turkana County



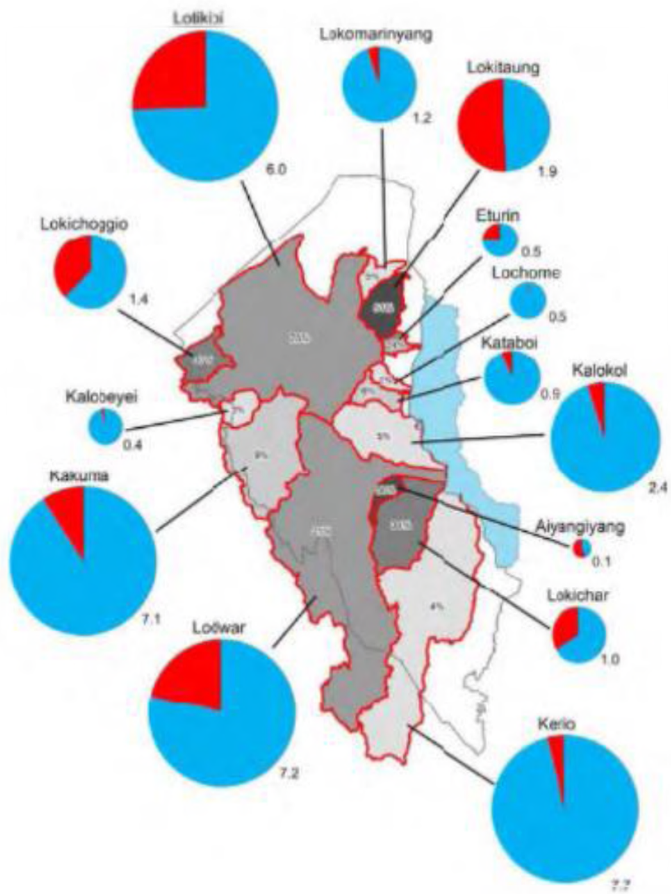
Source: Acacia Water (n.d.)

Figure 3.27: Recharge in the ASALS



Source: Acacia Water (n.d.)

Figure 3.28: Pumping Rates and Sustainable Yield by Sub-Basin, Turkana County



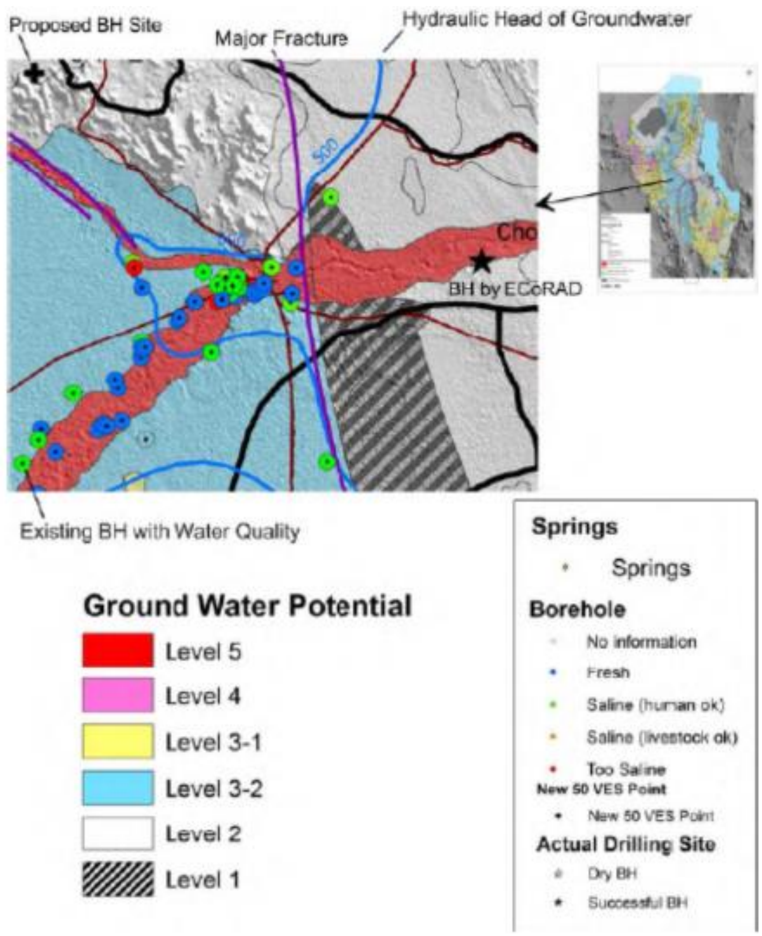
Source: Nippon Koie Ltd. (2015)

Table 3.29: TGDP Map Level Classification

Level	Area	Description
5	River and Major Laggas Area	Potential is high. Water struck level may be shallow and yield may be high. The water should be fresh.
4	Surround Area of Level 5	Potential is relatively high. Recommended site is along laggas. Fresh water is expected.
3-1	Volcanics and Basement Rocks Area	Potential is medium. Groundwater struck level is less than100m. Recommended site is along laggas. The water quality may be mildly saline in Volcanics.
3-2	Sediments Area	Potential is medium. Development target is limited along laggas. The water is fresh-saline.
2	Surround Area of Level 1	Potential is relatively low. Groundwater struck level may be more than 100m. The water may be saline.
1	Basin and Lake Turkana Coastal Area	Potential for hand pump is low. Groundwater struck level in Basin Area is more than 100m and hydraulic head may be low for hand pump. The water quality could be saline. Groundwater could be struck at shallow depth in Lake Turkana Coastal Area. However, the water could be saline.

