

# Kenya County Climate Risk Profile: Turkana County

## Highlights

- Agriculture is the main source of livelihood in Turkana County. It creates more than 74% of household incomes and employs more than 45% of the population.
  - Most farmers rely on pastoralism and rain-fed agriculture. This makes them more vulnerable to climate change and variability.
  - The effects of climate change in Turkana County include unpredictable rainfall, extreme rainfall, frequent and prolonged dry spells, and increased daytime temperatures.
  - Climate hazards that have been observed in the county include drought, floods, and intense rainfall. These hazards pose a growing threat to the agricultural sector.
  - Drought and heat stress are major threats to Turkana County that often result in loss of pasture, starving livestock, drying water sources, and conflict among pastoralists over resources.
  - Heavy rains in the Mt. Elgon and West Pokot regions of the county and intense rainfall over short periods of time create flooding. On-farm adaptation strategies include conservation agriculture, rainwater harvesting, fodder conservation, and planting early-maturing and drought-tolerant crops as well as drought-resistant and high-value livestock breeds.
  - Off-farm adaptation strategies include education and research on climate-smart agriculture practices, early warning systems and climate-based advisories, extension services, livestock and crop insurance, afforestation, and reforestation.
  - Women and youth contribute significantly to certain value chains. It is therefore important to promote the involvement of women and youth, and support their economic gains, decision-making powers, and participation.
  - Inadequate resources and poor coordination between different institutions in has undermined Turkana County's ability to adapt to climate change.
- The establishment of community action groups and the support of governmental institutions and stakeholders has empowered Turkana's farmers to help protect the environment and use natural resources sustainably

Figure 1: Map of Turkana County



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## List of Acronyms

<b>AEZ</b>	Agro-ecological Zone
<b>ASDSP</b>	Agricultural Sector Development Support Programme
<b>CIAT</b>	International Center for Tropical Agriculture
<b>CIDP</b>	County Integrated Development Plan
<b>DRSLP</b>	Drought Resilience and Sustainable Livelihoods Programme
<b>GoK</b>	Government of Kenya
<b>ILRI</b>	International Livestock Research Institute
<b>IPCC</b>	Intergovernmental Panel on Climate Change
<b>KALRO</b>	Kenya Agricultural and Livestock Research Organization
<b>KSh</b>	Kenya Shillings
<b>KMD</b>	Kenya Meteorological Department
<b>KNBS</b>	Kenya National Bureau of Statistics
<b>MoALFC</b>	Ministry of Agriculture, Livestock and Fisheries and Cooperatives
<b>NARIGP</b>	National Agricultural and Rural Inclusive Project
<b>NCCRS</b>	National Climate Change Response Strategy
<b>NDMA</b>	National Drought Management Authority
<b>NEMA</b>	National Environmental Management Authority
<b>VC</b>	Value Chain
<b>VCCs</b>	Value Chain Commodities



**Turkana**

## Foreword

The mandate of the Ministry of Agriculture, Livestock, Fisheries and Co-operatives is to create an enabling environment for sustainable development of agriculture and co-operatives for economic development. This objective underpins our desire and commitment to transform Kenya into a newly industrializing, middle income country providing a high quality of life to all its citizens in a clean and secure environment as envisaged in our development blueprints, the Kenya Vision 2030, the Big Four Agenda and the Agricultural Sector Transformation and Growth Strategy (ASTSG 2019 – 2029). The sector remains high on the national development agenda in terms of food and nutrition security, income generation, employment creation, saving and investment mobilization and export earnings. To realize the country's aspirations of food and nutrition security, the Government through this Ministry is implementing the National Agricultural and Rural Inclusive Growth Project (NARIGP) with the support of the World Bank. The development objective of the project is to increase the agricultural productivity and profitability of targeted rural communities in 21 counties and in the event of an eligible crisis or emergency, provide an immediate and effective response.

The agriculture sector is however, highly vulnerable to the impacts of climate change and extreme weather events. Responses that would enable the country to cope with these risks are outlined in the Kenya Climate-Smart Agriculture (CSA) Strategy and in the commitments of the Kenya Nationally Determined Contributions (NDC) to the United Nations Framework Convention on Climate Change (UNFCCC). In 2010, the Government developed the National Climate Change Response Strategy (NCCRS) which recognized the impacts of climate change on the country's development. This was followed by the development of the National Climate Change Action Plan in 2012. The focus of these initiatives include the development of county-level climate risk profiles to mainstream climate change perspectives in programs and development plans at county level. The Ministry has developed county climate risk profiles in 31 counties and NARIGP is supporting the development of profiles for an additional 14 counties. The purpose of the profiles is to inform county governments and stakeholders on the climate change risks and provide opportunities for integration into respective county development plans and processes.

This climate risk profiles study will be used as a basis to climate proof projects or any other developments in fourteen counties (Samburu, Turkana, Kitui, Narok, Kirinyaga, Kiambu, Muranga, Bungoma, Trans Nzoia, Nandi, Vihiga, Kisii, Nyamira and Migori). The study provides information on current and possible future climate scenarios, climate-related vulnerabilities and risks for key major agricultural value chains, policy landscape and the institutional capacity to deliver adaptation programs. Each profile presents adaptation and risk reduction options that can transform and reorient agricultural systems in the counties to increase productivity, enhance smallholder farmers' resilience and mitigate against climate change.

Finally, I call upon all stakeholders for their cooperation and support for adoption of CSA production practices that maximize the triple wins: increases productivity, enhanced resilience and reduced greenhouse gas (GHG) emissions. Through the adoption of new technologies and improved practices, we will realize the desired goal of Kenya being a food and nutrition secure country, fostering socio-economic development and improved livelihoods of Kenyans.



**Prof. Hamadi I. Boga, PhD, CBS**

**Principal Secretary**

**State Department for Crops Development and Agricultural Research**

# 1. Introduction

Climate change is becoming one of the most serious challenges to Kenya. The country is susceptible to climate-related events, and projections indicate that climate impacts will continue to affect the country in the future. In many areas, extreme and variable weather is now the norm. Rainfall is irregular and unpredictable; some regions experience frequent droughts during the long rainy season or severe floods during the short rains. Arid and semi-arid areas are particularly vulnerable to these extreme changes, putting the lives and socio-economic activities of millions of households at risk.

