Rapid Integrated Water Assessment in 10 Arid and Semi-Arid Land (ASAL) Counties, Kenya

Final Report

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Project No SSFA/2021/4055

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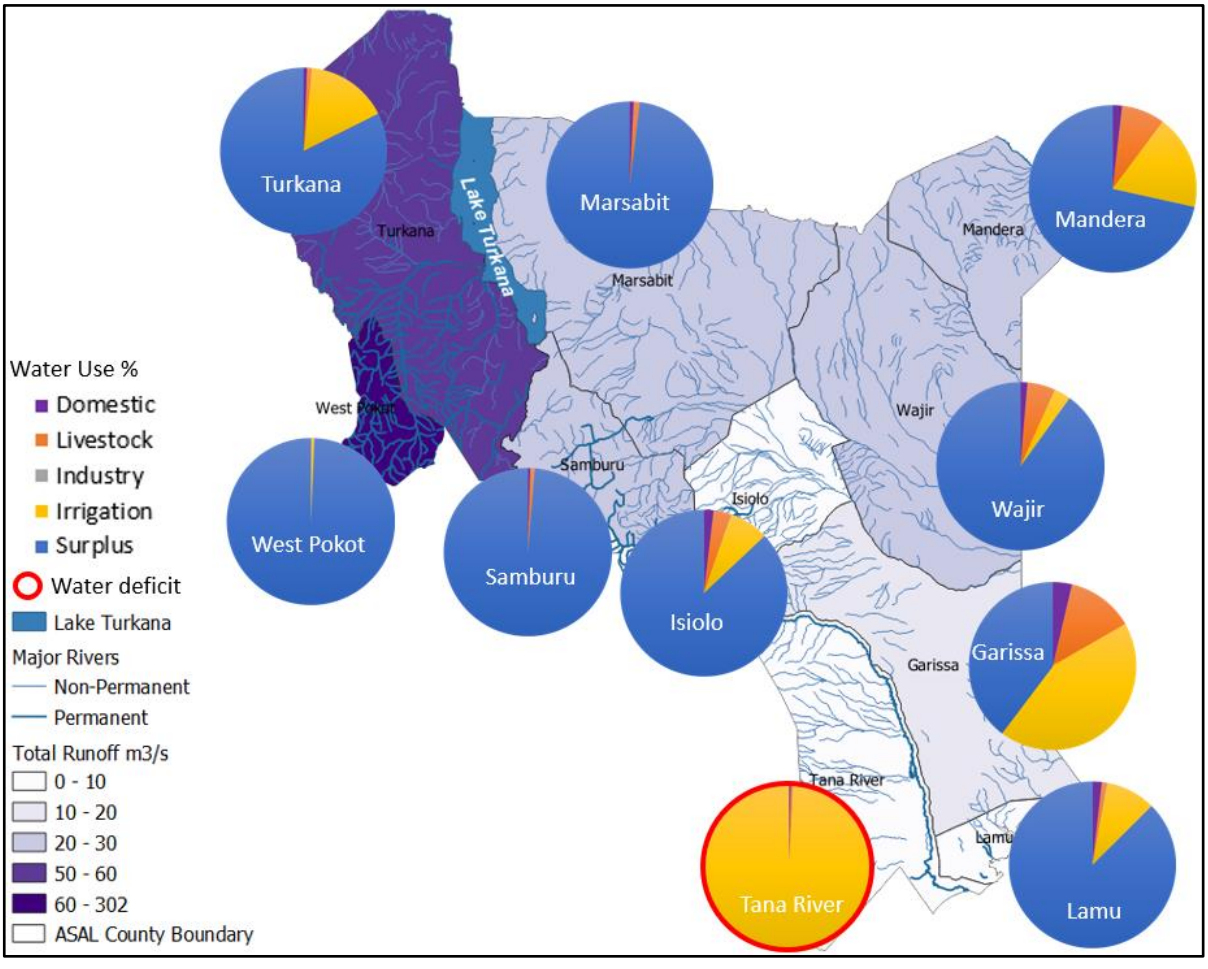
Prepared for UNEP Regional Office for Africa

Rapid Integrated Water Assessment, ASAL Kenya



Rapid Integrated Water Assessment in 10 Arid and Semi-Arid Land (ASAL) Counties, Kenya

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Project No SSFA/2021/4455

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Introduction

The Technical Committee for Water Security in the ASAL regions of Kenya identified a need for this rapid integrated assessment of water resources in 10 counties as part of the larger Government of Kenya and UN Strategic Partnership for Water Security in ASAL regions of Kenya. This holistic, multi-disciplinary assessment of water resources and management is based on a desk study of data provided by members of the Technical Committee and County governments. The aim of the rapid assessment is to identify challenges and opportunities for building water security in the ASAL regions by considering relevant hydrological and socioeconomic conditions and institutional arrangements that impact water security and water provision to inform future interventions in the region to be supported by the UN and other relevant actors. The target audience of this rapid assessment is the Technical Committee for Water Security in the ASAL regions of Kenya, county governments, relevant national government ministries, departments and agencies (MDSs) and donors active in the region.

The ASAL regions, comprising 29 counties with various degrees of aridity, are home to 36% of Kenya's population, 70 per cent of its livestock and 90 per cent of its wildlife. Improving the quality and availability of water in the region within sustainable limits is necessary for the improvement of health and economic development outcomes, and for achieving goals to increase water security. 10 counties were selected by the Technical Committee for this rapid assessment: Garissa, Isiolo, Lamu, Mandera, Marsabit, Samburu, Tana River, Turkana, Wajir and West Pokot.

The aim was to deliver a rapid integrated assessment that considers the key social, environmental, institutional, and economic issues facing water resources management in the 10 counties. The project was conducted as a desk study over a period of 18 weeks from August to December 2021.

Methodology

A four-week inception phase assessed the extent of the data previously submitted by the counties and members of the Technical Committee the UNEP Regional Office for Africa. The Office had circulated an Excel sheet early in 2021 for stakeholders to populate with relevant data from their counties. A basic mapping tool was used to categorize the data and reports into four broad categories which form the overarching structure of the study:

1. Governance
2. Demographics
3. Water Resources
4. Risks

This data assessment sought to establish whether there were any data gaps that needed to be filled prior to proceeding with the desk study. The outcome of the data mapping exercise, which is documented in the inception report, was that insufficient data had been submitted to conduct a comprehensive rapid integrated water management assessment for the 10 counties. While sufficient

data had been submitted on Governance and Demographics, insufficient data was submitted on water resources and risks in the counties.

A request was made for additional data to be submitted for consideration, with a deadline of 8 October 8, 2021. Following limited data submission after the additional data drive, it was decided, in agreement with UNEP that the study would proceed using freely available Earth observation data, as well as some additional internet searches to locate relevant reports and documents for review[1].

The main sources of external data that supported the development of this rapid assessment were the Kenya Census data from 2019, the National Water Master Plan 2030 reports, Earth observation data and derived indices including Copernicus Global Land Service (CGLS), Copernicus ERA5 rainfall, Shuttle Radar Topography Mission (SRTM) Digital Elevation Model, Normalized Vegetation Deviation Index (NDVI), Flash Flood Potential Index (FFPI), Flood Hazard Assessment, and the Effective Drought Index (EDI). Finally, DHI's Global Hydrological Model (GHM) has been used to estimate current and future water availability in the 10 counties. The time scales for assessments and planning for future scenarios are the years 2030 and 2050, which align with political targets and ambitions as well as climate change scenarios sourced from CORDEX.

Governance profile

The ASAL region's governance profile is shaped by international, regional and national goals and frameworks including Agenda 2030 (Sustainable Development Goals), the African Union Commissions' Agenda 2063, Kenya Vision 2030 and the National Water Master Plan 2030. The institutional framework for the Kenyan water sector is presented at national, regional, county and basin levels. The institutions are further divided to consider either water resources management or water supply and sanitation. Outside of the traditional water sector framework complementary institutions, which are key collaborators for water resources management are identified, including in agriculture and irrigation, environment, climate and meteorology, and drought management. Finally, an important consideration for the rapid assessment is the devolved system of governance which provides county governments with responsibility for provision of water services to their populations, while the overall responsibility for the management of water resources remains at the national level. Policies with respect to water are listed and the regulatory institutional frameworks presented in this section.

The major findings and conclusions from the section are:

- While many water sector and partner institutions are mandated to maintain national databases for information on, among others, water resources, water services and irrigation schemes, most of this data was not submitted for review for this study. This brings into question whether the county governments have access to relevant and up-to-date data on water resources and related infrastructure.

[1] Disclaimer: As a result, the majority of the data used to develop the water resources profile (Chapter 7) and the risk profile (Chapter 8) is based on satellite data and could not be calibrated with data from the ground.

- There are overlapping and potentially competing governance structures in place in relation to water and its management. County borders and hydrological catchment delineations are not aligned and basin and catchment management structures often cross county-borders. It is unclear whether collaboration across county-borders is functioning, but measures have been put in place, such as trans-county water resources management frameworks, to try and address the issue.

Demographic profile

The 10 counties selected for the study make up just over 10% of the population of Kenya but constitute an area that makes up more than 60% of the territory of the country. Population density is generally low in comparison to the national average. 2019 Census data allows for projections of population growth in each county for the years 2030, 2040 and 2050 using a growth rate of 2.2 per cent per annum from the 2019 Census. While no data was submitted on rates of urbanization in the region, projections for future urban population were calculated by adapting UN DESA's national urbanization rate for Kenya to the counties to estimate county numbers. Combining these figures enabled projections of the urban population in each county, important when considering future water demand.

Limited socioeconomic data was submitted to the study, but some data were available from the Kenya National Bureau of Statistics' 2017 Gross County Product (GCP) report, showing that per capita GCP was highest in Lamu and lowest in Mandera. Overall, the 10 counties are amongst the most economically challenged within Kenyat. An overview of water and sanitation services for the counties was also extracted from census data. While the National Water Master Plan 2030 (launched in 2014) targets 100 per cent access to good quality water by the end of this decade, the numbers show that drinking water sources and human waste disposal methods are well below national averages in terms of safety and hygiene.

Land use is a strong indicator not only of socioeconomic development but of water use and balance. Agricultural land use, for commercial and subsistence farming, takes place to varying degrees across the counties. Tana River County is above the national average level when it comes to the level of commercial farming, while Mandera and Wajir have the largest total area of agricultural land in the 10 counties. The counties are below the national average in terms of the number of rural households that practice agricultural farming, and the percentage of households that practice irrigation is very low. While the development of county irrigation plans is under the auspices of the National Irrigation Authority (NIA), none were submitted for review for this rapid assessment. Data has been extracted from the County Integrated Development Plans 2018-2022 on actual and potential irrigated land, as well as the National Water Master Plan 2030 and the NIA Strategic Plan. Discrepancies between the data on irrigation potential presented in these reports warrants further investigation, especially in Tana River County where the numbers are inconsistent. Analysis into the status of proposed irrigation and dam infrastructure from the National Water Master Plan show that of the 11 proposed investments within the 10 counties, only two have been completed since 2014 while the remaining 9 have yet to begin. Livestock is another important form of land use in the ASAL regions, with the latest data on

livestock population extracted from census data. This data will be used in a subsequent section to calculate present and future water demands.

The major findings and conclusions of this section are:

- Inconsistencies in available data on the irrigation potential of the counties, especially in Tana River County, requires further investigation
- Most of the proposed irrigation and dam infrastructure set out in the Water Master Plan 2030 is yet to be initiated in the 10 counties. It is unclear whether the planned infrastructure is on schedule or whether financing has been secured.
- More data and information are needed on livestock and pastoralism, which is an important form of land use in several counties
- There is a general lack of data on environmental issues

Water resources profile

This section provides an overview of water availability, including future water availability based on climate change projections, and an assessment of water demand to estimate the current and future water balance in the 10 counties. The key variable for water availability in the area is rainfall. As there were limited ground measurements available, Earth observation data were used to capture the full spatial variability across the 10 counties. Total run-off for each county is an output from DHI's Global Hydrological Model and provide estimates of the current water availability for the baseline period 2003 to 2020. High temperatures and potential evaporation in the area means that the spatial pattern of run-off (shown in the figure below) is similar to the pattern of rainfall.

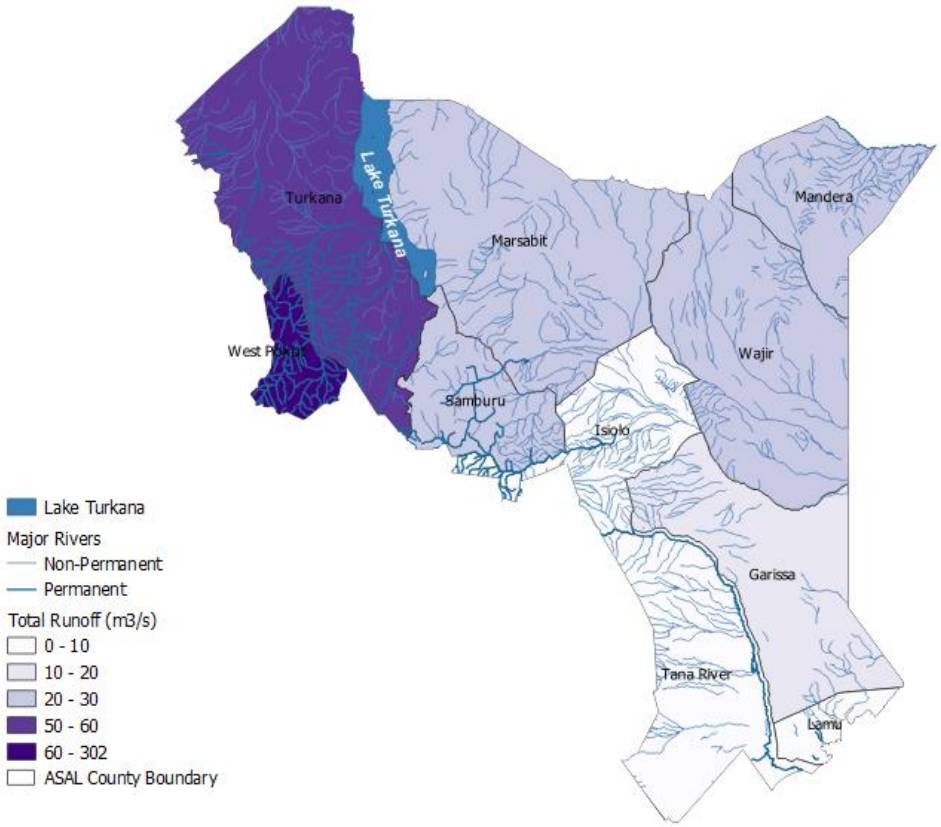
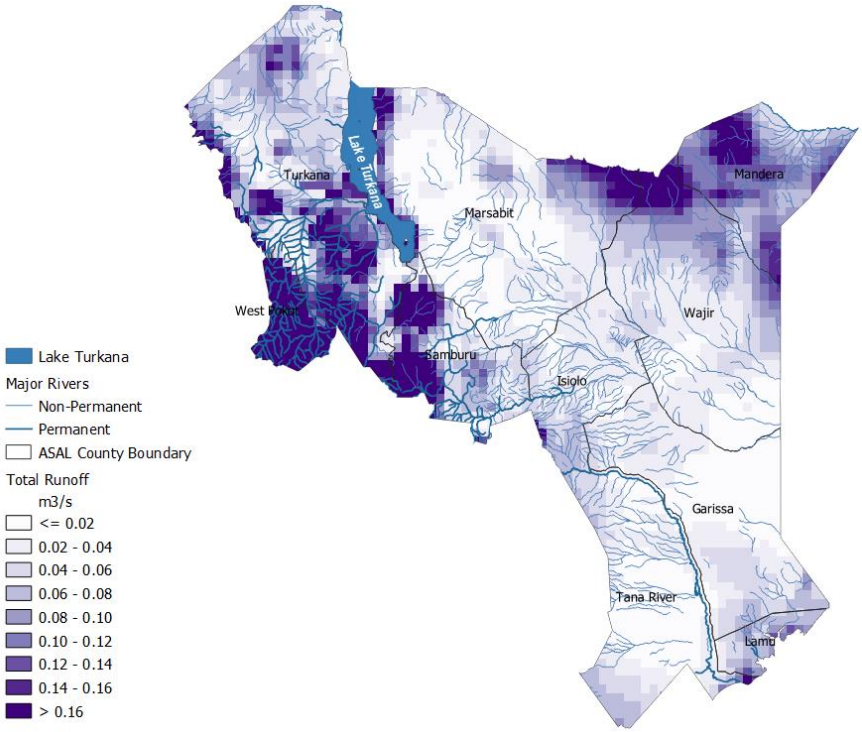


Figure 0-1 Total run-off (total water available) in each county simulated by DHI's Global Hydrological Model

Future projected changes in precipitation are generally more uncertain and more complex than temperature, with increases projected in some months and areas and decreases in others. Annual rainfall is projected to increase across the 10 counties from present day to 2050 by approximately 10-20 per cent. However, there is substantial variability in future rainfall projections through the year. In dry season months, rainfall is projected to increase in December to February from present day to 2050 but decrease in June to August. Annual temperatures are projected to increase between 1 and 1.6°C across all counties by 2050, with generally lower increases towards the coast.

Projected changes in temperature, evaporation and precipitation for 2050 indicate an expected increase in annual average run-off across most counties (see Figure 0-2 below for present and 2050 run-off).



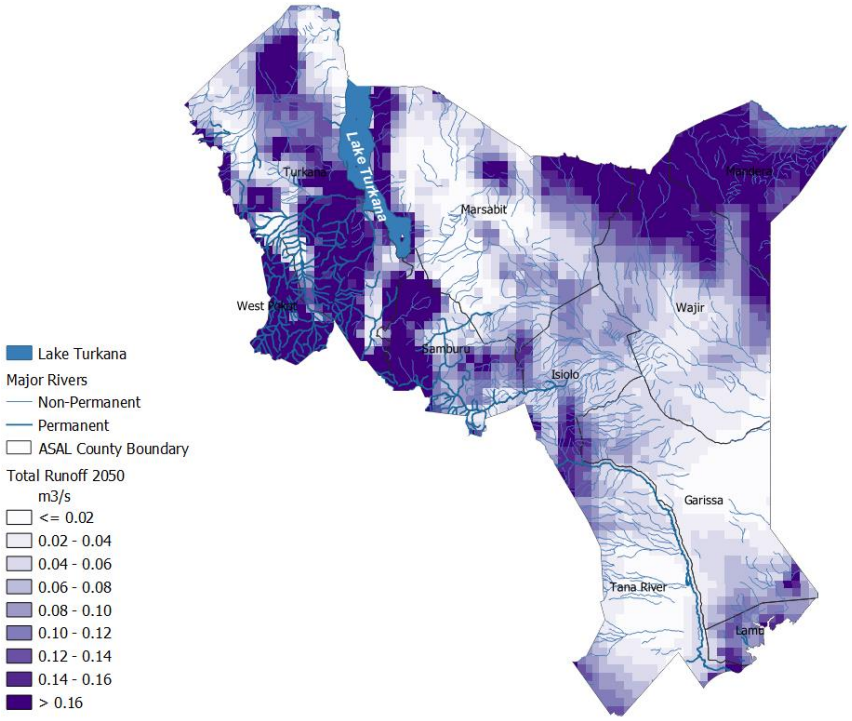


Figure 0-2 Total annual run-off simulated by DHI's Global Hydrological Model for present day (top) and under future climate change 2050 (bottom)

Data on existing water infrastructure in the 10 counties submitted for review were limited and, in many cases, outdated. Some data were submitted on location of boreholes, but not for all counties. Boreholes are an important source of drinking water. Households in the 10 counties depend more on water from boreholes than the national average, with over one quarter of households in Garissa and Wajir sourcing their drinking water from boreholes. No data were submitted on non-revenue water levels in the counties, hence attempts to calculate future losses were aligned with national targets which may be significantly lower than actual figures.

Limited data were submitted on the state of the environment and ecosystems in the 10 counties. NDVI derived from Earth observation data is presented as an indicator of green vegetation and the findings are consistent with spatial rainfall patterns. Plotting change over time in NDVI can indicate changes in vegetation patterns and indicate longer term ecosystem changes. Based on this data alone, there is limited evidence to suggest that vegetation has decreased in the region as a whole since 2000. Using data submitted to UNEP's SDG 6.6.1 Indicator's Freshwater Ecosystem Explorer, the study was able to identify the main wetlands in the project area, but lack of data submitted to the monitoring exercise meant that it was not possible to measure the extent of change over time. Protected areas including national parks, forests reserves, national reserves and game sanctuaries are found in the project area, while Lake Turkana is an important waterbody. Thousands of livelihoods are dependent on its ecosystem services. More information is needed to conduct a more in-depth assessment of the state of ecosystems in the project area.

Present and future water demand in the counties considers several sectors, including domestic consumption, institutional and commercial water demand,

non-revenue water, irrigation, livestock, and industry. Irrigation is by far the largest use of water. Based on potential irrigated areas used in future scenarios, there may be a mismatch between water availability and planned irrigation expansion, especially in Tana River County. Water demand from livestock was calculated using Livestock Units for each livestock type, based on population figures from the census and how much water each type required per day. Data on water demand due to industrial activities were limited, and there were no data available to assess future demand.

To estimate the water balance for each county, the modelled water availability (total run-off) and the estimated water demand are used. Limited data availability means that the final water balance is a best estimate but comes with inherent uncertainties and should be used with caution when drawing conclusions and making recommendations.

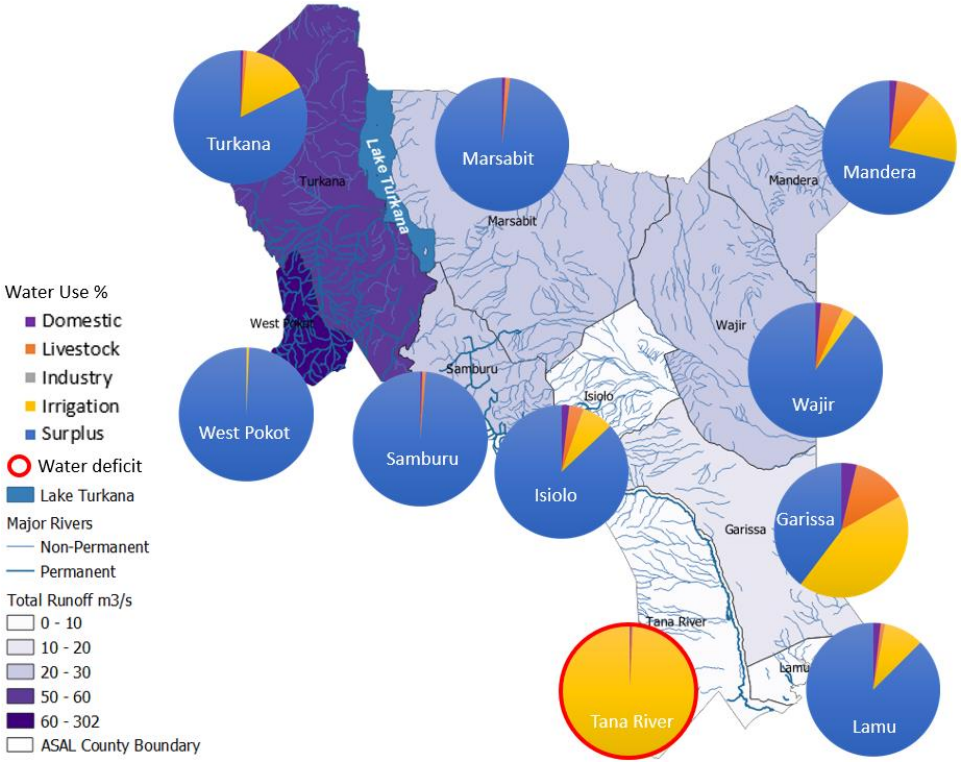


Figure 0-3 Present day total annual run-off and percentage water use by sector including surplus

The water balance has been calculated for the years 2030 and 2050. While total run-off is expected to increase, potential irrigation demand is so great that there is a negative water balance in Tana River, Garissa and Lamu counties.

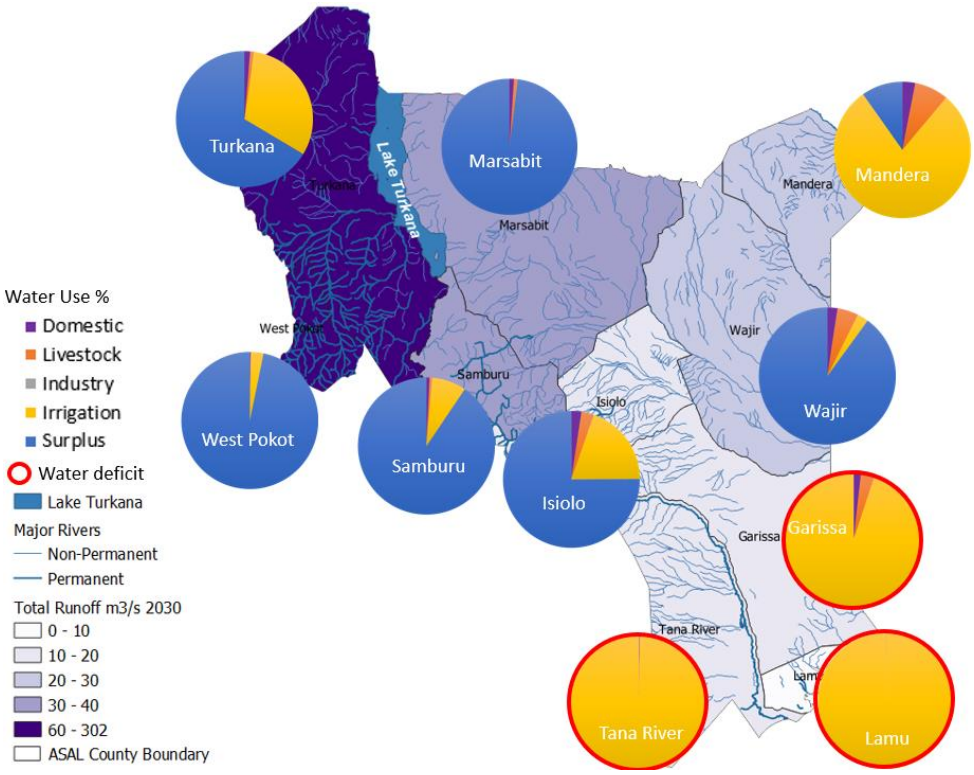


Figure 0-4 2030 total annual run-off and percentage water use by sector including surplus

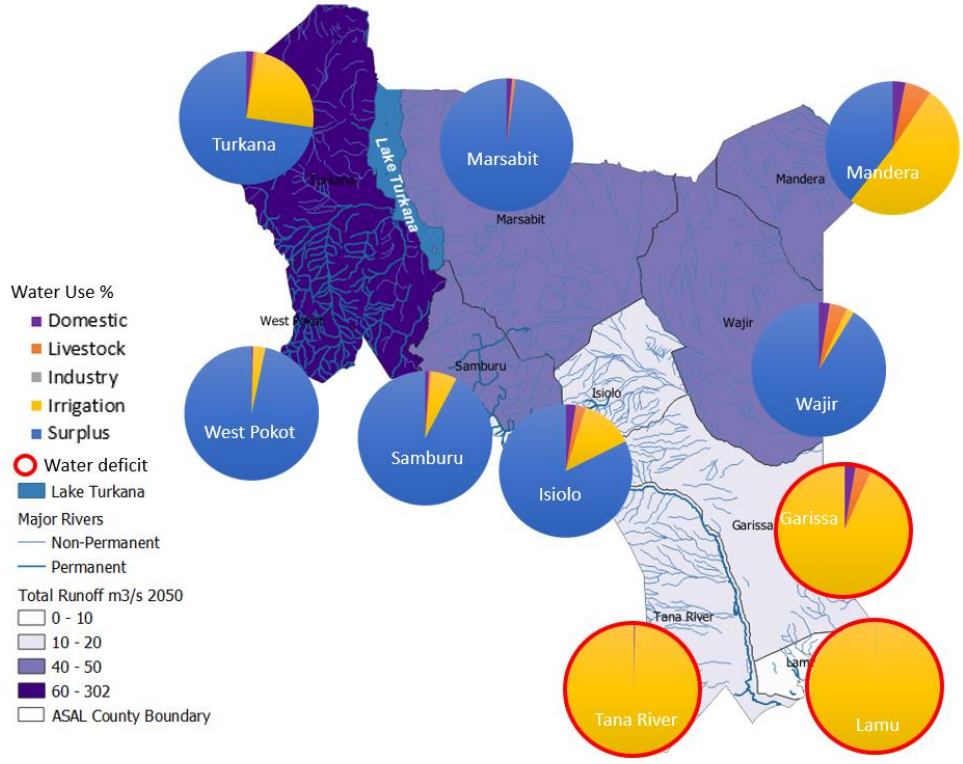


Figure 0-5 2050 total annual run-off and percentage water use by sector including surplus

The major findings and conclusions of this section are:

- Temperatures are projected to increase by 2050 across all counties and in all months, with increases in precipitation projected in both rainy and dry months
- Most counties have a surplus of annual water at present, and in future climate change projections, though most run-off occurs in the rainy seasons and a water deficit in the dry months is likely.
- Further analysis of the situation is needed in Tana River, Garissa and Lamu counties where there is an annual water deficit due to the irrigation
- Limited data has been submitted on groundwater, further analysis is needed of present and future groundwater resources

Risk profile

Climate change is expected to influence water resource availability around the globe, resulting in less or more water, and an increase in the frequency and intensity of hydrometeorological events such as floods and droughts. Competition for scarce resources could increase, thus increasing the risk and vulnerability of exposed populations. Studies on climate and vulnerability risk assessments have been conducted in some of the 10 counties, and an increase in focus on reducing hazard risk has led to the supposed development of community-based drought and flood risk action plans according to the Ministry of Water and Sanitation Strategic Plan 2018-2022 for the 29 most risk prone counties of Kenya, which include all 10 counties of this rapid assessment. No action plans were submitted for review as part of this study.

Water scarcity is projected to increase according to IPCC assessments. To analyse water availability in water scarce years, the lowest run-off year in the baseline period 2003 – 2020 was selected to represent a water scarce year. The resulting negative water balances in Garissa, Lamu and Tana River counties in the most water scarce years indicate that current demand cannot be met in water-scarce years.

Increased evidence of observed changes in extremes such as heavy precipitation could indicate future increases in flooding. Flood indicators were used to analyse flood risk across the 10 counties, with the Flash Flood Potential Index showing that Turkana, Samburu, Marsabit and West Pokot counties have the largest areas with a high (or above average) risk of flash flood. Parts of Tana River, Isiolo and Lamu counties are also at high risk.

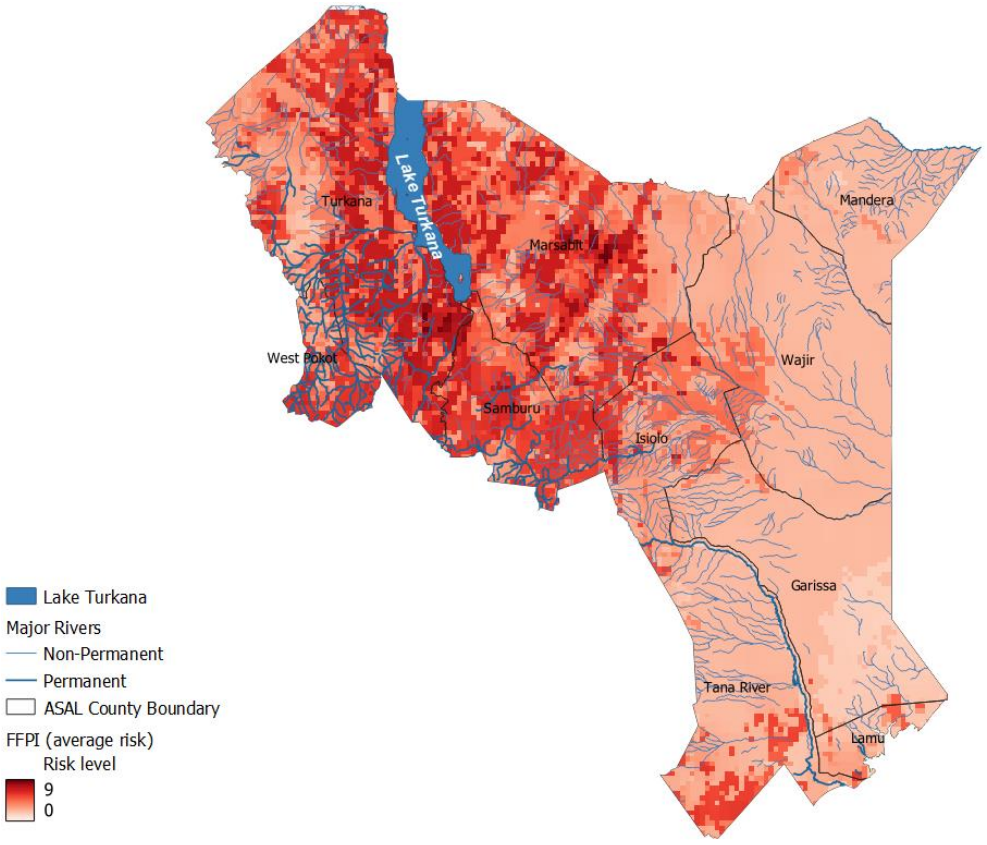


Figure 0-6 Average Flash Flood Potential Index (FFPI) 2007-2021 from low risk (0) to very high risk (9)

Riverine flooding, where water overflows riverbanks, is also mostly caused by heavy rain. Hazard maps for a 25- and 100-year return period are presented, and it is possible that riverine flood risk could increase in frequency and magnitude with projected increases in heavy rainfall.

Conflicts between water users are expected to be exacerbated as competition for scarce resources increase in the future. Limited data were submitted on existing conflicts, but hazard atlases developed for Garissa, Tana River and Turkana showed some of the more frequent water related conflicts arising include inadequate water and pasture, resource inequality, competition over limited resources, and conflicts between pastoral communities over land and water. During times of drought, pastoralists are often required to migrate to grazing ground or in search of water resources that are further away which can lead to conflict over available resources. The ASAL region also hosts most of the refugees in Kenya, with the two largest camps in Garissa and Turkana counties. This can also lead to conflict over water resources between host and refugee communities.

Limited data were submitted on health and water-borne diseases in the project area. Access to sanitation and handwashing services is important for hygiene and to combat the spread of Covid-19, and some additional financing has been channeled to the counties to combat the spread of the pandemic. It is unclear whether future potential impacts of the pandemic would result in a re-allocation of financing priorities.

Major findings and conclusions from this section:

- The IPCC Sixth Assessment Report shows increased evidence of observed changes in extremes such as heatwaves, droughts and heavy precipitation, including in the ASAL area
- Future climate change projections show increases in temperature extremes and in maximum one-day precipitation across Africa
- Turkana, Samburu, Marsabit and West Pokot have the largest areas with a high (or above average) risk of flash flood, and parts of Tana River, Isiolo and Lamu counties are also at high risk
- Conflicts for scarce water resources and climate change will exacerbate this risk

Projects and financing

ASAL counties receive financing for water resources from a range of partners, including internal partners such as ministries, departments and agencies, and ASAL county government budgets. External partners include bilateral and multilateral organizations, NGOs, CSOs, FBOs, UN Agencies and the Private sector. The ASAL Partnership Coordination Framework was created to ensure collaboration and cooperation between these partners. The two main internal funding mechanisms which finance water sector projects, which compliment county and national government allocations for water sector development, are the Equalization Fund and the Water Sector Trust Fund. Some external financers have grouped together, such as the ASAL Development Partners Group. A list of projects submitted for review is available in Annex 2 of this report, though it is not complete, as it does not include submissions from all members of the ASAL Development Partners Group. A comprehensive mapping of all donors and financers and their ongoing and planned projects is required as limited data were submitted upon request.

The major findings and recommendations from this section are:

- Technical trends: Most projects and programmes financed in the 10 counties focus on water supply and sanitation, with some climate proofing of existing infrastructure. These projects are aligned with the goals of the WSTF to tackle water supply and sanitation issues. There are fewer projects focused on water governance and data. Projects implemented using an IWRM approach are financed by the Netherlands Ministry of Foreign Affairs and include a focus on environmental considerations and nature-based solutions. No data were submitted on projects with a focus on groundwater.
- Financing gaps: Due to limited data it is challenging to estimate what the existing financing gaps are in the 10 counties. To achieve the SDG 6 goal of 100 per cent access to water supply and sanitation by 2030, Kenya needs to more than double its current investments annually. An analysis into the status of planned water infrastructure may shed light on further financing gaps. No data were submitted on financing or efforts made to leverage financing from the private sector, which may be an important stakeholder in plugging gaps.

Recommendations

Based on the rapid assessment exercise conducted across the four main profiles of this study (governance, demography, water resources, and risk) several gaps and topics which require further investigation or elaboration have been identified. Several key documents that support this study include plans and recommendations to be implemented by 2030. Achieving these goals will require continued support and investment in water resources planning and infrastructure. Priority actions for investments for IWRM have already been identified in the SDG 6.5.1 IWRM Action Plan, and many of these could be taken forward in the 10 counties. The rapid assessment exercise makes 9 high-level recommendations across three broad areas: improvement of physical infrastructure, governance arrangements, and data.

While data availability has limited the full potential of this rapid assessment, these recommendations target the areas where data has been sufficient or point towards gaps where further analysis would be beneficial. The recommendations require further consideration by the Technical Committee members.

1. Invest in more water supply and sanitation in the 10 counties to achieve targets, as standards are far below the national average (see section 6.3). This could be done by financing additional water storage capacity, improving water harvesting infrastructure, and increased understanding and research into groundwater recharge, to increase resilience to droughts, and bridge the increasing seasonal differences that have been projected to create a basis for secure livelihoods. This should be financed from government, private sector and development partner sources.
2. A comprehensive mapping exercise of available and planned financing from all stakeholders, including NGOs and organisations which were not considering in this study, could identify further gaps or opportunities for investment synergies. To compliment this, an analysis of the status of all planned interventions, including the CIDPs, MTP, Vision 2030 and the National Water Master Plan 2030 should be considered in each of the 10 counties. This could identify if plans are on track or whether there is a need to reprioritize planned investments in line with the water balance exercise. This exercise could also identify infrastructure investments that may require additional funding (see Table 6-13).
3. Investigate the potential for inclusion of nature-based solutions in future investments in water resources (see Section 9.3.1).
4. Increase capacity at the county level to access and engage with water resources data and information. This entails data collection, access to data, data consolidation, and management, as well as building staff capacity and system capacity on data access and handling.
5. Map stakeholder engagement more comprehensively to understand actors outside the public sphere who are engaging in water management and could potentially finance some of the gaps identified. This is also important for the continuation of the project. The right stakeholders need to be engaged for future planning of interventions. This includes stakeholders engaging in data, water services and water resources management.

6. Analyse and address potentially escalating conflict over water resources, including the increase of floods and drought as a driver of conflict for pastoral communities There are no obvious governance structures that apply to cross-border or mobile water users. One suggestion could be to investigate how this can be addressed at ASAL or cross-county level, with a recommendation to prioritize counties with the highest livestock populations, such as Mandera, Wajir, Garissa (see Figure 6-10).
7. Improve monitoring and access to data at county level on physical water-related resources, infrastructure, and the state of environment.
8. Improve access to data by implementing a Decision Support System (DSS) to support the relevant agencies in Kenya getting easy access to data to inform robust decision making. A DSS would improve monitoring and access to data (see Recommendation 8) and increase capacity for engagement with water resources data and information (see Recommendation 5). In addition, a DSS can support robust decision-making regarding investment and interventions, including nature-based solutions (see Recommendation 3), by providing a tool to analyse and compare the impact of interventions (e.g. irrigation schemes, dams, flood prevention) and prioritise investment through scenarios and multi-criterial decision analysis. The DSS, or existing databases, should be supplemented by freely available Earth observation datasets to provide easy access to a consolidated database of all available information.
9. Check whether the irrigation potential for each county is calculated appropriately considering the available water balance, including under climate change scenarios, in addition to soil/land potential, and support county governments to develop county water services strategies to inform future CIDPs in line with the Water Act 2016 regulations-

1 Introduction

As part of the larger project Government of Kenya and UN Strategic Partnership for Water Security in ASAL Regions of Kenya, the Technical Committee for Water Security in the ASAL Regions of Kenya identified a need for a rapid integrated assessment of water resources in 10 counties, the result of which is the current report. This holistic, multi-disciplinary assessment of water resources and management is based on a desk study of data provided through UNEP, by the relevant stakeholders and partner organizations.

The UNEP-DHI Centre for Water and Environment (www.unepdhi.org) was contracted by UNEP Regional Office for Africa to implement the rapid assessment and is referred to as both UNEP-DHI and the consultant in the following sections. The rapid assessment identifies the challenges and opportunities to building water security in the ASAL regions by considering relevant hydrological and socioeconomic conditions and institutional arrangements that impact water security and water provision and informs future interventions in the region supported by the UN and other relevant actors.

2 Project context

The ASAL regions are home to 36% of Kenya's population, 70% of its livestock and 90% of its wildlife[2]. They cover 29 counties with various degrees of aridity. Improving the quality and availability of water in the region within sustainable limits is necessary for the improvement of health and economic development outcomes, as well as to meet the national goals of increased water security through increasing per capita freshwater endowment, water storage per capita, flood control, and access to safe water.

Sustainable water management is impacted by natural conditions including droughts, floods and climate change, and socioeconomic challenges related to the provision of services, infrastructure, land use management, excessive demands and gender bias. Competition for water resources can result in conflicts between users while further reducing access to goods and services such as education, health care, trade, and food security, as well as impacting livelihoods.

To address these challenges, the UN has committed to supporting the Government of Kenya in its efforts to improve water security in the ASAL regions with a focus on ten selected counties: Garissa, Isiolo, Lamu, Mandera, Marsabit, Samburu, Tana River, Turkana, Wajir and West Pokot (see Figure 2-1). Of the 10 counties selected, two are classified as semi-arid (West Pokot 30-84% aridity, and Lamu 10-29%) while the remaining eight are classified as arid (85-100% aridity).