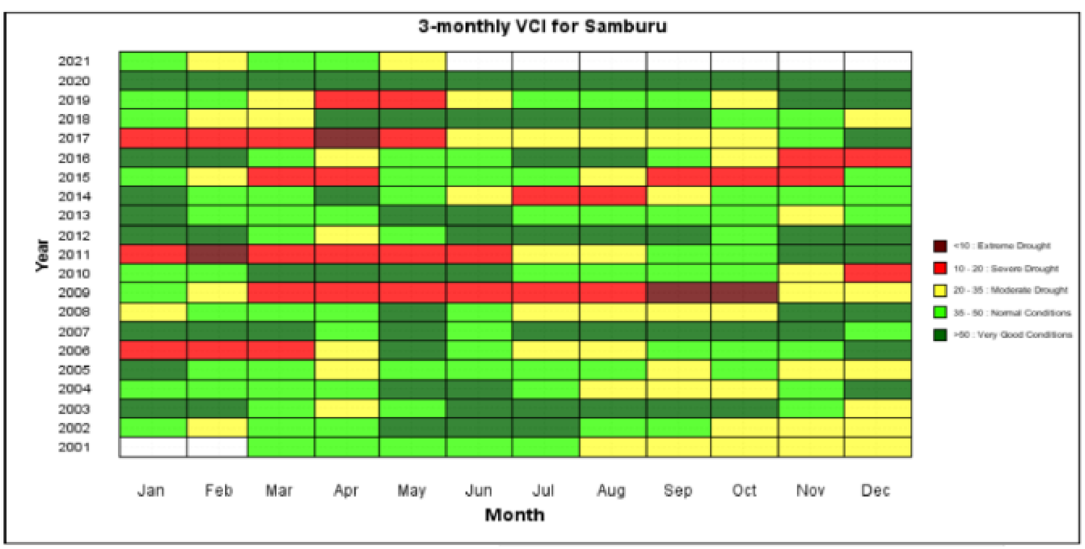
Source: Nippon Koie Ltd. (2015)

Figure 3.30: Groundwater Development Potential Example



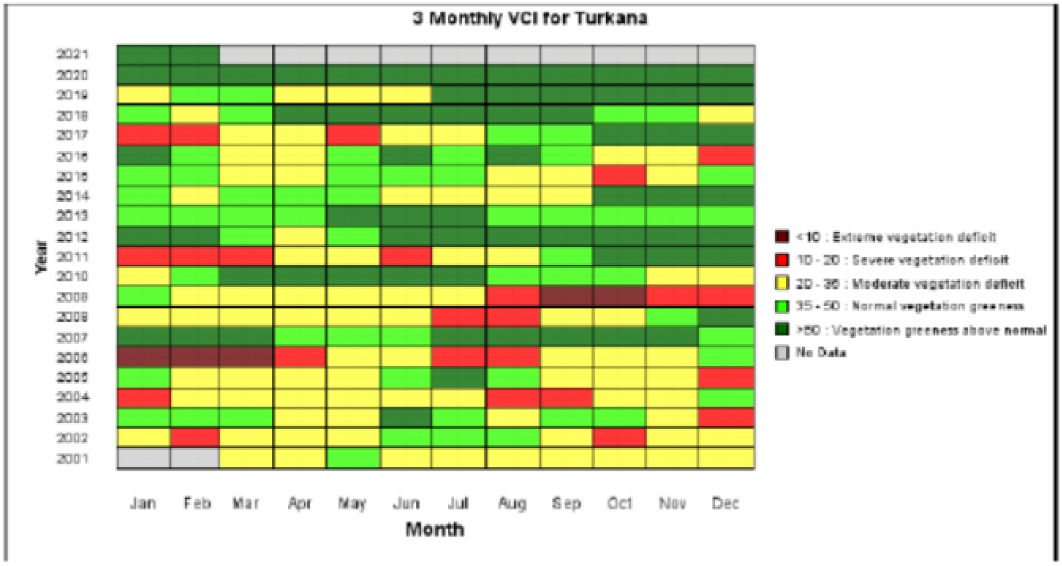
Source: Nippon Koie Ltd. (2015)