The Kenya Vision 2030 is a national blue print that seeks to transform Kenya into a newly middle-income country providing a high quality of life to all its citizens by 2030 in a clean and secure environment. Agriculture sector has been identified as one of the key sectors to contribute to the projected annual national economic growth. However, it has been constrained with inadequate access to quality inputs, marketing inefficiencies, non-conducive investment environment, declining soil fertility, low mechanization, land fragmentation and more significantly climate change.

In 2010, Kenya developed a National Climate Change Response Strategy (NCCRS) which recognized the importance of climate change impacts on the country's development. This was followed in 2012 by the National Climate Change Action Plan (NCCAP), which provided a means for implementing the NCCRS and highlighted agricultural adaptation priorities. These initiatives are focused on the national level, and climate change considerations still need to be mainstreamed in county-level policies, programs, and development plans. Locally relevant, integrated adaptation responses with active involvement of local stakeholders are necessary to achieve this goal.

Through the Ministry of Agriculture, the Government of Kenya (GOK) is implementing the National Agricultural and Rural Inclusive Growth Project (NARIGP) with

support from the World Bank. The project development objective is to increase agricultural productivity and profitability of targeted rural communities in selected counties. To address the climate change risks and vulnerabilities that negatively impact agricultural production, the Alliance of Bioversity International and the International Center for Tropical Agriculture (CIAT) completed a climate risk assessment in 14 counties supported by NARIGP. The aim of the assessment is to provide information on current climate and possible future climate scenarios; to identify climate-related vulnerabilities and risks for major agricultural value chains and specific groups of people involved in agriculture; to identify adaptation options that address climate risks/vulnerabilities; and to assess the institutional capacity to deliver adaptation programs.

This climate risk profile seeks to inform county governments and stakeholders about climate change risks and opportunities for agriculture so they can integrate these perspectives into county development. This report will help county governments and stakeholders integrate climate change risks and opportunities for local agriculture into county development plans.

The Alliance undertook the assessment in a set of interrelated stages (Figure 2). It first initiated a desk review of the conceptual and analytical contexts of climate change risks at the national and county levels. It made efforts to involve a wide range of institutions that have worked on climate change at the national and regional levels. The team used globally available data sources like the Kenya Open Data Portal and county development plans, and collected information from relevant government departments, such as the Department of Resource Surveys and Remote Sensing, the Kenya Meteorological Department, and the Drought Monitoring Centre. The team also collected data through focus group discussions, key informant interviews with carefully selected experts, climate modeling, and three days of sub-national stakeholder workshops. The final reports were then presented and validated by national- and county-level stakeholders.

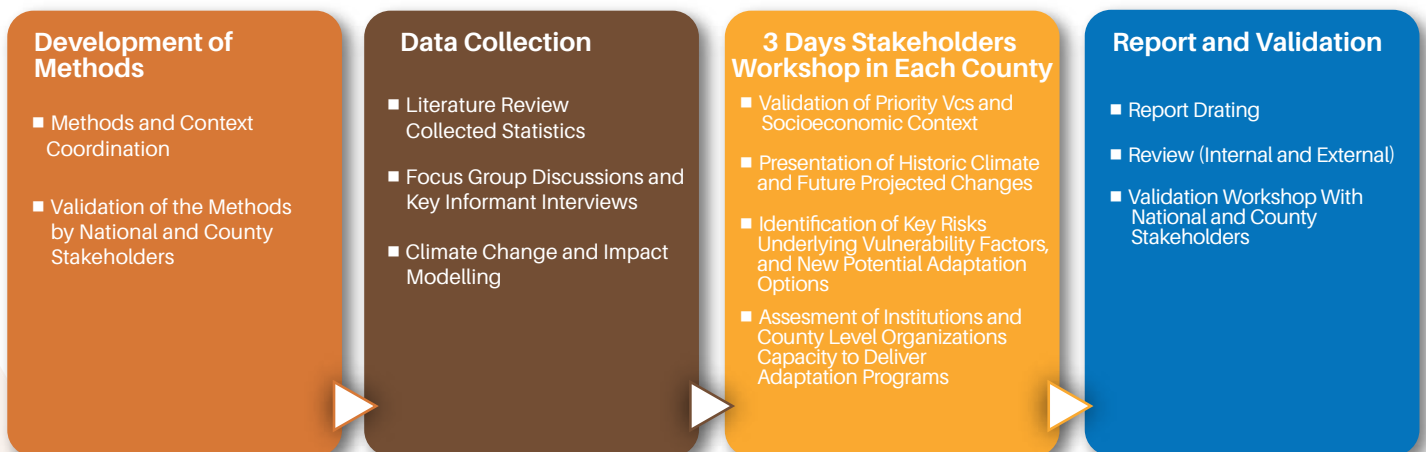


Figure 2: Climate Risk Profile Development Process

This document presents the Climate Risk Profile for Turkana County. It is organized into six main sections, each reflecting an essential analytical step towards understanding current and potential adaptation options in key local agricultural value chain commodities. The document first offers an overview of the agricultural commodities key to food security and livelihoods in the county, and then lists major challenges to agricultural sector development in Turkana. In the second section, it identifies the main climate hazards, based on an analysis of historical climate data and climate projections. These include scientific assessments of climate indicators for dry spells, extreme rainfall, moisture stress, and heat stress, among others. Third, the report continues with an analysis of vulnerabilities and risks posed by these climatic hazards on the identified value chains. Based on these vulnerabilities, the fourth section discusses current and potential on-farm adaptation options and off-farm services. In the fifth section, the report also provides snapshots of the enabling policy, institutional, and governance contexts for the adoption of resilience-building strategies. Finally, the sixth section presents pathways for strengthening institutional capacity to address climate risks.