[2] *ASALs Categorization*, 2019, Ministry of devolution and the ASALS.

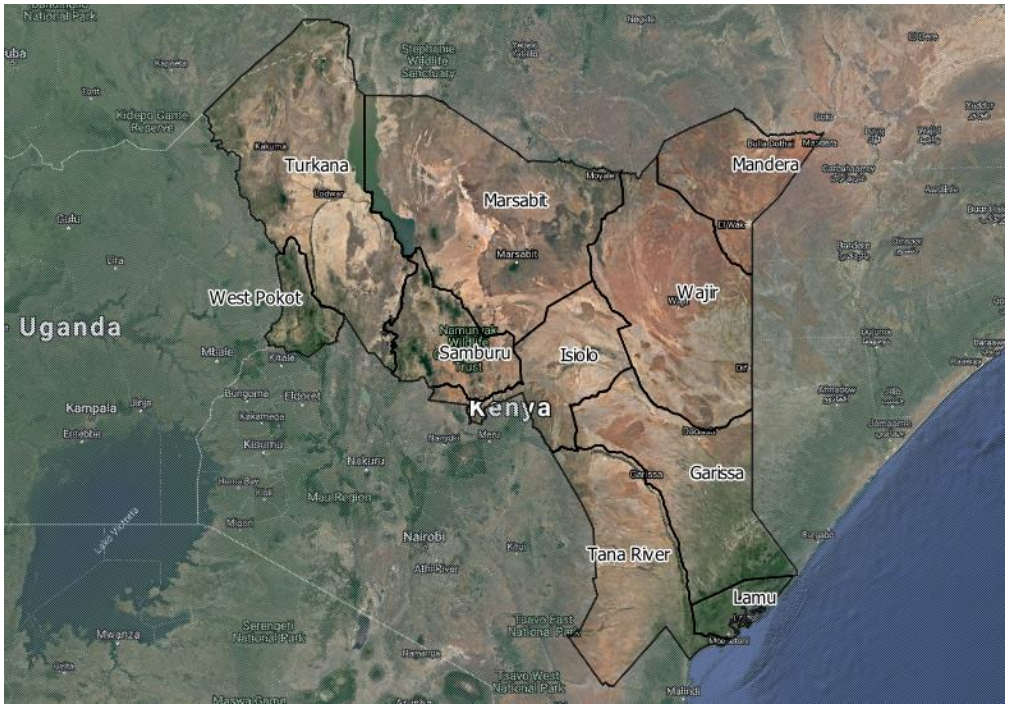


Figure 2-1 The 10 counties selected for rapid assessment

3 Project objective

The rapid assessment objective is to deliver a rapid integrated assessment that considers the key social, environmental, institutional, and economic issues confronting water resource management in the ten targeted counties. Based on the availability of data provided, the rapid assessment aims to identify the following:

- Existing water resources
- Socioeconomic benefits
- Institutional arrangements for water governance
- Regulatory frameworks and policies for the management and protection of water resources
- Completed, ongoing and proposed projects and initiatives related to water resources management
- Current and future threats to water resources, including climate change
- Available financial resources and mechanisms to support future programmes
- Gap analysis to describe priority areas for improvement in physical infrastructure, governance and data
- Next steps and high-level recommendations to identify and implement integrated water resources management (IWRM) actions and improve water security

The rapid assessment was conducted over a period of 18 weeks.

4 Methodology

4.1 Inception and data assessment

Implementation of the rapid assessment began with an inception phase to assess the extent of data previously submitted by counties and stakeholders for consideration. An excel sheet was developed by the UNEP Regional Office for Africa early in 2021 and circulated to members of the Technical Committee prior to the start of the rapid assessment. In addition to this excel document, a Google Drive was set up where stakeholders could upload relevant data and materials that could contribute to the study.

At the launch of the rapid assessment, there were a total of 12 folders or zip files of documents and 59 individual files uploaded to the Google Drive. During the inception phase, UNEP-DHI developed a basic mapping tool using excel to categorise the data and reports submitted into four broad categories which form the basis of this study:

1. Governance
2. Water Resources
3. Demographics
4. Risk Assessment

A rapid assessment was made to establish whether and which data had been submitted under each of these categories for all ten counties included in the study. The aim was to identify data gaps which were presented at the Second Technical Committee meeting on September 23rd, 2021. The outcome of the data mapping exercise, which is documented in the inception report, was that insufficient data had been submitted to conduct a comprehensive rapid integrated water management assessment for the 10 counties. While sufficient data had been submitted on Governance and Demographics, with the recent census data of 2019 providing up to date and relevant data at county and sub-county level, insufficient data was submitted on water resources in the counties.

A request was made for additional data to be submitted for consideration, with a deadline of October 8th 2021, after which UNEP-DHI would consider how to proceed with finalising the rapid assessment based on the available information, with a need to consider alternative methods to fill the data gaps which were identified.

Following limited data submission after the additional data drive, it was decided in agreement with UNEP that the study would proceed using freely available earth observation data, as well as some additional internet searches to locate relevant reports and documents for review[3].

[3] Disclaimer: As a result, the majority of the data used to develop the water resources profile (Chapter 7) and the risk profile (Chapter 8) is based on satellite data and could not be calibrated with data from the ground.

4.2 Literature review and data analysis

The documents and reports received by UNEP-DHI were then reviewed and any gaps filled, where possible, with additional internet search. The relevant laws, acts and policies for water management in Kenya and the ASAL region were submitted by members of the technical committee and reviewed to provide a comprehensive overview of the status of water governance in the 10 selected counties.

With the support of the Royal Danish Embassy in Nairobi, a datasheet was compiled and circulated to the ASAL Development Partners Group to gather information on past, ongoing and planned projects and financing targeting water resources management in the ten counties. Information regarding four financial partners (Danida, DGIS, USAID and World Bank) was received.

4.2.1 Census 2019

The Kenya National Bureau of Statistics conducted a census in 2019 which has provided much of the statistical demographic data that forms the basis of this rapid assessment, including data at county and sub-county level on:

- Population: Total, Urban and Rural
- Land area: Total, Agricultural land use
- Livestock: Population
- Water supply and sanitation: Main source of drinking water, human waste disposal

Projections for future population growth and rate of urbanization were developed using census 2019 population growth rate of 2.2% and data from UN DESA World Urbanization Prospects: The 2018 Revision[4].

4.2.2 National Water Master Plan 2030 (JICA Report)

During the literature review it became apparent that the National Water Master Plan 2030[5] developed with funding by JICA in 2013 could provide a comprehensive overview of relevant data at catchment and sub-catchment level for this rapid assessment. The NWMP 2020 was submitted as part of the original data drive by the counties. Given the lack of water resources data on a county level submitted for review, UNEP-DHI were able to use this report to corroborate and compare their data as well as provide information on specific sectors where data gaps had been identified. Data used from the NWMP 2030 include

- Irrigation: existing and planned interventions, water requirement per hectare
- Domestic and industrial demand: Institutional, commercial, and industrial water demand proportions
- Infrastructure investments: Significant projects proposed in the plan

[4] WUP2018-F01-Total_Urban_Rural.xls (live.com)
[5] https://wasreb.go.ke/national-water-master-plan-2030/

4.3 Earth Observation Data

Freely available Earth Observation data have been downloaded, processed and analysed to provide additional data for the 10 ASAL counties. The datasets and methodology for how they have been applied in this study are described below:

- **Copernicus Global Land Service (CGLS) land cover**[6]: to analyse spatial differences in land cover across the 10 ASAL counties
- **Copernicus ERA5 rainfall**[7]: to analyse rainfall magnitude and spatial distribution across the 10 ASAL counties
- **Shuttle Radar Topography Mission (SRTM) Digital Elevation Model**[8]: to analyse the varying elevation across the 10 ASAL counties in relation to the spatial variability of rainfall
- **Normalised Vegetation Deviation Index (NDVI)**[9]: to determine the vegetation density spatial distribution across the 10 ASAL counties and change over time.

In addition, flood and drought indicators have been calculated from Earth Observation data as described below:

- **Flash Flood Potential Index (FFPI):** to quantify the potential risk of flash flooding based physiographic catchment properties including slope (from SRTM DEM), soil water index (SWI) from Copernicus Global Land Service[10] and NDVI.
- **Flood Hazard Assessment:** Global Assessment Report on Risk Reduction (GAR) 2015 global flood hazard assessment[11] uses a probabilistic approach for modelling riverine floods for major river basins around the globe. It is based on a global database of streamflow data, river quantiles and river geometries from topographic data (SRTM). It allows for the determination of the reference flood hazard maps for different return period e.g., 25 years, 50 years and 100 years.
- **Effective Drought Index (EDI)**[12]: based on Global Precipitation Measurement (GPM)[13] of rainfall, this index considers daily water accumulation with a weighting function for time passage and is used as an indicator of drought.

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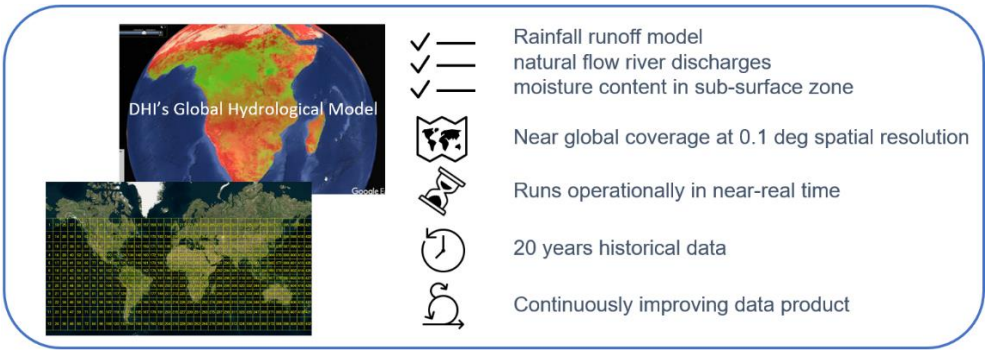
[6] https://land.copernicus.eu/global/content/annual-100m-global-land-cover-maps-available
[7] https://cds.climate.copernicus.eu/cdsapp#!/dataset/reanalysis-era5-single-levels
[8] usgs.gov/centers/eros/science/usgs-eros-archive-digital-elevation-shuttle-radar-topography-mission-srtm-void
[9] http://modis-land.gsfc.nasa.gov/vi.html
[10] http://land.copernicus.eu/global/products/swi
[11] https://preview.grid.unep.ch/index.php?preview=data&events=floods&evcat=1&lang=eng
[12] https://om.ciheam.org/om/pdf/a95/00801330.pdf
[13] https://www.nasa.gov/mission_pages/GPM/main/index.html

4.4 Global Hydrological Model

DHI's Global Hydrological Model (GHM)[14] is an operational service that provides fast and easy access to global hydrological information and other derived products. DHI's GHM combines global scale satellite data with every hydrological basin between 80°N and 60°S. Global weather data, geographical parameters, and hydrological conditions are used to produce hindcasted (~20 years), near real-time, and forecasted river discharge. Calibration of individual catchments is impractical on a global scale, therefore global maps of model parameters are generated from physical land characteristics such as soil and vegetation types and observed river discharges.

DHI's GHM has two modelling components: rainfall-run-off (NAM) modelling within model grids and routing between catchments. A rainfall-run-off model is run in each grid, and water is then routed between grids within each catchment, and lastly between catchments. The model produces global datasets of hydrologically relevant variables, including but not limited to total run-off, actual evaporation, baseflow, and root zone storage.

DHI's GHM is a useful tool in areas with very limited data and for studies where detailed local modelling is not carried out.



In this study, DHI's GHM has been used to estimate the current and future water availability in the 10 ASAL counties.

The GHM hindcast of total run-off from 2003 to 2020 provides the present-day water availability for the study. Inputs to the GHM hindcast include precipitation and temperature from the Copernicus ERA5 dataset[15] and evapotranspiration calculated using the Priestley-Taylor equation[16] based on ERA5 datasets.

4.4.1 Climate change scenarios

To forecast water availability in future years, the GHM has been run with monthly climate change factors applied to the input precipitation, potential evaporation, and temperature. The climate change factors are from Regional Climate Model (RCM) CORDEX Africa representative concentration pathway

[14] https://www.dhigroup.com/data-portals/global-hydrological-model
[15] Hourly global dataset from 1975 to present with 0.25° x 0.25° spatial resolution. Source: https://cds.climate.copernicus.eu/cdsapp#!/dataset/reanalysis-era5-single-levels
[16] Priestley, C.H.B. and Taylor, R.J. 1972. On the assessment of surface heat flux and evaporation using large scale parameters. Monthly Weather Review, 100, 81-92. DOI: http://dx.doi.org/10.1175/1520-0493(1972)100<0081:OTAOSH>2.3.CO;2

(RCP) scenario 4.5 (medium radiation forcing scenario) for 2016 – 2035 and for 2046 - 2065[17].

Data from the latest IPCC (AR6) report related to the five new emissions' scenarios (SSPs) has only recently been made available and has not been analysed and processed to apply in this study. Therefore, the climate projections in this study are taken from other recent studies. CORDEX is a World Climate Research Programme that has produced regional downscaled climate projections worldwide by running a set of Regional Climate Models (RCMs) for each continent. The RCMs are driven by the Representative Concentration Pathway (RCP) emissions' scenarios used in the previous IPCC AR5 report and the outputs are processed into projected changes in monthly mean potential evapotranspiration (PET), precipitation and temperature. Projected changes are relative to the control period (1986-2005) and are estimated for a medium radiation forcing scenario (RCP 4.5) and extreme radiation forcing scenario (RCP 8.5). The projection change factors are an ensemble, and the median is calculated as the expected future change.

In this study, the factors were interpolated to provide climate forecasts for 2030 and 2050. The CORDEX baseline for the change factors is 1986 - 2005 and the baseline in this study is 2003 – 2020 therefore interpolation was required to apply the change factors to the more recent baseline used in this study. In addition, interpolation of the factors enabled simulation of climate change scenarios for 2030 and 2050.

4.4.2 Time scales for assessments and planning

The study focuses on water resources assessment in the present-day and for future year scenarios in 2030 and 2050. Future year scenarios focus initially on the year 2030 to coincide with the Sustainable Development Goal (SDG) targets for 2030, political plans such as the Kenya's Vision 2030 and the National Water Master Plan (JICA Report) for 2030.

In addition, this study assesses a future year scenario for 2050 to provide a longer-term future scenario. The year 2050 was chosen because the National Water Master Plan (JICA Report) also considers a future year scenario in 2050, and the climate change scenarios (sourced from CORDEX), project change for the timeframe 2046 - 2065 where 2050 falls well within this range.

[17] Monthly change factors with spatial resolution 0.44°. Source: https://esg-dn1.nsc.liu.se/projects/esgf-liu/

5 Governance profile

This chapter identifies and highlights the relevant governance arrangements in place that impact that management of water resources in the 10 counties. This includes institutional arrangements, policies and regulations, stakeholders and financers of investments and projects of water projects. The complex nature of managing water across county and catchment limits requires collaboration across all parties.

5.1 Introduction

The ASAL region's governance profile is shaped by international, regional, and national goals and frameworks, including:

- Agenda 2030 (Sustainable Development Goals)
- African Unions' Agenda 2063
- Kenya Vision 2030
- Vision 2030 Development Strategy for Northern Kenya and other Arid Lands (2021)

These form the overarching framework within which development planning and investments in the ten counties take place.

5.1.1 Development plans and political ambitions for sustainable water management

At the national level, the **Constitution of Kenya** forms the overarching legal framework under which all relevant ministries operate. The most relevant articles are **Articles 6,174,175 and 176** which created a devolved system of government, whereby water resources management is by national government and provision of water and sanitation services is by county governments. **Article 204** looks to the reduction of inequality in service provision and the establishment of the equalisation fund (see Section 9.1.1 for more info). **Article 62** on water catchment areas, rivers, lakes, and water bodies are held in trust by the national government for the people of Kenya. Each ministry and government agency is responsible for developing their own strategic plan. An overview of the most relevant ministries and agencies as well as their strategies is presented in the next section.

Agenda 2030 (or the sustainable development goals – SDGs) which is a global framework whereby each country must strive towards achieving a level of sustainable development by the end of this decade. **SDG Goal 6**: *Ensure availability and sustainable management of water and sanitation for all* - is the main goal focused on water management, but there are many cross-cutting goals, including SDG 13 on climate action, that are important for water. Kenya is progressing towards these goals, with the current overview of progress available on the UN-Water SDG6 Data Hub (www.sdg6data.org) . In collaboration with the SDG IWRM Support Programme

the SDG6 IWRM Action Plan to achieve the goals was developed[18]. This action plan, which is not county specific, was published by the Ministry of Water, Sanitation, and Irrigation in April 2021. Specific actions identified are categorised under the four main pillars or IWRM, namely:

- Enabling environment (13 actions)
- Institutions and participation (13 actions)
- Management instruments (10 actions)
- Financing (4 actions)

Of the long list of required actions identified, six are currently taken forward for implementation[19], though none are specifically targeting county level actions.

Vision 2030 is the country's planned development path for the period 2008-2030 and is based on three pillars: economic, political, and social. To achieve Vision 2030, shorter (5 year) plans are implemented, with Medium Term Plan III being the most current of these.

National Water Master Plan 2030 was launched in 2013 and has three main components: the water supply development plan, the water resources development plan, and the environmental management plan. The ambitious targets of the master plan include increasing coverage of improved water supply to 100% in rural and urban areas, increase piped water supply to 100% for urban populations, increase the unit water supply amount to a suitable level (See figure 5.1), decrease non-revenue water (NRW) rate to 20%, meet all water demands projected for 2030 for domestic, industrial, irrigation, livestock, wildlife, and hydropower, and minimize the negative impacts on the environment.

Finally, the **Big Four Agenda[20]** (food security, affordable housing, manufacturing, and affordable healthcare) also includes important components that relate to water in terms of water service provisions and access to water, and WASH.

5.2 Institutional arrangements for water governance

The institutional arrangements for water governance in the ten ASAL counties are aligned with the national water institutional arrangements. A figure depicting the institutional framework for the Kenyan water sector is presented in Figure 5-1.

[18] Ministry of Water, Sanitation and Irrigation (2021) SDG6 IWRM Action Plan https://www.gwp.org/globalassets/global/activities/act-on-sdg6/sdg-map/stage-2-reports/kenya_report_final.pdf

[19] Kenya's IWRM Action Plans currently under implementation https://www.gwp.org/en/sdg6support/sdgmap/eastern-africa/kenya/

[20] See more about the Big Four Agenda on the official webpage https://big4.delivery.go.ke/

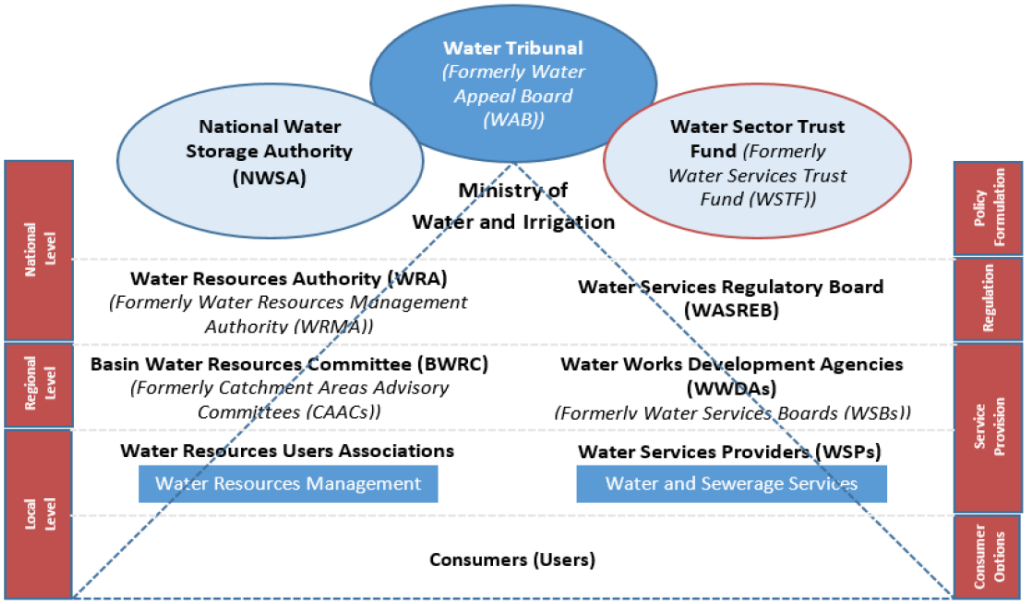


Figure 5-1 Institutional framework for the Kenyan Water Sector
Source: WSTF Strategic Plan 2018-2022

A summary of the relevant water sector institutions is presented in the following paragraphs, from National to Regional, County and basin level.

The **Ministry of Water and Sanitation (MoWS)** provides the overarching frame for water and sanitation management in Kenya and the ASALs. MoWS is responsible for water resources management policy, water catchment area conservation, control and protection, water and sewerage service management and policy, wastewater treatment and disposal policy, water quality and pollution control, sanitation management, the management of public water schemes and community water projects, water harvesting and storage for domestic and industrial use, flood control management and transboundary water policy.

The Ministry has its own Strategic Plan 2018-2022. The strategy aims to increase National Water Coverage to 60% and Urban Sewerage Coverage to 25%. Other significant targets for the strategy include:

- The creation of 56 sub-catchment management plans will be developed and 236 sub-catchment management plans implemented
- 400 monitoring stations to be rehabilitated
- Upgrading 130 monitoring stations to telemetry
- Establish 80 surface water and 50 ground water monitoring stations
- Establish 4 national water quality reporting stations

Within the frame of MoWS, the Water Resources Authority (WRA) and the National Water Harvesting and Storage Authority (NWHSA) are responsible for water resources management and water supply and sanitation respectively. The authorities are mandated to prepare and implement a water resources strategy and water services strategy every five years.

5.2.1 Water resources management

Water Resources Authority (WRA): The WRA has the overall authority of managing Kenya's water resources, as well as ensuring a national monitoring and geo-referenced information system on water resources. WRA is responsible for the establishment of **basin water resources committees (BWRCs)** which have been designated for each basin and are responsible for the management of water resources in each basin respectively. A representative from the county government is appointed to each basin committee which has authority within their county boundaries. These basin committees advise the WRA and county governments. **Water resources user associations (WRUAs)** are active at sub-basin level. These are community based and are active in collaborative management and conflict resolution.

The **National Water Resources Strategy** is developed every 5 years and provides the government's plans and programmes for the protection, conservation, control, and management of Kenya's water resources. In addition to the national strategy, BWRCs formulate a basin area water resources management strategy in consultation with WRA and the county government(s).

In addition, **Kenya Water Towers Agency** was created in 2012 with the aim to coordinate and oversee the protection, rehabilitation, conservation, and sustainable management of all the critical water towers in Kenya. Gazetted water towers included in this project area are:

- Huri Hills (Marsabit County)
- Mt. Kulal (Marsabit County)
- Mt. Marsabit (Marsabit County)
- Mt. Nyiru (Samburu County)
- Ndotos Range (Samburu County)
- Matthews Range (Samburu County)
- Kirisia Hills (Samburu County)
- Cherangani Hills (West Pokot+)

5.2.2 Water supply and sanitation

National Water Harvesting and Storage Authority. The NWHSA is responsible for the development of national public water works for water storage and flood control. Their functions include the maintenance and management of public water infrastructure, policy development, and undertake strategic water emergency interventions during periods of drought.

NWHSA develops and implements a **Water Services Strategy** every five years which aims to achieve the progressive realization of the rights of every person in Kenya to water. County governments are responsible for establishing **Water Service Providers**, whose responsibility is the provision of water services and the development of county assets for water service provision. The nine **Water Works Development Agencies (WWDA)** are responsible for development, maintenance, and management of national public works. **The Water Services Regulatory Board (WSRB)** protects the interests and rights

of consumers in the provision of water related services (see Section 5.5 on regulatory framework).

Finally, the **Kenya Water Institute (KEWI)** is responsible for training and capacity building within the water sector and is financed by the GoK and external financers.

Other important aspects of water management are also considered under the jurisdiction of the Ministry of Health, Ministry of Education, Ministry of Transport, Infrastructure, Housing and Urban Development, Ministry of Foreign Affairs (transboundary waters), Ministry of Environment and Forestry, and the Ministry of East Africa Community and Regional Development. There are several supporting and complimentary institutions that should also be mentioned which are external to the water institutional pyramid which are elaborated in the next paragraphs.

5.2.3 Water and irrigation

The **Ministry of Water, Sanitation and Irrigation (MoWSI)** is another important institution when considering water management in the ASAL as agriculture/irrigation is the most important water consuming sector in the region (see Section 7.4). The Ministry has designated the National Irrigation Authority to implement the national irrigation strategy, which is implemented in five-year cycles.

The National Irrigation Authority is responsible to develop and improve irrigation infrastructure for national public schemes. They also provide support services to private medium and smallholder schemes in collaboration with county governments. **NIA in consultation with county government** may facilitate the formulation and strengthening of Irrigation Water User Associations (IWUAs). Each county may also establish a **County Irrigation Development Unit** which are responsible for implementing County Irrigation Development Strategies with stakeholders to develop and maintain irrigation databases, identify community-based smallholder schemes, provide capacity building for farmers and implement measures to adapt or mitigate the effects of climate change. NIA oversees the management of irrigation schemes except for those which are under management of county governments. *No copies of County Irrigation Development Strategies were submitted for rapid assessment, so it is not clear if each of the ten counties has such a strategy in place.*

As part of the Irrigation Act which guides the work of the Ministry, the Government is responsible for maintaining a national database on irrigation development and management in collaboration with county governments. This database should include information on water supply, demand, projects, irrigated areas, management performance, expansion potential and human resources.

5.2.4 Climate and meteorology

The **Ministry of Environment and Forestry** is another key institution in the management and conservation of water resources in Kenya. Amongst other environmental topics, the MoEF is mandated with restoration of strategic water towers, protection and conservation of the natural environment, pollution control, meteorological and climate change affairs. This includes the generation and dissemination of weather and climate information for early warning,

planning and decision making. It is currently implementing it Strategic Plan for 2018-2022

The **Kenya Meteorological Department** within MoEF provides meteorological and climate information services for agriculture, disaster management and water resources development.

Directorate of Climate Change was established under the Climate Change Act of 2016 to provide leadership, guidance, and coordination on climate change matters in the country and is the lead government agency for implementation of national climate change plans and actions.

5.2.5 Drought management

National Drought Management Authority (NDMA) Mandated by the National Drought Management Authority Act, of 2016, NDMA exercises the coordination over all matters related to drought risk management. This includes establishing the mechanisms to end drought emergencies in Kenya, either on its own or with stakeholders, including NWHSA who are key stakeholders for emergency interventions for water supply during periods of drought. NDMA provides the necessary platform for long-term planning and action, with the Authority having established offices in the 23 ASAL counties considered most vulnerable to drought. NDMA works in five key areas:

- Drought resilience
- Drought information
- Drought contingency planning and response
- Knowledge management
- Coordination

NDMA is currently implementing its second Strategic Plan, covering the period 2018-2022. An overview of past and ongoing projects being implemented by NDMA is available on their website[21] and in Annex 2.

5.3 Devolution

An important consideration for this project is how devolution affects governance in the ASAL counties as well as the management of water resources. Under the Constitution of Kenya devolution has the intention to promote a democratic and accountable exercise of power, social and economic development, and easily accessible services throughout Kenya. As a result, 74 county governments were formed of which 10 are the subject of this rapid assessment. While the overall management of water resources remains at the national level, the counties themselves are responsible for provision of water services to their populations. Through the State Department for Devolution, the government has been facilitating the implementation of this devolved system of governance since 2013.

Complementary to the sector strategic plans, each county must develop a **County Integrated Development Plan (CIDP).** A review of the CIDPs showed

[21]NDMA Partner Supported Projects http://ndma.go.ke/index.php/partners

that the level of detail of reporting varies significantly between the counties making comparison challenging.

New institutions which also affect water governances in the ten counties include the **Department of Arid and Semi-Arid Lands (SDDA)**. The SDDA is a special vehicle for affirmative action, mainstreaming development issues of ASALs, coordinating, implementing, and fast-tracking investment for long term sustainable development. **The Ministry of Public Service, Gender, Senior Citizens Affairs & Special Programmes** (then **Ministry of Devolution and ASAL)**, has developed its own **Vision 2030 Development Strategy for Northern Kenya and other Arid Lands** (2021) which focuses on Vision 2030 objectives using an ASAL lens to prioritise initiatives relevant for the region.

5.4 Stakeholders and relevant actors

Ensuring the sustainable management of water resources entails coordination across a wide array of stakeholders, from the national to the community level. The table below presents a non-exhaustive list of stakeholders and actors who are active at the different levels with water management in the ten counties.

Table 5-1 Stakeholders active in water resources management

National Level	
Public	Ministry of Water,Sanitation and Irrigation (MOWSI) Ministry of Devolution National Drought Management Authority (NDMA), Water Resources Authority (WRA), National Water Harvesting and Storage Authority (NWHSA) National Irrigation Authority (NIA), Water Services Regulatory Board (WASREB) Council of County Governors (CoG) Kenya Climate Change Working Group
Private	No data submitted
NGO	No data submitted
ASALs Level	
Public	Ministry of Public Service, Gender, Senior Citizens Affairs and Special Programmes – State Department for Development of the Arid and Semi-Arid Lands
Private	No data submitted
Public	No data submitted
County Level	
Public	County Governments County Irrigation Development Unit
Private	Water Sector Providers (WSPs)
NGO	No data submitted
Basin Level	
Public	Basin water resources committees (BWRC)
Private	No data submitted
NGO	No data submitted
Sub-Catchment Level	
Public	Water resources user associations (WRUAs)
Private	No data submitted
NGO	No data submitted
Community Level	

Public	Irrigation Scheme Management Committees Irrigation Water Users' Associations
Private	No data submitted
NGO	No data submitted

Civil society organizations contribute significantly to the water and sanitation sector in Kenya. In 2015/16 alone, NGOs invested KSh 2.19b (USD 295m) in the sector on a national level, with 70% allocated to support the extension of safe water supply coverage.[22] This makes them an important stakeholder group, but no data was submitted on NGO plans, targets or levels of financing.

5.5 Regulatory Frameworks and policies with respect to water

The overarching regulatory framework with respect to water is governed by Kenya's policies and institutions. The Kenyan Constitution is the over-arching legal instrument for the government of Kenya. Article 43 of the Constitution of Kenya states that **every person in Kenya has the right to clean and safe water in adequate quantities and to reasonable standards of sanitation.**

National strategies are put in place with the aim of achieving Kenya's Vision 2030, or Medium-Term Strategy III as presented in Section 5.1.1.

5.5.1 Policies and Legislations

The number of policies, legislations and acts which are relevant for water management is extensive. The following policies, acts and strategies were submitted by the counties, and this list is not exhaustive for all those which consider the management of water in some way.

National Acts

- Agriculture Fishers and Food Authority Act 2013
- Community Land Act 2016
- County Governments Act 2012
- Environmental Management and coordination Act
- Environmental Management and coordination Act (Amendment)
- Forest conservations management act 2016
- Irrigation Act 2019
- LandAct 2021
- Physical planning Act
- Kenya Climate Change Act 2016
- Water Act 2016
- National Drought Management Authority

[22] UN Human Rights, Officer of the High Comissioner. Rights to Water in Kenya : Assessment of access to water in informal settlements OHCHR SGBV snapshot 11 December 2019 Ver7

- Urban Areas and Cities Act 2011
- Wildlife Conservation Act

National Policies and Strategic Plans

- Kenya Vision 2030
- Ministry of Water Strategic Plan 2018-2022
- National Water Master Plan 2030
- National Water Services Strategy
- Water Resources Authority Strategic Plan 2030
- Water Fund Strategic Plan 2018-2022
- Water Fund County Engagement Strategy 2019
- Climate change framework policy 2017
- Wetlands policy 2013
- Forest policy 2014
- Biodiversity strategy and action plan
- Environmental policy draft 2012

The Water Services Regulations 2021 outline the County Government Framework for Water Services Provision in detail, including the powers and duties of the county executive committee member to formulate and periodically review county policies, strategies and plans for the development and provision of water services. County Governments should ensure that the future development of county plans is aligned to these updated regulations.

5.5.2 Regulatory institutional frameworks

Water Services Regulatory Board (WSRB) is responsible for prescribing the nation standards for the provision of water services in Kenya. This includes setting water tariffs, managing the licensing and accreditation process for water service providers, and ensuring compliance. WSRB is also responsible for setting Non-revenue water (NRW) reduction standards. In addition, WSRB is responsible for maintaining a national database and information system on water services in Kenya. There are eight **Regional Water Services Boards** which assist with implementation of regulations. The water sector has undergone several reforms, the latest being the Water Act 2016 which ensured devolving water and sanitation services to the county governments in line with the constitution. Service provision is devolved to the Counties who are the owners of **Water Service Providers (WSPs).** Finally, the **Water Tribunal** exercises the powers and functions of the Water Act.

5.6 Major findings and conclusions

Recent reforms, including the Water Act 2016 regulations “The Water Services Regulations 2021”, have resulted in more comprehensive governance structures for water management in Kenya. This section has presented a

summary overview of the institutions, stakeholders and governance structures that are in place for water management.

Access to data: During the review process of the major water related institutions, it was apparent that many institutions are mandated to maintain national databases with information inter alia on water resources, water services and irrigation schemes. It is not clear whether the counties have access to these data, as limited data was submitted by the counties for this rapid review.

Overlapping and potentially competing governance structures: One of the challenges identified for the management of water resources is that county borders and hydrological catchment delineations are not aligned. As a result, there are some overlapping governance structures. This means that collaboration, information, and data exchange must be prioritised to ensure that all parties involved have access to the latest information regarding water management in the county.

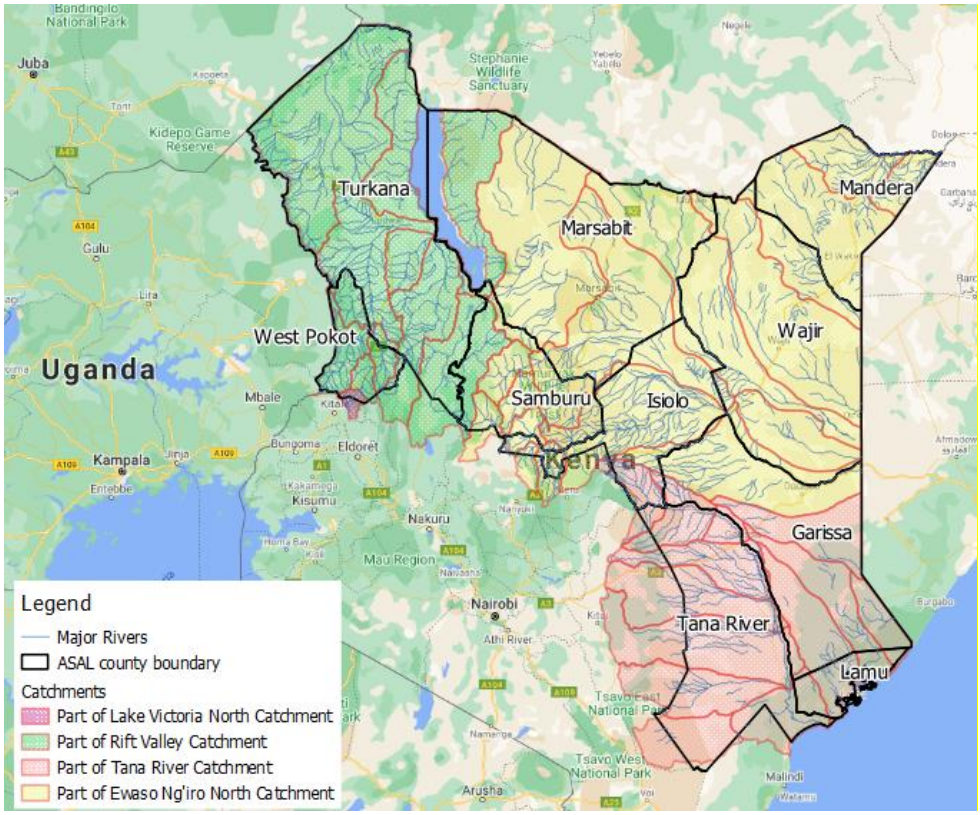


Figure 5-2 ASAL 10 county boundaries (black) and hydrological sub-catchment boundaries (red) as part of the wider Kenyan hydrological catchments (shaded)

Source of hydrological catchment boundaries is the JICA report 2013

Steps have already been taken to attempt better cross-over and coordination. An example is ensuring county level involvement in boards, for example in Basin Water Resources Committees, as well as the development of trans-county water resources management frameworks.

6 Demographic profile

This chapter looks at the data available on the population of the ten counties and they different ways that land, and therefore water, are used. The information presented in this section sets the scene for the following section on available water resource, current and future demands.

6.1 Demographic overview

The ten counties selected for the study make up just over 10% of the population of Kenya but inhabit an area that makes up more than 60% of the land area of the county. Therefore, population density overall is low in comparison to the national average, though urban areas in each county can be densely populated.

6.1.1 Current population

Population figures from the latest Census in 2019 are provided in Table 6-1.

Table 6-1 Population in each county (Census 2019)

County	Urban population	Rural population	Total population
Garissa	210 890	630 463	841 353
Isiolo	125 669	142 333	268 002
Lamu	38 466	105 474	143 920
Mandera	270 467	596 990	867 457
Marsabit	107 239	352 546	459 785
Samburu	47 132	263 195	310 327
Tana River	75 722	240 221	315 943
Turkana	140 791	786 185	926 976
Wajir	177 174	604 089	781 263
West Pokot	31 841	589 400	621 241
10 ASAL Counties Total	1 225 391	4 310 896	5 536 267

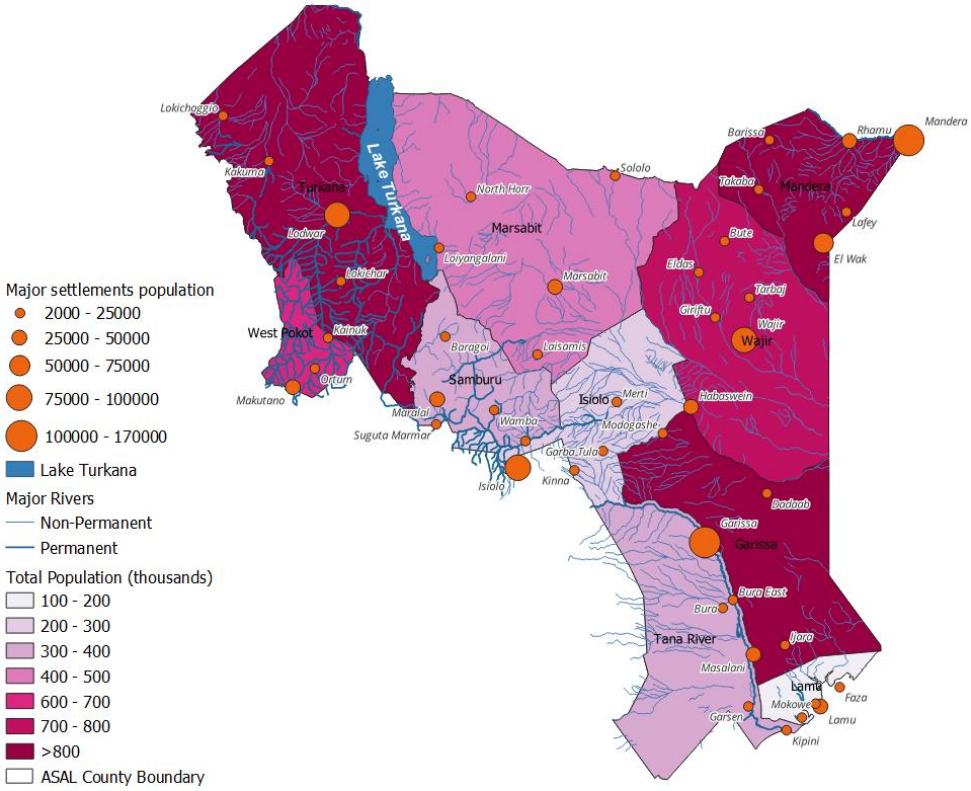


Figure 6-1 Population per county (thousands) and major settlements population (Census 2019)

Turkana, Mandera and Garissa have the highest total population, and Lamu and Isiolo the lowest.

The largest settlements in the region are in Mandera (Mandera), Isiolo (Isiolo), Turkana (Lodwar), Wajir (Wajir) and on the border of Garissa and Tana River (Garissa).

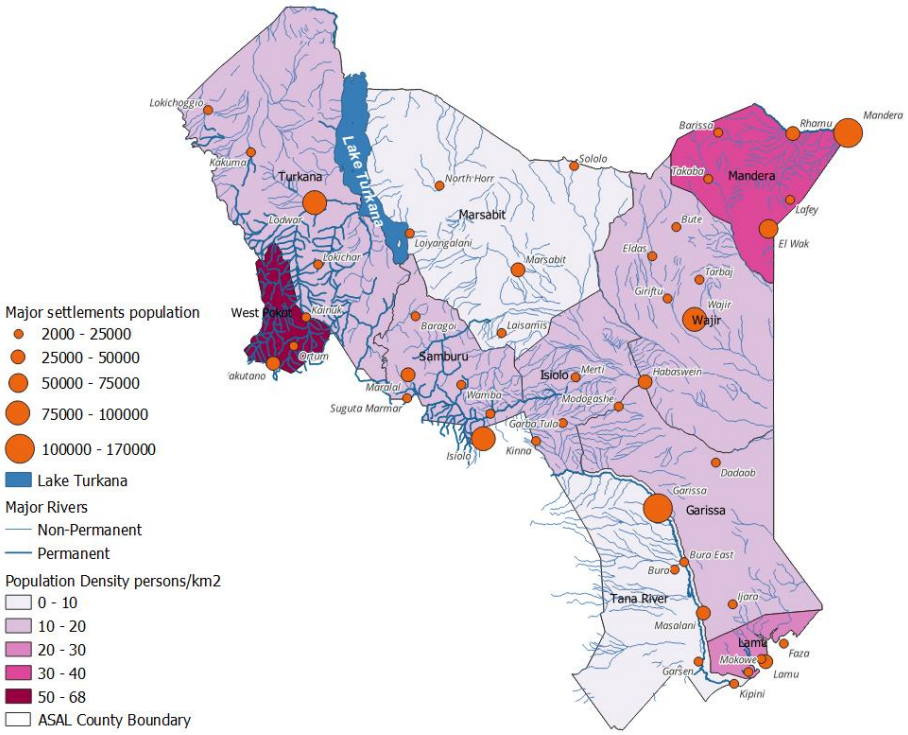


Figure 6-2 Population density (persons per km^2) of each county and population of major settlements across the 10 ASAL counties (Census 2019)

West Pokot is a relatively small county with the highest population density, followed by Mandera with a high population density. Lamu is also a small county with a relatively high population density.