Figure 3.31: Vegetation Condition Index for Samburu County, 2001-2021



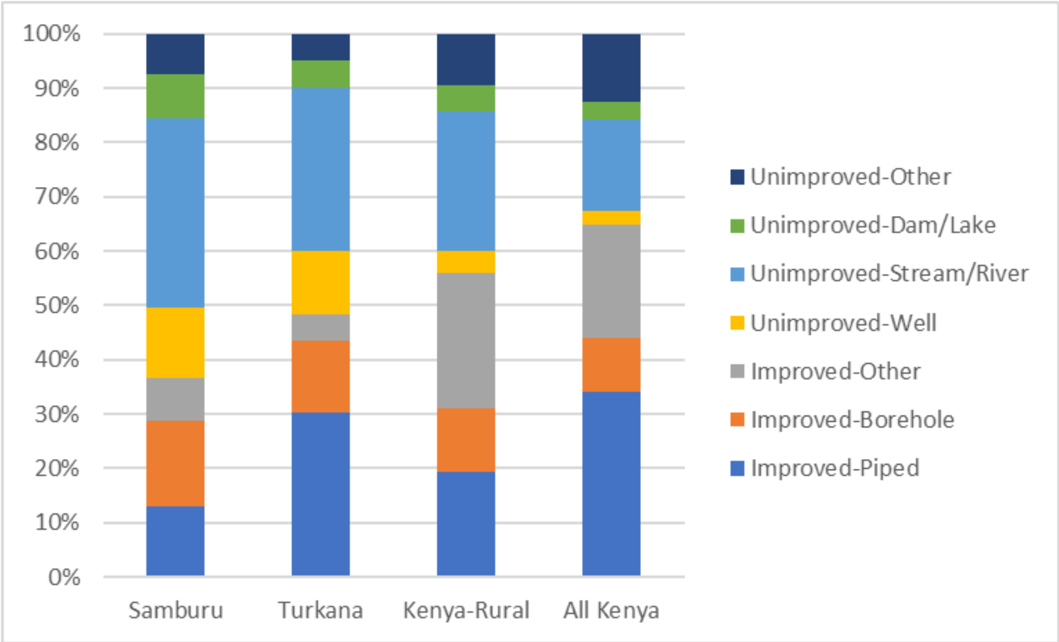
Source: NDMA (2021a)

Figure 3.32: Vegetation Condition Index for Turkana County, 2001-2021



Source: NDMA (2021b)

Figure 3.33: Water Sources for Samburu and Turkana Counties, 2015/16



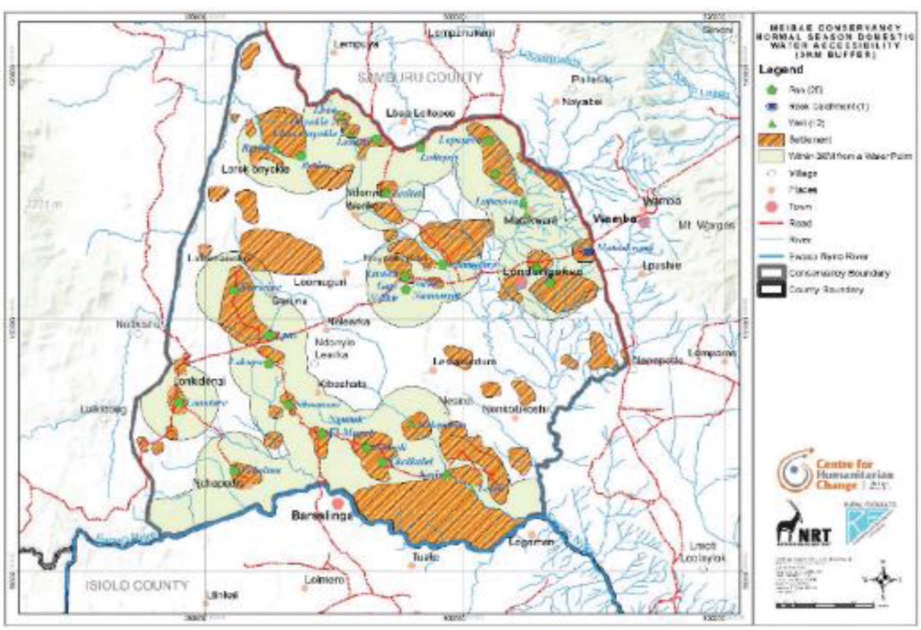
Source: KNBS (2019b)

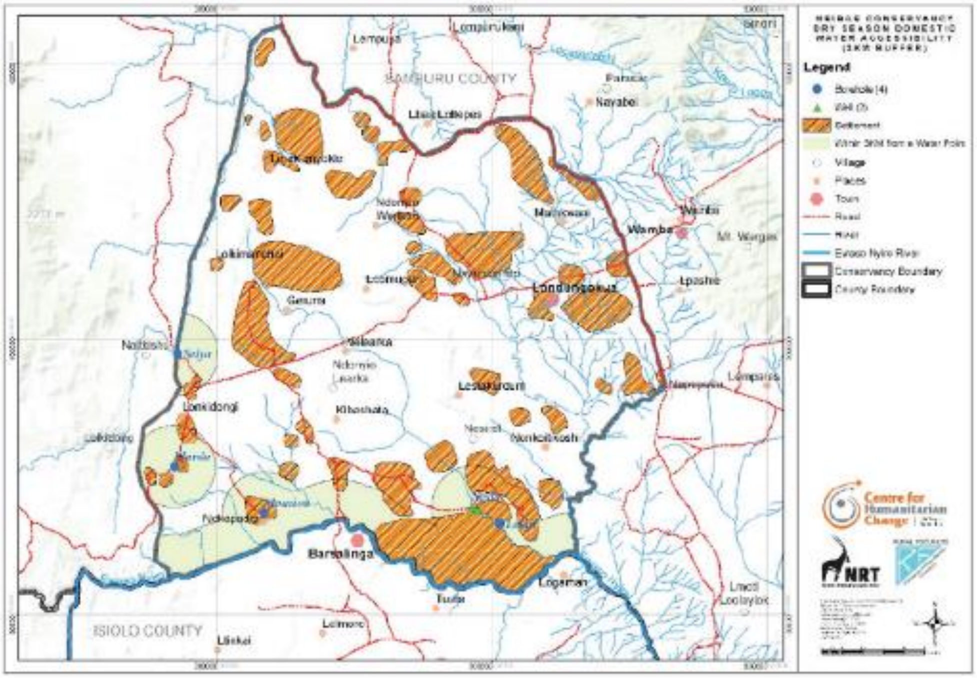
Table 3.34: Water Sources for Samburu and Turkana Counties, 2019 Census