## 2. County Context

Turkana County covers 68,233 km<sup>2</sup> of land and 2,279 km<sup>2</sup> of water (KNBS, 2019b; Turkana County Government, 2013). It is the second-largest county in Kenya. It lies 1,138 meters above sea level (Turkana County Government, 2013). The county is located in the north-western part of Kenya. Lake Turkana, located in the east of the county, is the world's largest permanent desert lake and lies 360 meters above sea level (Ojwang et al., 2016). The county borders Marsabit County to the east, West Pokot and Baringo Counties to the south, and Samburu County to the southeast. It also borders Uganda to the west, South Sudan to the north and Ethiopia to the northeast (Turkana County Government, 2013). It lies between longitudes 34° 30' and 36° 40' east, and between latitudes 1° 30' and 5° 30' north.

Turkana County is mostly arid, with a warm to hot climate. The southern areas are categorized as semi-humid to semi-arid (NDMA, 2016; Wiesmann et al., 2014). The temperature ranges from 20°C to 41°C, with a mean of 30.5°C (Turkana County Government, 2018). Turkana County has distinct agroecological zones that vary in humidity and temperature.

The county has rivers, low-lying, open plains, and mountain ranges. There are three main rivers in Turkana County, and they all drain into Lake Turkana. The river Turkwel flows from Mt. Elgon at the border of Kenya and Uganda, the river Omo flows from southern Ethiopia, and the river Kerio flows from the Amasya Hills at the west of Lake Bogoria. The Songot, Mogila, Kalapata, Silale, Loriu, Kailongol, Loima, and

Loirengippi mountain ranges are normally covered with green vegetation, high woody cover, and dense bushes. These ranges support wood and charcoal production, honey production, and grazing during the dry season. The open lying plains are arid and experience the least rainfall in the County at 180 mm/year (Turkana County Government, 2018). These plains grow grass and dwarf shrubs shortly after the rainy season (Turkana County Government, 2013).

There are two rainy seasons: the long rainy season and the short rainy season. The former occurs between April and July, and the latter occurs between October and November. The county receives an annual average of 200 mm of rainfall. The months of January, February, and September are usually the driest months. Low rainfall and high temperatures, coupled with high rates of evapotranspiration, result in salt and hard pans on the soil surface. Because of this, only 30% of the county's soil is suitable for farming (Turkana County Government, 2018). The county's rainfall is erratic and unreliable. Furthermore, heavy storms and catastrophic flash floods can occur. Heavy rains over short periods of time can also cause flooding (NDMA, 2016).

### 2.1 Economic Relevance of Farming

Agriculture is the main livelihood in Turkana County, where it is practiced for both subsistence and commercial purposes. Furthermore, about 25% of the county's population derives their livelihoods from agriculture (Turkana County Government, 2018). A majority of the county's income (67%) comes from livestock, while 4% comes from crop farming, and 3% comes from fish farming (Turkana County Government, 2018).

The county's has 2.5 million ha of arable land. Currently, 435,576 ha of this is used for agriculture; 366,142 ha is used for subsistence farming, and 1,484 has is used for commercial production (KNBS, 2019c). The county's livestock consists of 1.5 million cows, 6 million goats, 3.5 million sheep, 0.8 million camels, 0.2 million poultry birds. (Turkana County Government, 2013). Additionally, there are also 32,581 beekeeping apiaries in the county (Turkana County Government, 2013). Food crops are cultivated along bodies of water (e.g., Kerio and Turkwel rivers). The county is also home to a few, scattered rain-fed and irrigated farms. Each year, the county produces 10 million liters of milk (valued at KSh 165 million<sup>1</sup>), 286 million kg of beef (valued at KSh 130 million), 162 million kg of mutton (valued at KSh 24 million), 0.4 million kg of poultry meat, and 3 million eggs (valued KSh 45 million) (Turkana County Government, 2018). Lake Turkana, the Kerio and Turkwel rivers, and other seasonal rivers provide fish.