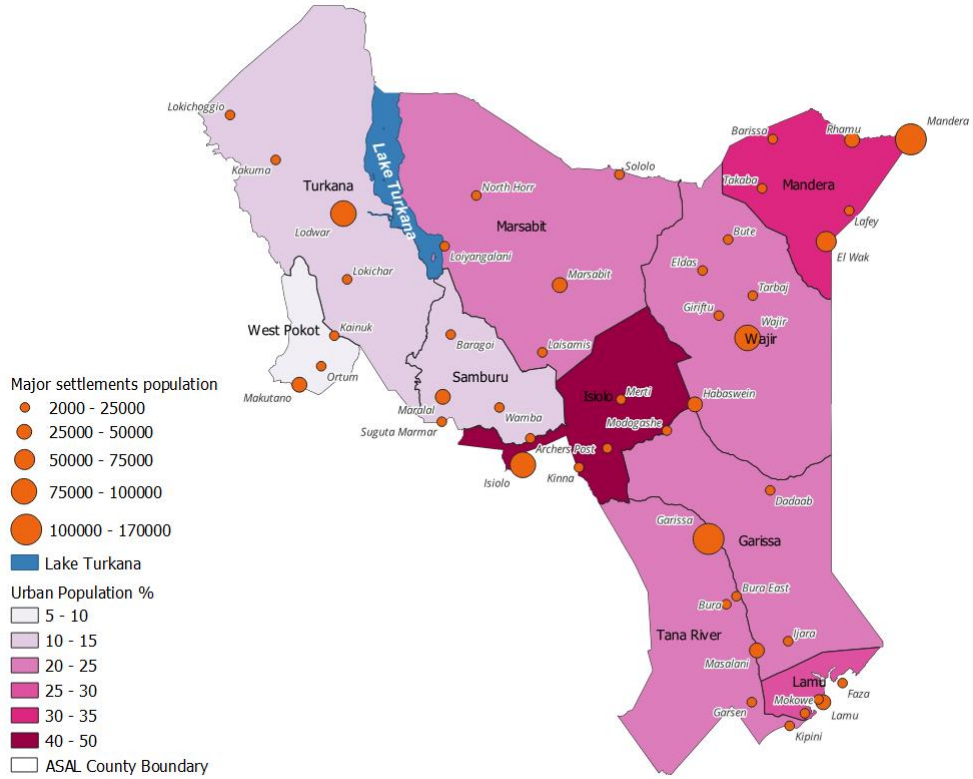


Figure 6-3 Percentage of population in urban areas in each county (Census 2019)

Isiolo county has the highest proportion of the population living in urban areas at 47% followed by Mandera and Lamu with above 25%. In contrast, West Pokot has the lowest urban population proportion with 5% followed by Turkana and Samburu with less than 20%.

6.1.2 Projections for growth

Projected rate of population growth

Projections for future population growth and rate of urbanization were developed using the census 2019 population growth rate of 2.2% per annum.

Table 6-2 Projected future population per county in 2030, 2040 and 2050

	Total Population 2030 ('000)	Total Population 2040 ('000)	Total Population 2050 ('000)
National	60,428	75,119	93,381
Garissa	1,069	1,329	1,652
Isiolo	340	423	526
Lamu	183	227	283
Mandera	1,102	1,370	1,703
Marsabit	584	726	903
Samburu	394	490	609
Tana River	401	499	620
Turkana	1,178	1,464	1,820
Wajir	993	1,234	1,534
West Pokot	789	981	1,220
10 ASAL Counties Total	7,034	8,744	10,869

The same exercise was conducted using the livestock data taken from the census using a simplified growth rate of 1% per annum. Read more about livestock in Section 6.4.4.

Projected rate of urbanization

As no official data on urbanization in Kenya was submitted as part of the rapid assessment, future rates of urbanization were taken from the latest report published by UN DESA World Urbanization Prospects: The 2018 Revision. A national rate of urbanization was developed for that report, the results of which are presented in Table 6-3 below:

Table 6-3 Urbanization rate for Kenya

UNDESA Urbanization Rate for Kenya (%)			
2020	2030	2040	2050

28,0	33,4	39,7	46,3

Since we can calculate the current rate of urbanization from the 2019 census data (% of urban population compared to total county population), we subtracted the calculated current urbanization rate from the projected rates by UN DESA to obtain the following projected change in urbanization rate for each county:

Table 6-4 County urbanization rate, change from 2019

County urbanization rate compared to 2019		
2030	2040	2050
+5,5%	+6,5%	+7,5%

These rates of urbanization were then applied to the projected population based on the 2.2% growth rate for 2030, 2040 and 2050. The results of this exercise can be found in Table 6-5 below:

Table 6-5 Projected urban population in 2030, 2040 and 2050

	Projected Urban Population 2030 ('000)	Projected Urban Population 2040 ('000)	Projected Urban Population 2050 ('000)
National	20,183	29,822	43,235
Garissa	326	492	735
Isiolo	179	250	350
Lamu	59	84	126
Mandera	402	589	860
Marsabit	166	254	384
Samburu	81	132	210
Tana River	118	180	270
Turkana	241	395	628
Wajir	273	420	637
West Pokot	83	167	299

The reason we used this method to calculate the urban growth rate is we can see that the rate of urbanization in the ASAL counties in 2019 is lower than the national average at only 22% - the exception being Isiolo (47% in 2019), while West Pokot is at the other extreme at only 5% in 2019.

The exercise of projecting population growth rates as well as the rate of urbanization are important for calculating the water balance available now and in the future, especially when considering the potential effects of climate change. The outcome of this projection exercise can be looked at in closer detail in Section 7.4.1 Water demand.

6.2 Socioeconomic analysis

Kenya has the largest and most diverse economy in East Africa and ranks highest in the region in terms of Human Development Index. The country has huge potential for growth, and recent discoveries of oil and mineral resources create great potential for the Kenyan economy. However, wealth is not distributed equally, and Kenya remains a highly unequal society in terms of income and assets, by gender, and by geographic location. Poverty levels are highest in the ASAL region.

No socioeconomic data was submitted for the rapid assessment by the counties so limited information was made available at county and sub-county level for this rapid assessment.

The 2017 Gross County Product report published by the Kenya Bureau of Statistics demonstrates that 9 of the 10 counties rank lowest on the overall GCP of all 47 Kenyan counties (Figure 6-5). We can use the GCP data and recent census data on population to calculate what the per capita GCP is per county in the study, as shown in Table 6-6 and Figure 6-4.

Table 6-6 Average county contribution to GDP and total gross county product (GCP)

	Average contribution to GDP 2013- 2017	Total Gross County Product, 2017 (KSh million)	Per-capita GCP (KSh)
Garissa	0.6%	39,394	46,822
Isiolo	0.2%	15,850	59,142
Lamu	0.4%	32,386	225,028
Mandera	0.5%	35,101	40,464
Marsabit	0.5%	34,073	74,106
Samburu	0.3%	26,503	85,403
Tana River	0.5%	33,498	106,025
Turkana	1.1%	78,301	84,469
Wajir	0.5%	37,159	47,563
West Pokot	0.7%	46,785	75,309

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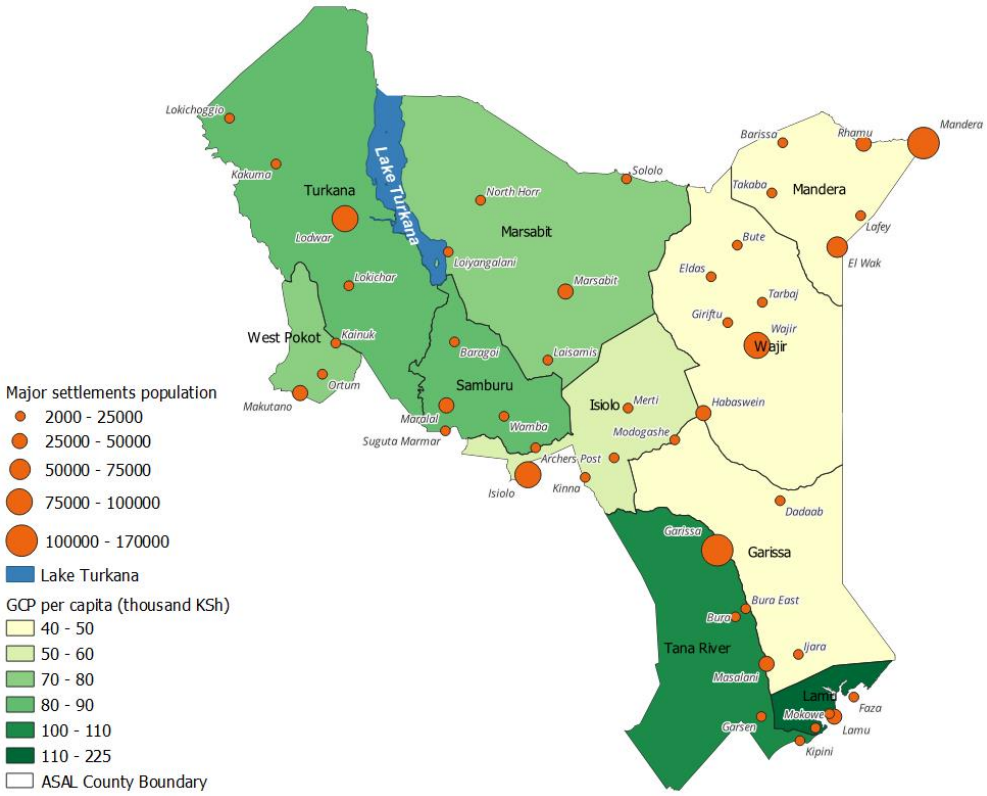


Figure 6-4 Gross County Product (GCP) per capita (thousand KSh)
Sources: 2017 Gross County Product Report (Kenya Bureau of Statistics) and Census 2019 population data

While the ASAL counties as a whole contribute the least to national GDP, we can see from the results that the range of per capita GCP between the 10 counties is substantial, with Lamu county having a much higher per-capita income compared to the other counties. Tana River County, which has the second highest, comes in with less than half of Lamu

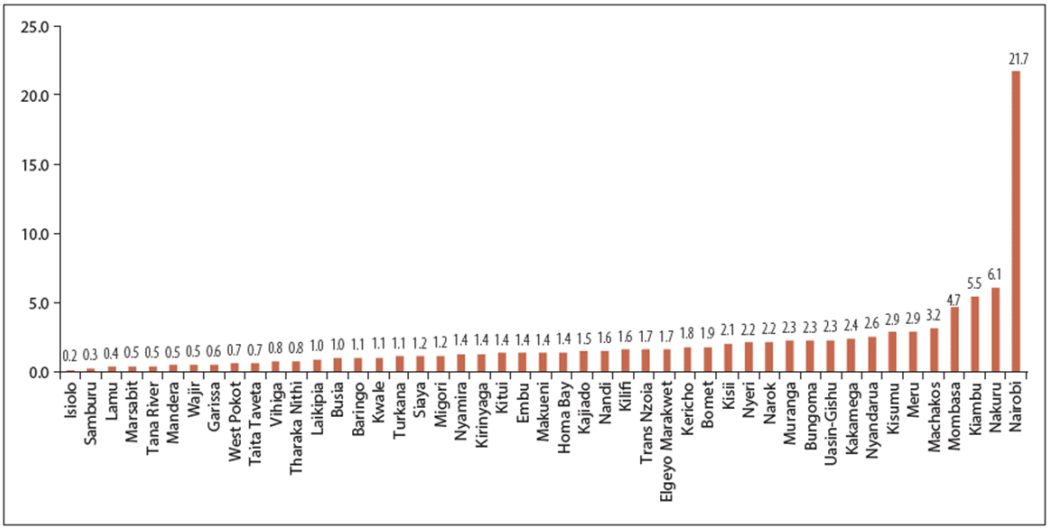


Figure 6-5 Share of Counties in GDP (2013-2017)

Source: Figure 3.1 in the 2017 Gross County Product report published by the Kenya Bureau of Statistics

Each county is responsible for developing a County economic development plan (CEDP). None were submitted for review for this rapid assessment.

6.3 Water and sanitation service provision

The provision of water services to ASAL populations is the responsibility of the county governments after devolution which is outlined in Section 5.3.

Several national and international targets have been set, with the Water Master Plan 2030 targeting 100% access to water of good quality by the end of this decade. Very limited data was submitted on water and sanitation service provision, so the data presented in the following section has been taken from Census 2019.

6.3.1 Main source of drinking water in households

SDG Target 6.1 - By 2030, achieve universal and equitable access to safe and affordable drinking water for all

Census 2019 data allows an insight into water supply for drinking in the ten counties, summarised in

Table 6-7.

Table 6-7 Drinking water supply sources (Census 2019)

	Conventional Households (N.)	Pond	Dam/Lake	Stream/ River	Protected Spring	Unprotected Spring	Protected well	Unprotected well	Borehole/ tube well	Piped into dwelling	Piped to yard/ plot	Bottled water	Rain / harvested water	Water vendor	Publi /stan
National	12043016	1,6%	3,3%	16,8%	7,1%	2,4%	7,0%	2,6%	9,9%	10,1%	14,1%	2,8%	3,9%	8,5%	9,9%
Garissa	138940	12,6%	17,9%	8,8%	0,9%	0,5%	2,4%	3,4%	26,3%	3,4%	8,6%	0,5%	0,4%	3,1%	11,2%
Isiolo	53217	0,6%	3,1%	17,7%	1,2%	1,9%	3,9%	8,5%	12,0%	6,0%	27,2%	0,7%	0,5%	3,9%	12,7%
Mandera	123954	12,6%	22,6%	7,7%	0,6%	0,3%	6,8%	4,1%	21,3%	1,1%	2,3%	0,4%	0,9%	16,7%	2,6%
Marsabit	76689	1,2%	15,7%	1,7%	1,4%	0,9%	9,1%	18,0%	23,2%	0,7%	1,2%	0,6%	2,9%	16,0%	7,3%
Samburu	63951	2,2%	7,9%	35,0%	1,5%	2,3%	4,2%	12,9%	15,8%	2,0%	4,9%	0,7%	1,5%	3,1%	6,1%
Turkana	162627	0,7%	5,1%	30,0%	1,2%	1,4%	3,3%	11,7%	13,2%	2,5%	6,5%	0,1%	0,2%	2,9%	21,2%
Tana River	66984	2,6%	9,8%	19,5%	1,1%	0,5%	9,8%	7,5%	22,1%	2,9%	7,8%	0,4%	0,1%	5,1%	10,8%
Lamu	34231	4,2%	1,8%	1,1%	1,4%	0,5%	17,3%	16,6%	7,0%	8,4%	3,7%	2,5%	10,2%	7,0%	18,3%
West Pokot	115761	1,3%	2,8%	59,5%	2,9%	2,2%	4,4%	2,2%	11,5%	3,4%	5,1%	0,2%	0,6%	0,6%	3,1%
Wajir	126878	5,8%	28,0%	0,3%	0,6%	0,6%	11,1%	8,8%	31,7%	1,4%	1,9%	0,6%	0,3%	7,2%	1,6%

10 ASAL Counties Average		4,4%	11,5%	18,1%	1,3%	1,1%	7,2%	9,4%	18,4%	3,2%	6,9%	0,7%	1,8%	6,6%	9,5%

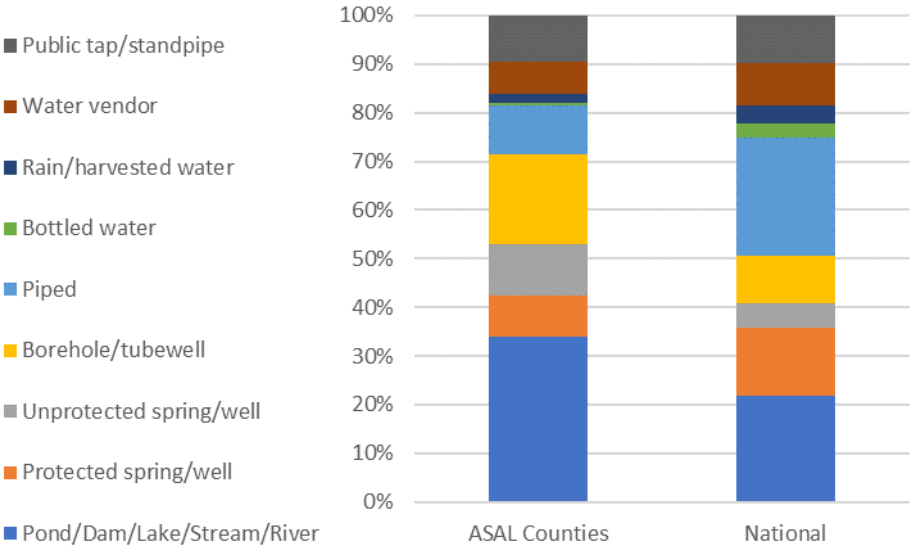


Figure 6-6 Sources of drinking water as an average across the 10 ASAL counties compared to the National average (Census 2019)

When looking at the average for the 10 counties, two main sources of drinking water in the 10 counties are from a river or stream (18.1%) and from boreholes and tube wells (18.4%), which is higher than the national average. 9.5% of households get their drinking water from an unprotected spring or unprotected well, which is also higher than the national average.

6.3.2 Human waste disposal

SDG Target 6.2 - By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations

Census 2019 data allows an insight into access to sanitation services in the ten counties. Different forms of human waste disposal have varying requirement for water supply. Access to basic sanitation and human waste disposal in the project area are considerably lower than the average figures for Kenya as a whole.

Table 6-8 Percentage of households using human waste disposal method (Census 2019)

	Main Sewer	Septic tank	Cess pool	VIP latrine	Pit Latrine covered	Pit Latrine uncovered	Bucket latrine	Open/ Bush	Bio-septic tank / biodigester
National	9,7%	9,2%	0,3%	11,9%	51,2%	9,4%	0,8%	7,4%	0,2%
Garissa	5,2%	4,9%	0,7%	3,6%	29,7%	16,7%	2,9%	36,2%	0,2%
Isiolo	4,0%	3,1%	0,4%	17,7%	36,8%	6,7%	0,6%	30,6%	0,1%
Mandera	1,2%	2,0%	0,3%	2,8%	28,3%	23,4%	2,4%	39,4%	0,1%
Marsabit	0,1%	0,7%	0,1%	5,1%	37,0%	9,3%	0,4%	47,4%	0,0%

Samburu	0,4%	1,4%	0,0%	4,2%	23,6%	4,2%	0,6%	65,6%	0,0%
Turkana	0,4%	1,4%	0,2%	3,3%	18,9%	6,8%	0,8%	68,1%	0,1%
Tana River	0,8%	4,0%	0,5%	4,6%	31,7%	9,0%	0,6%	48,6%	0,2%
Lamu	2,1%	9,4%	0,7%	11,5%	42,8%	14,0%	1,4%	17,9%	0,1%
West Pokot	0,2%	1,2%	0,1%	5,3%	41,7%	8,1%	0,7%	42,7%	0,0%
Wajir	1,7%	3,9%	0,3%	2,1%	21,6%	16,0%	10,5%	43,6%	0,2%
10 ASAL Counties Average	1,6%	3,2%	0,3%	6,0%	31,2%	11,4%	2,1%	44,0%	0,1%

The data presented in Table 6-8 above shows the average percentage of households using said method for human waste disposal. Connection to a main sewer is lower than the national average of 9.7% at 1.6% as an average for the 10 counties. Garissa and Isiolo have the highest average connection to the mains sewer at 5.2% and 4% respectively. Marsabit, Samburu, Turkana and West Pokot have less than 0.5% of households connected to the main sewer.

On average, almost half of households in the 10 counties revert to open or bush methods of human waste disposal. This is more than six times higher than the national average, and more common than households using pit latrines (both covered and uncovered).

No information was submitted for review on wastewater treatment so the status of this service provision in the ten counties is unknown. Given that many of the figures presented in the above two tables are below the national average and that there is still a significant gap to close to reach the targets for 2030, there is a significant need for investment in sanitation and human waste disposal.

6.3.3 Financing WASH

Most water projects being financed in the ASAL counties are focused on improving water and sanitation service provision. For example, between 2015-2020, USAID financed the Kenya RAPID (Resilient Arid Lands Partnership for Integrated Development) programme focused on five Northern Counties: Garissa, Isiolo, Marsabit, Turkana and Wajir. This WASH program aimed to increase the average water access coverage in the five counties from 37% to more than 50%. The program was designed to create a model that can be adapted for use by other counties but there is no indication that USAID will be financing a scale-up soon. An evaluation of the project could be conducted to assess success and whether upscaling the project to additional counties would be beneficial.

6.4 Land use

Land use is a strong indicator, not only for socioeconomic development, but also for water use and balance. For example, vegetation cover, forestry practices, cropping patterns, irrigation practices and wetland management are all examples of land use aspects that also greatly influence water use and run-off from catchments.

6.4.1 Land cover

Most land cover in the 10 ASAL counties is shrubs and herbaceous vegetation. Forest land cover is present at the coast in Lamu, along the permanent river valleys such as in Tana River and Turkana, and in areas of higher altitude and higher rainfall for example in West Pokot. Bare/sparse vegetated areas are found to the southwest and southeast of Lake Turkana in Turkana and Marsabit counties (see Figure 6-7).

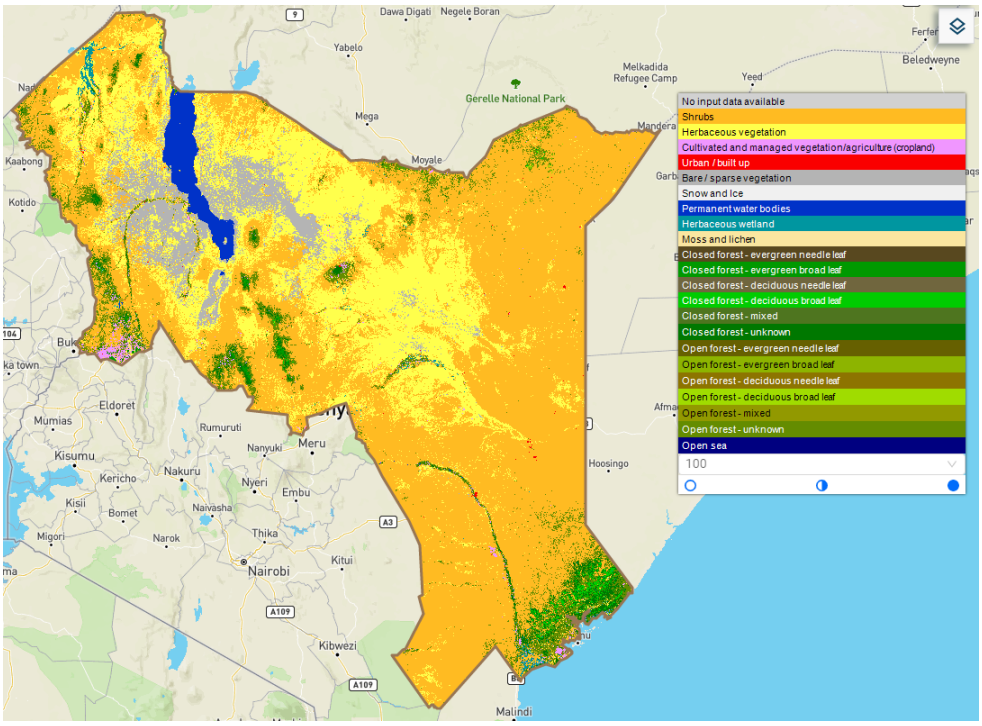


Figure 6-7 Land cover across the 10 ASAL counties, 2019
Source: Copernicus Global Land Service (CGLS) [23]

6.4.2 Agricultural land use

Commercial and subsistence farming

Mandera and Wajir have the largest total area of agricultural land, followed by Turkana county. Marsabit and Tana River, despite being large counties have relatively small total areas of agricultural land (see Figure 6-8).

[23] CGLS landcover, 100m spatial resolution. Source: https://land.copernicus.eu/global/content/annual-100m-global-land-cover-maps-available

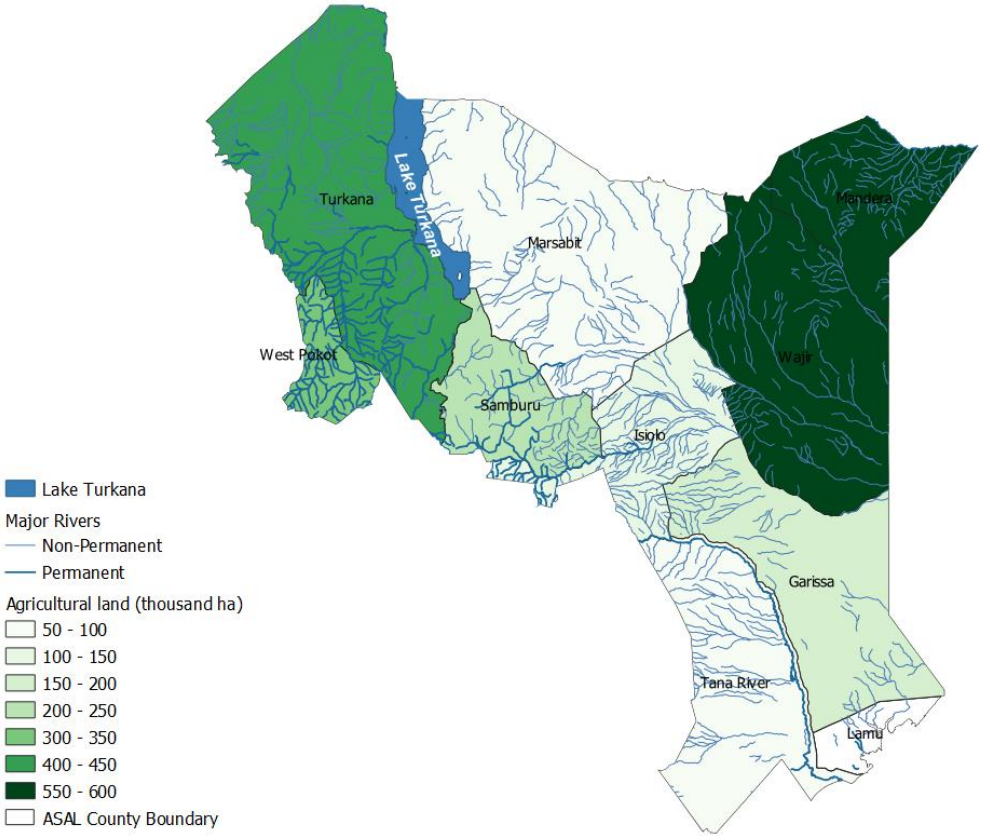


Figure 6-8 Total agricultural land (thousand hectares) in each county (Census 2019)

Agricultural land is used for both commercial and subsistence farming. In the case of the ten counties, most agricultural land is used for subsidence farming. On average, only 4.4% of agricultural land in the 10 ASAL counties is used for commercial farming. Only Tana River county with 11.7% is above the national average of 9.6%. Garissa and Lamu also have a relatively high proportion of land used for commercial farming, close to the national average.

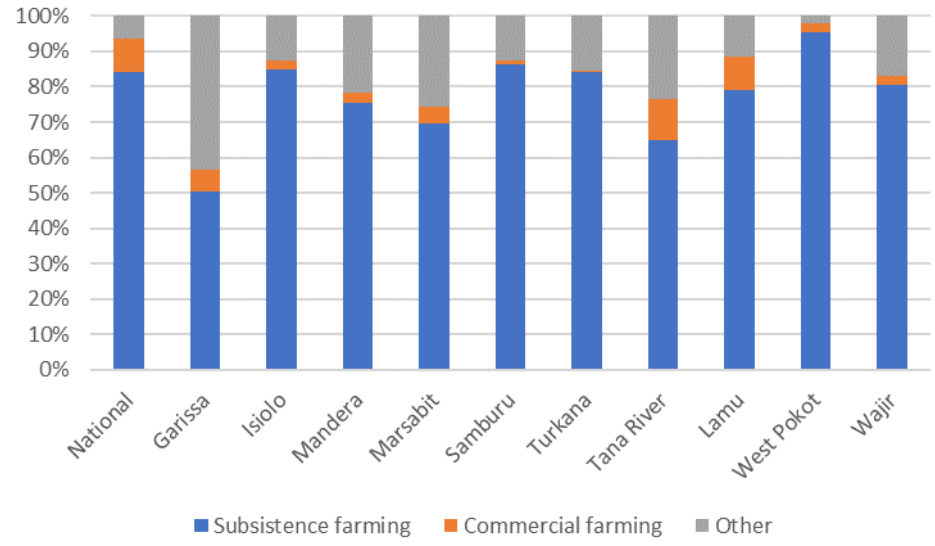


Figure 6-9 Proportion of agricultural land used for subsistence farming, commercial farming and other purposes (Census 2019) for the National average and each county

Households practicing farming and irrigation

The national average of rural households who practice agriculture is 19.4%. This is higher than the average in the 10 ASAL counties which is 12.8%. Especially in Garissa and Turkana counties, the number of rural households who practice agriculture is only 7.6% and 7.8% respectively[24]. Rural populations in these more arid counties are more dependent on livestock rearing than agriculture for their livelihood.

Of the farming households in each county, the percentage of households practicing irrigation is very low. The average of the 10 counties (5.6%) is only slightly lower than the national average (5.8%). However, a significantly higher percentage of farming households are practicing irrigation in Tana River (12.9%)[25]. This appears to confirm the data (see Section 0 on water demand) that actual irrigation in Tana River is higher than in the other counties, and as a result the percentage of commercial farming in Tana County is also significantly higher than in the other counties investigated in this study.

6.4.3 Irrigated areas

Under the auspices of National Irrigation Authority, each county should have developed a county irrigation plan. None have been submitted for review; hence it is not clear if a county irrigation plan is mandatory for each county in Kenya or only for those with high actual and potential irrigation (or if the counties just do not prepare the plan). The data available on existing and potential irrigation was extracted from the County Integrated Development Plans 2018-2022.

Though there were some inconsistencies between the way that data was reported between counties, in general there was an indication of the actual area of irrigated land and the potential area of irrigated land in hectares per county. It is not disclosed how the potential area has been calculated.

Furthermore, data on existing and potential future irrigated area has been extracted from the JICA report and from The National Irrigation Authority Strategic Plan 2019-2023 for comparison.

Existing irrigated area

The available data on existing irrigation and number of schemes was extracted from the County Integrated Development Plans 2018-2022 and from the JICA report where is irrigated area is specified for 2010[26], and compared in the Table below (noting that the CIDP data is more recent from 2018).

Table 6-9 Comparison of existing irrigated area and number of schemes per county from JICA report 2010 and CIDP 2018-2022 (ha)

County	JICA Existing	CIDP Existing	JICA Number of	CIDP Number of

[24] Source: Census 2019
[25] Source: Census 2019
[26] JICA Report Main Report Part A Table 6.5.1

	Irrigation (ha)	irrigation (ha)	schemes in county	schemes in county
Garissa	1950	3400	114	
Isiolo	1429	600	13	20
Lamu	41	300	10	10
Mandera	4858	4000	287	285 (small holder)
Marsabit	0	0	0	0
Samburu	15	No data	2	3
Tana River	5429	40000	25	37
Turkana	2118	7087	24	51
Wajir	200	607	10	6
West Pokot	1922	1800	109	9

This comparison of existing irrigated area shows some discrepancies, even allowing for a growth or decrease in irrigated area and/or schemes between the JICA 2010 data and CIDP 2018 data. The main difference is in Tana River county where the JICA report states 5,429 ha over 25 schemes and the CIDP report states 40,000 ha over 37 schemes of irrigated land. This discrepancy warrants further investigation into the actual irrigated area in Tana River county.

Potential irrigated area

The data available for potential irrigation in each county was also extracted from the County Integrated Development Plans 2018-2022. With regards to irrigation potential, The National Irrigation Authority Strategic Plan 2019-2023 published the irrigation potential for each water basin catchment area, see Table 6-10 below:

Table 6-10 Estimated irrigation potential area per catchment area (NIASP 2019 – 2023 Table 1 from source FAO AQUA STAT 2016)

Water Basin Catchment Areas	Irrigation Potential HIGH (WRA) (ha)	Irrigation Potential MEDIUM (NEMA) (ha)	Irrigation Potential HIGH (MWD) (ha)
Lake Victoria	327,219	200,000	180,000
Rift Valley	84,200	64,000	52,500
Athi River	295,956	40,000	-
Tana River	566,995	205,500	111,100
Ewaso Ng'iro North	151,730	30,000	9,460
TOTAL	1,341,900	539,500	352,060

After a preliminary water balance study, the JICA study found that the amount of available water resources was not enough to fulfil the water demands required for the 1.2 million ha irrigation area specified in the Kenya Vision 2030, therefore potential irrigated area was determined based on the water balance study, aiming to maximise the irrigation area within the available amount of water resources. The maximum irrigation area in 2030, as found in

the JICA water balance study, is presented below for each catchment, and compared to the National Irrigation Authority Strategic Plan.

Table 6-11 Comparison of JICA and National Irrigation Authority Strategic Plan potential irrigated area (ha)

Catchment	JICA existing	JICA potential irrigation	NIASP High (WRA)	NIASP Medium (NEMA)	NIASP high (MWD)
Lake Victoria	15,094	282,119	327,219	200,000	180,000
Rift Valley	9,587	92,166	84,200	64,000	52,500
Athi River	44,898	46,108	295,956	40,000	
Tana River	64,425	161,799	566,995	205,500	111,100
Ewaso Ng,iro North	7,896	41,483	151,730	30,000	9,460

In general, the JICA potential irrigated area is most in line with the Plans Medium (NEMA) potential irrigated area.

An approximation of the JICA irrigation potential for each county (surface and groundwater) can be estimated by summing the JICA hydrological catchments where the majority of the catchment area falls within each county. Based on this estimation, the JICA potential irrigated area is compared to the CIDP irrigated area in the table below.

Table 6-12 Comparison of JICA (2010) and CIDP (2018-2022) potential irrigated area (ha)

County	JICA Existing Irrigation (ha)	CIDP Existing Irrigation (ha)	JICA potential irrigation (ha)	CIDP potential irrigation (ha)
Garissa	1,950	3,400	3,571	32,000
Isiolo	1,429	600	14,400	2,000
Lamu	41	300	4,865	300,000
Mandera	4,858	4,000	1,373	20,000
Marsabit	0	0	2,743	0
Samburu	15	No data	5,143	3,000
Tana River	5,429	40,000	44,727	200,000
Turkana	2,118	7,087	16,653	16,600
Wajir	200	607	2,200	?
West Pokot	1,922	18,00	21,694	10,000

In the counties of Garissa, Lamu, Mandera and Tana River the JICA study calculates a lower potential irrigation area based on their water balance study than the CIDP potential area. This indicates that the water balance in 2030 may not be able to support the irrigated area specified in country or local plans and should be further investigated.

In contrast, the JICA study shows that Isiolo, Marsabit, Samburu and West Pokot can support a larger irrigated area than specified in the CIDP and this could also be further investigated.

An investigation was conducted into the status of the irrigation and dam schemes proposed in the Water Master Plan 2030. The outcome found that only two of the proposed infrastructure investments have been completed to date, with only eight years remaining for the duration of the Plan.

Table 6-13 Status of proposed irrigation and dam infrastructure

Project	County	Status	Comment
Turkwell irrigation	West Pokot	Not Done	A small Portion being done by CEFA under EU Downstream of Turkwell dam
Todonyang-Omo irrigation	Turkana	Not Done	Had been launched under the grand coalition government in 2012 but after change of government in 2013 it was not implemented
Hola irrigation	Tana River	Completed	About 1920 hectares under irrigation. Is also referred to as Tana Irrigation Scheme
Hola irrigation extension	Tana River	Not Done	About 4850 hectares possible.
High Grand Falls Dam	Garissa / Tana River	Not Started	
Kora irrigation	Tana River	Not Done	Small scale. Individual farmers carry out irrigation along the Kora River
Kom (Wajir) irrigation	Isiolo / Samburu	Not Done	
Murung-Sebit dam	West Pokot	Not Done	
Kora dam	Tana River	Not done	
Isiolo dam	Isiolo	Completed	2020
Archer's Post dam	Isiolo / Samburu	Not done	

No data was submitted on the types of crops being irrigated in each county. No data was submitted on irrigation efficiency.

6.4.4 Livestock and pastoralism

The latest data available on total livestock population per county level was extracted from census 2019. Data is available for cattle[27], sheep, goat, camel and donkey population which were selected as most relevant for this study. Total livestock per county is shown in Figure 6-10.

[27] Different type of cattle presented in the census (exotic cattle (dairy), exotic cattle (beef) and indigenous cattle where combined into one category called Total cattle in the figures below.

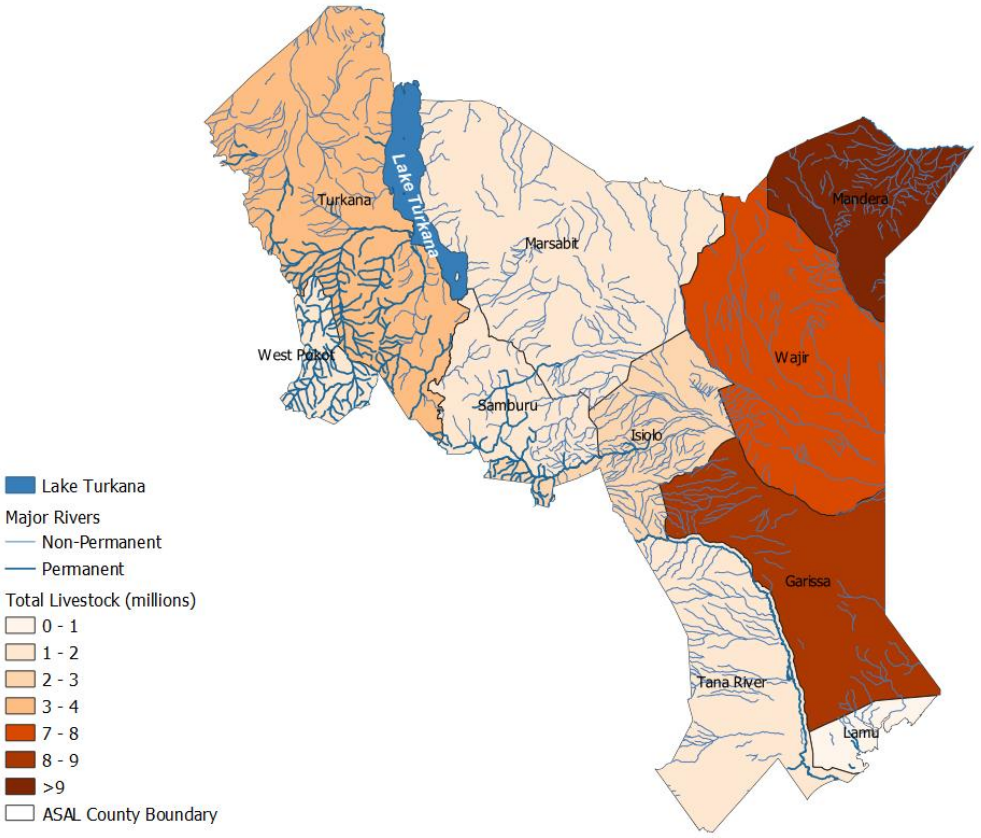
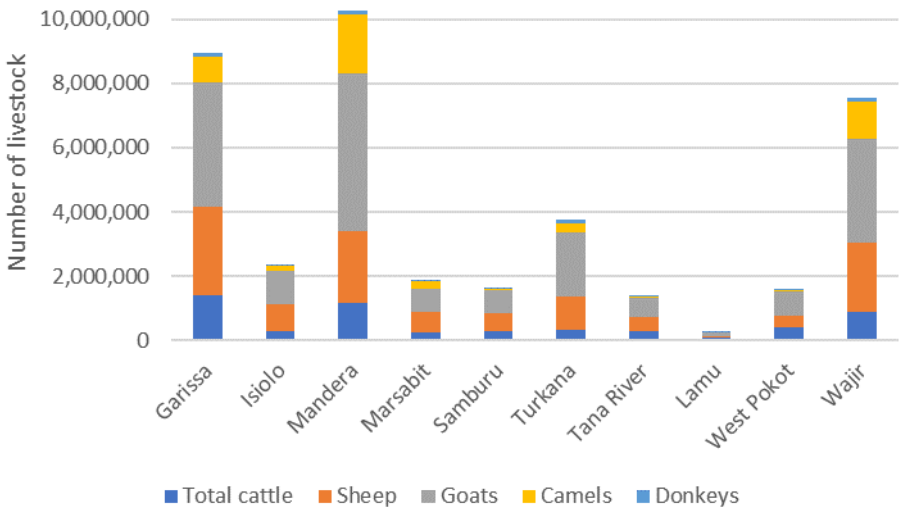


Figure 6-10 Total livestock population per county in millions (Census 2019)

Mandera has a significantly higher total population of livestock compared to all other counties, with more than 10 million animals in total. The three counties bordering on Somalia have the highest livestock populations in total. Lamu has the lowest with just under 250,000 animals in total.