Distribution of Household by Question	Samburu	Turkana	Kenya-Rural	All Kenya
Main Source of Drinking Water				
Improved				
Piped				
Into dwelling	2%	3%	5%	10%
Into plot/yard	5%	7%	8%	14%
Public tap/stand pipe	6%	21%	6%	10%
Total Piped	13%	30%	19%	34%
Tubewell or Borehole with Pump	16%	13%	12%	10%
Protected well	4%	3%	9%	7%
Protected spring	2%	1%	11%	7%
Rainwater collection	2%	0%	5%	4%
Bottled water	1%	0%	0%	3%
Total Improved	37%	48%	56%	65%
Unimproved				
Unprotected well	13%	12%	4%	3%
Unprotected spring	2%	1%	4%	2%
Vendors	3%	3%	3%	9%
Surface Water				
Pond	2%	1%	2%	2%
Dam/Lake	8%	5%	5%	3%
Stream/River	35%	30%	26%	17%
Total Surface Water	45%	36%	33%	22%
Total Unimproved	63%	52%	44%	35%
Not Stated	0%	0%	0%	0%
Grand Total	100%	100%	100%	100%

Source: KNBS (2019b)

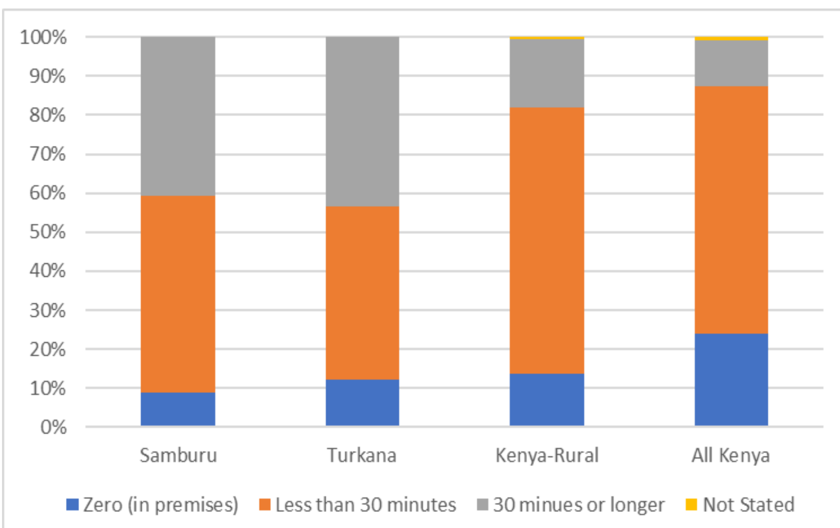
Figure 3.35: Normal and Dry Season Domestic Water Access in Meibae Conservancy





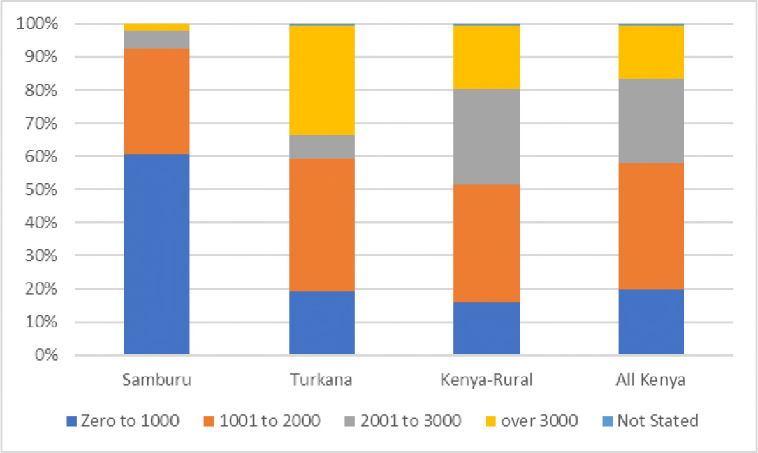
Source: Rural Focus Ltd. (2019)

Figure 3.36: Time to Fetch Water in Samburu and Turkana Counties, 2015/16



Source: KNBS (2018a)

Figure 3.37: Volumes of Water Consumed per Household in Samburu and Turkana Counties, 2015/16



Source: KNBS (2018a)

Table 3.38: Household Water Consumption

Item		Samburu	Turkana	Kenya
Average Household Size		4.7	5.6	3.9
Distribution of l/HH/month	Water Use l/HH/month	Water Use in l/c/day for each Increment		
Zero to 1000	1,000	7	6	9
1001 to 2000	1,500	11	9	13
2001 to 3000	2,500	18	15	21
over 3000		35	35	35
Weighted Average (l/c/day)		9	6	12
Population (2019)		307,957	922,210	47,564,296
Total Estimated Water Use (m m^3)		0.97	2.01	213
Total Water Use (m m^3) Projected by WHO levels				
Basic	at 20 l/c/d	2.2	6.7	347
Intermediate	at 50 l/c/d	5.6	16.8	868
Optimal	at 100 l/c/d	11.2	33.7	1,736