<sup>1</sup>As at 3/12/2020, 1 KSh is equivalent to 0.009 USD

# Livelihoods and agriculture in Turkana

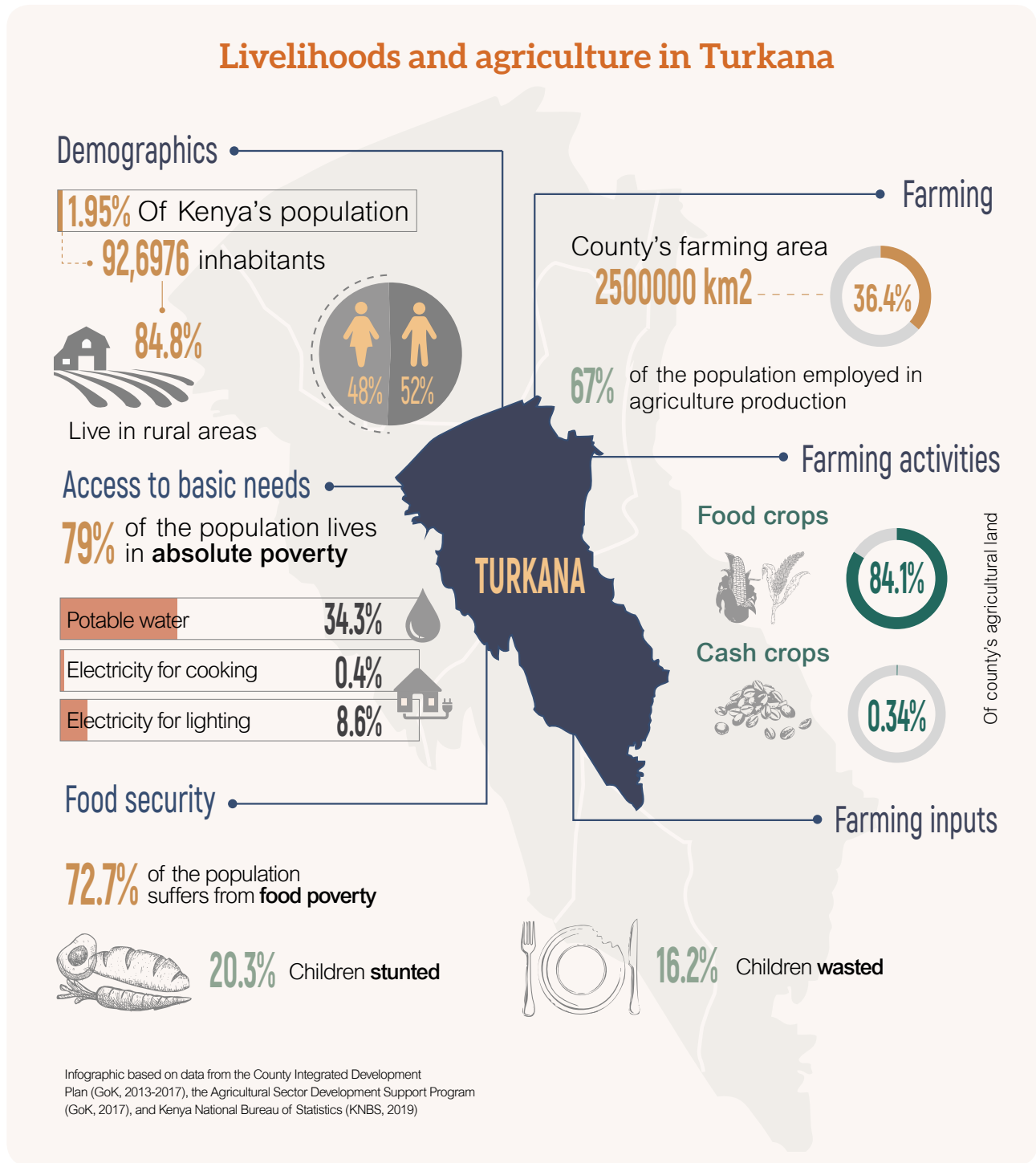


Figure 3: Agriculture and Livelihoods in Turkana County

## 2.2 People and Livelihoods

Turkana County has a total population of 926,976 people (Figure 3); 51.6% are males and 48.4% are females according to the 2019 census (KNBS, 2019a). There are 164,519 households, and the average household consists of 5.6 people. The county has 7 sub-counties: Kibish, which is home to 4% of the county's population, Loima, which is home to 11.6%, Turkana Central, which is home to 20%, Turkana East, which is home to 14.9%; Turkana North, which is home to 7%, Turkana South, which is home to 16.6%,

and Turkana West, which is home to 25.9% (KNBS, 2019a).

About 37% of Turkana's households are involved in farming. Of these households, 25% practice subsistence farming and 0.4% practice commercial farming (KNBS, 2019b). Out of all farming households, 93% are involved in livestock production, 23% are involved in crop production, 0.7% are involved in aquaculture (fish farming in controlled aquatic environments), 7% are involved in fishing, and 8% are involved in irrigation. The average farm in Turkana County is between



0.8 ha and 2 ha large. The labor force in Turkana County consists of 332,100; 150,500, or 45%, of this population is employed in small-scale agriculture and pastoralism. Turkana County's agriculture has great potential (Turkana County Government, 2018, ASDSP, 2014). Its main crops include maize, millet, sorghum, and vegetables, which are farmed at the household level along the rivers Kerio and Turkwel.

The county has several urban centers: Lodwar, Lokori, Lokichoggio, Kakuma, Kalokol, Logurum and Lokitaung. There are also many settlements near Lake Turkana. The county's rural population is 760,374; of this population, 363,787 (48%) are females and 396,587 (52%) are males (KNBS, 2019b). The population is denser in the urban areas, especially in Turkana Central Constituency and the county's capital, Lodwar Town. Turkana West Constituency has the highest population because it is home to a refugee camp. The county averages 14 persons per km<sup>2</sup> (KNBS, 2019), which is an increase from 2013's recorded 12 persons per km<sup>2</sup>.

The county's labor force consists mainly of youth (ages 15 to 29) and constitutes 49% of the entire population of the county. The labor force mainly consists of unskilled labor. The county's employment rate is 70%, compared to the national rate of 42%. The county's dependency ratio (the percentage of the population who are not in the labor force) is 31% (KNBS, 2014). Mining is a key source of livelihood in Turkana County. This includes small-scale gold mining, oil mining, and gemstone and mineral mining (Turkana County Government, 2013). Road construction employs more than 500. The county's minor roads are in poor condition. This adversely affects economic activities, especially during the rainy seasons.

In Turkana County, the absolute poverty rate is 79% and food poverty rate is 73% (Turkana County Government, 2018). Nationally, the county is ranked third in terms of poverty contribution, with an estimated 87.5% of the population living below the poverty line (below USD 1.90 per day). Due to its residents' inadequate and unbalanced diets, Turkana records high levels of Global Acute Malnutrition (GAM) and Severe Acute Malnutrition (SAM). In June 2019, GAM rates were at 25.6%, while in June 2018 they were at 18.1%. In June 2019, SAM rates were at 5.9% and in June 2018, they were at 4.1% (Turkana County Government, 2019).

According to the Turkana County Integrated Development Plan of 2018-2022, the main water sources in the county are rivers and boreholes. Other sources include wells, springs, water pans, roof catchments, and rock catchments. Urban areas have piped water that is serviced by boreholes and pumped using solar power and generators at night. Currently, there are 1,267 boreholes, 129 water pans, 531 shallow wells, 35 unprotected springs, 10 protected springs, and 6,819 roof catchments in the county (Turkana County Government, 2018). Currently, 66,085, or 7%, of households have access to safe water, and 12,119, or

1%, have access to piped water. The average distance to the nearest water source is 10 km. Settlements can be located up to 20 km away from water sources. Currently, 30% of households get drinking water from streams and rivers, 21% of households get drinking water from standpipes, 13% get water from boreholes or tube holes, 12% get water from unprotected wells, 6% get water piped into their plot, 6% get water from a dam or lake, 3% get water from a protected well, 3% get water from vendors, 3% get water piped into their home, 1% get water from an unprotected spring, 1% get water from a protected spring, 0.2% get water by harvesting rain, .1% buy bottled water, 0.7% get water from a pond (KNBS, 2019b).