The number of each type of livestock per county and the proportion of livestock type per county is shown in Figure 6-11 below.



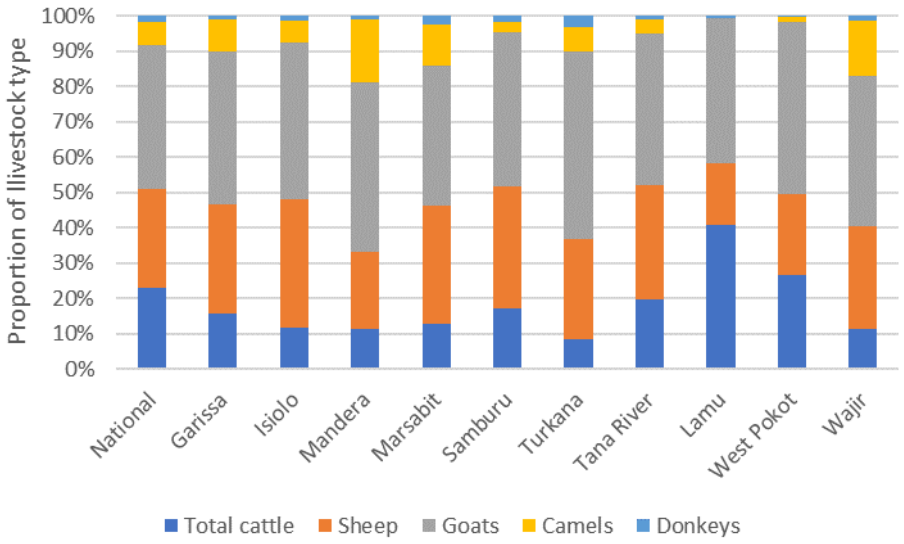


Figure 6-11 Number of livestock by type in each county (top) and proportion of livestock type (bottom) (Census 2019)

The highest proportion of livestock in all counties is goats (of between 40 and 55%), followed, in most counties, by sheep. The exception is West Pokot and Lamu which have a higher proportion of cattle than sheep and higher than the national average. Mandera and Wajir have higher proportions of camel livestock.

Different livestock types require varying amount of water to survive. The effect on water demand and water balance is presented in Section 7.4.3.

Pastoralism, herding livestock as opposed to farming a set piece of land, is a highly efficient way of living in the harsh drylands.

No documents were submitted with any information on livestock rearing or pastoralism in the ten counties. While this may be because livestock is not so obviously related to water resources, animals are just as dependent on a constant supply of water to support lives and livelihoods.

6.5 Major findings and conclusions

Irrigation: There is a mismatch between the data available on irrigation potential in the counties. Numbers differ significantly between the CIDP that have been developed by county governments and those from the Water Master Plan. Especially in Tana River county, there is a huge difference in existing irrigated area: Further investigation is required for Tana river because of mismatch between available water and irrigation potential. There is also a need to investigate potential irrigated area mismatch for Garissa, Lamu and Mandera where the JICA calculation based on water balance in 2030 show a smaller potential irrigated area than the CIDP data.

Planned interventions from the Water Master Plan 2030 for irrigation and dams have yet to be implemented. In 2022 we are more than halfway through masterplan duration (8 years remaining). Suggest further investigation whether the planned interventions are even feasible considering the water balance – if not, how will Master Plan be achieved by 2030.

Livestock: More information is needed on livestock and especially pastoralism. The potential future impacts of climate change/drought on choice of livestock. Choosing animals with lower Livestock units who require less water?

Not enough data on environmental issues related to land use, no data on crops,

7 Water resources profile

This Chapter provides an overview of water availability (including future water availability based on climate projections), water infrastructure and the state of ecosystems, and furthermore provides an assessment of water demand to estimate the current and future water balance in the 10 ASAL counties. This provides the basis for recommendations on the use of water resources in each of the counties and identifies areas where further research is required. Disclaimer: The majority of the data used to develop the water resources profile is based on satellite data and could not be calibrated with data from the ground.

7.1.1 Water availability at present

Rainfall

The key variable to analyse when assessing water availability in an area is rainfall. In northern Kenya there are two main rainy seasons, from approximately March to May and from approximately October to December.

There are limited ground measurements available for this assessment, and therefore earth observation data has been used to capture the full spatial variability of rainfall across the 10 counties. Average annual rainfall for each county is calculated based on the Copernicus ERA5 dataset (see Section 4.3) for the present-day baseline period 2003 to 2020, shown in Figure 7-1

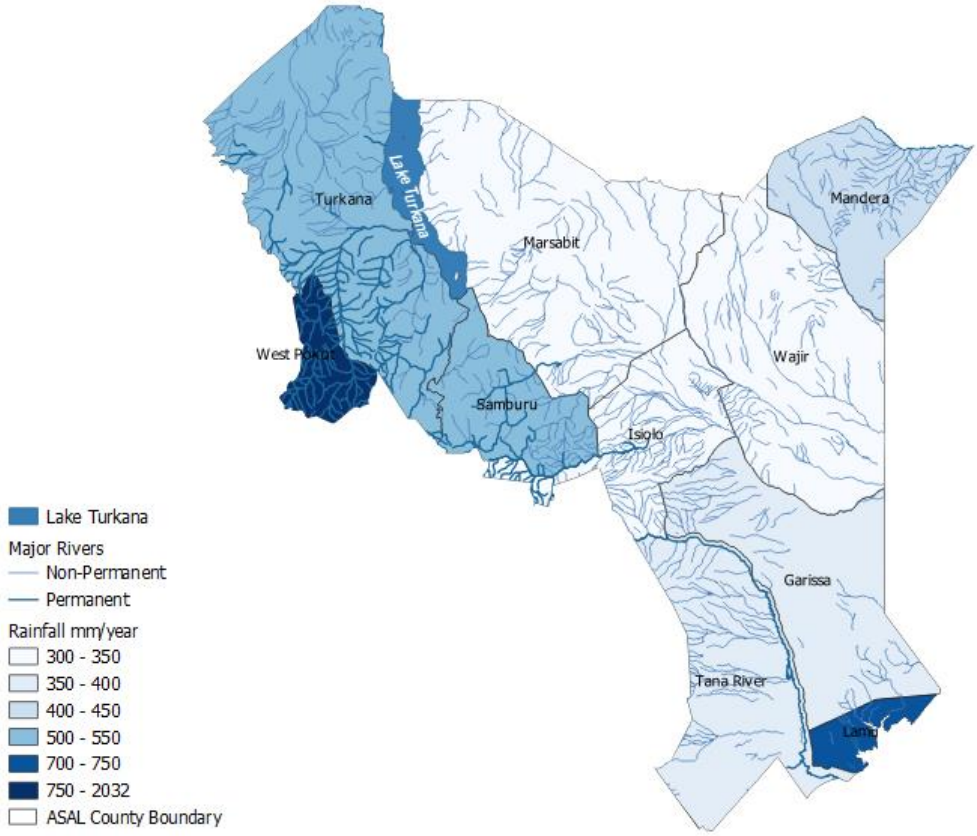


Figure 7-1 Average annual present-day rainfall (2003 – 2020) based on ERA5 earth observation data

ERA5 rainfall indicates that the greatest average annual rainfall is in West Pokot county, followed by Lamu, Turkana and Samburu. The driest counties are Marsabit, Isiolo and Wajir which are also the counties where the majority of rivers are non-permanent. The main permanent rivers are located in West Pokot, southern Turkana, Samburu, western Isolo and on the border of Tana River/Garissa and the border of Mandera/Ethiopia. The majority of water in Lake Turkana on the border of Turkana and Marsabit counties comes from the river inflow from upstream Ethiopia.

The freely available global database and application CLIMWAT[28] provides some ground measurements of rainfall data within and around the 10 ASAL counties in northern Kenya for a period of at least 15 years anytime between 1971 and 2000. This data is not directly comparable to the ERA5 2003 to 2020 dataset due to differing time periods. However, due to the lack of alternative ground measurement data a comparison has been made to give a broader overview of the rainfall distribution across the 10 counties. Figure 7-2 shows the gridded ERA5 rainfall data and the CLIMWAT ground station measured rainfall data in average mm per year.

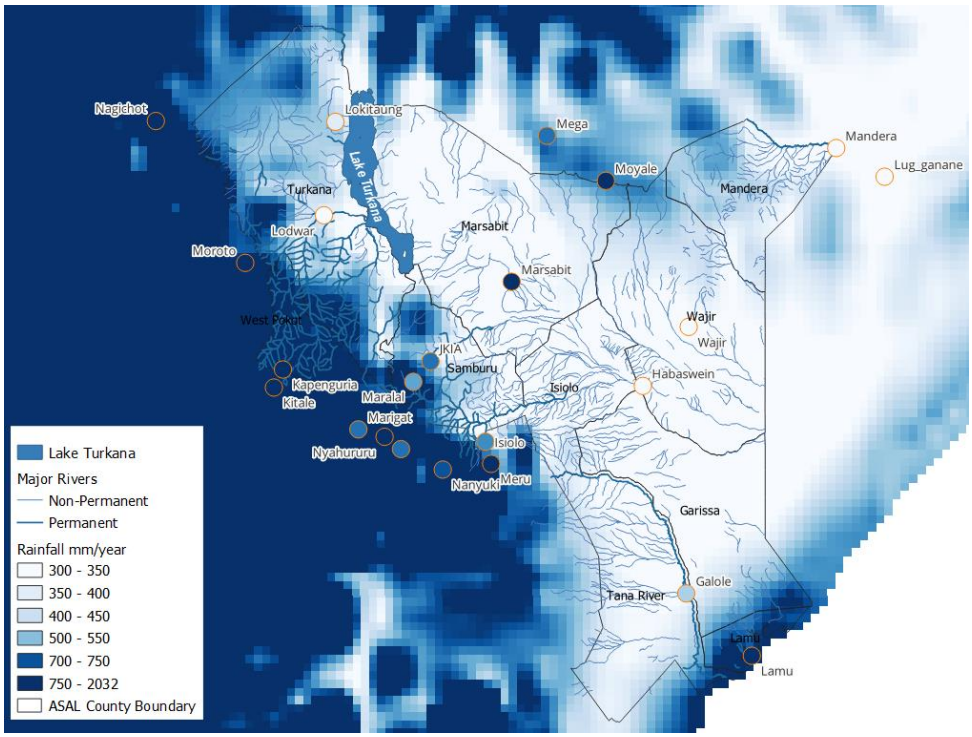


Figure 7-2 ERA5 earth observation gridded rainfall 2003 – 2020 and CLIMWAT measured rainfall station data between 1971 - 2000

Both the CLIMWAT station data and the ERA5 satellite data both show that the wettest areas are along the coast in Lamu and in the west, in West Pokot and the west of Turkana, Samburu and Isiolo. Analysis of the elevation of the area further explains the spatial distribution of rainfall, as shown in Figure 7-3.

[28] CLIMWAT 2.0 database provided by the Agrometeorological Group of Environment and Natural Resources Service (SDRN) of FAO

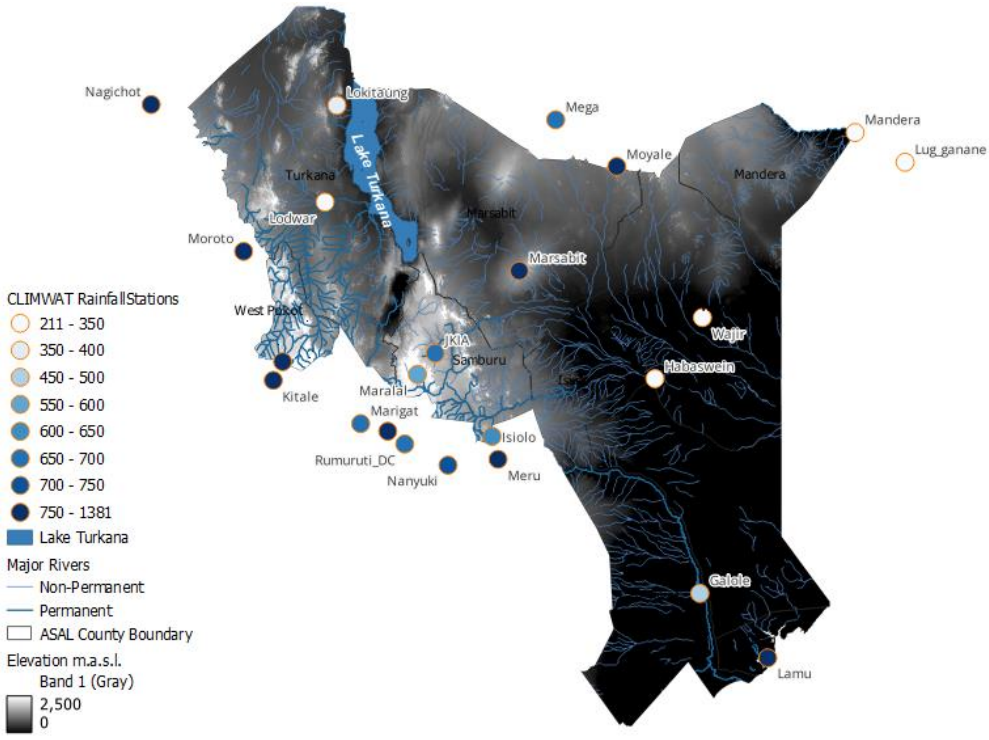


Figure 7-3 Digital Elevation Model (DEM) of the 10 ASAL counties and location of the CLIMWAT rainfall stations

DEM source: Shuttle Radar Topography Mission (SRTM)[29]

Figure 7-3 shows that higher rainfall generally occurs at areas of high elevation (coloured in white), with the exception of Lamu on the coast. The elevation variation also helps to explain the high rainfall at the CLIMWAT station Marsabit which is located at a localised high elevation point of 1,345 m.a.s.l. compared to the drier and lower elevation surroundings in the rest of the county. In addition, the CLIMWAT station in Mandera is located at a low altitude of 231 m.a.s.l. and therefore has a lower average rainfall than the rest of the county which has a higher elevation in the west.

The spatial distribution of rainfall is also reflected in the land cover, where these areas with the highest rainfall support forest landcover (see Figure 6-7) while the remaining areas are primarily shrubland, herbaceous vegetation or bare/sparse vegetation.

Generally, the ERA5 gridded rainfall shows a similar pattern and magnitude to the CLIMWAT measured rainfall data, noting that there are differences in the dataset time periods, so they are not directly comparable. Figure 7-4 shows the monthly average rainfall from the CLIMWAT stations and the ERA5 dataset at the point location of the CLIMWAT station.

One exception is the rainfall station in West Pokot, where the difference in magnitude of the average annual rainfall is greater than would be expected from a comparison of datasets with different time periods. Both datasets show that West Pokot is the wettest county and that it does not have a dry season

[29] usgs.gov/centers/eros/science/usgs-eros-archive-digital-elevation-shuttle-radar-topography-mission-srtm-void

from June to September, however the ERA5 data shows much higher rainfall than is measured at the CLIMWAT station Kapenguria.

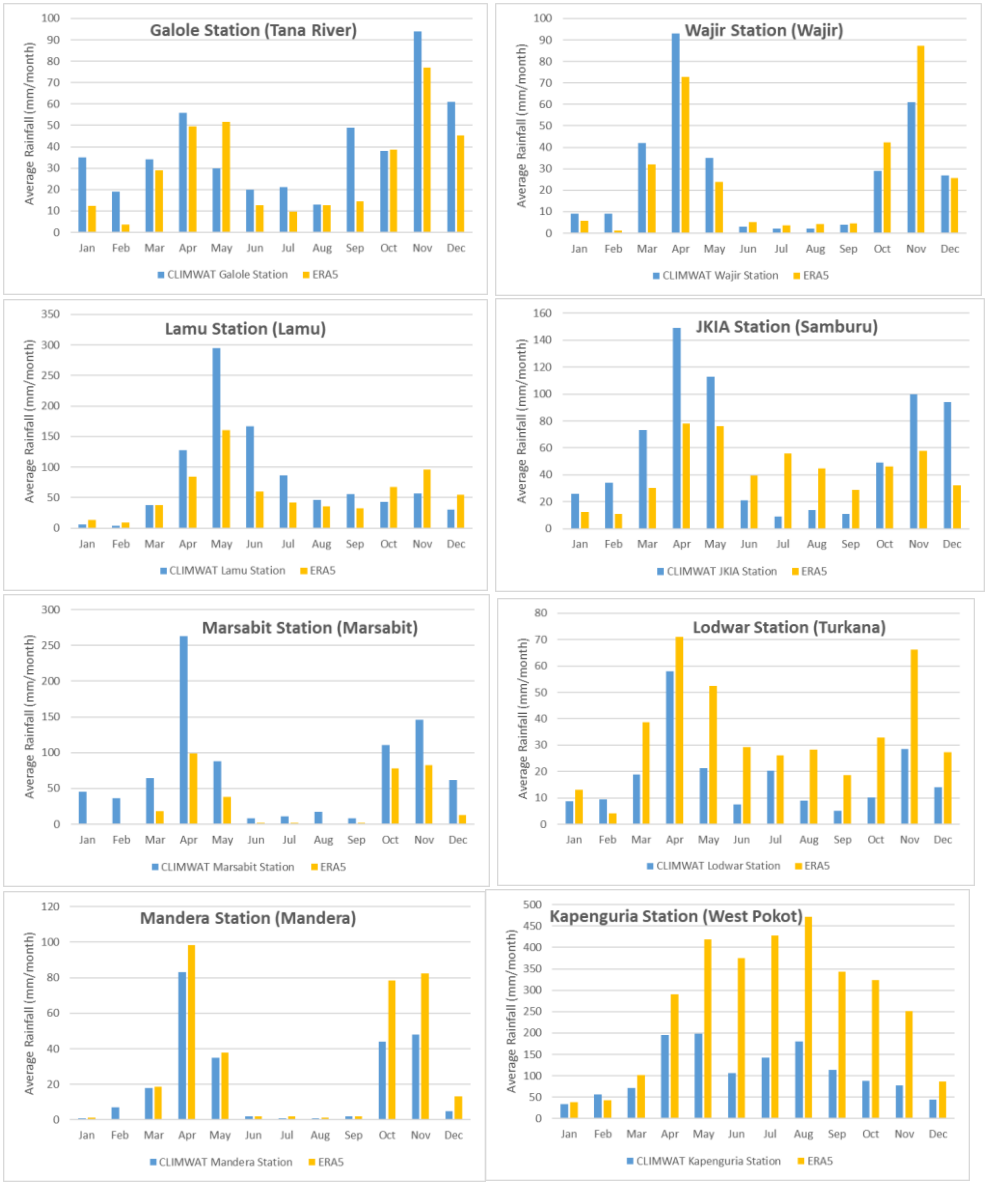


Figure 7-4 Comparison of CLIMWAT ground station rainfall data (for minimum 15 years within 1971 – 2000) and ERA5 rainfall (2003 – 2020) extracted at the point location of the ground station.

The ERA5 dataset is the input precipitation in DHI's Global Hydrological Model which has been used to estimate run-off and water availability in this study. Therefore, based on this comparison of rainfall data, it should be noted that the water availability in West Pokot county could be an overestimate.

Temperature and Evaporation

Temperature is lowest at the higher altitudes, for example in the western areas of West Pokot, Samburu and western Turkana and Isiolo. Higher elevations in the west of Mandera, north of Wajir and northeast of Marsabit also have lower temperatures, as shown in Figure 7-5.

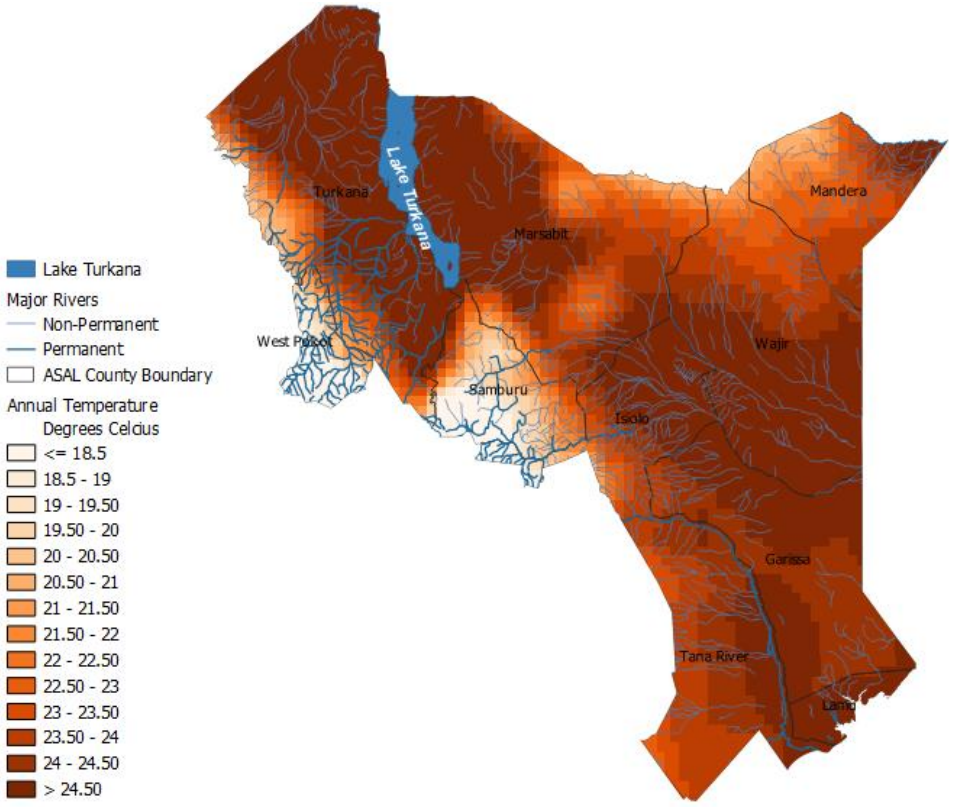


Figure 7-5 Annual average temperature distribution across the 10 ASAL counties based on ERA5 data (2003 – 2020)

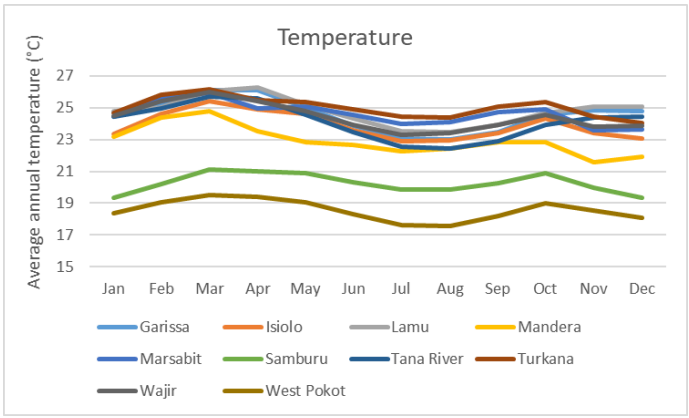


Figure 7-6 Monthly temperature variation across the 10 ASAL counties (ERA5 data from 2003 – 2020)

Monthly variability in temperature shows higher seasonal temperatures around March and October, which coincide with the beginning of the two rainy seasons in most counties.

Potential Evapotranspiration (PET) in the 10 ASAL counties follows a similar spatial distribution to the temperature and is significantly higher than the rainfall. PET is greater than 2,000 mm per year (as an annual average from 2003 to 2020) in every county, as calculated using the Priestly-Taylor equation based on ERA5 data, shown in Figure 7-7. In contrast, only West Pokot has an annual average rainfall of greater than 1,000 mm per year.

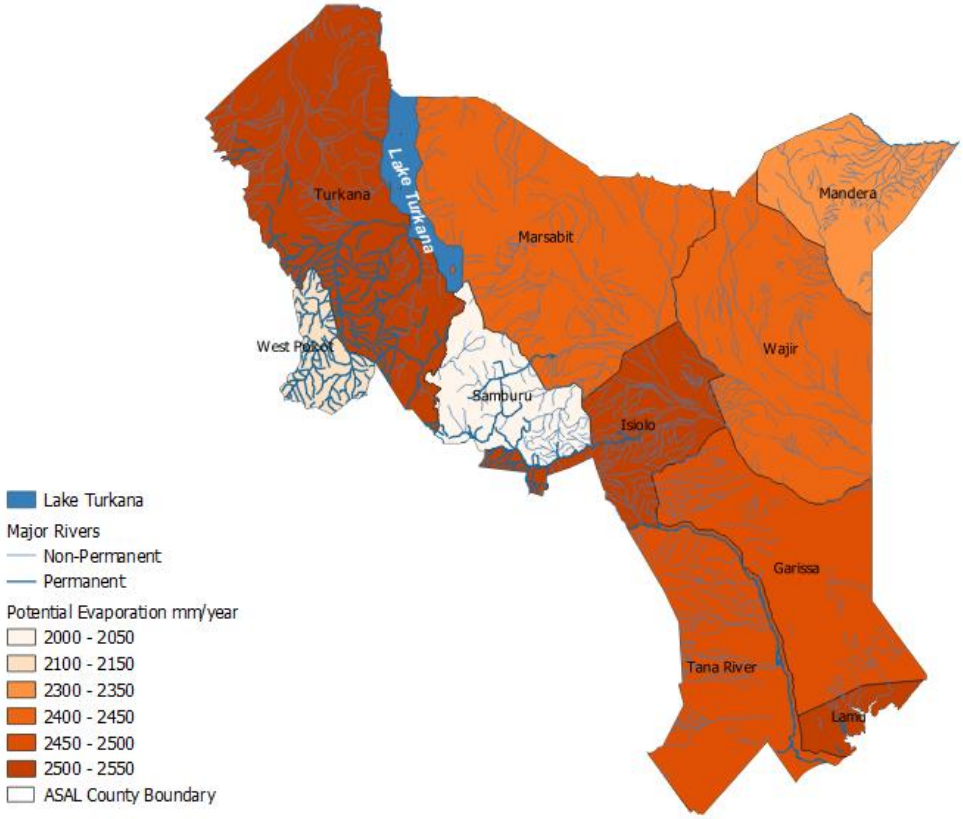


Figure 7-7 Average annual Potential Evapotranspiration (2003-2020) calculated using the Priestly-Taylor equation using ERA5 data

Samburu and West Pokot counties have the lowest annual PET at 2,035 and 2,123 mm per year, respectively, but this is still higher than the annual rainfall.

Actual evaporation from each of the counties therefore has the same spatial distribution as rainfall, because the rainfall is the limiting factor. For example, West Pokot has one of the lowest annual PET, but because it has the highest rainfall it also has the highest actual evaporation because there is more water available for evaporation. Actual evaporation is calculated by DHI's Global Hydrological Model (see Section 4.4) and is shown in Figure 7-8.

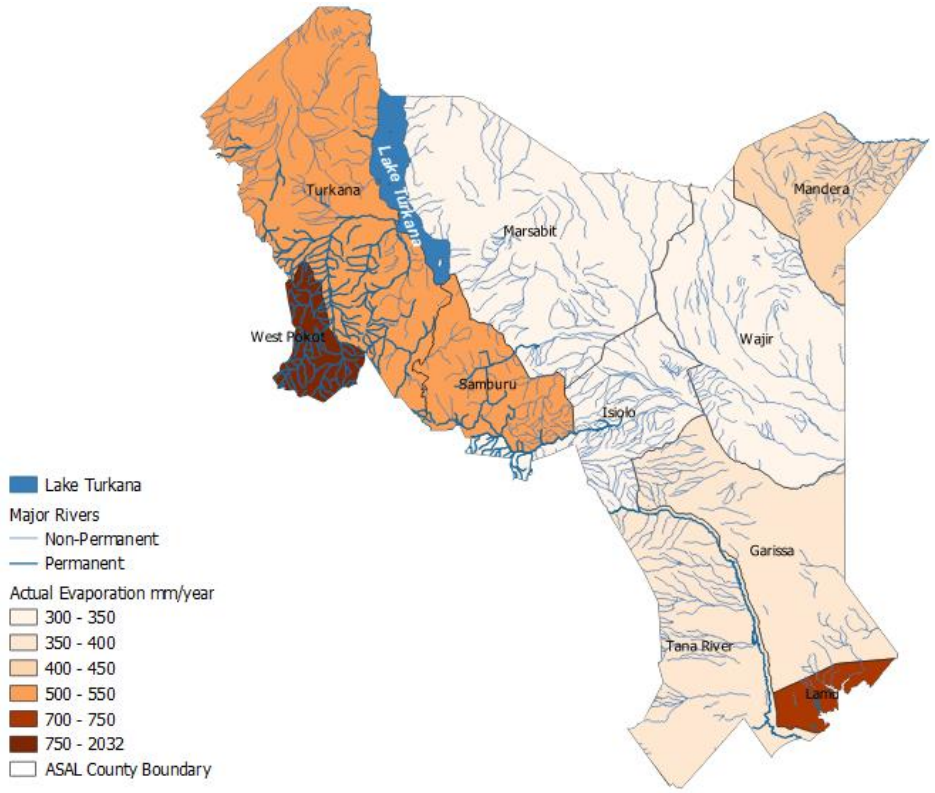


Figure 7-8 Actual evaporation calculated by DHI's Global Hydrological Model based on ERA5 data (2003 – 2020)

Total Run-off

Total run-off for each county is an output from DHI's Global Hydrological Model (GHM) (see Section 4.4) and provides an estimate of the current water availability for the baseline period 2003 to 2020. The gridded output from the GHM of total run-off (as shown in Figure 7-9) shows a similar spatial pattern to the rainfall combined with the temperature and actual evaporation distribution.

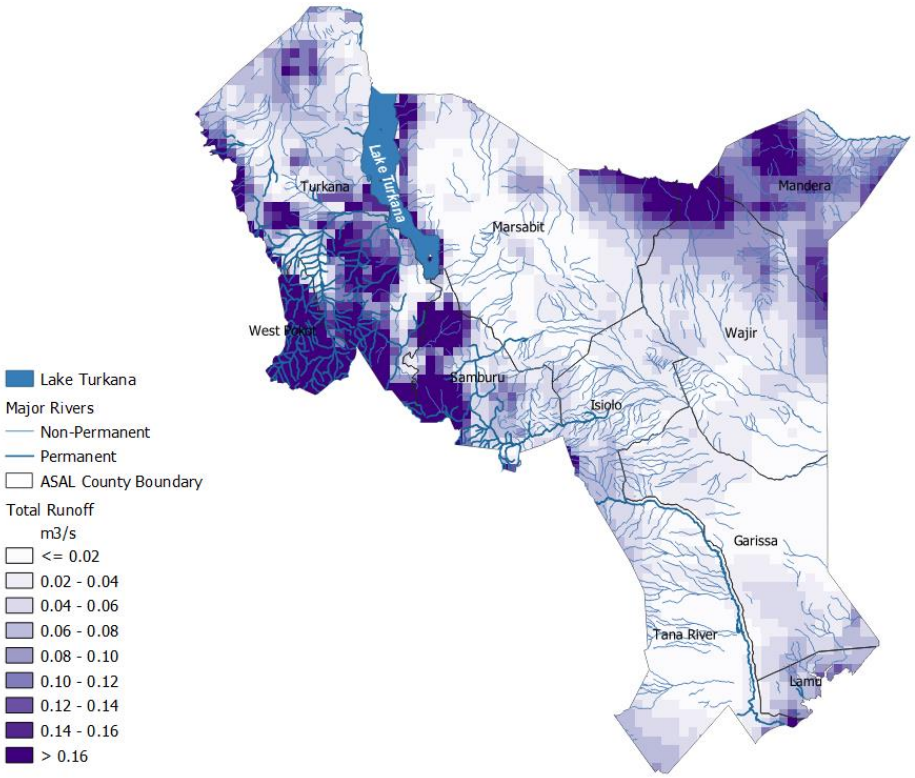


Figure 7-9 Total run-off as simulated by DHI's Global Hydrological Model based on ERA5 data and Priestley-Taylor equation from 2003 to 2020

Total run-off is highest West Pokot, western Turkana and Samburu at higher altitudes where there is high rainfall and low temperatures and evaporation. Lamu at the coast experiences high rainfall but is also at a low altitude with high temperatures and evaporation, so has lower run-off than the western areas.

The mid-range altitude areas to the north of Mandera, north Wajir and northeast Marsabit also have lower temperatures and evaporation, and relatively higher rainfall than the remaining county area so also have relatively higher run-off.

Southern Wajir, eastern Isiolo, Garissa and Tana River all have low rainfall and high temperatures and evaporation, and therefore have the lowest run-off.

The average specific run-off in litres per second per km^2 for each county is shown in Figure 7-10, this is irrespective of the size of the county and is therefore a summary of the gridded data shown in Figure 7-9.

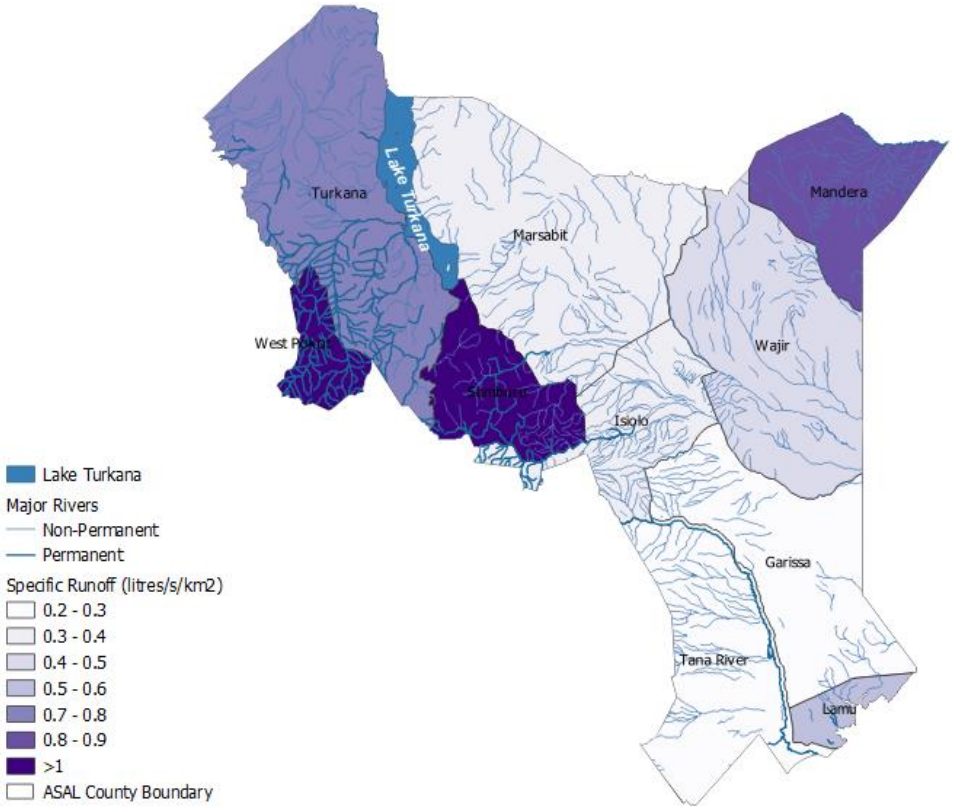


Figure 7-10 Average specific run-off for each county simulated by DHI's Global Hydrological Model (2003-2020)

Finally, the total run-off in each county as simulated by DHI's Global Hydrological Model is calculated as an estimate of the total water availability (shown in Figure 7-11). The total run-off (water availability) in each county takes into account the size of the county, and therefore (for example) Lamu has a low total water availability despite having high rainfall and high specific run-off.

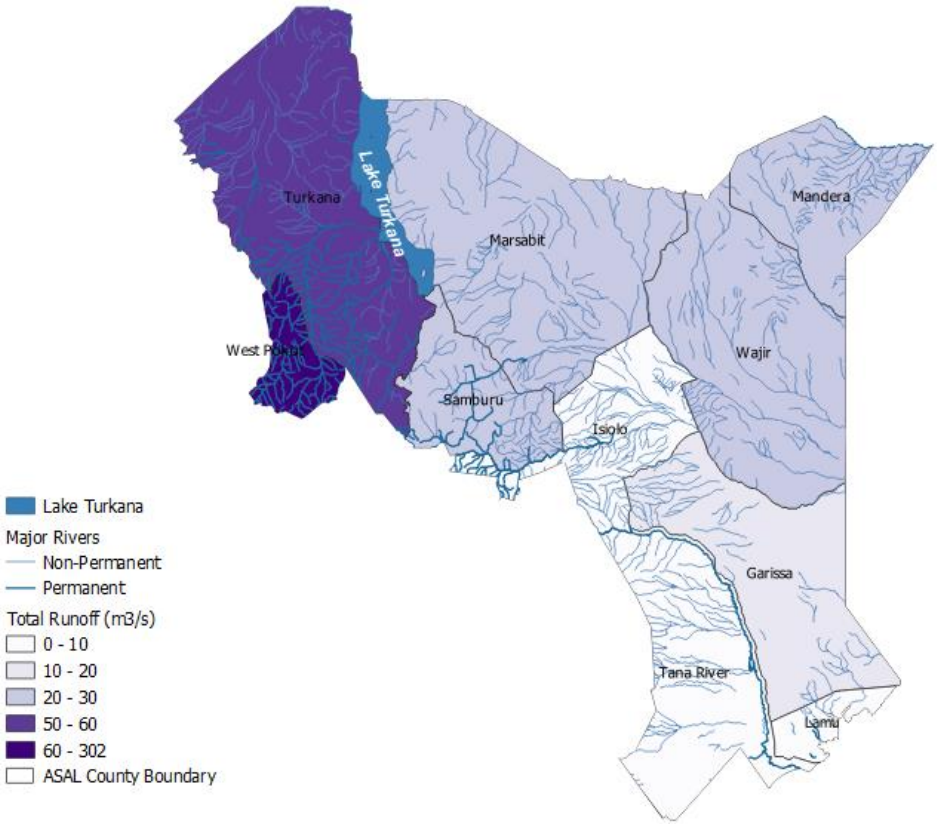


Figure 7-11 Total run-off (total water availability) in each county simulated by DHI's Global Hydrological Model (2003 – 2020)

As shown in the previous figures, for example in the gridded run-off in Figure 7-9, water availability varies within each county. As an annual average for the whole county, West Pokot and Turkana have the highest total water availability, and Isiolo, Garissa, Tana River and Lamu have the lowest total water availability in the present-day baseline. Table 7-1 provides a summary of the annual average water availability for each county for the present-day baseline (2003 – 2020).

Note that it is likely that the water availability in West Pokot is an overestimation based on the comparison of the ERA5 and CLIMWAT ground station rainfall data (see Section 7.1.1 Rainfall).

Table 7-1 Average annual rainfall, actual evaporation and total run-off for each of the 10 ASAL counties (2003 – 2020) simulated by DHI's GHM using ERA5 data and the Priestly-Taylor equation

County	Rainfall (mm)	Actual Evaporation (mm)	Specific Run-off (litres/s/km^2)	Total Run-off (m^3/s)
Garissa	357	334	0.23	10
Isiolo	322	296	0.34	9
Lamu	729	683	0.59	4
Mandera	439	394	0.9	23
Marsabit	318	291	0.38	27

Samburu	516	458	1.23	26
Tana River	383	358	0.21	8
Turkana	532	477	0.77	52
Wajir	348	319	0.44	25
West Pokot	2031	977	33.05	302

7.1.2 Water resources trends and long term climate change.

Water availability in future years has been simulated using DHI's Global Hydrological Model and applying climate change factors for precipitation, temperature and PET interpolated for the years 2030 and 2050. The climate change factors are from Regional Climate Model (RCM) CORDEX Africa representative concentration pathway (RCP) scenario 4.5 (medium radiation forcing scenario) for 2016 – 2035 and 2046 - 2065[30].

Rainfall change

Future projected changes in precipitation are generally more uncertain and complex than temperature, with projected increases in some months and areas and decreases in others. In the following figures, green-blue indicates an increase in rainfall, yellow is no change and orange-red indicates a decrease in rainfall.

Annually, rainfall is projected to increase across the 10 ASAL counties from present day to 2050 by approximately 10% - 20%. However, there is substantial variability within the year. In the rainy season months of March/April and October/November, any projected change factor has a large impact on the actual rainfall.

In 2050, rainfall is projected to increase in the rainy season months by on average 20%. The projected change factors for 2050 are shown in Figure 7-12 for two rainy season months. A change factor is the multiplier that takes you from the initial (baseline) precipitation value to the changed (future) value of precipitation, therefore a change factor above one is an increase, a change factor of 1 is no change, and a change factor below 1 is a decrease. These maps also show the variability within each county, especially in April where there are projected localised decreases in rainfall in some areas of Turkana and Marsabit.