Source: KNBS (2018a), KNBS (KNBS 2019b)

Table 3.39: Summary of Water Access, Adequacy and Health Concern from WHO

Access level and typical volumes of water used in the home[a]	Accessibility of water supply	Adequacy for health needs	Level of health concern[b]
Inadequate access (quantity collected can be below 5.3 L/person/day)	More than 1000 m in distance or 30 minutes total collection time	Drinking – cannot be assured Cooking – cannot be assured Hygiene – cannot be assured at the home,[c] compromising food hygiene, handwashing and face washing; other hygiene activities have to be undertaken away from the home	Very high
Basic access[d] (average quantity unlikely to exceed 20 L/person/day)	100–1000 m in distance or 5– tel:100-1000 otal collection time	Drinking – should be assured Cooking – should be assured Hygiene – food hygiene, handwashing and face washing may be assured; bathing and laundry cannot be assured at the home but may be carried out at water source	High
Intermediate access (average quantity about 50 L/ person/day)	Water delivered through one tap on- plot, or within 100 m or 5 minutes total collection time	Drinking – assured Cooking – assured Hygiene – all food hygiene, handwashing and face washing assured under non-outbreak conditions; enhanced hygiene during infectious disease outbreaks not assured; bathing and laundry at the home should also be assured	Medium
Optimal access (average quantity more than 100 L/ person/day[e])	Water supplied through multiple taps and continuously available	Drinking – all needs met Cooking – all needs should be met Hygiene – all food hygiene, handwashing and face washing needs should be met, including for bathing and laundry at the home, and household cleaning	Low

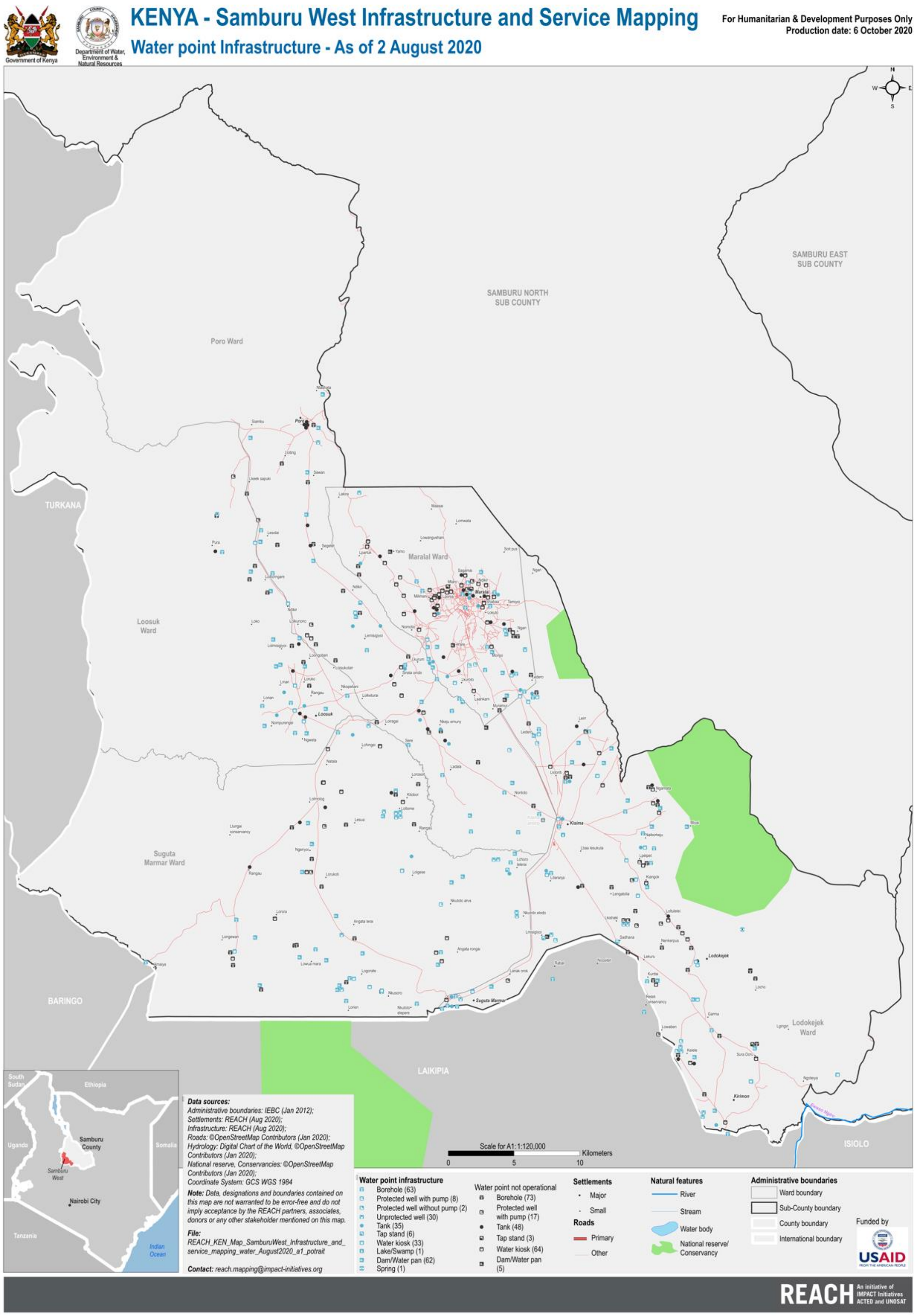
Source: Howard et al. (2020)