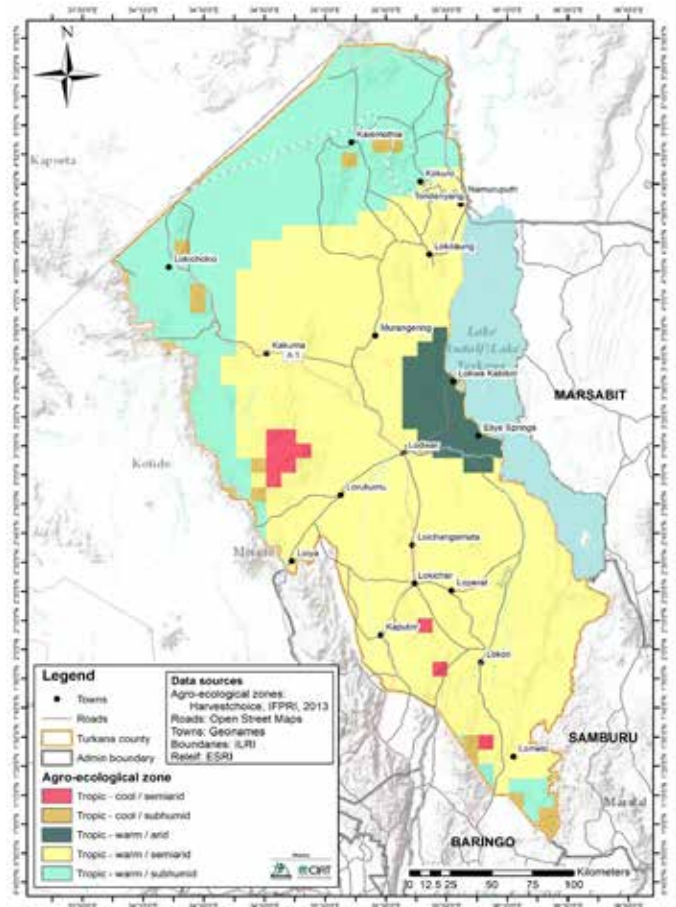


Figure 4: Map of Agroecological Zones in Turkana County

## 2.3 Agricultural Activities

Certain areas of Turkana County are unsuitable for farming and only viable for activities like livestock rearing and settlement. (ASDSP, 2014). There are three distinct farming systems in the county. These systems are based on the characteristics of different agroecological zones (Figure 4). These systems are: pastoralism that is present across all the agroecological zones, while small-scale farming and mixed farming systems are concentrated in the tropic-cool/subhumid and tropic-warm/subhumid agroecological zones (ASDSP, 2014). Irrigation is widespread in Turkana

County and is mainly practiced by small-scale farmers. Water Resource Users Associations direct that water should be used first for domestic purposes, then for livestock, then for irrigation. However, there is barely enough for water in the rivers for domestic and livestock purposes. Additionally, very few farmers harvest rainwater for irrigation.

Most land is held in trust for the community by the Turkana County Government. However, there are reports that several people have purchased land for commercial development (KNBS, 2014). There are no reported of landless persons in Turkana County; in the rural areas, land is communally owned. In the urban centers, the local authority allots land for a fee. The county government holds the forest cover in trust; local communities can utilize its resources without restrictions. Currently, the county has only one gazetted forest, the Loima Forest. The gazettement of the Songot Hills forest<sup>2</sup> is underway.

The main crop value chains in Turkana County are maize, millet, sorghum, cowpeas, and mung beans. Other crops include local vegetables, date palm, spinach, bananas, kale, and tomatoes. Most of these crops are farmed at the household level along the banks of the rivers Kerio, Tarach, Malimalite, and Turkwel. Farmers in Turkana County use relatively low amounts of agricultural supplies (ASDSP, 2014). Livestock rearing is very common in the county. The livestock are usually indigenous breeds of cows, goats, sheep, camels, donkeys, and poultry (Turkana County Government, 2018).

Many farmers in Turkana County grow fruit trees. The county's Katilu Irrigation Scheme grows banana, guava, mango, orange, and pawpaw trees (Turkana County Government, 2018).

## 2.4 Important Value Chains

Several of Turkana County's value chains are prioritized by the County Integrated Development Plan, the National Agricultural Rural Inclusive Growth Project, the Agricultural Sector Development Support Program, and the Kenya Agricultural and Livestock Research Organization. For this profile, the county's major value chains were compiled into a list using the following indicators: productivity characteristics, including harvested area, production, and production variations in the past five years; economic value (KSh); and nutrition characteristics like dietary energy consumption (Kcal/capita/day) and protein, iron, zinc, and vitamin A content. The team presented this list to stakeholders during a three-day workshop for in-depth analysis and selection. We further honed the selection using a set of criteria which were first determined with the stakeholders. The criteria were resilience to current and future climate change impacts, on a scale from low to high; the percentage of population involved in

the value chain (%); and involvement in the value chain of economically and socially vulnerable groups such as poor people, women, and youths, again measured on a scale from low to high. First, we assessed each value chain against each criterion. Then, we selected the value chains that involved the highest percentage of the population and engaged poor people, women, and youths. For this profile, the county's major value chains were compiled into a list using the following indicators The value chains that they selected are: sheep and goats, local chicken, sorghum, and fish.

### 2.4.1 Sheep and Goats

Between 81-100% of the county's population is involved in the sheep and goats value chain. That means almost every household keeps sheep and goats. This value chain involves both small-scale and large-scale actors; for example, the vaccine, medicine and feed suppliers are small-scale. Farmers also depend on herbal medicine to treat their animals. Most farmers keep huge numbers of animals. Wholesalers and retailers sell live animals in bulk within and outside the county. Slaughterhouses operate on a large scale basis and butcheries operate on a small-scale basis in Turkana County.

Most farmers in Turkana use few supplies, or inputs, in this value chain. For example, as stated, most farmers depend on herbal medicine to treat animals. This means that they do not buy medicine inputs for their livestock. Men are less involved on-farm than women and youth. This is because, traditionally, it is the duty of women and youth to take care of sheep and goats. Men are somewhat involved at the post-production stage; men and the youth become more involved at slaughterhouses and butcheries. Men and youth are highly involved in transporting, marketing, and selling the animals.