[30] Monthly change factors with spatial resolution 0.44°. Source: https://esg-dn1.nsc.liu.se/projects/esgf-liu/

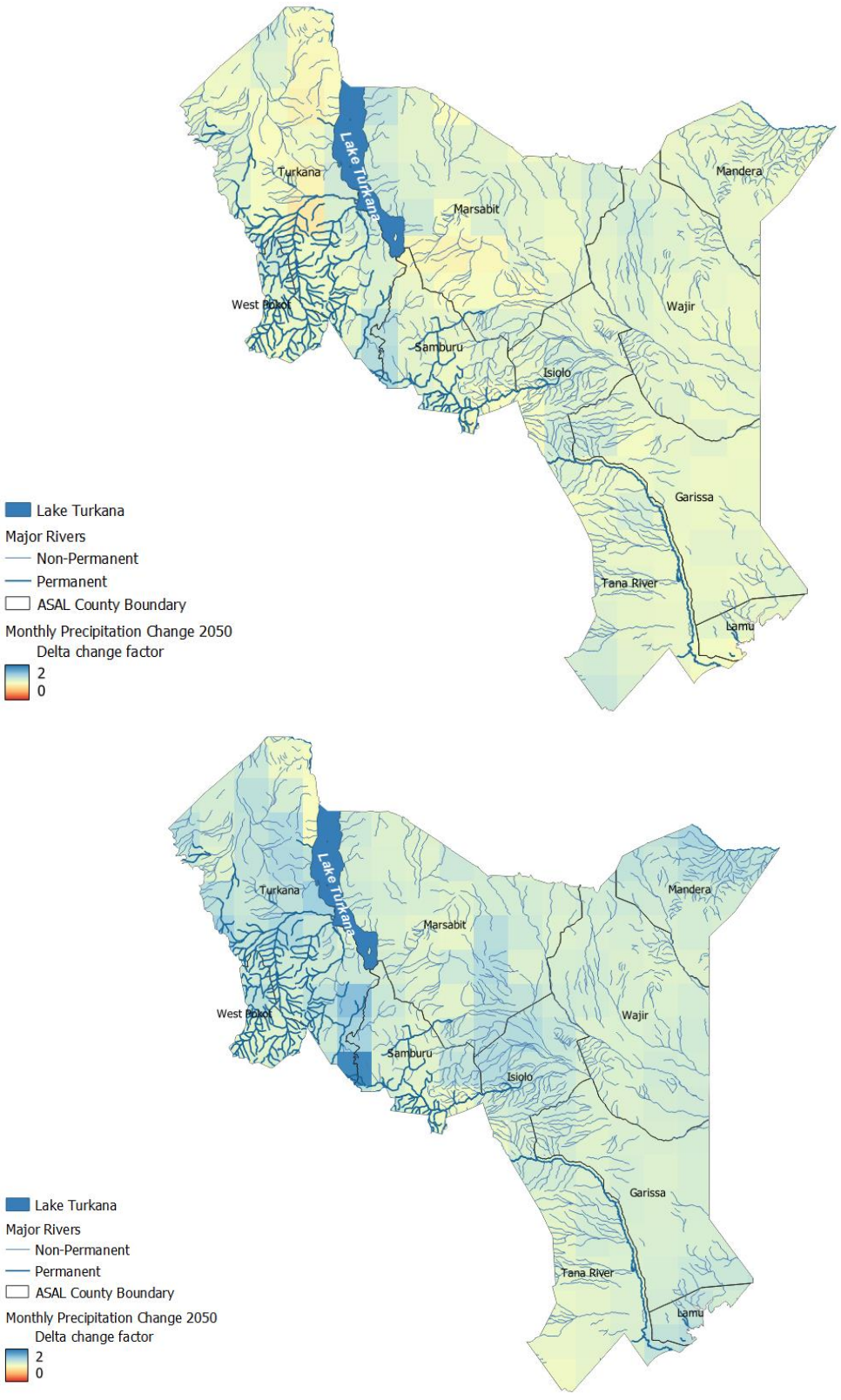
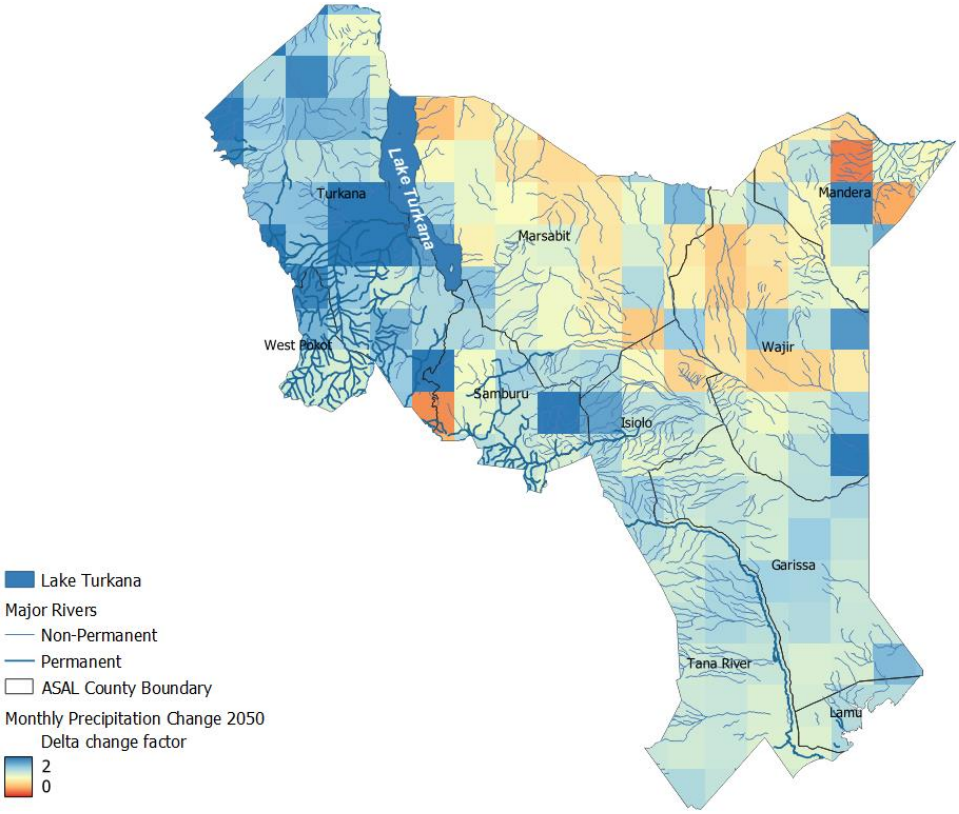
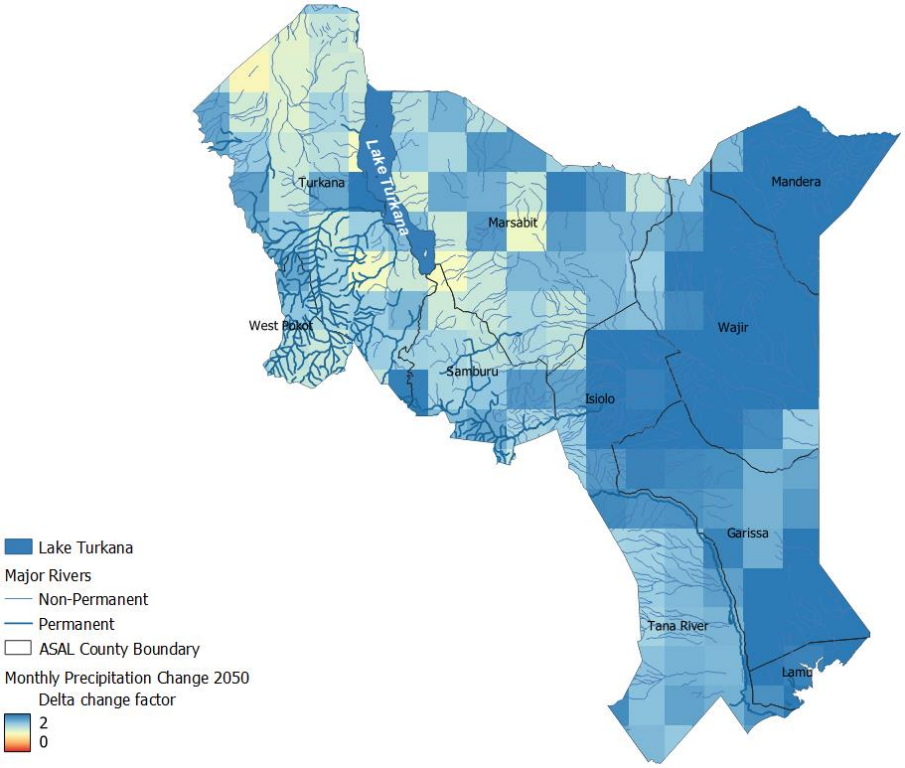


Figure 7-12 Projected delta change factor in April (top) and November (bottom) (rainy season) precipitation across the 10 ASAL counties in 2050

Source: CORDEX Africa Regional Climate Model RCP4.5 2046 - 2065

In the dry season months, rainfall is projected to increase in the December to February months (especially in February) but decrease in the June to August months as shown in Figure 7-13.





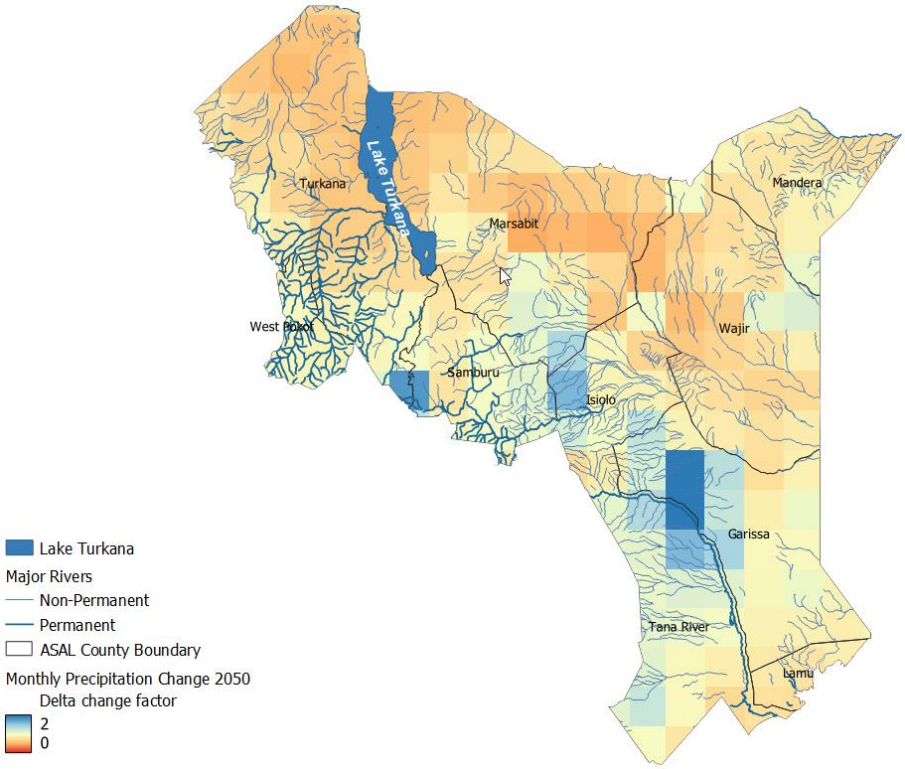


Figure 7-13 Projected delta change factor in January (top), February (middle) and July (bottom) (dry season) precipitation across the 10 ASAL counties in 2050

Source: CORDEX Africa Regional Climate Model RCP4.5 2046 - 2065

An overview of the average precipitation change in each county is shown in Table 7-2.

Table 7-2 Average monthly precipitation delta change factor in each of the 10 ASAL counties in 2050

Source: CORDEX Africa Regional Climate Model RCP4.5 2046 - 2065

County	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Garissa	1.3	2.0	1.3	1.1	1.1	1.1	1.1	0.7	1.2	1.1	1.2	1.2	1.2
Isiolo	1.3	1.9	1.2	1.1	1.1	0.8	1.0	0.7	1.1	1.2	1.3	1.4	1.2
Lamu	1.3	2.0	1.3	1.1	1.0	1.1	0.9	0.6	0.9	1.0	1.3	1.1	1.1
Mandera	1.0	2.8	1.4	1.1	1.1	0.9	0.9	1.0	1.2	1.2	1.3	1.2	1.2
Marsabit	1.1	1.5	1.4	1.1	1.1	0.8	0.8	0.9	1.1	1.4	1.2	1.3	1.1
Samburu	1.4	1.5	1.2	1.1	1.1	0.9	1.0	1.0	1.1	1.2	1.2	1.1	1.1
Tana River	1.3	1.7	1.3	1.1	1.1	1.0	1.2	0.6	1.0	1.0	1.2	1.2	1.1
Turkana	1.6	1.4	1.5	1.1	1.0	0.8	0.8	0.9	1.1	1.5	1.3	1.1	1.2
Wajir	1.1	2.3	1.1	1.1	1.1	0.9	0.8	0.7	1.3	1.1	1.2	1.4	1.2
West Pokot	1.5	1.5	1.4	1.1	1.0	1.0	0.9	0.9	1.0	1.3	1.2	1.0	1.2

Change factors are applied to the baseline precipitation 2003 – 2020 to give projected rainfall in future years, the pattern is similar but the magnitude varies depending on the magnitude of the baseline precipitation, as shown in Table 7-3. For example, the small change factors in a rainy season month e.g., in April have a larger impact on the total rainfall than larger change factors in a dry season month e.g., in February.

Table 7-3 Average monthly rainfall difference (mm) from present day (2003 – 2020) to 2050 in each of the 10 ASAL counties

County	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Garissa	2.6	3.8	7.7	5.7	3.4	2.1	0.2	-2.8	0.7	2.5	17.8	8.0	4.3
Isiolo	3.2	4.5	6.8	7.4	0.8	-0.3	-0.3	-0.4	0.3	5.5	23.7	17.8	5.8
Lamu	4.5	10.7	13.4	9.5	4.8	6.0	-5.5	-13.0	-1.9	-0.2	32.1	8.3	5.7
Mandera	0.2	3.4	11.0	10.0	4.4	-0.9	-0.7	-0.3	1.0	16.3	28.2	3.9	6.4
Marsabit	0.5	2.8	13.5	8.0	3.0	-2.4	-2.4	-0.3	0.9	13.0	14.1	7.0	4.8
Samburu	5.3	6.4	10.8	11.5	9.1	-0.5	0.3	2.6	3.7	16.0	21.0	5.4	7.6
Tana River	4.1	4.1	11.6	6.1	6.9	0.2	0.1	-3.4	-0.1	1.4	13.6	11.9	4.7
Turkana	7.0	2.3	15.3	5.2	2.6	-8.2	-12.8	-4.4	2.9	22.1	17.2	2.6	4.3
Wajir	0.3	2.4	5.3	9.5	2.9	-0.4	-0.7	-1.3	1.2	7.1	18.0	11.3	4.6
West Pokot	6.9	10.9	19.1	17.7	-14.7	-16.8	-7.8	-20.6	8.9	35.6	20.7	-0.6	4.9

West Pokot and Turkana have greater rainfall in June and July than the other counties which generally experience a dry season in these months. Therefore, the negative change factors in June and July result in a greater decrease in rainfall in these months in West Pokot and Turkana. Similarly, whilst the greatest positive change factors are in February in most counties, actual rainfall is low in this dry season month therefore there is only a small increase in actual rainfall.

In general, actual rainfall in the wet seasons of March – May and October – December is projected to increase, and precipitation in the dry season January - February is also projected to increase. However, precipitation in the dry season June – August is projected to decrease.

Temperature change

The temperature change factors from the CORDEX Africa Regional Climate Model show an increase in annual temperature of between 1 and 1.6 °C across all counties from present day to 2050. Annual temperature increases are generally less towards the coast, as shown in Figure 7-14.

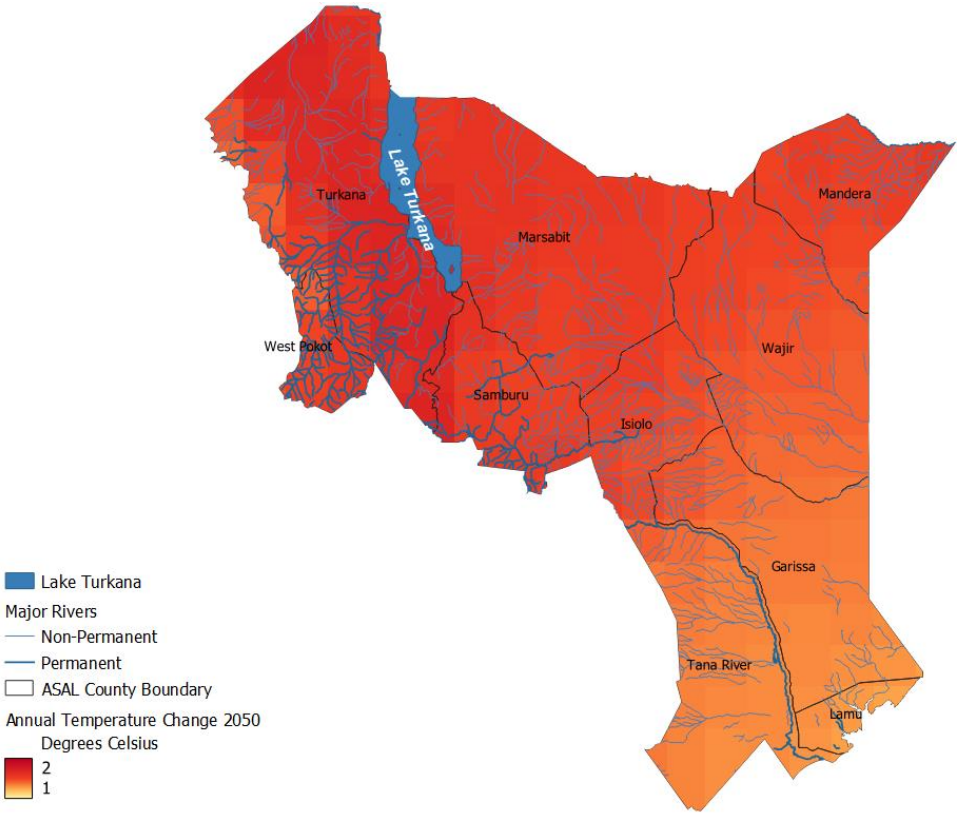


Figure 7-14 Projected change in annual temperature across the 10 ASAL counties in 2050

Source: CORDEX Africa Regional Climate Model RCP4.5 2046 - 2065

Projected monthly temperature change varies, with most counties experiencing greater temperature increase in January, August and September, and lower temperature increases in November as shown in Table 7-4.

Table 7-4 Average monthly temperature change in each of the 10 ASAL counties in 2050

Source: CORDEX Africa Regional Climate Model RCP4.5 2046 - 2065

County	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Garissa	1.5	1.5	1.4	1.4	1.4	1.3	1.3	1.5	1.5	1.4	1.1	1.3	1.4
Isiolo	1.8	1.6	1.6	1.5	1.6	1.5	1.5	1.6	1.6	1.4	1.1	1.4	1.5
Lamu	1.3	1.3	1.3	1.3	1.3	1.3	1.2	1.4	1.4	1.4	1.2	1.3	1.3
Mandera	1.8	1.6	1.6	1.5	1.5	1.5	1.5	1.6	1.7	1.3	1.1	1.4	1.5
Marsabit	1.8	1.5	1.6	1.5	1.7	1.8	1.7	1.8	1.8	1.3	1.2	1.4	1.6
Samburu	1.8	1.5	1.5	1.5	1.7	1.6	1.6	1.8	1.7	1.3	1.1	1.5	1.5
Tana River	1.5	1.5	1.3	1.4	1.3	1.3	1.3	1.5	1.5	1.4	1.2	1.2	1.4
Turkana	1.8	1.6	1.6	1.5	1.7	2.0	1.9	1.9	1.8	1.2	1.2	1.6	1.6
Wajir	1.8	1.6	1.6	1.5	1.5	1.4	1.4	1.6	1.6	1.3	1.1	1.1	1.5
West Pokot	1.8	1.5	1.5	1.4	1.6	1.6	1.6	1.8	1.8	1.2	1.0	1.4	1.5

Evaporation

Potential evapotranspiration is projected to increase in all counties and all months, with an annual average increase of between 3 and 5% by 2050 (CORDEX Africa RCP 4.5 projections). PET is therefore projected to remain significantly higher than rainfall, and so, similar to the baseline, actual evaporation follows a similar change and spatial distribution to rainfall change.

Actual evaporation is calculated by DHI's Global Hydrological Model in the climate change scenarios for 2030 and 2050. Annual average actual evaporation is projected to increase, but with a decrease in the June to August dry season months due to the decrease in rainfall.

Table 7-5 Average monthly actual evaporation change in each of the 10 ASAL counties in 2050 simulated by DHI's GHM

County	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Garissa	3.1	3.8	6.0	5.7	2.6	1.9	0.3	-2.7	0.6	2.0	12.0	9.4	3.7
Isiolo	4.1	4.0	5.2	6.2	1.8	-0.2	-0.1	-0.4	0.3	3.4	15.1	16.4	4.7
Lamu	6.5	10.6	10.5	8.5	2.9	4.9	-4.3	-12.6	-1.8	0.1	18.7	13.2	4.8
Mandera	0.5	2.1	7.4	7.9	6.1	-0.6	-0.7	-0.3	0.9	6.1	16.0	7.5	4.4
Marsabit	1.2	2.3	8.5	6.9	4.1	-1.7	-1.8	-0.8	0.6	7.5	10.9	7.6	3.8
Samburu	4.8	5.7	7.2	6.8	4.8	-0.3	-0.7	-0.6	1.9	7.3	11.9	6.7	4.6
Tana River	4.3	4.2	9.4	6.4	4.9	0.9	0.2	-3.3	-0.1	1.1	9.6	10.9	4.0
Turkana	4.5	3.0	10.2	6.1	2.6	-4.9	-8.3	-5.3	1.3	12.1	11.7	4.2	3.1
Wajir	0.8	1.9	3.2	6.9	4.6	-0.3	-0.7	-1.2	1.1	3.2	11.6	12.0	3.6
West Pokot	3.9	5.8	9.9	8.2	4.6	2.9	3.2	3.5	3.8	9.5	9.1	2.3	5.5

Future Total Run-off

Similar to the baseline, changes in rainfall are expected to be the main factor in determining changes in run-off due to the PET being significantly higher than the rainfall in this region.

DHI's GHM has been used to simulate the impact of the projected changes in temperature, PET and precipitation on the total run-off for each county, and the results are presented below for 2030 and 2050.

In general, total annual run-off increases across the majority of counties, as shown in a comparison of the gridded total annual run-off in Figure 7-15 for present day (2003 – 2020) and 2050.

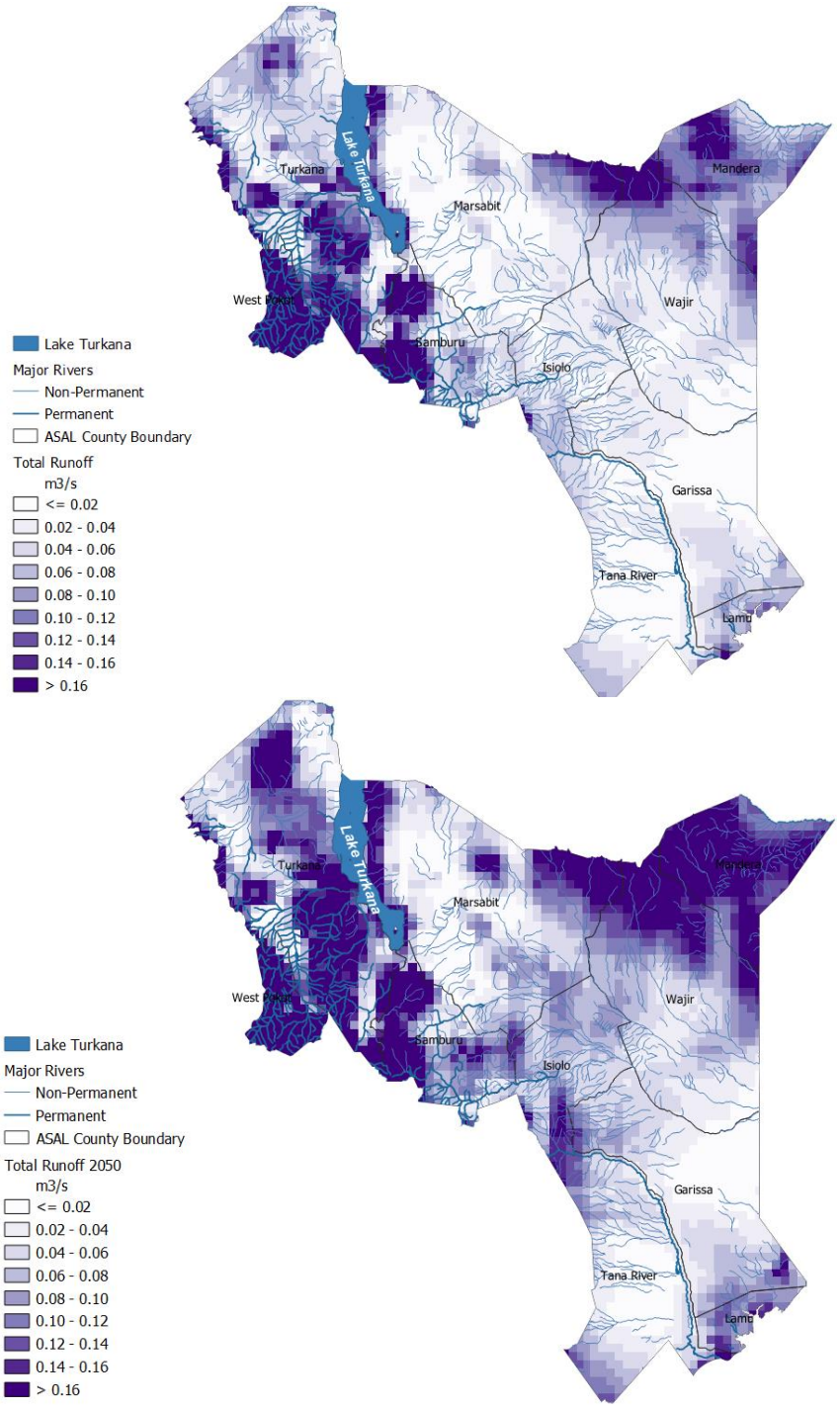


Figure 7-15 Total annual run-off simulated by DHI's Global Hydrological Model for present day 2003-2020 (top) and under future climate change 2050 (bottom)

The average difference in run-off for each county is shown in Figure 7-16. Annually, Turkana, Marsabit and Samburu have the largest absolute increase in run-off. West Pokot has an annual decrease in run-off due to the decrease in precipitation in the June – August months.

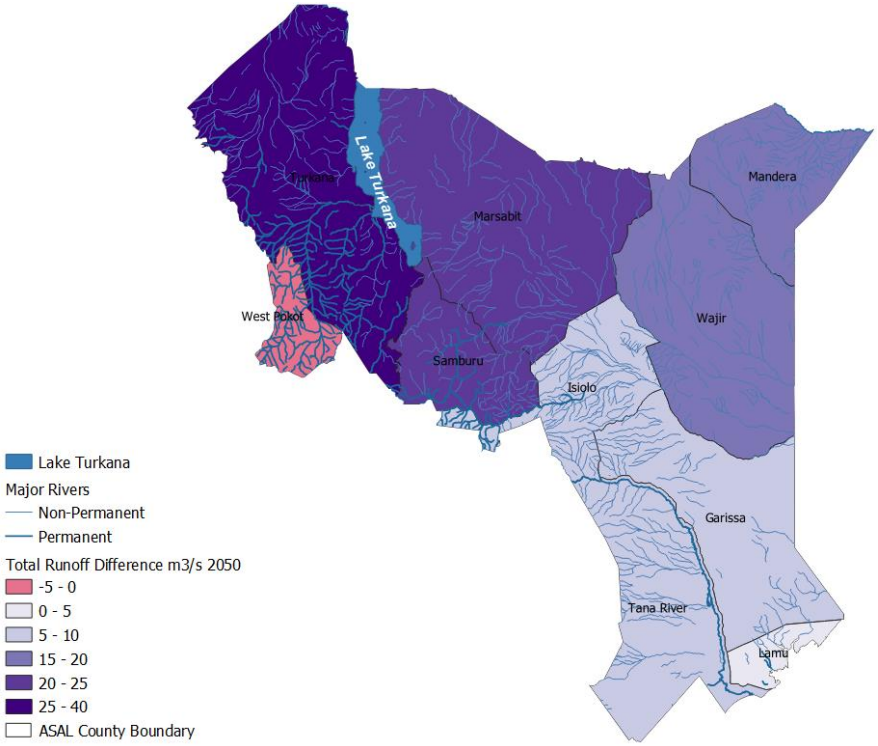


Figure 7-16 Difference in annual average run-off (m^3/s) for the 10 ASAL counties from present day (2003-2020) to 2050

The monthly change in run-off is shown in Table 7-6, with the largest increases in the rainy months of April, October and November. West Pokot and Turkana show a decrease in run-off in June to August due to the decrease in precipitation in these months.

Table 7-6 Difference in monthly average run-off (m^3/s) for the 10 ASAL counties from present day (2003-2020) to 2050

County	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Garissa	7	6	5	5	15	4	4	3	3	3	9	11	6
Isiolo	12	9	8	10	7	5	4	3	3	4	15	22	8
Lamu	1	1	1	1	8	1	1	1	1	1	2	1	2
Mandera	17	13	14	19	15	10	8	7	5	32	59	23	18
Marsabit	21	15	31	41	23	13	10	9	9	31	49	33	24
Samburu	14	10	13	29	45	16	18	20	14	27	52	22	23
Tana River	8	7	6	6	13	5	4	3	3	3	6	11	6
Turkana	37	26	30	31	35	0	-11	-17	0	48	101	44	27
Wajir	16	14	15	24	16	13	11	10	8	26	40	29	18
West Pokot	5	15	14	32	-30	-51	-32	-65	-8	39	37	9	-3

A summary of the total annual run-off in each county for present day (2003 – 2020) and future years 2030 and 2050 is shown in Table 7-7 and used in the water balance calculations in Section 7.5.

Table 7-7 Total annual run-off (m^3/s) in the 10 ASAL counties in present day (2003 – 2020) and future years 2030 and 2050

County	Total run-off Baseline	Total Run-off 2030	Total Run-off 2050
Garissa	10	13	17
Isiolo	9	11	17
Lamu	4	5	5

Mandera	23	27	42
Marsabit	27	39	50
Samburu	26	38	49
Tana River	8	12	14
Turkana	52	62	79
Wajir	25	30	44
West Pokot	302	298	299

IPCC Sixth Assessment Report (AR6)

The Intergovernmental Panel on Climate Change (IPCC) released its Sixth Assessment Report (AR6)[31] on the physical science basis of climate change in August 2021. The Summary for Policy Makers AR6 Report shows that human-induced climate change is already affecting many weather and climate extremes in every region across the globe, and there is increased evidence of observed changes in extremes such as heatwaves, heavy precipitation and droughts.

Due to the time schedule for the current water resources assessment, it has not been possible to apply data and assumptions from AR6 in the model predictions for 2030 and 2050. Instead, we can use AR6 to check the direction of change predicted.

In the report, a set of five new emission scenarios are used to explore the climate response to a range of greenhouse gas, land use and air pollutant futures. The emission scenarios cover the range of possible future development of anthropogenic drivers of climate change found in the literature. Under all five new emission scenarios, global surface temperatures will continue to rise until at least mid-century. Global warming of 1.5°C and 2°C will be exceeded during the 21st century unless deep reductions in CO_2 and other greenhouse gas emissions occur in the coming decade.

Given the projected rise in global temperatures under all five emission scenarios, the report looks at the impact of different degrees of global warming on surface temperatures, precipitation and extreme events.

Figure 7-17 shows the increase in temperature across all continents, including in Kenya, in three global warming scenarios: at global warming levels of 1.5°C, 2°C and 4°C.

[31] https://www.ipcc.ch/report/ar6/wg1/

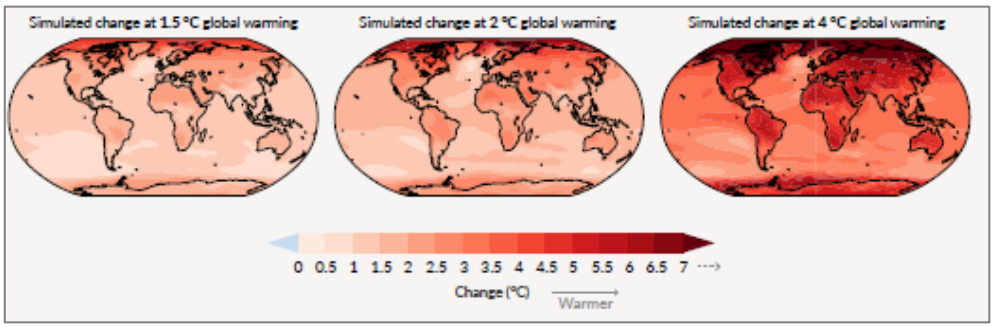


Figure 7-17 Annual mean temperature change (°C) relative to 1850-1900 in three global warming scenarios: at global warming levels of 1.5 °C, 2 °C and 4°C

Source: IPCC 2021: Summary for Policy Makers (Figure SPM.5, page SPM-21)

Figure 7-18 shows the annual mean precipitation change across all continents, including increased precipitation in Kenya, in three global warming scenarios: at global warming levels of 1.5°C, 2°C and 4°C.

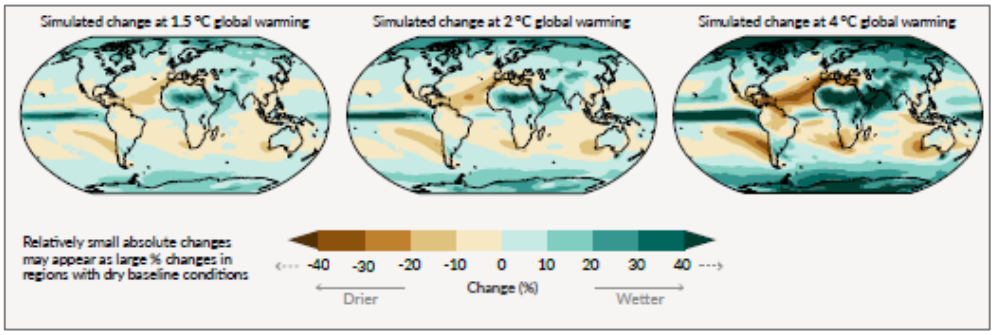


Figure 7-18 Annual mean precipitation change (%) relative to 1850-1900 in three global warming scenarios: at global warming levels of 1.5 °C, 2 °C and 4°C

Source: IPCC 2021: Summary for Policy Makers (Figure SPM.5, page SPM-22)

This study uses climate change projections from the CORDEX Africa model driven by the emission scenarios used in the previous IPCC AR5 report. The changes, however, are in the same direction as the latest IPCC AR6 global warming scenarios, with both showing an increase in temperature and also precipitation in northern Kenya.

7.2 Water infrastructure overview

Limited data was submitted on existing water infrastructure in the 10 counties.

7.2.1 Boreholes

The figure below shows the data received (and gaps) on borehole locations in the project area. All information is relatively outdated, the most recent data dating back to 2007.

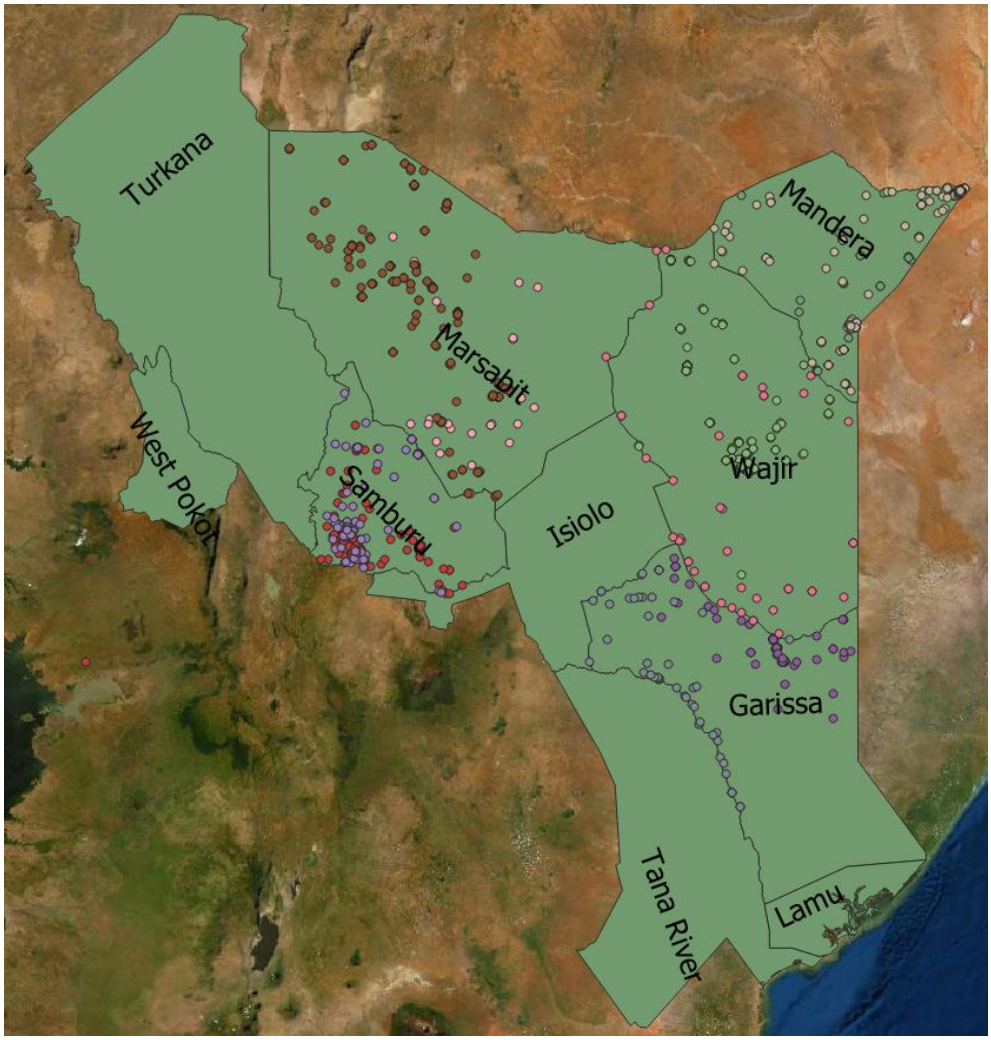


Figure 7-19 Boreholes and wells as per received information from counties

The 10 counties on average depend more on boreholes for drinking water for their drinking water supply, except for Lamu county which is below the national average of 9.9% at only 7%. In Garissa (26.3%) and Wajir (31.7%), more than one quarter of all households get their drinking water from boreholes.

Table 7-8 Percentage of households using boreholes as main source of drinking water

Area	Borehole/ tube well
National average	9.9%
Garissa	26.3%
Isiolo	12.0%
Lamu	7.0%
Mandera	21.3%
Marsabit	23.2%
Samburu	15.8%
Tana River	22.1%

Turkana	13.2%
Wajir	31.7%
West Pokot	11.5%
10 ASAL Counties Average	18.4%

More information is required on the status of these boreholes.

7.2.2 Non-revenue water (NRW)

Reducing Non-Revenue Water (NRW) is a high priority for the water sector in Kenya. The goal of the National Water Services Strategy is to reduce NRW to under 30%, while the Vision 2030 goal is to reduce this to under 25%. The sector benchmark for NRW is 20%.[32] WASREB define a level of NRW of under 20% as 'good', 20-25% as 'acceptable', and over 25% as 'not acceptable.

No data have been submitted on actual levels of NRW in the ten counties, hence under this rapid assessment we are only able to calculate future losses in the system based on the strategic numbers mentioned above. See section 7.4.1 on future water balance calculations using these national targets.

7.3 State of Ecosystems

Normalized Difference Vegetation Index (NDVI) provides consistent spatial and temporal comparisons of vegetation canopy greenness, a composite measure of leaf area, chlorophyll and canopy structure. NDVI can be used to detect changes in the vegetation pattern from year to year. Average NDVI for the region is shown in Figure 7-20.

[32] WASREB (2018) Non-Revenue Water Audit of WSPs, Final Report. Findings and Recommandations. https://wasreb.go.ke/downloads/Wasreb%20NRW%20Audit%20Report%20of%20WSPs%20Final%20Report%20August%202018.pdf

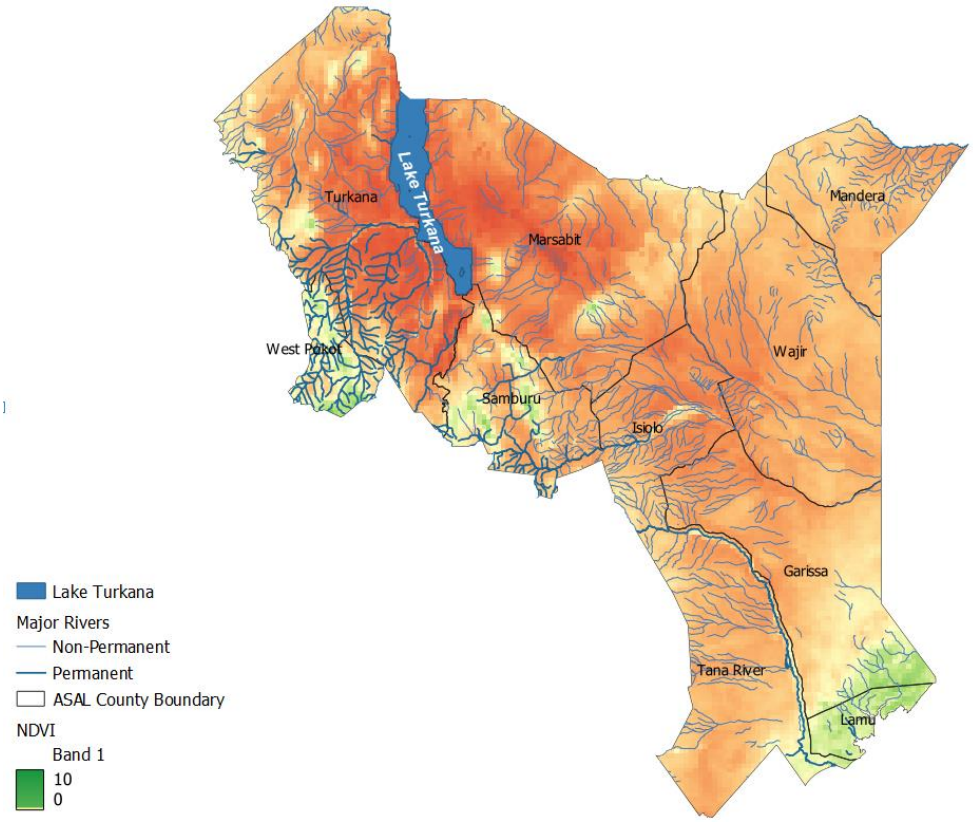


Figure 7-20 Normalized Difference Vegetation Index (NDVI) (average NDVI over 2000 – present time period)

Lamu, West Pokot and Samburu have the highest NDVI suggesting these areas have the most dense vegetation. This is consistent with the rainfall pattern as described in section 7.1.1.