Table 3.40: Summary of Water Infrastructure Status, REACH 2019

Water Sources	Total Number	Functional?		
		Yes	No	as % of Total
Borehole	314	168	146	54%
Water Pan	135	122	13	90%
Protected Well	85	74	11	87%
Unprotected Well	53	45	8	85%
Water Kiosk	121	43	78	36%
Dam	48	44	4	92%
Tank	67	67		100%
Tap Stand	12	9	3	75%
Other	14	10	4	71%
	849	582	267	69%

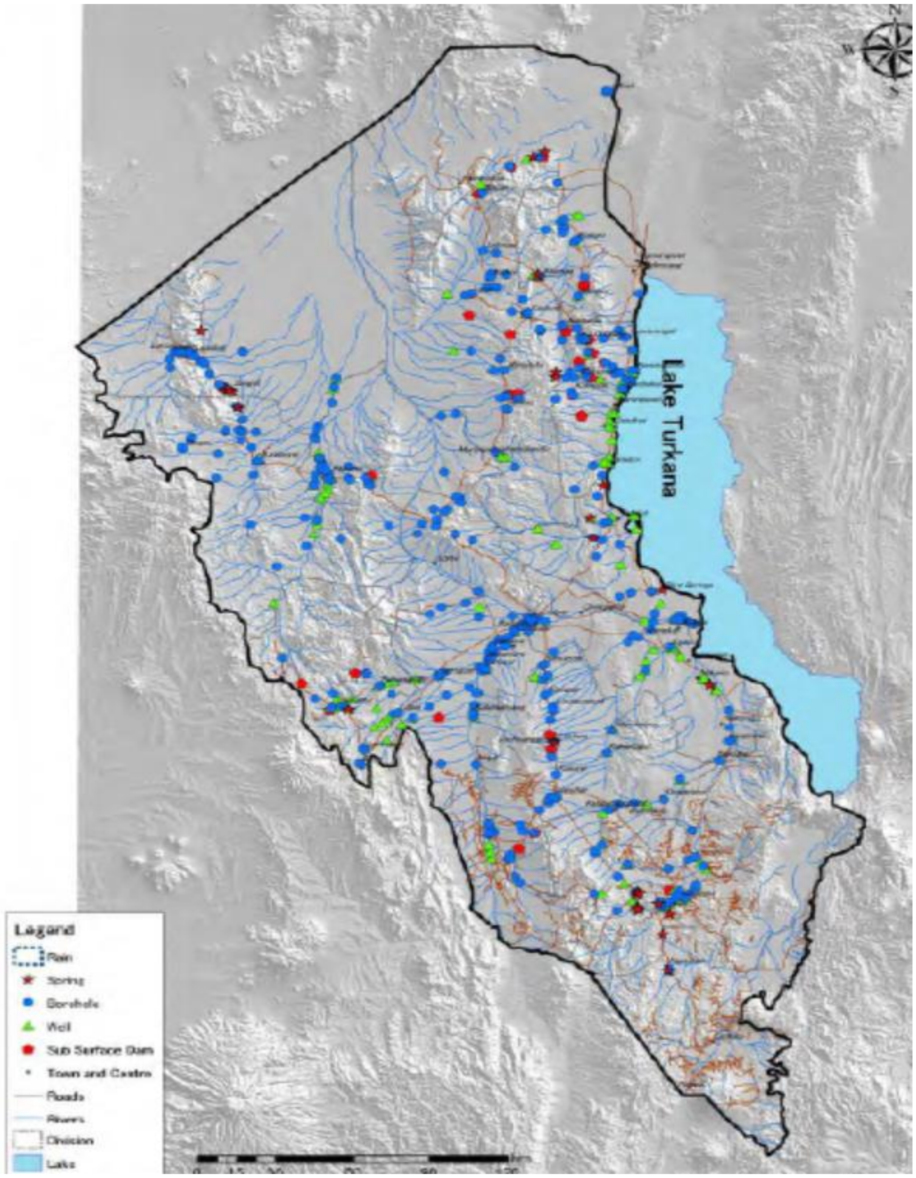
Source: REACH spreadsheet on Samburu Infrastructure Mapping 2019