Whereas land and fodder are mostly communally owned and shared, other inputs, such as feed, must be obtained by individual farmers. The Department of Development, its partners, and the farmers carry out major activities like breeding, deworming, and vaccinating. Processors, transporters, butchers, middlemen, wholesalers, and brokers become important in later stages of the value chain. Farmers, wholesalers, the government, middlemen, development partners, and processors carry out marketing, linking, buying, and selling activities

### 2.4.2 Local Chicken

Between 61 and 80% of Turkana County's population is involved in the local chicken production chain. Local chicken is reared on a small scale across the county. Local chicken meat and eggs support food security in the county. Poultry farming in individual homesteads is mainly controlled by women and youth. They clean

<sup>2</sup> Gazetted: published in an official gazette, such as the Kenya gazette



poultry houses, feed the birds, select and grade eggs, sell eggs, and process chicken meat. Men are often involved in obtaining vaccines, cleaning and spraying poultry sheds, preparing feed, and providing water, but rarely engage beyond these activities. Eggs and chicken meat are consumed and also sold.

At the production stage, farmers acquire feed, veterinary services, and breeding materials from the Department of Livestock, vendors, and agro-vets. The Department of Livestock, the Caritas Lodwar charity, and the International Livestock Research Institute play important roles at this stage. The Department of Veterinary Services and agro-vets in the areas of Silo and Sidai supply chicken feed, vaccines, and medicines on a medium-scale basis. There are also chicken cooperatives, supported by the Technology Conservation Group. Processing happens on a small-scale basis, as most chicken is consumed at the household level.

On farms, farmers carry out vaccinations and feeding and build housing for their birds. Local chicken is mainly raised free-range. However, parasites, diseases, and unfavorable weather conditions have made poultry farmers reconsider the viability of free ranging. Local chicken does well during warm weather. However, farmers are forced to house their chicken during very hot days, drought, and floods. Success in poultry farming largely depends on the quality and availability of inputs like vaccines, medicine, and feeds, and proper practices like proper housing.

Post-production, farmers transport their chickens to markets, slaughter, and process meat. Although farmers transport their goods throughout the county, slaughtering and processing activities are concentrated in areas like Lodwar, Kakuma, Lokichoggio, Eliye Springs, Kainuk, and Lokichar. Restaurants buy a lot of chicken meat. In towns like Lodwar, Kakuma, Lokichar, Lokori, and Lokichoggio, farmers, development partners, and chambers of commerce engage in selling, promotion, and marketing at the local level. To deal with problems in pricing and quality, farmers form groups like the Nateleng Group to standardize chicken prices, process through freezing, and better market their produce. These groups are successfully streamlining the poultry value chain.

### 2.4.3 Sorghum

Most of Turkana County's population (61-80%) is involved in the sorghum value chain; it is a traditional crop in Turkana County. It is also drought-tolerant and fast growing. Sorghum production is optimized through intercropping with cowpeas, another early-maturing and drought-tolerant crop. Intercropping ensures that a farmer does not incur a total loss if one of the crops fails. Intercropping also helps conserve soil and water and protect against runoff and soil erosion. Cow peas also improve soil fertility. Youth and women

are involved across all stages of production. Men are generally uninvolved in this value chain.

The suppliers, farmers, and wholesalers/retailers in this value chain operate on a small-scale basis. Farmers mainly use their own seeds. The government and some non-governmental organizations provide limited amounts of seeds. Sorghum is grown on small plots, with no inorganic fertilizer, under rain-fed conditions. Farmers who live along rivers irrigate during dry spells. Most sorghum is grown for consumption. However, a few sorghum flour mills have recently been established in Loyal, Etic and Morulem.

The Department of Agriculture, in collaboration with other programs like the Agricultural Sector Development Support Program and National Agricultural and Rural Inclusive Growth Project, provides help to sorghum farmers. Farmers also acquire equipment and tools from local markets. Some farmers buy seeds, but most recycle seeds. On-farm, farmers prepare land, weed, and harvest. Post-production, the sorghum is processed, stored, and transported on a small scale. Oftentimes, youths transport the sorghum using motorbikes and produce is stored in traditional granaries constructed within farms, while the surplus is taken to the National Cereals and Produce Board in Lodwar Town. At the market, actor price and sell and link farmers to buyers.

### 2.4.4 Fish

Fish involves 21-40% of the county's population. The fish value chain offers off-farm opportunities to fishermen, as well as women and youth, who are involved in cutting, grading, processing, packaging and transporting. According to the Kenya Maritime and Fisheries Research Institute, the fish value chain has the potential to significantly contribute to the national economy and support Turkana's population.

Most of the players in the fish value chain are located near lakes. Fish is consumed locally, and transported to markets in Nairobi, Kisumu, Lodwar, Busia, Uganda, Congo, and Tanzania. Most fishing gear suppliers operate on a medium-scale basis, and are found near lakes. Most fishermen and processors operate on a medium-scale basis, although there is one large-scale processor in the town of Loropio. Wholesalers operate on a large-scale basis and target external markets like the Congo, while retailers operate on a medium-scale basis and target local markets in other counties

The most important input for this value chains is fishing equipment. Men and male youth are very involved in procuring equipment. Most suppliers are located in the Kalokol and Kang'atosa wards. The key players are private suppliers, the county government, and its partners (the United States African Development Foundation and the International Organization for Migration). The Kenya Maritime Authority, the Department of Fisheries, and the Kenya Maritime and

Fisheries Research Institute offer education and other services. Local artisans from the Kalokol, Kang'atosa, and Kerio wards, build boats. Some farmers own their fishing gear, while others rent boats and fishing nets daily.

On-farm, fishermen engage in sorting, cutting, and washing fish. Youth are very involved in this stage. Post-production, laborers engage in transportation, processing, and packaging. Youth are also highly involved at this stage. Most fish processors are located near makes. Fishermen and agents then link producers to buyers. Traders, processors, and middlemen engage in weighing and grading fish. Middlemen and brokers

collect and store fish. Men, women, and youth are highly involved in these stages of the value chain.

## 2.5 Challenges to the Agriculture Sector

Turkana County is prone to climate variability; prolonged dry spells are becoming the new norm (Turkana County Government, 2018). The county is hit hard by drought and famine, which force people to rely on relief and food donations. Turkana County's agriculture is threatened by lack of access to water and aid, climate-change related soil degradation, aridity, erosion, a reliance on rain-fed agriculture, and political roadblocks (Turkana County Government, 2018).