Plotting changes over time in NDVI can indicate changes in the vegetation pattern and indicate long term ecosystem changes. Figure 7-21 shows the relative deviation of NDVI from 2000 to present for the ASAL area, where green is a higher NDVI than 'normal' (the long term average) and brown a lower NDVI than normal. Fluctuations are expected to coincide with, for example, seasonal rainfall patterns and wet/dry years.

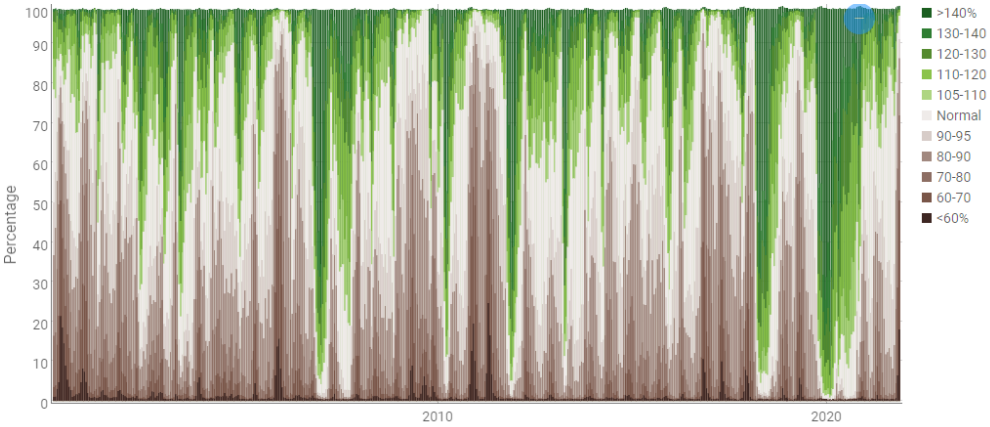


Figure 7-21 Average relative deviation of Normalised Difference Vegetation Index (NDVI) over ASAL area (2000 – present)

Based on the NDVI alone, there is nothing to suggest vegetation has decreased or increased in the region as a whole between 2000 and present.

7.3.1 Forests

No data has been submitted on forests in the project area. The link between water balance and future demand to maintain forests in the future is an important consideration, but due to lack of data we are unable to determine impact at this time.

7.3.2 Wetlands

Using the SDG 6.6.1 Freshwater Ecosystems Explorer, Kenya has a total of 4319.06 km^2 of wetlands which are indicated by the light blue colour on Figure 7-22. The major wetland hotspots in the project area have been circled in yellow.

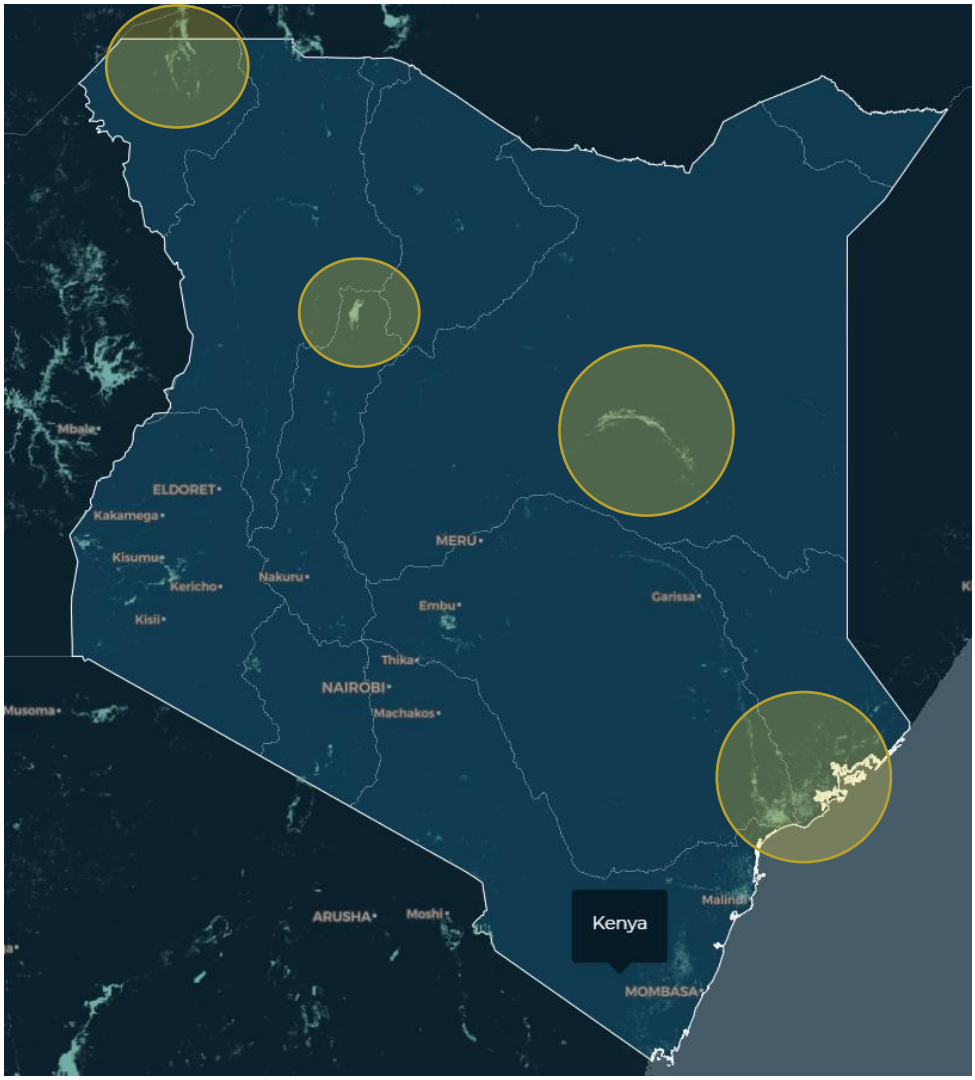


Figure 7-22 Major wetlands in the project area

The freshwater ecosystem explorer indicates data on a catchment and sub-catchment basis. The data presented is baseline only, and as such it is not

feasible yet to measure the state of change of wetland ecosystems in Kenya until further data is submitted to SDG 6.6.2 monitoring and reporting activities.

7.3.3 Lake Turkana

Lake Turkana is the largest lake in the project area. A transboundary lake that receives most of its water from the Omo River in Ethiopia, the lake provides many important ecosystem services to the surrounding environment[33]. Lake Turkana is a major breeding ground for hippos, Nile crocodiles and more than 350 species of fish and birds and was thus made a UNESCO World Heritage Site in 1997[34].

A planned increase in hydropower dams upstream of the lake could potentially threaten the lake and surrounding communities due to declining lake water levels, which would likely have a negative impact on the lake's wildlife and fish stocks. However, a recent analysis[35], accounting for projected climate change, shows that the projected increase in rainfall in the lower parts of the Omo basin around 2040 counterbalances the decrease in inflow to the lake due to planned hydropower development in the upstream parts of the Omo basin, leaving total annual lake inflow little affected whereas seasonal fluctuations may be affected.

Land use changes in the surrounding of the lake have impacted its turbidity, salinity, algal productivity and habitats along with the water quality. Using satellite data, a decade-long monitoring activity in Lake Turkana demonstrates the complexity and vulnerability of freshwater ecosystems. More data needs to be collected to measure change over time of the state of ecosystems in the lake.

7.3.4 Protected areas

There are a number of protected areas, including national parks, forest reserves, national reserves and a game sanctuary in the project area. These are shown in Figure 7-23.

[33] Link Turkana State of Ecosystems Report
[34] SDG 6.6.1 Indicator Report: PROGRESS ON FRESHWATER ECOSYSTEMS - 2021
[35] UNEP-DHI, 2021: Results of Scenario Modelling of Lake Turkana and its River Basins, Technical Report.

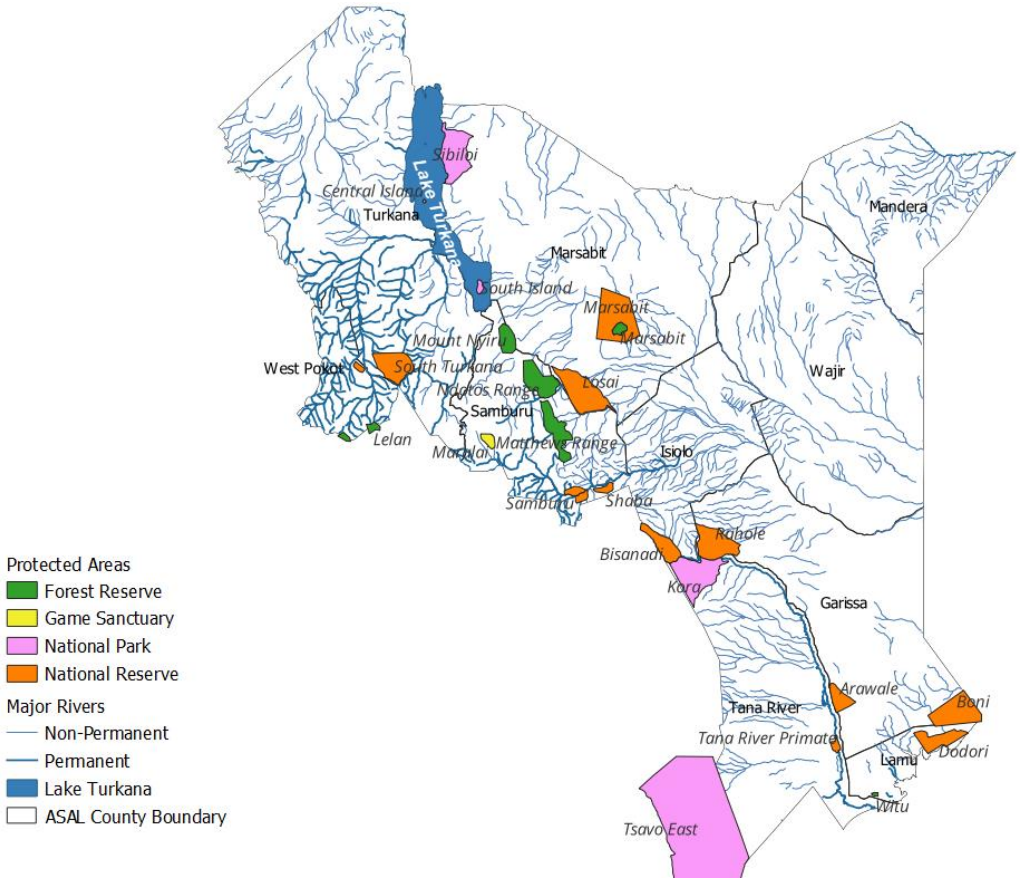


Figure 7-23 Protected areas in the 10 ASAL counties
Source: Subset of the World Conservation Monitoring Center (WCMC) Africa protected areas database (2017) from ICPAC_IGAD_UNOSAT

According to the database, Mandera and Wajir do not contain any protected areas. The majority of forest reserves are in Samburu, and the majority of national parks are in Tana River, Marsabit and in Lake Turkana. Samburu also contains a game reserve, and there are national reserve areas in all counties except Mandera and Wajir.

7.4 Water demand – Present and Future

This Section explores the present and future water demand in the 10 counties.

7.4.1 Domestic consumption

Domestic consumption includes residential water demand, institutional water demand and commercial water demand. In addition, the non-revenue water (NRW) is also accounted for within domestic consumption as a water loss.

Residential water demand

Population and projected urban and rural population growth from the latest Census 2019 has been used to calculate residential water demand. The population and projected population growth for each county is provided in Section 6.1.

To calculate water demand, urban and rural consumption rates (litres per person per day) have been applied to the current and projected population.

Current consumption rates of 50 litres per person per day for the urban population and 20 litres per person per day for the rural population have been applied. This is based on the specification that the standard water supply for personal and domestic uses should be 50 – 100 litres/person/day to meet basic needs, and 20-25 litres/person/day as a minimum (without meeting all needs). We have assumed the low end of these ranges for urban and rural consumption on the basis that only approximately 10% of households in the ASAL counties have water piped into their dwelling or yard (see Section 6.3.1).

A water use survey in Kenya carried out as part of the JICA study found that the current water supply system could satisfy only 61% of the design water consumption amount. The design water consumption amount was taken from the JICA Report (originally from the MWI Design Manual for Water Supply in Kenya), which ranged from 10 to 60 litres/person/day for rural population and 20 – 150 litres/person/day for low and medium class urban population housing. Our assumption of 50 litres/person/day for the urban population and 20 litres/person/day for the rural population is approximately in the middle of the consumption range applied by JICA.

In future year 2030 and 2050, it is assumed that consumption rates in both rural and urban areas meet the minimum standard requirements to meet basic needs of approximately 50 litres/person/day in line with the targets set out in the Water Master Plan 2030 (See Figure 5-1). The proposed target unit water supply amount for domestic use in 2030 taken from the Water Master Plan for urban areas in the project area is 119 l/p/d while for small scale rural water supply in arid areas this descends to 42 l/p/d

Proposed Unit Water Supply Amount in 2030

Target Area	Unit Water Supply Amount for Residential Water Use (L/p/d)	Ratio of Institutional & Commercial Water Use	Target NRW Ratio	Unit Water Supply Amount for Domestic Water Use (L/p/d)
1) Urban Water Supply for Nairobi, Mombasa and Kisumu	92	27%	20%	146
2) Urban Water Supply	75	27%	20%	119
3) Large Scale Rural Water Supply	50	22%	20%	76
4) Small Scale Rural Water Supply	36	22%	20%	55
5) Small Scale Rural Water Supply in Arid Area	28	20%	20%	42

Source: JICA Study Team based on MWI Design Manual and "Guidelines for Water Allocation (WRMA, First Edition, March 2010)" (Ref. Main Report Part A, Sub-section 6.3.2 and Sectoral Report (C), Sub-section 3.4.3)

Figure 7-24 Proposed unit water supply amount in 2030

Institutional and commercial water demand

Due to the lack of data, the institutional and commercial demand was calculated using the ratios applied in the JICA Report, which are stated to be in line with common international practices. The ratios applied are:

- Institutional demand is 10% of residential demand
- Commercial demand is 15% of urban residential demand and 10% of rural residential demand

Due to lack of data, the same ratios are applied in future scenarios therefore assuming that institutional and commercial demand grows in line with population growth.

Non-revenue water

In the present-day baseline, non-revenue water is taken from the WASREB Impact Report for Kenya 2018/2019[36] where NRW is 43% of the urban residential demand.

In future scenarios, it is assumed that the NRW in the 2030 and 2050 future scenarios is in line with the sector benchmark in the WASREB Impact Report for Kenya at 20%. This is also in line with the Vision 2030 goal to reduce NRW to under 25%.

Total Domestic Consumption

Based on population figures and unit water demand as per above, domestic consumption in present day, 2030 and 2050 future scenarios is summarised in the tables below.

Table 7-9 Domestic consumption (MCM/year) in present day

County	Residential Urban	Residential Rural	Institutional	Commercial	NRW	Total
Garissa	3.8	4.6	0.8	1.0	1.7	12
Isiolo	2.3	1.0	0.3	0.4	1.0	5
Lamu	0.7	0.8	0.1	0.2	0.3	2
Mandera	4.9	4.4	0.9	1.2	2.1	14
Marsabit	2.0	2.6	0.5	0.6	0.8	6
Samburu	0.9	1.9	0.3	0.3	0.4	4
Tana River	1.4	1.8	0.3	0.4	0.6	4
Turkana	2.6	5.7	0.8	1.0	1.1	11
Wajir	3.2	4.4	0.8	0.9	1.4	11
West Pokot	0.6	4.3	0.5	0.5	0.2	6

Table 7-10 Domestic consumption (MCM/year) in 2030

County	Residential Urban	Residential Rural	Institutional	Commercial	NRW	Total
Garissa	5.9	13.6	2.0	2.2	1.2	25
Isiolo	3.3	3.0	0.6	0.8	0.7	8
Lamu	1.1	2.3	0.3	0.4	0.2	4
Mandera	7.3	12.8	2.0	2.4	1.5	26
Marsabit	3.0	7.6	1.1	1.2	0.6	14
Samburu	1.5	5.7	0.7	0.8	0.3	9
Tana River	2.2	5.2	0.7	0.8	0.4	9
Turkana	4.4	17.1	2.1	2.4	0.9	27

[36] https://kewasnet.co.ke/download/wasreb-impact-report-12-2020/?wpdmdl=2050&refresh=61a609fb0201e1638271483

Wajir	5.0	13.1	1.8	2.1	1.0	23
West Pokot	1.5	12.9	1.4	1.5	0.3	18

Table 7-11 Domestic consumption (MCM/year) in 2050

County	Residential Urban	Residential Rural	Institutional	Commercial	NRW	Total
Garissa	13.4	16.7	3.0	3.7	2.7	40
Isiolo	6.4	3.2	1.0	1.3	1.3	13
Lamu	2.3	2.9	0.5	0.6	0.5	7
Mandera	15.7	15.4	3.1	3.9	3.1	41
Marsabit	7.0	9.5	1.6	2.0	1.4	22
Samburu	3.8	7.3	1.1	1.3	0.8	14
Tana River	4.9	6.4	1.1	1.4	1.0	15
Turkana	11.5	21.8	3.3	3.9	2.3	43
Wajir	11.6	16.4	2.8	3.4	2.3	36
West Pokot	5.5	16.8	2.2	2.5	1.1	28

The domestic water consumption is summarised in Figure 7-25, Figure 7-26 and Figure 7-27 for each county based on present day population and future projected population change combined with unit water demand.

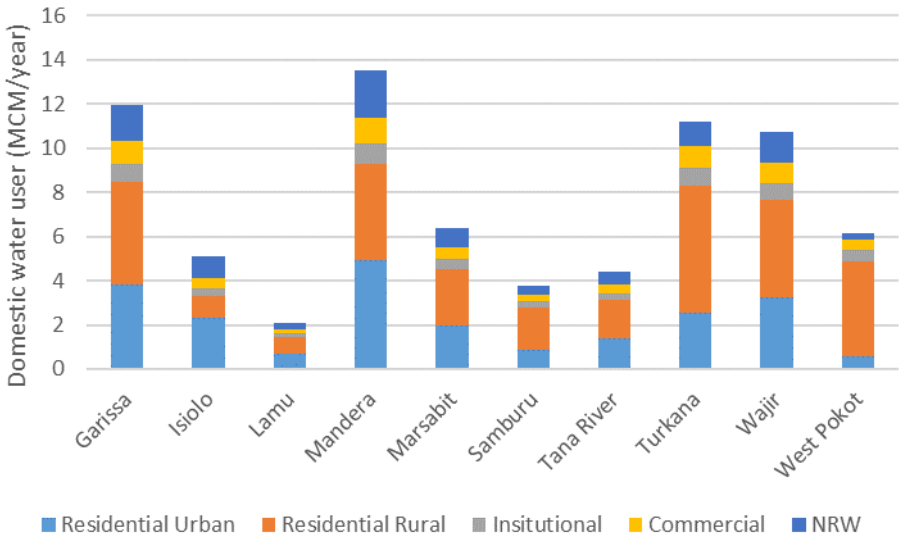


Figure 7-25 Domestic consumption per type for each county in present day

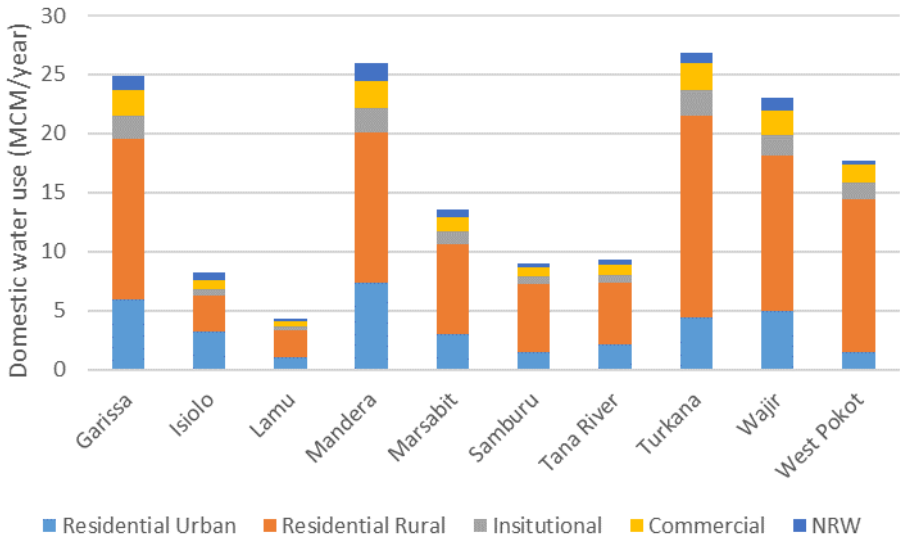


Figure 7-26 Projected domestic consumption per type for each county in 2030

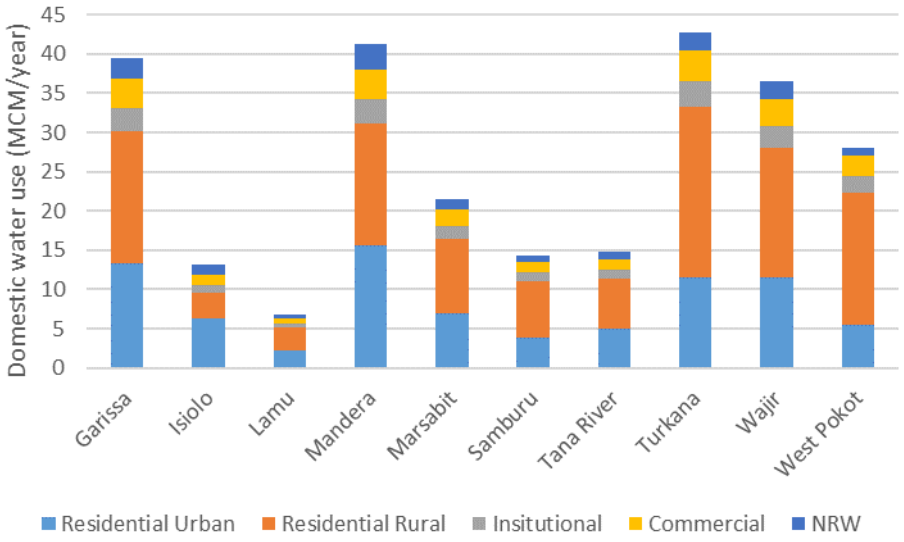


Figure 7-27 Projected domestic consumption per type for each county in 2050

Changes in domestic water demand in future years reflect projected changes in urban and rural population. The greatest proportion of domestic water demand is from residential water demand.

7.4.2 Irrigation

Present day and potential irrigated areas have been extracted from the County Integrated Development Plans 2018-2022 (see Section 6.4.3). The existing irrigated area in Samburu is not specified in the CIDP, so instead the existing irrigated area from the JICA report for Samburu county is used (15 hectares).

Irrigation water demand has been calculated using the annual average water requirement from the JICA report[37] under 60% efficiency and full cropping produced for each hydrological catchment, averaged over each of the 10 ASAL counties.

The irrigation water demand applied to the existing irrigated area and potential future irrigation area, as sourced from the CIDP, is shown in Table 7-12.

Table 7-12 Existing and future potential irrigated area (ha) from CIDP and irrigation water demand (MCM/year) for each county

County	Existing irrigated area (CIDP)	Existing irrigation water demand	Potential future irrigation area (CIDP)	Potential future irrigation water demand
Garissa	3400	142	32,000	1337
Isiolo	600	21	2,000	69
Lamu	300	11	300,000	11,116
Mandera	4,000	135	20,000	677
Marsabit	0	0	0	0
Samburu	*15**	No data	3,000	98
Tana River	40,000	1,274	200,000	6,368
Turkana	7,087	264	16,600	618
Wajir	607	25	*607*[+]	25
West Pokot	1,800	50	10,000	278

*Samburu existing irrigated area sourced from the JICA Report Main Report Part A Table 6.5.1 due to lack of data

[+]No data available, assume area is the same as existing

The irrigation water demand data is summarised in Figure 7-28.

[37] Annual average water requirement from Table 6.5.2 in the JICA Report

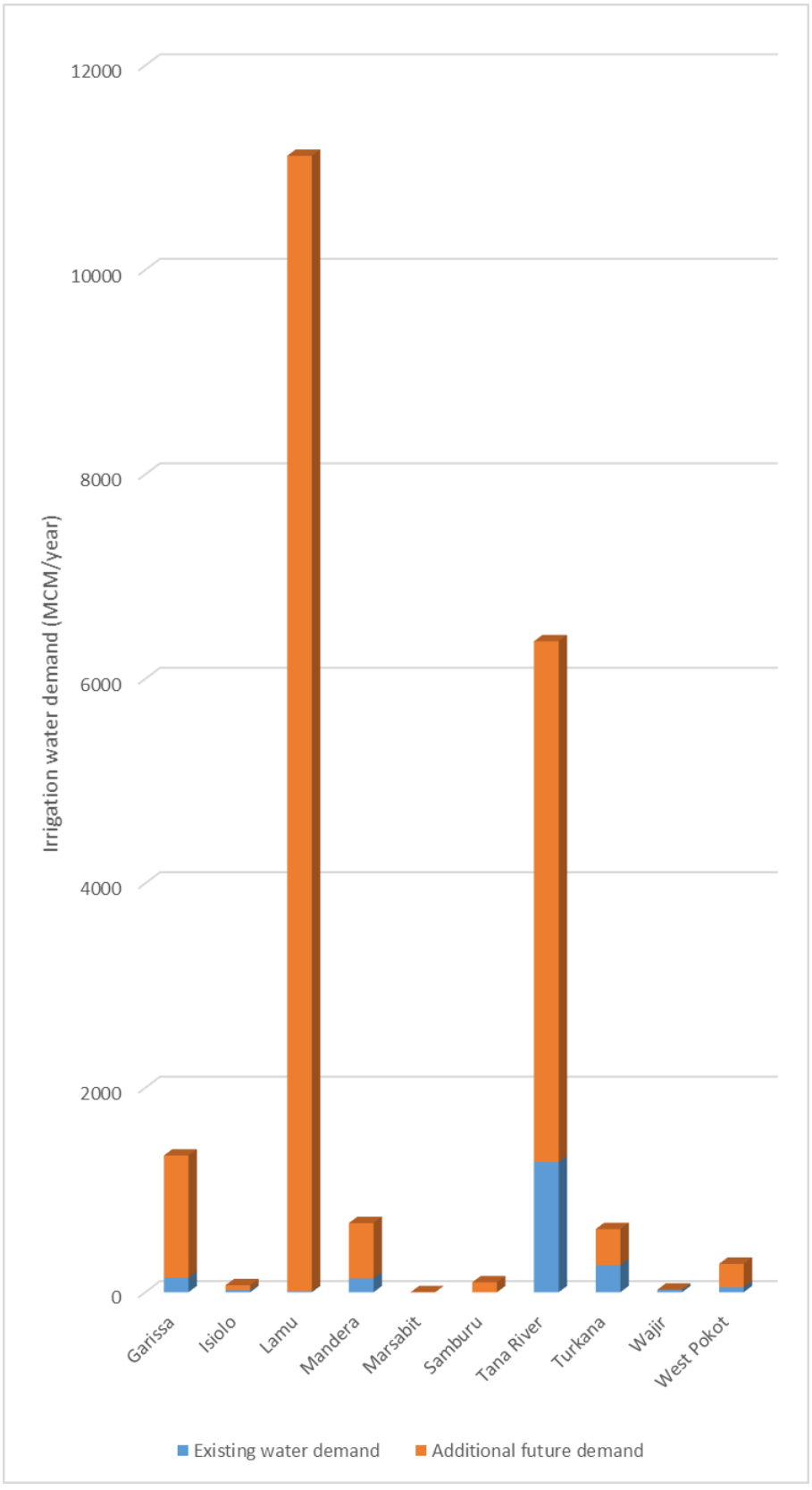


Figure 7-28 Irrigation water demand based on existing area and additional future potential area from CIDP combined with crop water requirements from JICA Report 2013.

7.4.3 Livestock

Livestock populations have been sourced from the latest Census 2019 and projected using growth rates to provide livestock population estimates in 2030 and 2050 (see Section 6.4.4). In line with standard practice, livestock water demand is calculated by applying Livestock Units (LU) and the assumption that each LU uses 50 litres per day. Livestock Units are a global standard measurement unit where Cattle is 0.5 LU, Goats and Sheep 0.1 LU, Camels 1.1 LU, Donkeys 0.6 LU and Pigs 0.2 LU. The resulting present day and future livestock water demand for each county is presented in the table below.

Table 7-13 Livestock water demand for present day and future 2030 and 2050 for each county (MCM/year)

County	Existing Livestock Water Demand	2030 Livestock Water Demand	2050 Livestock Water Demand
Garissa	43	47	58
Isiolo	9	10	13
Lamu	1	1	2
Mandera	62	69	84
Marsabit	10	11	13
Samburu	6	7	8
Tana River	6	6	8
Turkana	15	17	20
Wajir	43	48	58
West Pokot	6	7	9

The data is summarised in Figure 7-29.

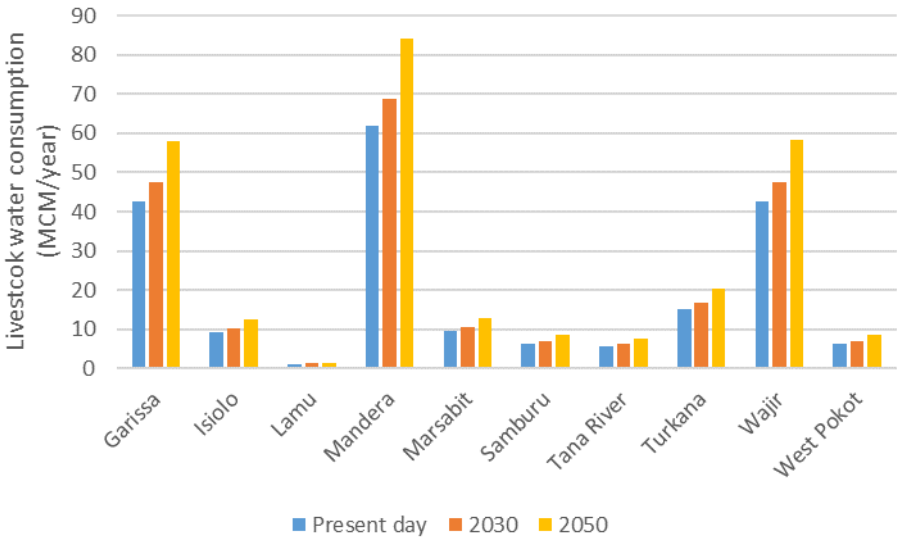


Figure 7-29 Livestock water consumption for each county in present day, 2030 and 2050 based on standard livestock units and water consumption rates

Mandera, Garissa and Wajir have the highest livestock water demand, and Lamu the lowest followed by Samburu, Tana River and West Pokot.

No data was submitted on wildlife populations in the counties; thus it was not feasible to calculate the water demand for wildlife. Further investigation is needed to better understand the water needs of wildlife in the ASAL counties.

7.4.4 Industry

Data relevant to industrial activities sufficient to carry out the present and future water demand estimation are not available. Therefore, we have used the industrial activity and consumption rates from the JICA report[38]. The JICA study categorised districts[39] across Kenya as having high, medium, low or none industrial activity levels based on the number of existing firms in the area as a proportion of the number of existing firms in the country. Isiolo and West Pokot were categorised as low activity areas, Lamu was categorised as a medium activity area and the remaining ASAL counties were categorised as non-activity areas.

The JICA study then applied industrial water consumption rates as a percentage of the urban domestic water demand to estimate present industrial water consumption. Using the rates from the JICA study, in medium-activity areas (Lamu) the industrial water consumption is assumed to be 15% of urban domestic water demand, in low-activity areas (Isiolo and West Pokot) the industrial water consumption is 5% and in the remaining non-activity counties the industrial water consumption is 0%.

In future years, the same consumption rates have been applied and, due to lack of data, it is assumed that industrial water demand will increase in line with the growth of urban water demand in Lamu, Isiolo and West Pokot.

The total industrial water consumption in present and future years 2030 and 2050 is shown in Table 7-14

Table 7-14 Industrial water consumption at present and in future years 2030 and 2050 (MCM/year) for each county

County	Industrial consumption present day	Industrial consumption 2030	Industrial consumption 2050
Garissa	0	0	0.64
Isiolo	0.11	0.16	0.69
Lamu	0.11	0.16	0
Mandera	0	0	0
Marsabit	0	0	0
Samburu	0	0	0

[38] JICA Main Report, Part A, Chapter 6.
[39] Districts as defined under the former constitution of Kenya prior to the 2010 Constitution that came into full effect following elections in 2013

Tana River	0	0	0
Turkana	0	0	0
Wajir	0	0	0.55
West Pokot	0.03	0.08	0.64

7.5 Water Balance

An estimate of the water balance for each county is calculated from the water availability (total run-off) simulated by the GHM (Section 7.1.1 and Section 7.1.2) and the water demand estimated in Section 7.4.

This study is a rapid water resources assessment and furthermore limited data has been made available. The calculations of water availability are, therefore, an estimate based on earth observation data and DHI's Global Hydrological Model which has not been calibrated nor validated for this area partly due to the nature of a rapid water resources assessment and partly due to the lack of observed data, namely historic streamflow data.

Similarly, limited data means that the calculations of water demand are also an estimate, based on data from previous reports and plans and a series of assumptions.

The final water balance is, therefore, our best estimate but comes with inherent uncertainties and should be used with caution when making conclusions and recommendations.

The present-day water balance with availability from total run-off estimated by the GHM (2003 -2020) and water demand estimated for domestic, irrigation, livestock and industry is presented in the table below.

Table 7-15 Present day water balance (MCM/year)

County	Total Run-off	Domestic	Irrigation	Livestock	Industry	Total Demand	Balance
Garissa	326	12	142	43	0	197	129
Isiolo	271	5	21	9	0.11	35	236
Lamu	116	2	11	1	0.11	15	101
Mandera	740	14	135	62	0	211	529
Marsabit	843	6	0	10	0	16	827
Samburu	818	4	0	6	0	10	807
Tana River	254	4	1274	6	0	1284	-1030
Turkana	1647	11	264	15	0	290	1357
Wajir	793	11	25	43	0	79	714
West Pokot	9508	6	50	6	0.03	63	9446

The water balance shows that, on an annual basis, all counties except Tana River county have a surplus of water availability (although in West Pokot this is

likely to be an overestimation, see Section 7.1.1). However, it should be noted that this is a water surplus on an annual basis and the majority of run-off occurs in the rainy seasons whereas the dry seasons are more likely to have a water deficit.

The major discrepancy is in Tana River county where the large existing irrigated area (40,000 ha according to CIPD 2018-2022) yields a negative water balance which cannot be possible and points to inconsistencies in data. The results from the GHM also show that Tana River county has relatively low water availability. The conclusion of this study is that further investigation should be undertaken into the existing irrigated area in Tana River county and the water availability with regards to the potential irrigated area that can be supported.

The total run-off per county and the percentage water use by sector, including the surplus is shown in Figure 7-30.

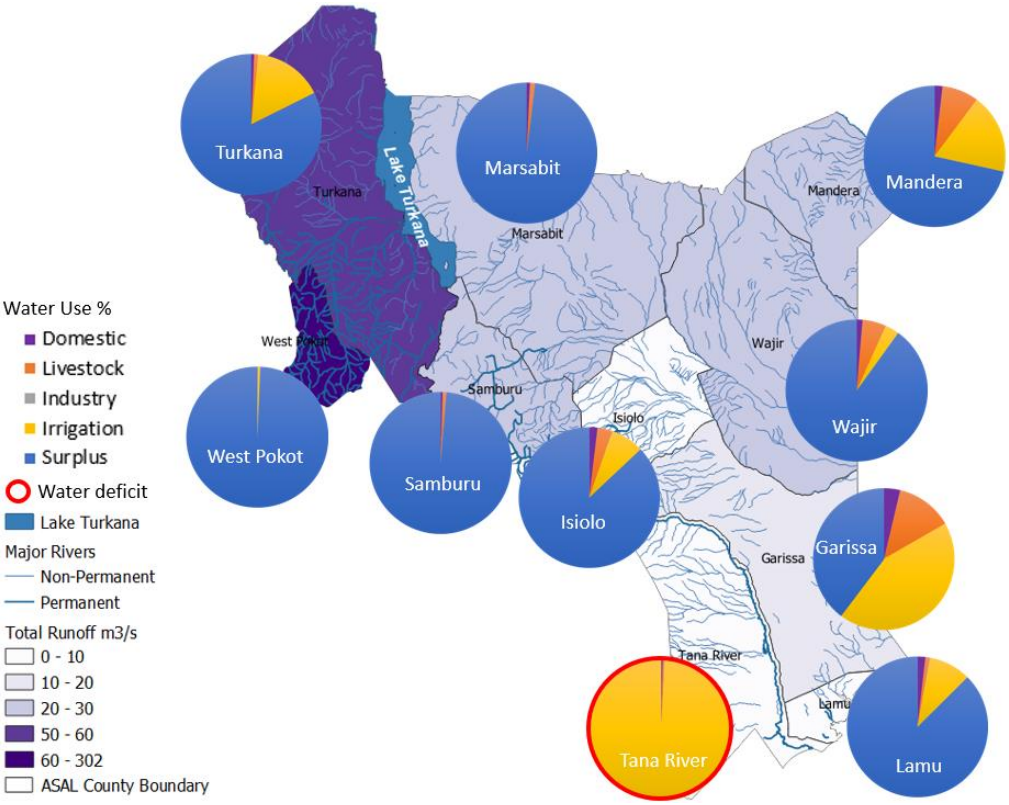


Figure 7-30 Present day total annual run-off (map) and percentage water use by sector including surplus (pie charts), for each county

Irrigation is the sector with the highest proportion of water use in many counties including Tana River, Garissa, Turkana, Mandera, Lamu and Isiolo. In Garissa, Mandera, Wajir and Isiolo counties, livestock also uses a large proportion of the total run-off. Domestic and especially industrial water use is relatively small in all counties compared to the total run-off. In Marsabit, West Pokot and Samburu, the water use by all sectors is relatively small compared to the water availability.

The water balance has also been calculated for future years 2030 and 2050 and is presented in the tables below.

Table 7-16 Future 2030 water balance (MCM/year)

County	Total Run-off	Domestic	Irrigation	Livestock	Industry	Total Demand	Balance
Garissa	409	25	1337	47	0	1409	-1000
Isiolo	352	8	69	10	0.16	88	264
Lamu	152	4	11116	1	0.16	11122	-10970
Mandera	856	26	677	69	0	772	84
Marsabit	1231	14	0	11	0	24	1207
Samburu	1200	9	98	7	0	114	1086
Tana River	367	9	6368	6	0	6384	-6017
Turkana	1970	27	618	17	0	662	1308
Wajir	958	23	25	48	0	96	862
West Pokot	9412	18	278	7	0.08	303	9109

Table 7-17 Future 2050 water balance (MCM/year)

County	Total Run-off	Domestic	Irrigation	Livestock	Industry	Total Demand	Balance
Garissa	525	40	1337	58	0	1435	-909
Isiolo	538	13	69	13	0.32	95	443
Lamu	167	7	11116	2	0.34	11125	-10958
Mandera	1323	41	677	84	0	803	520
Marsabit	1588	22	0	13	0	35	1553
Samburu	1555	14	98	8	0	120	1435
Tana River	450	15	6368	8	0	6390	-5941
Turkana	2497	43	618	20	0	681	1815
Wajir	1374	36	0	58	0	95	1279
West Pokot	9420	28	278	9	0.27	315	9105

In future years, run-off is expected to increase, however in some counties the potential irrigation demand is so great that there is a negative water balance. Similarly, the JICA study found that the water balance could not support the potential irrigated area (see Section 6.4.3). Further investigation is therefore required into the potential irrigated area in Garissa, Lamu, and Tana River.

In other counties, there is still a surplus of water availability on an annual basis and therefore increased water demand could be supported. However, this is on an annual basis and there will likely be a water deficit in the dry season months especially with increased temperatures and evaporation.

Figure 7-31 and Figure 7-32 show total run-off per county and the percentage water use by sector, including the surplus, in 2030 and 2050.