Figure 3.41: Samburu West Water Infrastructure Map, REACH 2020



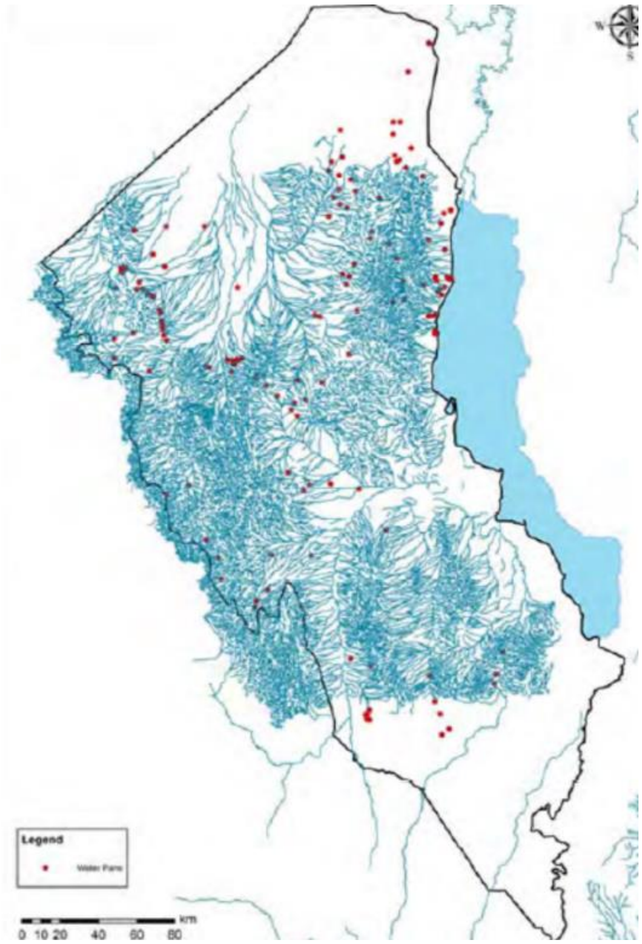
Source: https://reliefweb.int/map/kenya/kenya-samburu-west-infrastructure-and-service-mapping-water-point-infrastructure-2-august

Figure 3.42: Turkana Water Supply Infrastructure, 2015 JICA



Source: Nippon Koie Ltd. (2015)

Figure 3.43: Water Pans and Laggas, JICA 2015

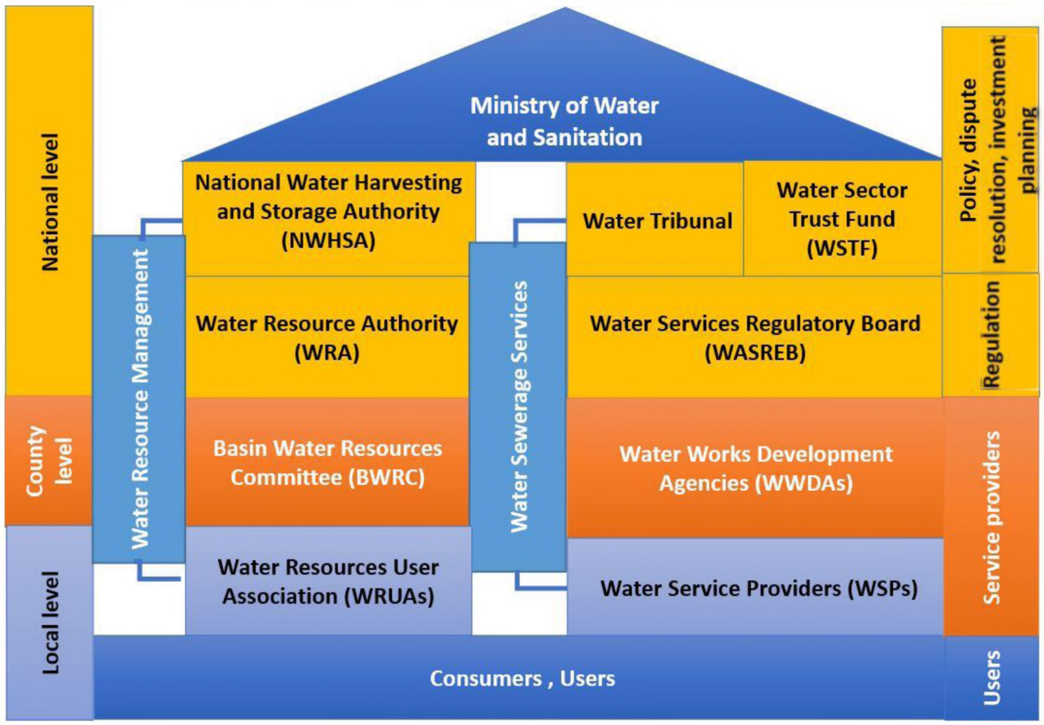


Source: Nippon Koie Ltd. (2015)

Figure 3.44: Household Water Insecurity in sub-locations in Samburu County

Source: Balfour et al. (2020)

Figure 3.45: Hierarchy of Kenya's water institutions



Source: World Bank (2016) and https://www.waterreforms.go.ke/institutional-framework-for-the-water-sector/