### Agricultural value chains in Turkana



#### Conventions

Service Providers: S Suppliers f Farmers P Processors W Wholesalers/ retailers

small-scale medium-scale large-scale

ND: No data

Importance of women, youth men and women: 5 4 3 2 1  
1 = very low; 2 = low; 3 = medium; 4 = high; 5 = very high; 0 = non-existent; N/D = no data.

Figure 5: Characterization of Selected Value Chains in Turkana County

Turkana County's inadequate and unreliable rainfall fails to adequately support its agricultural activities. Irrigation is expensive, labor-intensive, and rare in Turkana County. The county's size makes it difficult to allocate limited resources equitably. Furthermore, during heavy rainfall and floods, the existing water infrastructure is damaged or destroyed, further aggravating the problem as noted by the Water Department in Turkana County.

Turkana County farms are not highly diversified; farmers mainly depend on livestock like sheep and goats. Turkana County is culturally inclined to pastoralism. Overdependence on livestock makes farmers vulnerable to climate change. The county government encourages farmers to sell animals before difficult periods to avoid loss, and to restock during favorable periods.

The rainy seasons are often late and torrential in Turkana County. This causes soil erosion and crop destruction. In extreme cases, floods destroy property and infrastructure, and displace farming communities. Heavy rains also form large pools that can drown humans and livestock. Soil erosion also causes water pollution, which affects fish breeding grounds. Conversely, drought affects the quality and quantity of fish, and leads to overfishing as farmers from other value chains engage in fishing as an alternative source of income (ASDSP, 2020).

Farmers are threatened by emerging livestock diseases, like *Lolewo*, a goat disease that is caused by prolonged wet periods, and pneumonia that affects local chicken. Heat stress hinders livestock growth and nutrition. Livestock farmers in Turkana County compete for resources, which leads to conflict. This is another challenge that the county faces.

Turkana County is further disadvantaged by inadequate aid and advisory services. Farmers reported that aid workers historically reached them through field visits and demonstrations. Today, this type of aid is threatened by insufficient means of transport, fewer workers, and inadequate financial support. Furthermore, the nomadic way of life in the county makes it difficult to follow-up. As a result, technical experts and farmers rarely communicate. This leads to subpar fodder conservation techniques, poultry feed, pest and disease management, technology use, and more.

Turkana County also suffers from poor coordination, overlaps in official duties, and poor communication. For instance, the county's Lands Department had allotted wetlands and riverbank areas to citizens, despite this being prohibited by the National Environmental Management Authority. This has encouraged encroachment on rivers and water catchment areas. The county government has also

approved major constructions near marshlands, despite the fact that there are departments that exist to safeguard marshlands. Because existing policies are not integrated into plans, Turkana County's ecosystem is suffering.

### 3. Climate Change and Agriculture: Risks and Vulnerabilities

In generating this profile, we assessed past trends and future projections of precipitation and temperature, and computed several related hazards from these two variables. These hazards included extreme hydrological events like flash floods, droughts, moisture stress, heat stress, and the start and length of the growing seasons, in order to assess climate change and variability in Turkana County. The growing season was defined as follows: the first, long rainy season is the 100-day wettest period from January to June, while the second, short rainy season is the 100-day wettest period from July to December (KMD, 2020).

We used Representative Concentration Pathway (RCP) 8.5, one of the four greenhouse gas concentration trajectories adopted by the Intergovernmental Panel on Climate Change (IPCC) for its fifth Assessment Report (AR5) in 2014. Future climate projections were generated based on an ensemble of multiple Coupled Model Intercomparison Project (CMIP5) models (Taylor et al., 2012), using RCP 8.5 for two future periods, 2030 and 2050.<sup>3</sup>

To assess droughts and dry spells, we focused on the maximum number of consecutive dry days (CDD), defined as days receiving rainfall measuring less than 1mm (precipitation < 1 mm day<sup>-1</sup>). We determined heat stress by measuring the total number of days with maximum temperatures greater than or equal to 35oC (NT35). Growing days are the days during a season when average temperatures are greater than or equal to 5°C and precipitation exceeds half the potential evapotranspiration. The start of the growing season was determined by the occurrence of 5 consecutive growing days, while the length of the growing period (LGP) was determined as the total number of growing days.

For each season, heavy precipitation events were captured with the 5-day running average of rainfall, indicative of floods, and the 95th percentile of daily precipitation, indicative of extremely high rainfall over a short period of time, indicating flash flooding risk. The 95th percentile of daily precipitation distribution, based on the 100 wettest days per season per year, was calculated for each pixel.

To assess the degree adequacy of rainfall and soil moisture to meet the potential water requirements

<sup>3</sup> For historical precipitation and temperature trends, we used the Climate Hazards Group InfraRed Precipitation with Station (CHIRPS) and Climate Hazards Group Infrared Temperature with Stations (CHIRTS). For future climate projections we used an ensemble of downscaled Coupled Model Intercomparison Project Phase 5 (CMIP5) (Taylor et al., 2012, Navarro-Racines et al 2020), specifically the MOHC\_HADGEM2\_ES, CESM1\_CAM5, GFDL\_CM3, MPI\_ESM\_LR, and MIROC\_MIROC5 models

for agriculture, indicators for drought stress were examined in terms of the number of consecutive days in each season where the ratio of actual to potential evapotranspiration (ETa/ETp) is below 0.5. This was calculated for each pixel per season per year by evaluating soil's water capacity and evapotranspiration to define the number of days that could undergo a certain level of stress.

### 3.1 Climate Change and Variability: Historic and Future Trends

Historical monthly temperatures in Turkana County between 20 and 40°C. South-eastern Turkana is significantly hotter than the rest of the county. The long rainy season is significantly wetter than the short rainy season. The dry season runs from the end December into February. April experiences the most rainfall (more than 50 mm per month) (Figure 6 and 7).