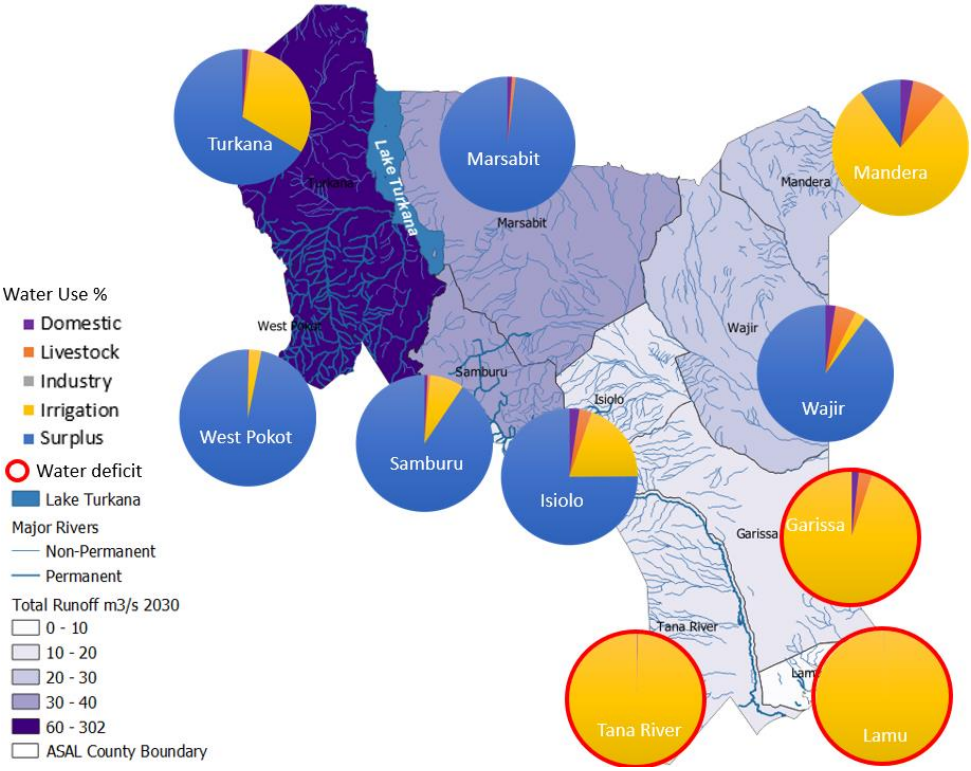


Figure 7-31 2030 total annual run-off (map) and percentage water use by sector including surplus (pie charts), for each county

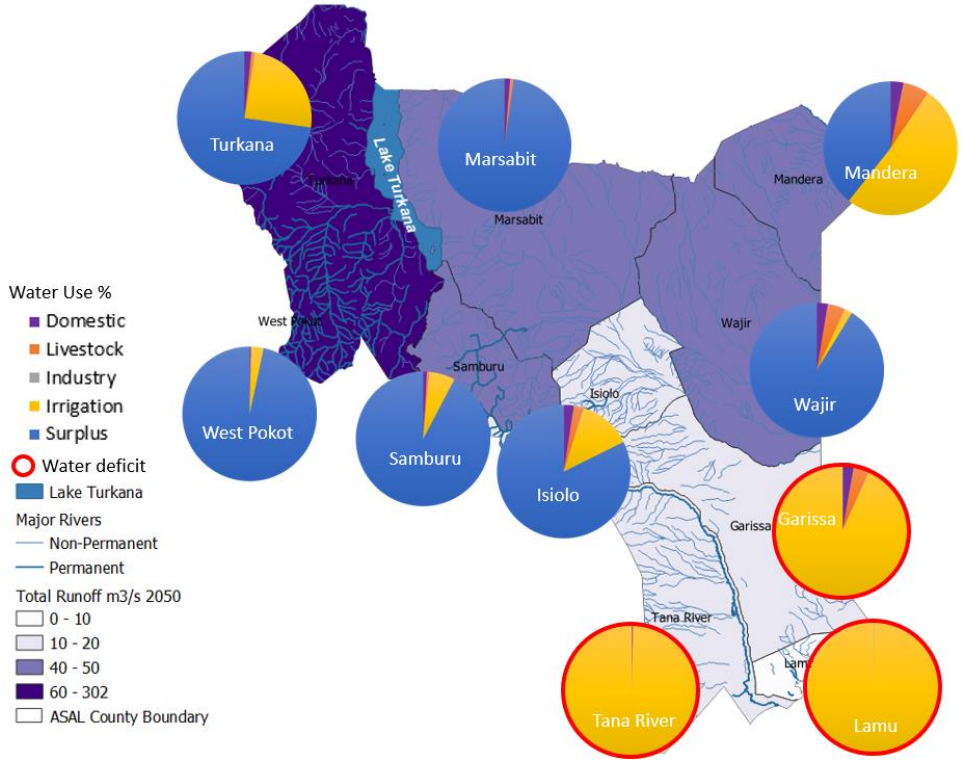


Figure 7-32 2050 total annual run-off (map) and percentage water use by sector including surplus (pie charts), for each county

In future years, irrigation is the main water use sector in the majority of countries except Marsabit (with no irrigated area) and Wajir (where no data was available for future irrigated area and therefore existing irrigated area is used). In Garissa, Lamu and Tana River counties there is an annual deficit of water, therefore suggesting that further analysis should be completed on water availability and projected water demand in these counties especially with regards to potential irrigated area.

7.6 Major findings and conclusions

With regards to climate change, temperatures and PET are projected to increase from present day to 2050 across all counties and months. Precipitation is projected to increase to 2050 in the rainy months and also in the dry months December to February. In the dry months June to August precipitation is projected to decrease. As simulated by the GHM, these projected changes result in an increase in annual total run-off to 2050 in most counties (although West Pokot and Turkana have a decrease in run-off in July and August).

Annually, the water balance indicates that most counties have a surplus of water in the present-day baseline and in future years 2030 and 2050, although the majority of run-off occurs in the rainy seasons and there is likely a water deficit in the dry months. Given that there is an annual surplus, it is possible that the surplus run-off in the rainy seasons could be stored to support water demand in the dry seasons (although storage in reservoirs results in increased water losses through evaporation).

The exception from an annual water surplus in the present-day situation is Tana River county where further investigation should be undertaken into the existing irrigated area and the water availability with regards to the potential irrigated area that can be supported.

The exception in future years is Tana River County, and to a lesser extent in Garissa and Lamu, where there is an annual water deficit due to the demand from the large potential irrigated area. Further investigation is therefore required into the potential irrigated area in these counties.

Limited information has been submitted on groundwater and there are currently no known interventions being financed to explore groundwater potential in the project area. In Kenya's IWRM Action Plan[40], action 2.7 proposed a multistakeholder initiative to map groundwater potential specifically in Turkana, Marsabit, Wajir and Mandera. A tentative timeline of 2022 has been mentioned with financing flagged by the Government of Kenya, UNESCO and JICA.

[40] Link IWRM Action Plan

8 Risk assessment

This chapter builds on the information presented in chapter 7 on water resources to consider the effects of future climate change and hazard risks on the available water and county populations. This includes water related risks and some social dimensions of vulnerability such as conflict and health. Disclaimer: The majority of the data used to develop the risk profile is based on satellite data and could not be calibrated with data from the ground.

8.1 Introduction

In August 2021 the IPCC published its latest global assessment on climate change. The impacts of human-induced climate change will influence water resource availability around the globe, resulting in less or more water, and an increase in the frequency and intensity of hydrometeorological events. Competition over already scarce resources could increase, increasing the vulnerability of exposed populations. The Global Status of Water Security Report[41] identifies four main headline risks that impact on water security. These are water scarcity, floods, inadequate water supply and sanitation, and ecosystem degradation and pollution.

As a result of increasing risk, more focus is being put on reducing the risk of hazards to avoid disaster. Community-based approaches are becoming more widespread and integrated into institutional and planning arrangements, in line with the global Sendai Framework for Disaster Risk Reduction. As part of the Ministry of Water and Sanitation Strategic Plan 2018-2022, community-based drought and flood risk reduction action plans will be developed in 29 at-risk counties. The ten counties of this study are included in those identified as the most prone counties.

Some studies on climate and vulnerability risk assessments have been conducted in the study area. As part of the NDMA project "Hazard Atlas Development for Turkana, Tana River, Garissa, Kwale, Kilifi and Baringo Counties" funded by UNDP, there are three hazard maps for the project area dating from 2016 which investigate drought, flood and conflict hazards in the three counties. Some relevant data has been extracted from these hazard maps to inform some of the sections below (see Section 8.3)

8.2 Climate risk assessment

8.2.1 Water scarcity

Present day

The Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report (AR6) (August 2021) shows that human-induced climate change is already affecting many climate extremes in every region across the globe, and there is increased evidence of observed changes in extremes such as heatwaves and droughts.

[41] securing-water-sustaining-growth.pdf (gwp.org)

The observed changes in temperature extremes and drought across the world since the 1950s (split into IPCC AR6 WGI reference regions) is shown in Figure 8-1 and Figure 8-5, where Kenya is within the North Eastern Africa (NEAF) region.

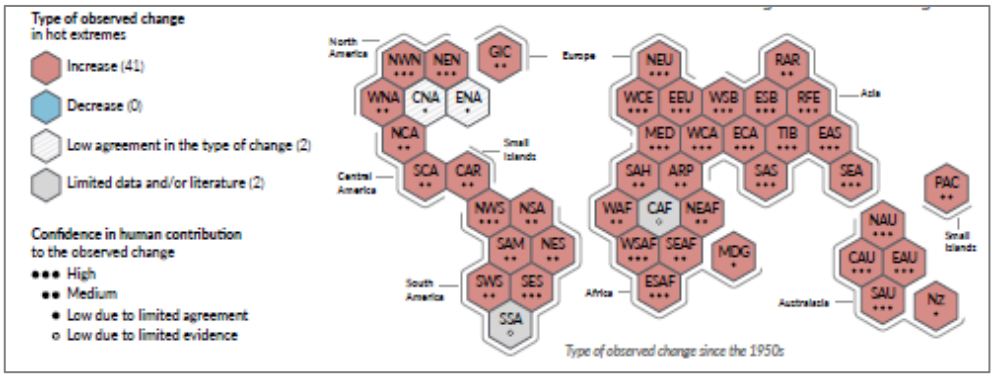


Figure 8-1 Assessment of observed change in hot extremes and confidence in the human contribution to observed changes in the world's regions

Source: IPCC 2021 Summary for Policy Makers (Figure SPM 3, page SPM-12)

Across nearly all regions, hot extremes have increased since the 1950s with medium confidence in human contribution to this change including in the NEAF region in Africa. The rate of surface temperature increase has generally been more rapid in Africa than the global average.

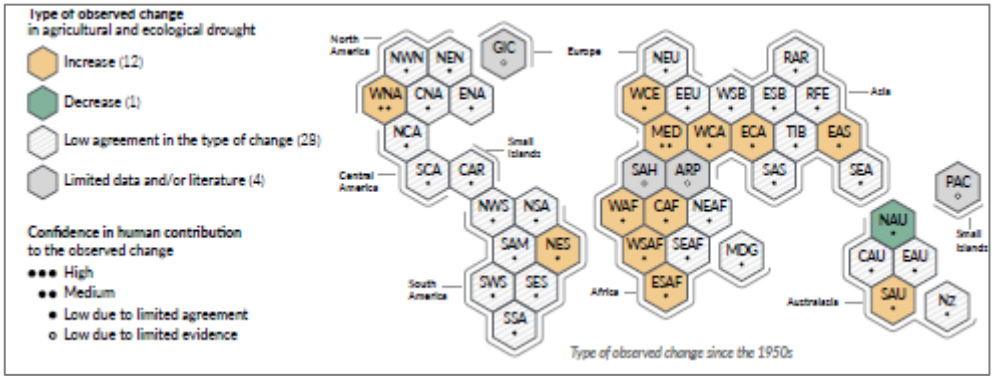


Figure 8-2 Assessment of observed change in agricultural and ecological drought and confidence in the human contribution to observed changes in the world's regions

Source: IPCC 2021 Summary for Policy Makers (Figure SPM 3, page SPM-12)

The data and/or literature evidence is too limited or diverging to determine observed change in agricultural and ecological drought since the 1950s in many regions including NEAF. However, for nearly all regions across the globe where there is sufficient and converging data and/or literature, there has been an increase in agricultural and ecological drought events since the 1950s.

Indicators using Earth Observation datasets can also be used to analyse water scarcity. The Effective Drought Index (EDI) (see Section 4.3) can be used to assess drought periods and the EDI average for the whole ASAL area is shown in Figure 8-3 in two different formats: timeseries and column chart.

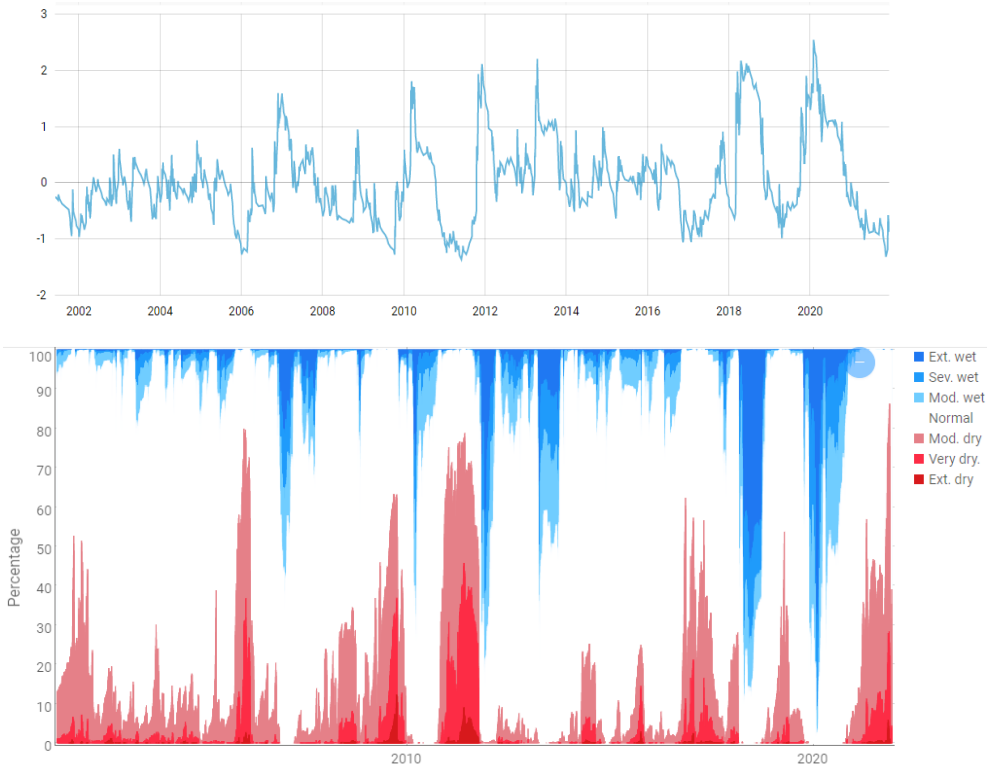


Figure 8-3 Effective Drought Index 2000-2020 for the 10 ASAL area as average EDI timeseries (top) and as percentage area in each EDI category column chart (bottom)

EDI ranges: <-2 = extreme drought, -2 to -1.5 = severe drought, -1.5 to -1 = moderate drought. Between -1 and 1 is near normal conditions.

The EDI shows that drought periods (where the EDI falls below -1) occurred in 2005/2006, 2009, 2011, 2016/2017, 2019 and currently in 2021.

To analyse water availability and demand in water scarce years, the total run-off for each year as simulated by the GHM was analysed for each county (2003 – 2020) and the lowest run-off year selected to represent a water scarce year. The lowest run-off year differs for each county depending on, for example, the spatial distribution of rainfall across the counties each year. The resulting present-day water balance for each county in the most water scarce year during the 2003 – 2020 period is shown below.

Table 8-1 Water balance (MCM/year) for the most water scarce (lowest annual run-off) year within 2003 - 2020 for each county

County	Total Run-off	Domestic	Irrigation	Livestock	Industry	Total Demand	Balance
Garissa	49	12	142	43	0	197	-147
Isiolo	45	5	21	9	0.11	35	9
Lamu	3	2	11	1	0.11	15	-12
Mandera	257	14	135	62	0	211	46
Marsabit	257	6	0	10	0	16	241

Samburu	105	4	0	6	0	10	95
Tana River	82	4	1274	6	0	1284	-1202
Turkana	537	11	264	15	0	290	246
Wajir	283	11	25	43	0	79	204
West Pokot	2205	6	50	6	0.03	63	2143

In Garissa (2017), Lamu (2016) and Tana River (2011) counties there is a negative water balance in the most water scarce year, indicating that in the present day the total demand cannot be met in water scarce years. Note that this is an annual water balance, and there will therefore be a greater water deficit in the dry seasons.

Future projection

In the future, with additional increases in global warning, changes in hot and cold temperature extremes are projected to get larger according to the IPCC AR6 report. Projected changes in annual maximum temperature and annual minimum temperature at 1.5 °C, 2 °C and 4 °C of global warming compared to 1851 – 1900 is shown in Figure 8-4. Results are based on simulations from the CMIP6 multi-model ensemble mean.

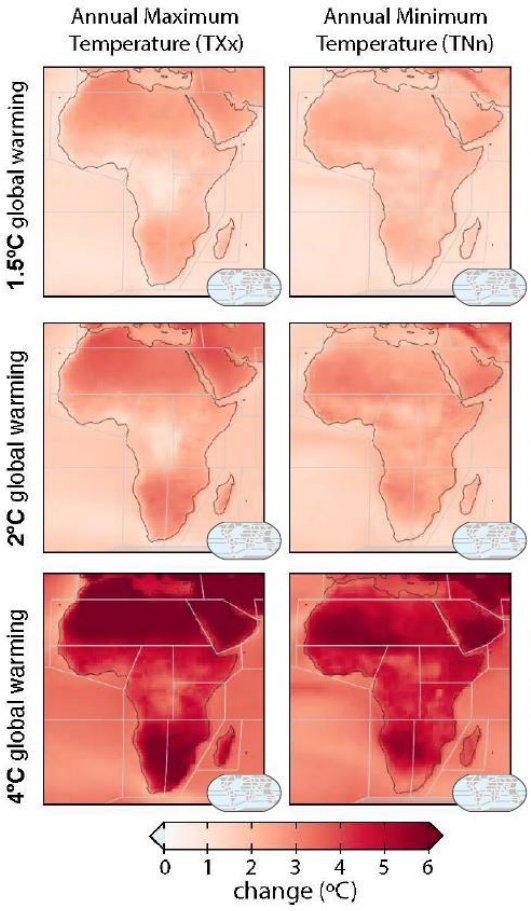


Figure 8-4 Projected changes in annual maximum temperature and annual minimum temperature at 1.5 °C, 2 °C and 4 °C of global warming compared to 1851 – 1900

Source: IPCC Sixth Assessment Report Regional Fact Sheet Africa

8.2.2 Floods

Present day

The Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report (AR6) (August 2021) also shows that there is increased evidence of observed changes in extremes such as heavy precipitation, as shown in Figure 8-5.

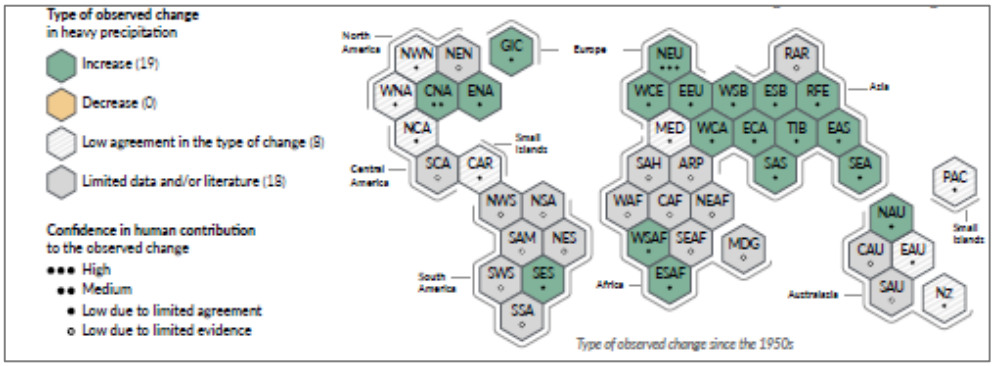


Figure 8-5 Assessment of observed change in heavy precipitation extremes and confidence in the human contribution to observed changes in the world's regions

Source: IPCC 2021 Summary for Policy Makers (Figure SPM 3, page SPM-12)

The data and/or literature evidence is too limited to determine observed change in heavy precipitation extremes since the 1950s in many regions including NEAF. However, for all regions across the globe where there is sufficient and converging data and/or literature, there has been an increase in heavy precipitation events since the 1950s.

Flood indicators can also be used to analyse flood risk across the 10 ASAL counties. Flash floods are local floods, which are rapidly evolving and occur on a small catchment scale often initiated by local convective storm cells. The main factor causing flash floods is heavy rainfall, but their severity and initiation are influenced by the catchment characteristics and the current state of the catchment.

The Flash Flood Potential Index (FFPI) calculated from earth observation data (see Section 4.3) is shown in Figure 8-6 as the average flash flood risk over the time period of data (2007 – 2021), where 0 is low risk and 9 is very high risk.

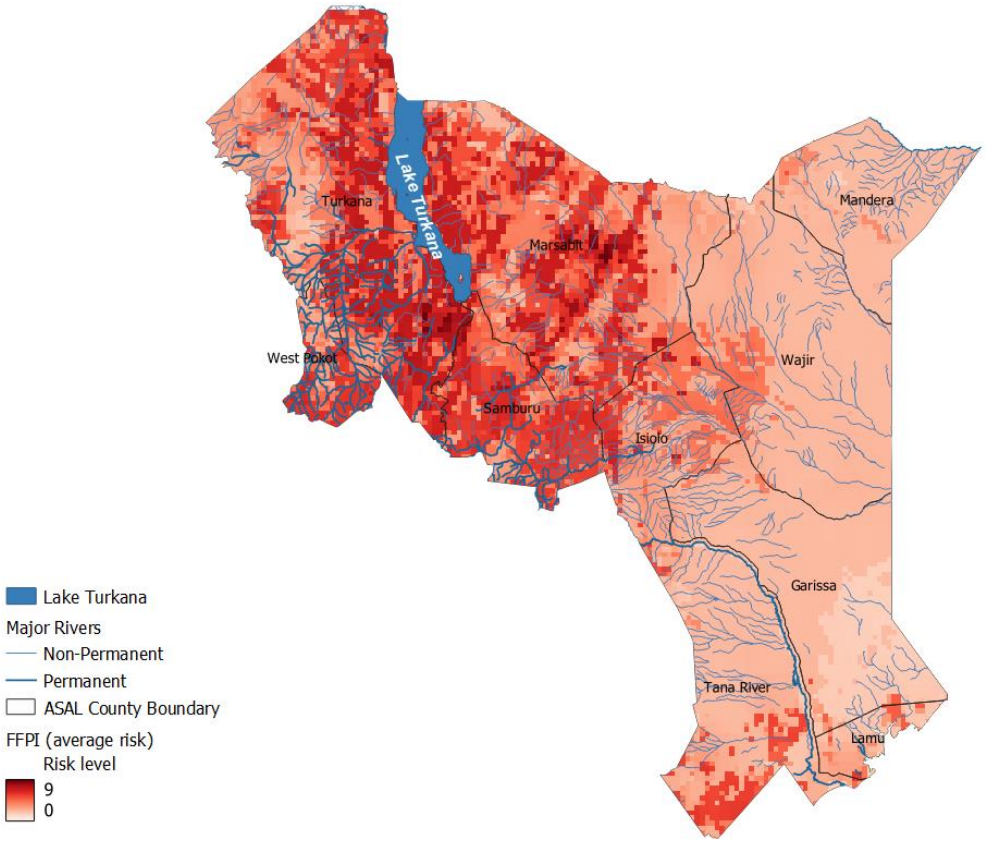


Figure 8-6 Average Flash Flood Potential Index (FFPI) 2007 – 2021 from low risk (0) to very high risk (9)

The FFPI data has been averaged to summarise the flash flood risk for each county. Figure 8-7 shows the proportion (%) of each county with a flash flood risk of high or very high as an average over the data time period (2007-2021).

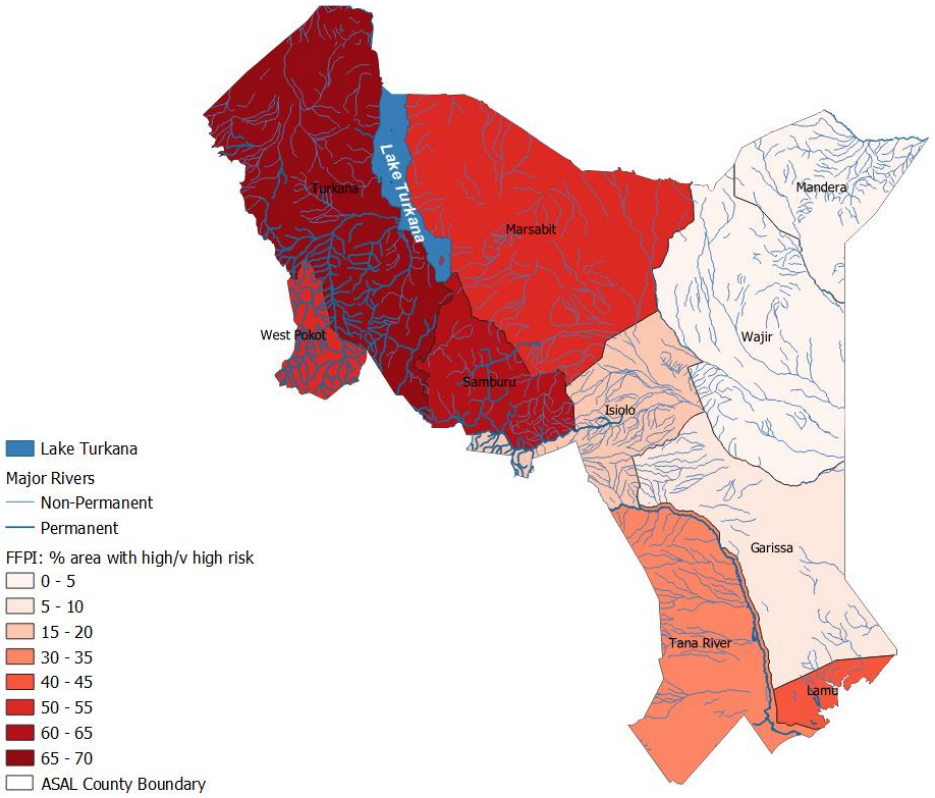


Figure 8-7 Total area of each county with an average flash flood risk of high or very high between 2007-2008 based on the Flash Flood Potential Index (FFPI)

Turkana, Samburu, Marsabit and West Pokot counties have the largest areas with a high (or above) risk of flash flood, and parts of Tana River, Isiolo and Lamu counties are also at high risk. In general, Wajir and Mandera are at low risk of flash flooding, and only a small proportion of Garissa (5-10%) is at high risk of flash flooding.

Riverine flooding, where water overflows the riverbanks, is also mostly caused by heavy rainfall. The GAR 15 global flood hazard assessment (see Section 4.3) determines reference flood hazard maps for different return periods. The flood hazard maps with a 25- and 100-year return period are shown in Figure 8-8 and Figure 8-9. It is possible that these flood hazards will occur at a higher frequency in future years with projected increases in rainfall.

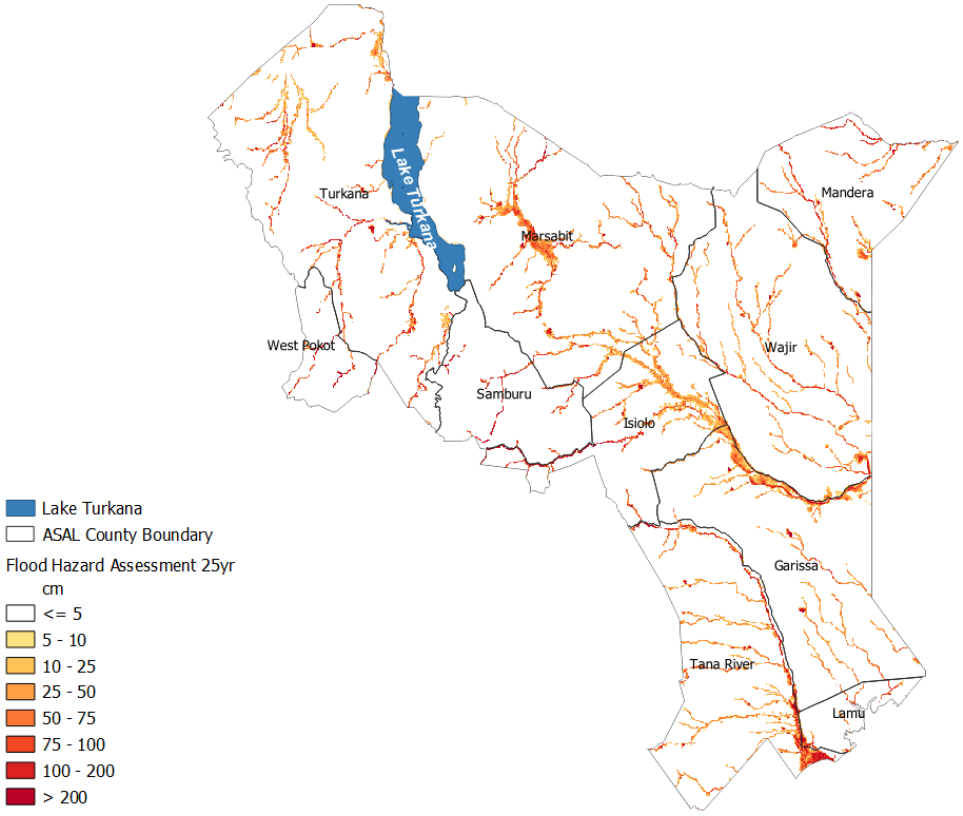


Figure 8-8 Flood Hazard Assessment (riverine floods) for 25 year return period

Source: GAR15 Global Flood Hazard Assessment

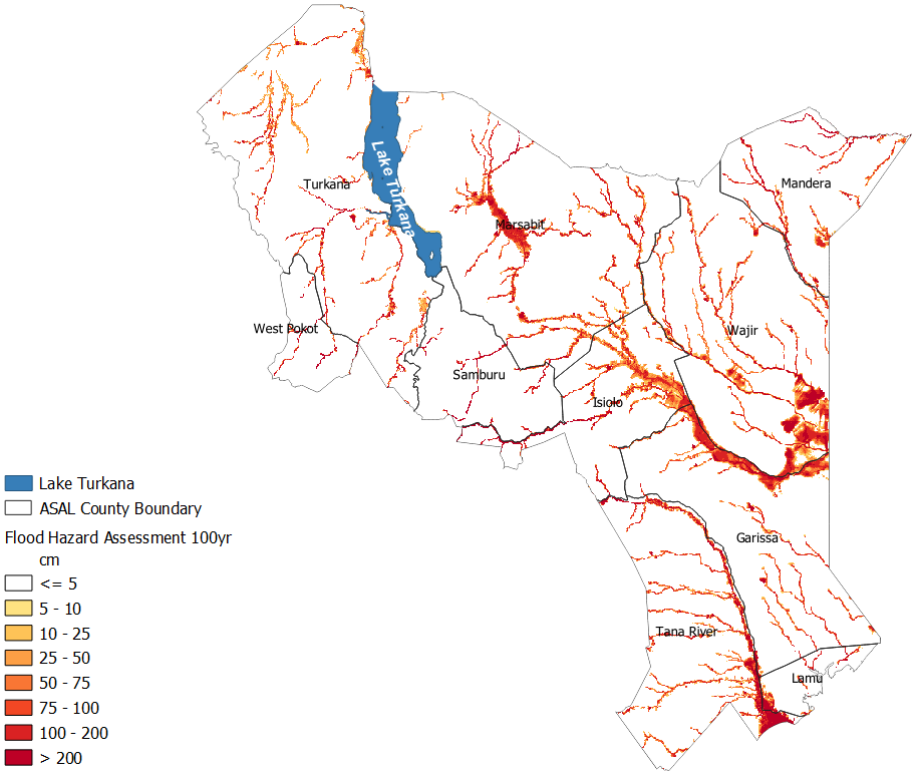


Figure 8-9 Flood Hazard Assessment (riverine floods) for 100 year return period

Source: GAR15 Global Flood Hazard Assessment

Riverine flooding is, by nature, concentrated around river channels as seen in the Figures above, with more widespread flooding where the elevation is relatively low around the river channels e.g., on flood plains. This indicator uses the SRTM elevation model (shown in Figure 7-3), and the more widespread flooding occurs adjacent to river channels e.g., in Marsabit, Isiolo, Garissa, Wajir and Lamu where the elevation is relatively low around the river channel.

Future projection

In the future, with additional increases in global warning, the IPCC Sixth Assessment Report (AR6) (August 2021) reports that changes in mean and maximum one day precipitation are projected to get larger. Heavy precipitation and pluvial flooding (flash floods and surface water) are projected to increase for the mid-21st century for a global warming of at least 2 °C.

Projected changes in annual mean precipitation and annual maximum daily precipitation at 1.5 °C, 2 °C and 4 °C of global warming compared to 1851 – 1900 are shown in Figure 8-10. Results are based on simulations from the CMIP6 multi-model ensemble mean.

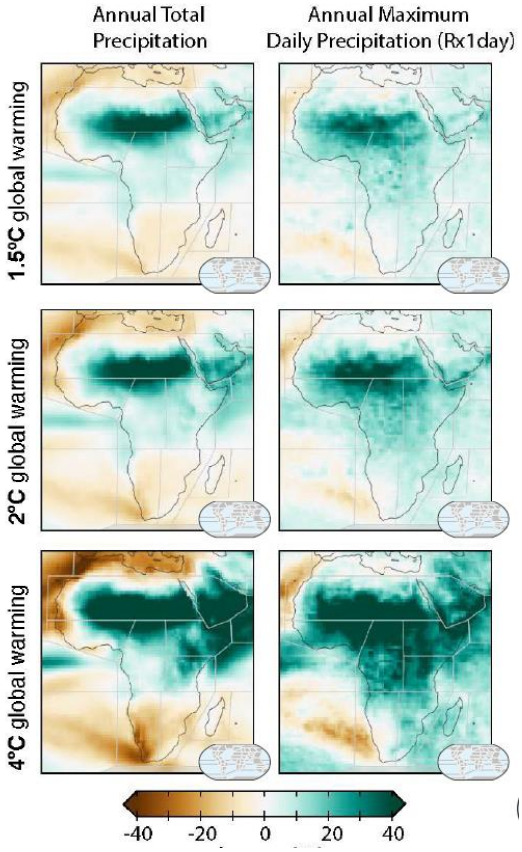


Figure 8-10 Projected changes in annual mean precipitation and annual maximum daily precipitation at 1.5 °C, 2 °C and 4 °C of global warming compared to 1851 – 1900

Source: IPCC Sixth Assessment Report Regional Fact Sheet Africa

8.3 Vulnerability risk assessment

8.3.1 Conflict between water users

Limited data were submitted on existing conflicts between water users in the project area. From the hazard atlases developed for the three counties, we can see conflicts identified and interventions proposed by the county DRR steering committees. Some conflicts identified relating to water are presented in the table below for the three counties where risk mapping has occurred:

Table 8-2 Conflicts identified in Garissa, Tana River and Turkana counties (Source: Kenya County Hazard Atlases 2016[42])

County	Conflicts identified
Garissa	Land ownership disputes, farmland disputes, pasture and water, resources inequality, human wildlife conflicts, electoral and administrative boundaries, communal land use problems, pastureland and water sources, competition over pasture and water, lack of access to water points, livestock destruction, crop destruction, tribalism, and politics
Tana River	Lack of land adjudication, inadequate water and pasture, lack of respect in relation livelihoods, competition over limited resources
Turkana	Internal clan-based conflicts between pastoral communities over land and water, cross-border conflicts (especially with Pokot county)

Some of the impacts of conflict include displacement of population, increased vulnerability, reduced food and livelihood security, disruption to family and community life including attendance at school, as well as increased risk of disease for both human and livestock populations.

During droughts, pastoralists are often forced to migrate to grazing grounds and water sources further away from their usual pasture lands. Conflict over natural resources is commonplace, especially among pastoralist communities. Their conflicts involve disagreements around water and grazing sites, administrative and constituency boundaries.

An increase in land grabbing in pastoralist areas is an increasing concern and could further exacerbate existing conflicts. Blocking pastoralist migration routes will reduce their mobility and increase vulnerabilities if provisions are not made to protect the right of passage.

[42] County Hazard Atlases can be accessed via https://opendata.rcmrd.org/pages/atlases

8.3.2 Refugees and host communities in ASAL counties

The ASAL region in northern Kenya is geographically located in an area surrounded by historical and ongoing conflicts. The counties border with Somalia to the East, Ethiopia to the North, and South Sudan to the Northeast. As of November 2021, there are 540,433 registered refugees and asylum seekers in Kenya. Most originate from Somalia (54%), with other major nationalities being South Sudanese (24.6%), Congolese (9%); Ethiopians (5.8%)[43] . The majority are hosted in two main camps, Dadaab in Garissa County and Kakuma in Turkana County.

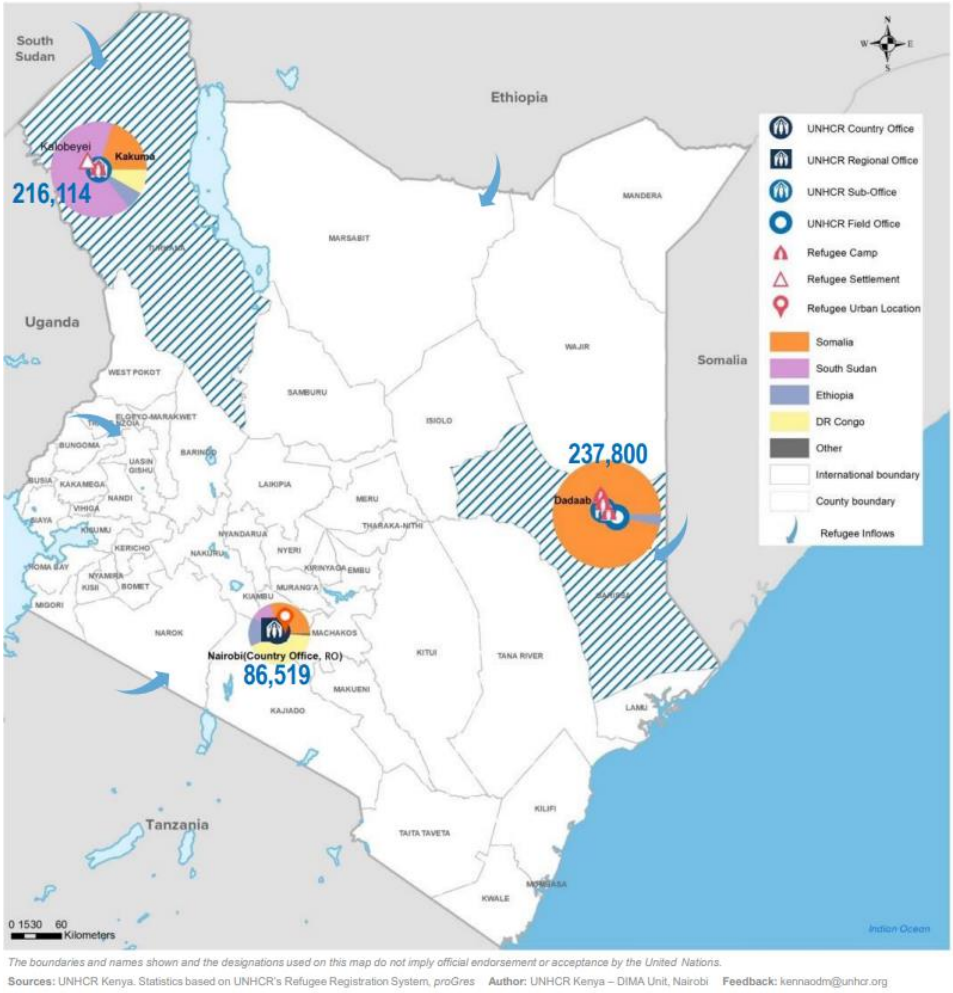


Figure 8-11 Registered refugees and asylum-seekers as of 30 November 2021

Source: UNHCR[44]

Hosting increasing refugee populations creates additional need for water resources (they are not included in water demand estimates in Chapter 7), supply, and sanitation as well as livelihood provision to ensure human security, not only for refugees, but also the host population and can lead to additional tensions or conflicts over scarce (water) resources.

[43] Key figures in Kenya (unhcr.org)
[44] PowerPoint Presentation (unhcr.org)

8.3.3 Health

Water borne diseases

Limited data were submitted on health relating to water borne diseases. The three hazard atlases for Turkana, Garissa and Tana River counties referenced in Section 8.1 have some indication of health-related hazards in those counties but further investigation should be made.

Covid-19

Access to sanitation and handwashing is important to combat the spread of Covid-19. While no specific data has been submitted relating to the Covid-19 pandemic in the ten counties, we can see that additional financing has been channelled to some counties to combat the spread of the virus (see overview of projects financed in Annex 2). Whether the future impacts of the pandemic will result in a re-allocation of finance remain unclear, but it can be assumed that at least a part will be allocated to water resources, water supply and sanitation investments and improvements.

8.4 Major findings and conclusions

The Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report (AR6) (August 2021) shows that there is increased evidence of observed changes in extremes such as heatwaves, droughts and heavy precipitation, including in the ASAL area.

In the future, with additional increases in global warning, changes in hot and cold temperature extremes and changes in mean and maximum one day precipitation are projected to get larger across Africa. Heavy precipitation and pluvial flooding are projected to increase for the mid-21st century for a global warming of at least 2 °C.

With regards to Flooding, Turkana, Samburu, Marsabit and West Pokot counties have the largest areas with a high (or above) risk of flash flood, and parts of Tana River, Isiolo and Lamu counties are also at high risk

Conflicts exist between users over scarce water resources, and climate change could exacerbate these.

9 Financing and projects

This chapter looks at the available information and data received on past, ongoing, and planned programmes, projects and investments in the 10 selected counties. A gap analysis of technical and geographical scope is conducted and major findings and conclusions from this exercise are presented.

9.1 Available finance and major sources

ASAL counties receive financing for water resources from a range of partners, including internal partners: Ministries, Departments, and Agencies (MDAs), Academic Institutions, ASAL County Governments, ASAL Parliamentary group of County Assemblies. External partners include bilateral and multilateral organizations, NGOs, CSOs, FBOs, UN Agencies, and the Private Sector.

ASAL Partnership Coordination Framework (PCF)[45] was created to ensure collaboration and cooperation between partners. It aims to complement existing frameworks and structures to ensure harmonization of stakeholders' activities, efficient programming, responsive service delivery, information reporting, sharing and knowledge management.

9.1.1 Internal funding mechanisms

The Equalisation Fund which is part of the Constitution of Kenya is a Fund into which 0.5% of all revenue collected by the national government of Kenya is allocated. The government can use these funds only for provision of basic services, including for water, in marginalised areas with the aim to raise the quality of services in these areas to a level enjoyed in other parts of the country. ASAL counties and communities qualify for these funds as a result of their socioeconomic status.