Table 3.46: County Government of Samburu Revenue and Expenditure, 2019/20

	Samburu 2019/2020						
	KSHs millions		USD millions		USD per capita		Actual vs
Budget Category	Planned	Actual	Planned	Actual	Planned	Actual	Planned
Finance/Revenue							
Exchequer	4,620	4,270	44	41	143	132	92%
Local	267	216	3	2	8	7	81%
B/F Revenue	917	917	9	9	28	28	100%
Other	1,165	911	11	9	36	28	78%
Total	6,969	6,314	67	61	215	195	91%
Expenditure							
Recurrent	4,733	4,069	45	39	146	126	86%
Compensation	2,165	2,140	21	21	67	66	99%
O&M	2,568	1,929	25	19	79	60	75%
Development	2,236	1,099	21	11	69	34	49%
Total	6,969	5,168	67	50	215	160	74%
Expenditure as % of Revenue	100%	82%					
Water-Related Expenditure Items							
Water, Env & NR							
Recurrent	173	144	1.7	1.4	5.3	4.5	83%
Development	408	204	3.9	2.0	12.6	6.3	50%
Total	580	348	5.6	3.3	17.9	10.8	60%
Programs (sub-Dept)							
Water and Sanitation	342	219	3.3	2.1	10.6	6.8	64%
Environmental Management	24	7	0.2	0.1	0.7	0.2	29%
Water Catchment and Protectior	14	2	0.1	0.0	0.4	0.1	14%
Soil Conservation	6	4	0.1	0.0	0.2	0.1	67%
Water Capital Items							
35 Boreholes	76	76	0.7	0.7	2.3	2.3	100%

Source: County Government of Samburu (2020)

Annex 4: Research Questions

The overall research and learning effort on water governance and management under Nawiri aims to answer the following research questions. The desk review will answer those that can be addressed through review of literature and data, supplemented by Key Informant Interviews (KIIs). It is anticipated that some questions will lend themselves more to the stakeholder discussions at the WASHBAT workshop, while some will be more amenable to the desk review. The questions are listed below. The Executive Summary consists of the responses to these questions as informed by this desk review.

What are the conditions, trends and prospects for water supply and water demand in each county?

   a. What is known/not known with respect to the behavior, flows, stocks of surface and groundwater systems? Similarly, with respect to demand and actual withdrawals and consumption of water by different users (including gender/age of those withdrawing, transporting and consuming water)?
   b. Which groups and subgroups (cultural, producer, gender) are affected by water insecurity? When and where? How does this change throughout the year and as nomadic groups move across the landscape?
   c. What are the gender-differentiated systems for access to resources, labor, water uses, water rights, and the distribution of benefits and production? How well do these serve to reduce gender imbalances to access and services?
   d. How have these groups responded to chronic water insecurity and to that brought on by shocks and stresses?
   e. Has water insecurity and/or competition over scarce supplies led to disputes and/o conflict between households or communities? Has water scarcity affected social cohesion?

2. What water governance arrangements are in place for water resources, which are being implemented and which are achieving their intended objectives?
   a. How are surface water and groundwater sources monitored and measured? How is this information used by users/managers and/or deployed back to communities (e.g., in the form of early warning systems)?
   b. How is permission provided for the use of these water sources? To whom and for what?
   c. Are sources of water scarce, across the year or seasonally, and, if so, how is access and use regulated by state or traditional authorities?
   d. Is over-drafting of groundwater sources, or dewatering of surface water sources by one set of users affecting other sets of users? Who benefits from these uses and who is left water insecure? What tenure rights apply in these cases and what monitoring, enforcement and redress mechanisms are available, used and effective?
   e. What are the gender dimensions in water governance arrangements and structures? How do these affect sustainability?
3. What governance arrangements are in place for public, private and community water systems, which are being implemented and which are achieving their intended objectives?

a. What are the gaps in counties institutional, financial and administrative capacity and support, to water services providers and community systems? Is there clear delineation of roles and functions and effective and coordination during and between emergency response periods between involved agencies and departments?
b. What are the tariffs guidelines? Are there pro-poor tariffs? Are the most vulnerable able and/or willing to pay for access to domestic water when it is available, and, if not, what are the household factors that drive this behavior? Are there effective ways to partially/fully subsidize uses? What are the political and economic challenges associated with tariff-setting and cost recovery?
c. Are there well laid and clearly defined water assets development and management plans? Is there appropriate planning for expansion, ownership and what are the gaps in technical-know for management of these assets?
d. What are the gaps in monitoring and regulation of the water systems in collating relevant data about water services delivery – performance of services providers and regulatory oversight to ensure consumer protection and meeting community needs?
e. What are the short-comings of existing water service management models? What are the barriers to professionalized rural sub-sector water services delivery models? Are efforts to address these barriers through new models working?
f. What are the gender considerations that have been put in place in relation to monitoring, and regulation of water systems and how effective are they at addressing gender imbalances and sustainability?

4. What water management approaches have been implemented, which are achieving their intended objectives and what alternatives are contemplated, desired or in a pilot phase?
    a. How do these management approaches vary with agro-ecological landscape, producer/socio-economic group?
    b. What management techniques for increasing water storage (above/below ground) have been developed? By whom and with what groups? Are risks due to inadequate water quality properly monitored and addressed? How effective have these storage projects been in achieving their objectives and avoiding adverse impacts?
    c. What irrigation practices and technologies are used by producers? How efficient are these practices? What is the potential to conserve water, save other inputs and reduced production costs by deploying improved management strategies?
    d. What methods for addressing or adapting to saline water or other pollutants are in place and how are they working? Are there improved practices or technology available that are cost-competitive?
    e. To what extent are the water management approaches gender responsive and what improvements would be necessary?

CONTACT

DARIUS RADCLIFFE

Chief of Party (CoP), USAID Nawiri
MERCY CORPS
tel +254 701 442 396 | skype mdariusradcliffe
The Almont Park
Church Rd. | Westlands – Nairobi, Kenya

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