Water Sector Trust Fund (WSTF) is a financing institution which provides conditional and unconditional grants to counties to assist with financing the development and management of water services, especially in marginalised areas or localities which are under-served. Initiatives financed by WSTF are often at community level, providing water services in rural areas or under-served poorer urban areas.

WSTF receives funding from the national budget, the Equalisation Fund, county governments, as well as donations, grants and bequests.

WSTF's strategic objective is to raise Ksh.36.5 Billion by 2022[46]. Current Funding to WSTF from the European Union and its Member states stand at an approximate total of 90.46 Million Euros (KSh. 10.403 Billion). Projects being financed and implemented in the 10 ASAL counties by EU members include:

- Water Supply and Sanitation for Urban Poor (WSSUP) Program
- Green Growth Employment Programme (GGEP):

[45] Partnership Coordination Framework for Development of Arid and Semi-Arid Lands developed by Ministry of Devolution and Arid and Semi-Arid Lands
[46] Water Sector Trust Fund Brief 2019 – access via https://waterfund.go.ke/brochures#

- Water and Livelihood Programme: subset of the Green Growth and Employment Programme
- Ending Drought Emergencies: Climate Proofed Infrastructure for improved access to water supply and sanitation in ASALs (EDE CPIRA) Programme
- COVID-19 Emergency Response Programme – EDE CPIRA Programme

Full details of these projects can be found in Annex 2. It is not confirmed if all these projects proceeded as planned due to the Covid-19 pandemic outbreak. Programmes financed by Finland, Sweden and Spain are not targeting ASAL counties covered in this rapid assessment.

9.1.2 External funding

ASAL Development Partners Group, whose members comprise of (at least) the following[47] :

- ACTED
- Denmark
- EU
- FAO
- JICA
- National Drought Management Authority (NDMA)
- Netherlands
- SDDA
- Switzerland
- UNICEF
- UNOPS
- USAID
- World Food Programme (WFP)

Multilateral development banks including the World Bank and African Development Bank are also active in financing interventions.

International NGOs and Foundations, as well as national and local organizations, are also important sources of financing for investments and projects in the 10 counties. No data were submitted, hence there is a gap in the knowledge of how these stakeholders are contributing to water resources management in the project area and further investigation is needed to maximise potential collaboration.

[47] List of members developed from list of attendants in the minutes of meeting from ASAL Development Group meeting 19th May 2021

9.2 Projects and programmes

Limited data on previous and ongoing projects was submitted by members of the technical committee for review. With the support of the Royal Danish Embassy in Nairobi a request for information was circulated to ASAL Development Partners Group for input on their ongoing and planned projects and financing opportunities.

This information has been complemented with the information on projects submitted by the counties and further complemented by some internet searches. The full list of previous and ongoing projects in the 10 selected countries can be found in Annex 2.

9.3 Major findings and conclusions

9.3.1 Technical trends of implemented projects

According to the limited data received, most programmes and projects financing focus on water supply and sanitation, and climate proofing infrastructure. This is aligned with the goals of the water sector trust fund to tackle water supply and sanitation issues, for which data has been made available. There is less focus on governance or data related projects.

DGIS Netherlands (The Dutch Ministry of Foreign Affairs) has implemented several projects which are more aligned with IWRM principals as well as a focus on environment and nature-based solutions.

No data has been submitted to suggest that there have been previous projects financed with a focus on groundwater, but there are planned interventions with funding from the World Bank as part of the Horn of Africa Groundwater for Resilience Programme to take place from April 2022 in all ten counties.

Limited information has been submitted on the use of nature-based solutions when considering infrastructure investments.

9.3.2 Financing gaps

Due to limited data it is challenging to estimate what the existing financing gaps are in the ten counties.

SDG 6 envisions 100% access to water supply and safe sanitation by 2030. To this end, Kenya will need to invest an estimated KSh 100b annually while actual expense is currently only KSh 60b[48]. While this is a national figure, we know that access to water and sanitation services are low in the 10 counties so significant investments will be needed to raise these figures to reach the target.

From the investigation into the status of planned irrigation and dam investments from the Water Master Plan, only 2 out of 11 investments were completed. It is unclear whether the remaining planned investments lack the

[48] From a Statement by Cabinet Secretary, Ministry of Water, Sanitation and Irrigation, Sicily K. Kariuki (Mrs) *See:* https://nation.africa/kenya/brand-book/initiatives-by-kenya-government-to-boost-national-water-security-3331024

financing to continue. An investigation into the status of planned investments from the Water Master Plan may shed light on further financing gaps.

To fill this financial gap, there could be more focus on mobilising financial resources from the private sector. No data was submitted on current efforts to leverage financing for water resources investments or public-private-partnerships (PPP).

10 Recommendations

Based on the rapid assessment conducted across the four profiles of this study (governance, demography, water resources and risks) a number of gaps have been identified and topics investigated which require elaboration or further investigation.

Several of the key documents assessed for this study include plans and recommendations to be implemented by 2030. Achieving these political goals will require continued support and investments in water resources planning and infrastructure. Several priority actions for investments in IWRM at the national level have already been identified in the IWRM Action Plan, and many of these could be taken forward in the 10 counties.

10 high-level recommendations that have come out of this rapid assessment are presented in the sections below. While data availability has limited the full potential of this rapid assessment, these recommendations target the areas where data has been sufficient or point towards gaps where further analysis would be beneficial. The recommendations require further consideration by the Technical Committee members.

10.1 Priority areas for improvement physical infrastructure

1. Invest in more water supply and sanitation in the 10 counties to achieve targets, as standards are far below the national average (see section 6.3. This could be done by financing additional water storage capacity, improving water harvesting infrastructure, increased understanding and research into groundwater recharge, to increase resilience to droughts, and bridge the increasing seasonal differences that have been projected to create a basis for secure livelihoods. This should be financed from government, private sector and development partner sources.
2. A comprehensive mapping exercise of available and planned financing from all stakeholders, including NGOs and organisations which were not considering in this study, could identify further gaps or opportunities for investment synergies. To compliment this, an analysis of the status of all planned interventions, including the CIDPs, MTP, Vision 2030 and the National Water Master Plan 2030 should be considered in each of the 10 counties. This could identify if plans are on track or whether there is a need to reprioritize planned investments in line with the water balance exercise. This exercise could also identify infrastructure investments that may require additional funding (see Table 6-13.
3. Investigate the potential for inclusion of nature-based solutions in future investments in water resources (see Section9.3.1.

10.2 Priority areas of improvement for governance arrangements

4. Increase capacity at the county level to access and engage with water resources data and information. This entails data collection, access to data,

data consolidation, and management, as well as building staff capacity and system capacity on data access and handling.

5. Map stakeholder engagement more comprehensively to understand actors outside the public sphere who are engaging in water management and could potentially finance some of the gaps identified. This is also important for the continuation of the project. The right stakeholders need to be engaged for future planning of interventions. This includes stakeholders engaging in data, water services and water resources management.
6. Analyse and address potentially escalating conflict over water resources, including the increase of floods and drought as a driver of conflict for pastoral communities There are no obvious governance structures that apply to cross-border or mobile water users. One suggestion could be to investigate how this can be addressed at ASAL or cross-county level, with a recommendation to prioritize counties with the highest livestock populations, such as Mandera, Wajir, Garissa (see Figure 6-10).

10.3 Priority areas of improvement data

7. Improve monitoring and access to data at county level on physical water-related resources, infrastructure and the state of environment.
8. Improve access to data by implementing a Decision Support System (DSS) to support the relevant agencies in Kenya getting easy access to data to inform robust decision making. A DSS would improve monitoring and access to data (see Recommendation 8) and increase capacity for engagement with water resources data and information (see Recommendation 5). In addition, a DSS can support robust decision making regarding investment and interventions, including nature-based solutions (see Recommendation 3), by providing a tool to analyse and compare the impact of interventions (e.g. irrigation schemes, dams, flood prevention) and prioritise investment through scenarios and multi-criterial decision analysis. The DSS, or existing databases, should be supplemented by freely available Earth observation datasets to provide easy access to a consolidated database of all available information.
9. Check whether the irrigation potential for each county is calculated appropriately considering the available water balance, including under climate change scenarios, in addition to soil/land potential, and support county governments to develop county water services strategies to inform future CIDPs in line with the Water Act 2016 regulations-

Appendix A List of Literature and Documents Consulted

Appendix A.1 Documents received from Technical Committee and UNEP

Author	Year	Title / Publication / Document
AFRICAN DEVELOPMENT FUND	2005	KENYA EWASO NG'IRO NORTH NATURAL RESOURCES CONSERVATION PROJECT (ENNNRCP) APPRAISAL REPORT, FEBRUARY 2005
Alois Muthini David, assisted by Prof. Munguti Katui Katua	2013	Arid and Semi-arid lands (Asals) Water Sector Institutional Analysis in Marsabit County, Kenya, published in Feb 2013
AMCOW	2011	Water Supply and Sanitation in Kenya - Turning Finance into Services for 2015 and Beyond - An AMCOW Country Status Overview
Birgitte von Christierson and Sílvia Leirião	2020	Support to Sustainable Development in Lake Turkana and its River Basins, Establishment of the online portal Report, October 2020
Brooklyn Economic Consulting Ltd for UNICEF Kenya	2020	WATER AUDIT REPORT, LOIMA AND TURKANA CENTRAL SUBCOUNTIES, TURKANA COUNTY, KENYA, 2020
County Government of Garissa	Unknown	Second Garissa County Integrated Development Plan (2018-2022) Building basic, people responsive infrastructure for the socioeconomic transformation of Garissa County, Prepared by the County Government of Garissa
County Government of Garissa	2020	County Fiscal Strategy Paper, February 2020, Prepared by the County Government of Garissa
County Government of Garissa	2014	County Drought Contingency Plan of Garissa County, February 2014
County Government of Garissa	2019	Kenya Gazette Supplement, Garissa County Act 2018, published in Nairobi in January 2019,
County Government of Isiolo	2018	Isiolo County Integrated Development Plan 2018-2022, published in March 2018,
County Government of Isiolo	Unknown	Isiolo County Water and Sanitation Services Bill 2019
County Government of Isiolo	Unknown	Isiolo County Climate Change Fund Act 2018
County Government of Isiolo	Unknown	Strategic Planning for Isiolo County - Water Energy Climate Change Sector Objectives (2017-2021)
County Government of Mandera	Unknown	Mandera County Integrated Development Plan 2018-2022
County Government of Mandera	2014	Mandera County Gazette Supplement 2014, published in Nairobi in August 2014
County Government of Mandera	2014	Mandera County Gazette Supplement 2014, published in Nairobi in November 2014

County Government of Mandera	2014	Mandera County Gazette Supplement 2014, published in Nairobi in July 2014
County Government of Marsabit	Unknown	Marsabit County Integrated Development Plan 2018-2022
County Government of Marsabit	2019	County Annual Development Plan 2020/21, published in Aug 2019
County Government of Marsabit	2016	Marsabit County Gazette Supplement 2016, published in Nairobi in June 2016
County Government of Marsabit	2018	Marsabit County Gazette Supplement 2018, published in Nairobi in August 2018
County Government of Samburu	2019	Samburu County Fiscal Strategy Paper, Feb 2019
County Government of Samburu	2019	Samburu County Annual Development Plan 2020-2021, published in August 2019
County Government of Samburu	Unknown	Samburu County Disaster Management Act 2015
County Government of Samburu	2018	Samburu County Second Integrated Development Plan 2018 – 2022, published in Feb 2018
County Government of Tana River	2016	Tana River County Gazette Supplement 2016, Published in Nairobi in Sept 2016
County Government of Tana River	2016	Tana River County Gazette Supplement 2016, Published in Nairobi in Oct 2016
County Government of Tana River	2018	Tana River County Second Integrated Development Plan 2018 – 2022, published in Apr 2018
County Government of Tana River	2017	Tana River County Gazette Supplement 2017, Published in Nairobi in Oct 2017
County Government of Tana River	2017	Tana River County Gazette Supplement 2017, Published in Nairobi in Oct 2017
County Government of Tana River	2017	TANA RIVER COUNTY DRAFT WATER ACT
County Government of Tana River	Unknown	County Department of Water & Energy, Water Sector Strategic Plan 2018-2022
County Government of Turkana	2019	County Government of Turkana Approved County Fiscal Strategy Paper 2019
County Government of Turkana	2019	Policy Framework for Extractive Industries in Turkana County
County Government of Turkana	2019	Kenya Gazette Supplement, Turkana County Acts 2019, published in Nairobi in 2019
County Government of Turkana	Unknown	Turkana County Government Investment plan 2016-2020
County Government of Turkana	Unknown	Turkana County Water and Sewerage Services Bill 2018
County Government of Turkana	Unknown	Turkana County Water and Sanitation Regulations 2018
County Government of Turkana, Min of Water	Unknown	Turkana County Water Sanitation Services Sector Strategy Plan 2017-2021

Services, Environment and Mineral Resources		
County Government of Turkana, Min of Water Services, Environment and Mineral Resources	2020	Turkana County Climate Change Policy, published June 2002
County Government of Wajir	Unknown	Wajir County Climate Information Services Plan
County Government of Wajir	2020	Wajir County Fiscal Strategy Paper, published in Feb 2020
County Government of Wajir	2014	Wajir County Drought Contingency Plan, published in Feb 2014
County Government of Wajir	2018	Wajir County Integrated Development Plan 2018-2922, published in Feb 2018
CPAC Technical Team: Adan A.Mohammed, Kassim O. Farah, and Hamud Osman.	2020	Management of Rangelands and Diversified Livelihoods in the Igad Asal Region – a Synthesis Report,
Development Initiatives	2018	Enhancing access to safe water and improved sanitation services in Kenya – are we on track? Report, December 2018
Edward Ontita, PhD Zamconsult Consulting Engineers Ltd	2017	Coast Water Services Board, A social Assessment Report on Wajir Town Water Masterplan Project, Final Report, February 2017
Eike Luedeling, Jan De Leeuw	2014	Water for Wajir, Decision modeling for the Habaswein-Wajir Water Supply Project in Northern Kenya, August 2014
Francesco Rampa	2011	Analysing governance in the water sector in Kenya
George M. OgendiIsaac M. Ong'oa	2009	Santa Clara Journal of International Law, Volume 7, Issue 1, Article 3, Water Policy, Accessibility and Water Ethics in Kenya, January 2009
Government of Kenya	2013	Draft National Wetlands Conservation and Management Policy, published in June 2013
Government of Kenya	2007	Kenya Vision 2030 – A globally Competitive and Prosperous Kenya, October 2007
Government of Kenya	Unknown	Kenya National Biodiversity Strategy & Action Plan 2019 - 2030
Government of Kenya	2010	National Climate Change Response Strategy Executive Brief – April 2010
Government of Kenya	2013	National Water Master Plan 2030
Government of Kenya	2013	Kenya Gazette Supplement 2013, published in Nairobi in Jan 2013, The Agriculture, Fisheries and Food Authority Act
Government of Kenya	2016	Kenya Gazette Supplement 2016, published in Nairobi in Jan 2016, The Community Land Act
Government of Kenya	2015	Kenya Gazette Supplement 2015, published in Nairobi in Jun 2015, The Environmental management and co-ordination (Amendment) Act
Government of Kenya	2016	Kenya Gazette Supplement 2016, published in Nairobi in Sep 2016, the Forest Conservation and Management Act

Government of Kenya	2019	Kenya Gazette Supplement 2019, published in Nairobi in Aug 2019, the Irrigation Act
Government of Kenya	2016	Kenya Gazette Supplement 2016, published in Nairobi in May 2016, The Climate Change Act
Government of Kenya	2016	Kenya Gazette Supplement 2016, published in Nairobi in Sep 2016, the Water Act
Government of Kenya	2016	Kenya Gazette Supplement 2016, published in Nairobi in Apr 2016, National Drought Management Authority Act.
Government of Kenya	2013	Kenya Gazette Supplement 2013, published in Nairobi in Dec 2013, Wildlife Conservation and Management Act
Henrik Larsen and Sílvia Leirião	2020	Support to Sustainable Development in Lake Turkana and its River Basins, Water Resources Assessment of the Dawa-Genale-LagDera-Juba-Shabelle Basin Technical Brief, August 2020.
ilda Moraa, Albert Otieno, Anne Salim	2012	Water Governance in Kenya – Ensuring Accessibility, Service delivery and Citizen Participation – July 2012,
International Union for Conservation of Nature and The Food and Agriculture Organization of the United Nations and UNEP	2020	2019 – The Restoration Initiative, Year in Review,
IVM Institute for Environmental Studies	2015	The Economics of Ecosystem Services of the Tana River Basin – Assessment of the impact of large infrastructural interventions, Report R15-03, 15 December 2015
J. Kibiiy and J. R. Kosgei	2018	A review of Kenya's National Water Master Plan 2030
James Mwangi, Laikipia Wildlife Forum	Unknown	Mount Kenya Ewaso Water Partnership
Laura Comeau	2020	Support to Sustainable Development in Lake Turkana and its River Basins, Ecosystem Services Assessment Report, Prepared for UNEP, August 2020
Lenneke Knoop, Francesco Sambalino, and Frank van Steenberger	Unknown	Securing Water and Land in the Tana Basin, a resource book for water managers and practicioners
Mandera County Government, Ministry of Water, Energy, Environment and Natural Resources	Unknown	Assessment of Boreholes in Mandera County
Marina Puzyreva, Dimple Roy	2018	Adaptive and Inclusive Watershed Management – Assessing Policy and institutional support in Kenya
Mélanie Carrasco	2014	Water Master Plan Logologo and Gudas sub-locations, Marsabit Kenya Arid Lands Disaster Risk Reduction (KALDRR-WASH) program, December 2014
Mélanie Carrasco	2014	Water Master Plan Kalemgorok and Katilu sub-locations Turkana Kenya Arid Lands Disaster Risk Reduction (KALDRR-WASH) program

Mélanie Carrasco	2014	Water Master Plan Eyrib sub-location, Wajir Kenya Arid Lands Disaster Risk Reduction (KALDRR-WASH) program
Ministry of Environment and Mineral Resources, Republic of Kenya	2012	National Environment Policy 2012, published in Apr 2012
Ministry of Environment and Natural Resources, Republic of Kenya	2016	Sessional Paper 5 of 2016 – National Climate Change Framework Policy
Ministry of Environment and Natural Resources, Republic of Kenya	2013	Draft of Integrated Coastal Zone Management (ICZM) Policy
Ministry of Environment and Natural Resources, Republic of Kenya	2014	Forest Policy 2014, published in Feb 2014
Ministry of Environment and Natural Resources, Republic of Kenya	2013	Project on the Development of the National Water Master Plan 2030- Final Report, October 2013
Ministry of Lands and Physical Planning	2017	Sessional Paper 1 of 2017 – National Land Use Policy
Ministry of Public Service, Gender, Senior Citizens Affairs and Special Programmes	2021	Drought & Food Security Situation and Response in ASALs, October 2021
Ministry of State for Development of Northern Kenya and Other Arid Lands	2012	Sessional Paper 8 of 2021 – National Policy for the Sustainable Development of Northern Kenya and Other Arid Lands.
Ministry of Water and Irrigation, Republic of Kenya	2007	National Water Services Strategy (2007-2015)
Ministry of Water and Sanitation, Republic of Kenya	2018	Strategic Plan 2018 – 2022, published in Dec 2018
Ministry of Water Development, Republic of Kenya	1991	Samburu District Water Development Study 1993 – 2013, Part 3 – Guidelines and Recommendations for Investment Packages, February 1991
Muhoro Ndung'u with support of team membersNicola ReadeNancy NdiranguRoger Chenevey	2009	KENYA WATER AND SANITATION PROGRAMME AND THE WATER SECTOR REFORM PROGRAMME:A Joint Sida, GTZ and Government of Kenya Mid-Term Evaluation Mission Report, SIDA Review 2009-29
National Council for Law Reporting with the Authority of the Attorney-General	2012	County Government Act no 17 of 2012
National Council for Law Reporting with the Authority of the Attorney-General	2012	Environmental Management and Co-ordination Act

National Council for Law Reporting with the Authority of the Attorney-General	2012	Ewaso Ng'iro North River Basin Development Authority Act
National Council for Law Reporting with the Authority of the Attorney-General	2012	The Land Act 2012
National Council for Law Reporting with the Authority of the Attorney-General	2012	Physical Planning Act
National Council for Law Reporting with the Authority of the Attorney-General	2011	Urban Areas and Cities Act
National Drought Management Authority	2020	Final Narrative Report, published in Nov 2020
National Environment Management Authority	2009	National Environment Action Plan Framework 2009-2013, published in Mar 2009
National Environment Management Authority	Unknown	National Sand Harvesting Guidelines 2007
Nisha Gill Hansted, Torsten Vammen Jacobsen,Sílvia Leirião, Jens Kristian Lørup	2020	Support to Sustainable Development in Lake Turkana and its River Basins, ESS hotspot identification and Baseline Model Final Report, Prepared for UNEP, November 2020
Nordic Climate Fund	2019	Building and Construction of low carbon low cost houses in Marsabit Town, Environmental and Social Impact Assessment, June 2019
Prime Minister's Office	2012	Sessional Paper x of 2021 – Kenya Vision 2030
REACH	2015	REACH (2015) Country Diagnostic Report, Kenya. REACH Working Paper 3, University of Oxford, Oxford, UK.
René van Lieshout	2014	Water Master Plan Kate and Bori sub-locations Moyale Kenya Arid Lands Disaster Risk Reduction (KALDRR-WASH) program, December 2014
REPUBLIC OF KENYAMINISTRY OF WATER AND IRRIGATION	Unknown	Sustainable Development Goal (SDG) 6 PILOT PROGRESS REPORT, December 2017,
Rural Agency for Community Development and Assistance	Unknown	TECHNICAL PROPOSAL ON WATER SUPPLY AND SANITATION PROJECT IN SELECTED LOW INCOME SETTLEMENT AREAS OF MANDERA TOWN
Rural Agency for Community Development and Assistance	2013	Water Supply and Sanitation in low Income settlement in Mandera town, Project Final Narrative Report, November 2013
Rural Focus ltd	2006	Water, Schools and Health Management Information System (MIS) for Turkana District, Final Report, Volume One: Main

		report, Prepared by Rural Focus ltd, Submitted to UNICEF-KCO-WES, July 2006
Rural Focus ltd	2006	User Manual Turkana Water MIS, Prepared by Rural Focus Ltd, July 2006
Thuita Thenya, Njoki Kahiu, Francis Karanja, Dennis Ojwang', Carolyne Ouko, Grace Wambugu, Evanson Njuguna	2011	Assessment of Ecological Status and Socioeconomic Dynamics of Upper Ewaso Ng'iro Basin Wetlands, Volume 1 : Summary of findings, May 2011,
UNEP	Unknown	SDG INDICATOR 6.5.1Degree of Implementation of Integrated Water Resources Management (0-100) – 2017 baseline reporting results
UN-HABITAT		Sustainable low cost housing development in Marsabit County HOUSING AND SITE PLANNING PROJECT Climate resilient low cost buildings in Marsabit County. Nordic Climate Facility, 27 July 2018
Unknown	2019	NATIONAL WATER HARVESTING AND STORAGE AUTHORITY, STRATEGIC PLAN 2019-2022
Unknown author	Unknown	Pasture Forage Situation – Turkana District
Unknown author	Unknown	All Districts Water Sources Schools and Health MIS Report
Unknown author	Unknown	Garissa Water Sources Schools and Health MIS Report
Unknown author	Unknown	Ijara Water Sources Schools and Health MIS Report
Unknown author	Unknown	Isiolo Water Sources Schools and Health MIS Report
Unknown author	Unknown	Laikipia Water Sources Schools and Health MIS Report
Unknown author	Unknown	Mandera Water Sources Schools and Health MIS Report
Unknown author	Unknown	Marsabit Water Sources Schools and Health MIS Report
Unknown author	Unknown	Moyale Water Sources Schools and Health MIS Report
Unknown author	Unknown	Samburu Water Sources Schools and Health MIS Report
Unknown author	Unknown	User Manual NWSB Water MIS Report
Unknown author	Unknown	Wajir Water Sources Schools and Health MIS Report
Unknown author	Unknown	NWSB Harmonised MIS Database Report
Unknown author	Unknown	Garissa Water Sources Schools and Health MIS Final Report
Unknown author	Unknown	Isiolo Water Source Mapping
Unknown author	Unknown	Mandera Water Source Assessment & Mapping Final Report
Unknown author	Unknown	Marsabit Water Source Assessment & Mapping Final Report
Unknown author	Unknown	Moyale Water Source Assess Phase 2 Final Report
Unknown author	Unknown	Samburu Water Sources Schools and Health MIS Final Report
Unknown author	Unknown	Wajir Water Source Assessment & Mapping Final Report
Unknown author	2021	Step-by-step Guide - Climate Hazard (Exercice)
Unknown author	2021	Step-by-step Guide - Climate Forecast
Unknown author	2021	Step-by-step Guide - Drought Hazard

Unknown author	2021	Step-by-step Guide - Introduction Data Monitor
Unknown author	2021	Step-by-step Guide - Introduction Water Indicator
Unknown author	2006	Environmental Management and Co-ordination Act No 8 of 1999, THE ENVIRONMENTAL MANAGEMENT AND CO-ORDINATION (CONSERVATION OF BIOLOGICAL DIVERSITY AND RESOURCES, ACCESS TO GENETIC RESOURCES AND BENEFIT SHARING) REGULATIONS, 2006, published in Dec 2006
Unknown author	Unknown	ENVIRONMENTAL MANAGEMENT AND CO-ORDINATION (WASTE MANAGEMENT) REGULATIONS, 2006
Unknown author	Unknown	Water Quality Regulations, Water Quality Licensing Discharge Licence
Unknown author	Unknown	The Environmental (Impact Assessment and Audit) Regulations 2003
Unknown author	Unknown	The Environmental Management and Co-ordination (Wetlands, River Banks, Lake Shores and Sea Shore Management) Regulations 2009
Unknown author	Unknown	Good Practices and Innovations from the Regional Pastoral Livelihoods Resilience Project – Tana River County
Unknown author	Unknown	Kenya County Climate Risk Profile Series, Climate Risk Profile Garissa County
Unknown author	Unknown	Borehole Repair Requirements
Unknown author	Unknown	Kenya County Climate Risk Profile Series, Climate Risk Profile Isiolo County
Unknown author	Unknown	Promoting Urban Energy for Climate Resilient low cost buildings in Marsabit County
Water Resources Authority, Kenya	2019	Water Resources Authority Strategic Plan 2018-2022
Water Resources Authority, Kenya	Unknown	Water Resources Authority Strategic Plan 2018 - 2022
Water Sector Trust Fund, Ministry of Water and Sanitation, Republic of Kenya	Unknown	Strategy towards accelerating water and sanitation access for the underserved in Kenya 2018-2022
Water Sector Trust Fund, Ministry of Water and Sanitation, Republic of Kenya	2019	County Engagement Strategy
Water Services Regulatory Board	2019	IMPACT – A performance Report of Kenya's Water Services Sector – 2017/18, Issue No. 11/2019
Wolde Mekuria Alemseged Tamiru Fitsum Hagos Rebelo, Lisa-Maria, International Water Management Institute (IWMI)	2019	ECOSYSTEM SERVICES, HYDROLOGY AND LIVELIHOOD IN THE OMO-TURKANA BASIN: A REVIEW. Sept 2019

Yasin Mahadi Salah, Akshay Vishwanath, Robert Wild and John Nyachieo	Unknown	Water for Livestock Promoting resilience by influencing water infrastructure development in community managed rangelands of Kenya

Appendix B List of Projects and Programmes financed in then 10 ASAL counties

This appendix presents the data submitted to UNEP-DHI by Partners from the ASAL Development Group in November 2021.

Appendix B.1 Past and ongoing projects financed by ASAL Development Group

Financing Source	**Beneficiary**	**Implementation Period**	**Implementation Status** (Completed / Ongoing)	**Name of Project / Initative**	**Short Description**	**ASAL County targeted**	**Partners** (List all relevant partners)	**Budget**	**URL Links**	**Contact Person**	**Additional Comments**
DANIDA	Water Sector Trust Fund	2016 - 2020	In the process of closing	Access to and management of water resources in the arid and semi arid lands (ASALs)	Enhanced water resources management and investments in selected ASAL counties for improved and sustained access by communities and households to water and sanitation for their domestic and productive needs	Lamu, Tana River, Garissa, Isiolo, Marsabit, Wajir, Turkana, Mandera	Ministry of Water, Sanitation & Irrigation	DKK 65 Million		Nancy Njenga nannje@um.dk	
DANIDA	Water Sector Trust Fund	07.2021-06.2026	Ongoing	Sustainable Management and Access to Water and Sanitation in the ASALs	Increased community resilience and adaptation to climate change through sustainable, peaceful use of natural resources including improved access to water and sanitation services in the target ASAL Counties.	Turkana, Garissa, Marsabit, Lamu, Isiolo, Tana River	Ministry of Water, Sanitation & Irrigation	DKK 70 Million		Nancy Njenga nannje@um.dk	
DGIS _Netherlands	SNV-FCDC-AGRA	2020-2023	Implementation	LISTEN-Laikipia, Isiolo and Samburu Transforming the environment through NEXUS	Institutional capacity for natural and livelihood resource management, Landscape management Ewaso Nyro basin, climate resilient value (agri) chain development and knowledge component.	Isiolo, Samburu	County Governments, WRA,	EUR 3.6 Mln.	n.a.	Stephn Gichuki - <sgichuki@snv.org>	

DGIS _Netherlands	WRA	2019-2022	Implementatoin	Blue-Deal	Main deliverables are a water allocation plan and the existing sub-catchment management plans will be revised. Upscaling to other geographical areas and extending to water quality issues will be taken up from the second phase onwards	Upper Tana Basin	WRA, Water Authority of Aa and Maas and Stichtse Rijnlanden. WaterNet Amsterdam	EUR3.2 Mln. For regional programme. Only partially linked to Kenya	Kenya World Waternet Sustainable water management in the Upper Tana Basin (wereldwaternet.nl)	Marieke van Nood, regional manager. Nood, Marieke van <marieke.van.nood@waternet.nl>	Linked to WaterWorX programme, strengthening capacity of Nairobi Water Company.
DGIS _Netherlands	WWF-VEI-WaterNet	2020-2023	Implementation	Catchment to Tap (C2T)	Improving sustainable access to water by advocating for IWRM approaches and strengthening the institutional framework for IWRM	Nakuru, but also Upper Tana Basis (Thika)	WRA,	EUR 4.4 Mln.	Catchment to Tap (C2T) Project | WWF Kenya	William O. Ojwang <wojwang@wwfkenya.org>	
DGIS _ Netherlands	Hivos - WWF	2021-2024	Implementation	Voices for Climate Action	Capacity building for alternative local/nature based solutions, lobby and advocacy to put local and nature based solution on the national/international/local agenda and resource mobilization	Turkana, Marsabit, Lamu (amongst others)	HIVOS, WWF, AMwA, SSN, SDI, Avina	55 mln divided over 7 countries	Voices for Just Climate Action - Hivos	Country Engagement Manager - Maimuna Kabatesi, mkabatesi@hivos.org	
DGIS _ Netherlands	County Govts of Turkana basin	2021-2025		Water, Peace and Security Partnership	After a scoping period, the specific proposed objective is to strengthen the capacity and coordination of key county and basin level agencies to better prevent and resolve water-related conflict in Turkana Basin (with a particular focus on North Turkana sub-county).	Turkana basin	WRI, International Alert, IHE Delft, Deltares, Westlands International	1mln	Water, Peace and Security (waterpeacesecurity.org)	Rabindra Gurung <rgurung@international-alert.org>	

Appendix B.2 Planned projects by ASAL Development Group

Financing Source (Your organization)	**Beneficiary**	**Implementation Period for planned financing**	**Financing Status** (Planned)	**Name of planned Project / Programme/ Initative to be financed**	**Short Description of planned investment**	**ASAL County targeted**	**Partners**	**Budget**	**Contact Person** (	**Additional Comments**
DANIDA	Northern Rangeland Trustfund	2022-2025	Pending approvement from Danish Government	Improved access to Water and Energy for resilient communities and natural resources	35 million DKK allocated for water and energy in ASAL's	Marsabit, Isiolo, Samburu, Turkana, West Pokot, Baringo, Laikipia, Meru, Lamu, Tana River, Garissa		DKK 35 million	Nancy Njenga nannje@um.dk	This programme is an addendum with earmarked funding in addition to the core funding the DANIDA is already providing to NRT.
World Bank	Ministry of Water, Sanitation and Irrigation (MoWSI), Water Sector Trust Fund (WSTF), Water Resources Authority (WRA)	04.2022 - ?	Planning phase	Horn of Africa Groundwater For Resilience Program	The overarching objective of the Horn of Africa Groundwater for Resilience Program is “To increase the sustainable use and management of groundwater by beneficiary groups in the Horn of Africa.”	Turkana, Marsabit, Mandera, Wajir, Garissa, West Pokot, Samburu, Isiolo, Tana River, Lamu	Regional Center on Groundwater (RCGW), the National Drought Management Agency (NDMA), Water Services Regulatory Board (WASREB), Water Works Development Agencies (WWDAs), Water Resource User Associations, Water Works Development Agencies, Basin Management Committees, County Governments.	USD 80 Million	James Origa Otieno jotieno2@worldbank.org	

USAID		Starting early 2022		STAWI	Stawi's purpose is to strengthen resilience and expand economic opportunities through management of water resources, expansion of sustainable water services, and improved utilization of water for productive purposes.	Samburu, Turkana, Wajir, Marsabit, Garissa, Isiolo, Kitui, Makueni, Taita Taveta		USD 39.5 million	Amanda Robertson arobertson@usaid.gov	
DGIS _Netherands	SNV-FCDC-AGRA	2020-2023	implementation	LISTEN-Laikipia, Isiolo and Sumburu Transforming the environment through NEXUS	Institutional capacity for natural and livelyhood resource management, Landscape management Ewaso Nyro basin, climate resilient value (agri) chain development and knowledge component.	Isiolo, Samburu	County Governments, WRA,	EUR 3.6 Mln.	Stephn Gichuki - <sgichuki@snv.org>	
DGIS _Netherands	WRA	2019-2022	implementation		Main deliverables are a water allocation plan and the existing sub-catchment management plans will be revised. Upscaling to other geographical areas and extending to water quality issues will be taken up from the second phase onwards					

Appendix B.3 NDMA Projects

Year	Title	Description	Budget	Status	Links
2018-2022	**EDE/Support to Resilient Livelihoods (EDE Pillar 4)**	Implemented through a 'Call for Proposals' targeting Non-State actors, county governments or consortia in target four (4) marginal agriculture and agro-pastoral counties with high vulnerability to droughts and high proportion of children and women that suffer from malnutrition.		ongoing	http://www.ndma.go.ke/index.php/partners
2018-2022	**EDE/Support to Drought Risk Management (EDE Pillar 5)**	Implemented by NDMA with focus on drought early warning and response, specifically timeliness, accountability and efficiency of drought response, in all 23 ASAL counties.		on.going	Partners (ndma.go.ke)
2016-2020	EDE/Support to Pillar 5 (Drought Risk Management and Coordination)	This component focuses on enhancing drought preparedness at county and community level, leading to better capacity for early response to drought crises as follows; Drought Preparedness/Resilience - focuses on enhancing drought preparedness at county and community level, leading to better capacity for early response to drought crises. Drought Response - focuses on reducing loss of household livelihood assets during drought episodes by ensuring effective and transparent mechanisms for the timely disbursement of drought contingency funds.	EU Budget: Euro 22,894,296 (79.2%) GoK Budget: Euro 6,030,000 (20.8%)	completed	Partners (ndma.go.ke)
2016-2020	EDE/Support to Pillar 6 (Support to Institutional Development and Knowledge Management)	The component supports realisation of the objectives of EDE Pillar 6 by supporting institutional development and knowledge management.	EU Budget: Euro 6,815,880 (79.4%) GoK Budget: Euro 1,765,360 (20.6%)	completed	Partners (ndma.go.ke)
2011-2016	**KRDP -ASAL Drought Management**	The ASAL Drought Management (ASAL DM) Project was implemented through four annual programme estimates (work plans) funded wholly by the EU. It built on the activities of the DMI project to strengthen, institutionalise and operationalise drought management systems at national and county levels. This enhanced capacity of ASAL communities to effectively respond to drought crises.	EU Budget - Euro 11 million	completed	Partners (ndma.go.ke)
2011-2016	**KRDP-ASAL Drought Contingency Fund (2011-2016)**	The objective of the ASAL Drought Contingency Fund Project (ASAL-DCFP) was to ensure that communities in drought prone areas are more resilient to drought and other effects of climate change through provision of financing for both drought preparedness and mitigation under two specific components; i) Drought preparedness ii) Flexible financial resources for early response to drought The Fund facilitated early mitigation and reduced the time between warning of drought stress and response at county level. The DCFP enabled the NDMA to successfully pilot and test the use of set-aside finances for early response.	EU Budget: Euro 10 million (88.4 %) GOK Budget: Euro 1,307,428 (11.6 %)	completed	Partners (ndma.go.ke)

2007-2011	**Drought Management Initiative (2007 - 2011)**	The Drought Management Initiative (DMI) was implemented through four annual programme estimates (work plans) funded wholly by the European Union within the framework of the Arid Lands Resource Management Project (ALRMP II) in the Ministry of State for Development of Northern Kenya and other Arid Lands. The overall project objective was to contribute to the improvement of effectiveness and efficiency of the drought management system in Kenya, building on the activities of the ALRMP II and the ECHO -funded drought disaster reduction and preparedness projects. The DMI focused on improving drought management capacities in the ASALs through establishment of robust systems for drought risk management at national, sub national and community levels. The project contributed to the consolidation and institutionalisation of Kenya's drought management system.	EU Budget - Euro 17.7 million	completed	Partners (ndma.go.ke)
	Hunger Safety Net Programme (HSNP)	This project is financed by DFID to reduce extreme hunger and vulnerability of the poorest households through the regular payment of an unconditional cash transfer. It ensures effective, financially secure and well-targeted use of safety net and cash transfer programmes to support some of the most vulnerable and poor in Kenya. It is currently in four counties namely Turkana, Marsabit, Wajir and Mandera;			Home (hsnp.or.ke.)
	Climate Adaptation (ADA Consortium)	The Adaptation consortium is a four-year Department for International Development (DFID) funded initiative that is central to the National Drought Management Authority strategy. The consortium funded under Strengthening Adaptation and Resilience to Climate Change in Kenya plus (StARCK+) aims at preparing county government access global climate finance fund in support of adaptation and climate resilient development and to mainstream mechanisms that allow communities to prioritise investments in public goods that build their resilience to climate change.			
	UNDP NDMA Projects - 2 projects: The following UNDP projects are implemented under the National Drought Management Authority (NDMA):	The United Nations Development Programme (UNDP) works towards strengthening the resilience of communities affected by climate change risks and disasters through a number of projects implemented by the National Drought Management Authority (NDMA). The projects aim at promoting national institutional and policy frameworks and infrastructure for disaster risk mitigation while working with vulnerable communities to reduce the impacts and risks of natural and man-made disasters in Kenya by supporting recovery, stabilization of livelihoods and protection and empowerment of vulnerable groups.			https://opendata.rcmrd.org/pages/atlases

	Disaster Risk Reduction Climate Change Adaptation Kenyan Counties Hazard Atlases and IGAD Hazard Atlas				

Appendix B.4 Water Sector Trust Fund projects financed by Team Europe in the 10 counties

Donor	Project / Programme and short description of objective	Implementation period	Target counties	Total Programme Funding[49]
KFW	**Water Supply and Sanitation for Urban Poor (WSSUP) Program**: The objective of the Programme is to provide affordable, economically viable and sustainable access to safe water supply and basic sanitation services to the urban poor.	Phase III – October 2015 to 2020 Phase IV: July 2020 to July 2025	All 47 counties of Kenya	KfW Funding Phase III- KSh. 1 Billion (8.5 Million Euro) GOK Ksh.200 million (1.7 Million Euro) KfW Funding Phase IV- KSh. 1.27 Billion (11 Million Euro) with Counter Part Funding from Government of Kenya at KSh. 253 Million (2.2 Million Euro).
Danida – Ministry of Foreign Affairs Denmark	Green Growth Employment Programme (GGEP): The expected outcome of the programme is enhanced water resource management and investments in selected counties for improved and sustained access by communities and households to water and sanitation for their domestic and productive needs.	July 2016 – December 2020	Garissa, Isiolo, Lamu, Marsabit, Mandera, Tana River, Turkana and Wajir	Ksh. 975 Million (65 Million DKK)
	Water and Livelihood Programme: subset of the Green Growth and Employment Programme, targeting Turkana West Sub-County Refugees and host communities. The Programme' objective is to enhance access to improved Water and Sanitation, for 6000 new households and Conserve 2000 km2 of land through water resource and rangeland management interventions.	January 2020 – February 2021	Turkana	Ksh. 600 Million (40 Million DKK)

[49] NB: This is the total programme funding amount; it does not mean that this is the amount the target county received as it may be divided with other counties which do not make up part of this rapid assessment

European Union	Ending Drought Emergencies: Climate Proofed Infrastructure for improved access to water supply and sanitation in ASALs (EDE CPIRA) Programme: The programme has three outcome areas namely: - improved access to water supply and sanitation services, improved and sustained management of Water Resources, and implemented Public Private Community Partnerships in Water Provision.	December 2017 – December 2026	Samburu, Mandera, West Pokot	Euro 27.1 Million (Ksh. 3 Billion) of which EU is Euro 20 Million (Ksh.2.3 billion) and GOK (National and County) Euro 7.1 Million (Ksh.801 Million)
	COVID-19 Emergency Response Programme – EDE CPIRA Programme: The objective of this programme was to mitigate the effects of COVID-19 in the target Counties by financing the installation of water supply and hand washing facilities to underserved identified hotspot and potential hotspot areas affected by the pandemic.	May 2020 – October 2020	Mandera (+ 3 other counties)	KSh. 28 Million (243,478 Euro)