Up until the 1990s, Turkana County had a favorable climate for agriculture. The rains were regular and adequate and, during the long rainy season, the county would record between 750 mm and 1000 mm of rainfall. Currently, the county receives an annual average of 180-200 mm of rainfall and this is projected to reduce by 2040 during the long rainy season. By 2060, rainfall trends are projected to increase for both seasons (Figure 8). Flooding is also becoming a frequent phenomenon, especially during the short rainy season (Turkana County Government, 2013). The climate has become very hot and dry, with increased incidence of drought and famine during the long rainy season. Temperature trends show a steady increase during both seasons for climate projections until 2040 and 2060 (Figure 9)

Analysis of temperature changes in Turkana County since 1985 indicate an increase in heat stress during the long rainy season. It also indicates a slight increase in average precipitation and a slight decrease in heavy rainfall. The data also indicates highly variable levels of moisture stress and a delayed growing season. During the short rainy season, the number of consecutive dry days has significantly decreased. The data also shows increases in flood risk, rainfall, and heat stress, and a delayed growing season.

During the long rainy season, most of the county experiences fewer than 60 consecutive dry days (CDD). In the future, the county will experience an overall increase of up to 25 CDD days during this season (Figure 10). During the short rainy season, most of

the county experiences between 60 to 80 CDD. In the future, the county will experience an overall decrease of up to 30 CDD. These changes mean that farmers should plant early maturing and drought-tolerant varieties of crops.

During the long rainy season, average precipitation (P5D) has historically remained below 20 mm (Figure 11). Future climate projections indicate that the P5D number will increase by between 8 and 10 mm. During the short rainy season, P5D has historically also remained below 20 mm. Future climate projections indicate that P5D will increase by 10 mm or more during the short rainy season. This increases opportunities for farmers to engage in flood-based farming.

During the long rainy season, average precipitation (P5D) has historically remained below 20 mm (Figure 9). Future climate projections indicate that the P5D number will increase by between 8 and 10 mm. During the short rainy season, P5D has historically also remained below 20 mm. Future climate projections indicate that P5D will increase by 10 mm or more during the short rainy season. This increases opportunities for farmers to engage in flood-based farming.

Analysis shows that during the long rainy season, there are typically more than 70 days with a maximum temperature greater or equal to 35°C (NT35). Future climate projections indicate the NT35 number will marginally increase in some regions, by up to 30 more days during the long rainy season, and by more than 15 days during the short rainy season. This means that there will be risk of heat stress, especially to animals like local chicken, sheep, and goats.

Moisture stress is estimated as the number of days with a ratio of actual evaporation levels to potential evaporation levels below 0.5. This ration serves as an indicator of the amount of soil moisture that is available to plants. Higher values of moisture stress negatively affect crop growth. Comparison of historical and future trends indicates that Turkana County is expected to experience between 10 and 12 more days of moisture stress in the future. However, this number will decrease during the short rainy season, by up to 20 days.

This data offers hope for a productive short rainy season for farmers. However, poor planning and lack of education has resulted in farmers that don't know when to plant or to acquire inputs. Furthermore, delayed rain sometimes forces farmers to not plant at all.

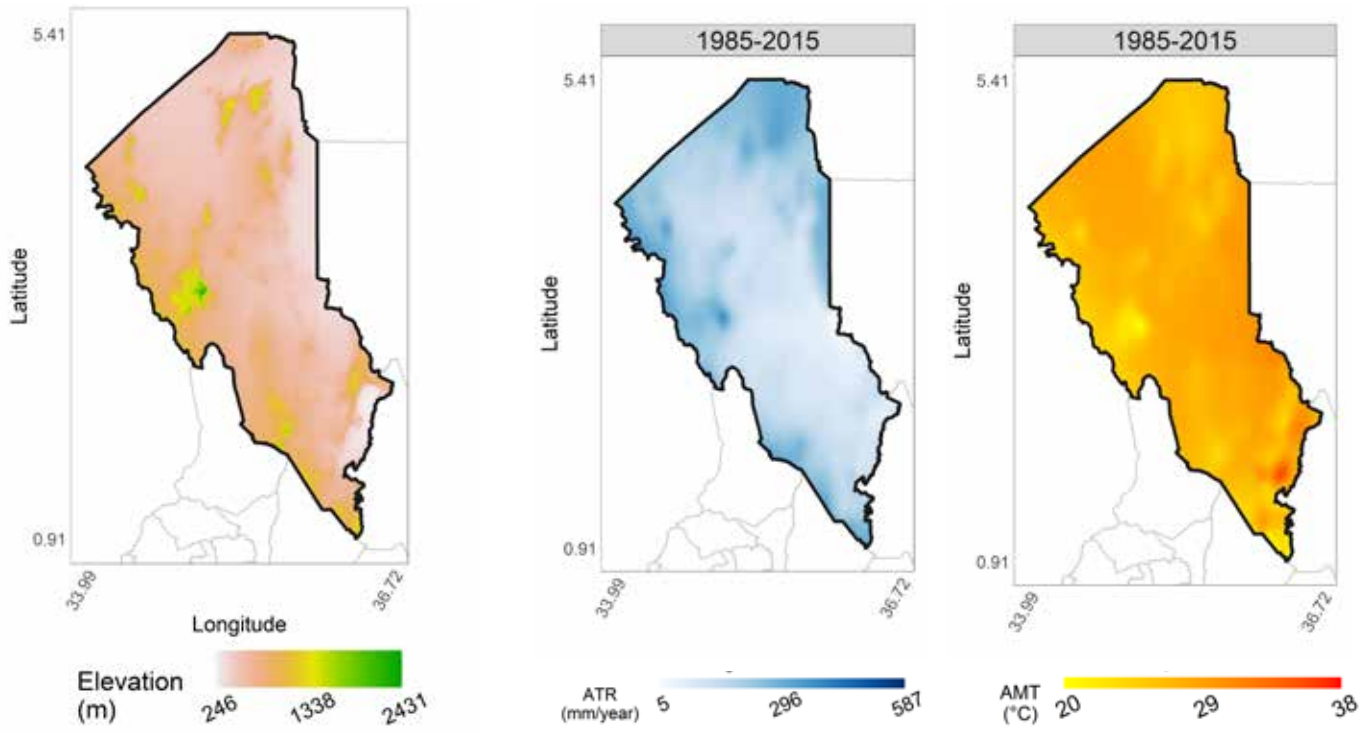


Figure 6: Elevation, average annual rainfall, and average annual temperature in Turkana County (average 1985-2015) for the long rainy season

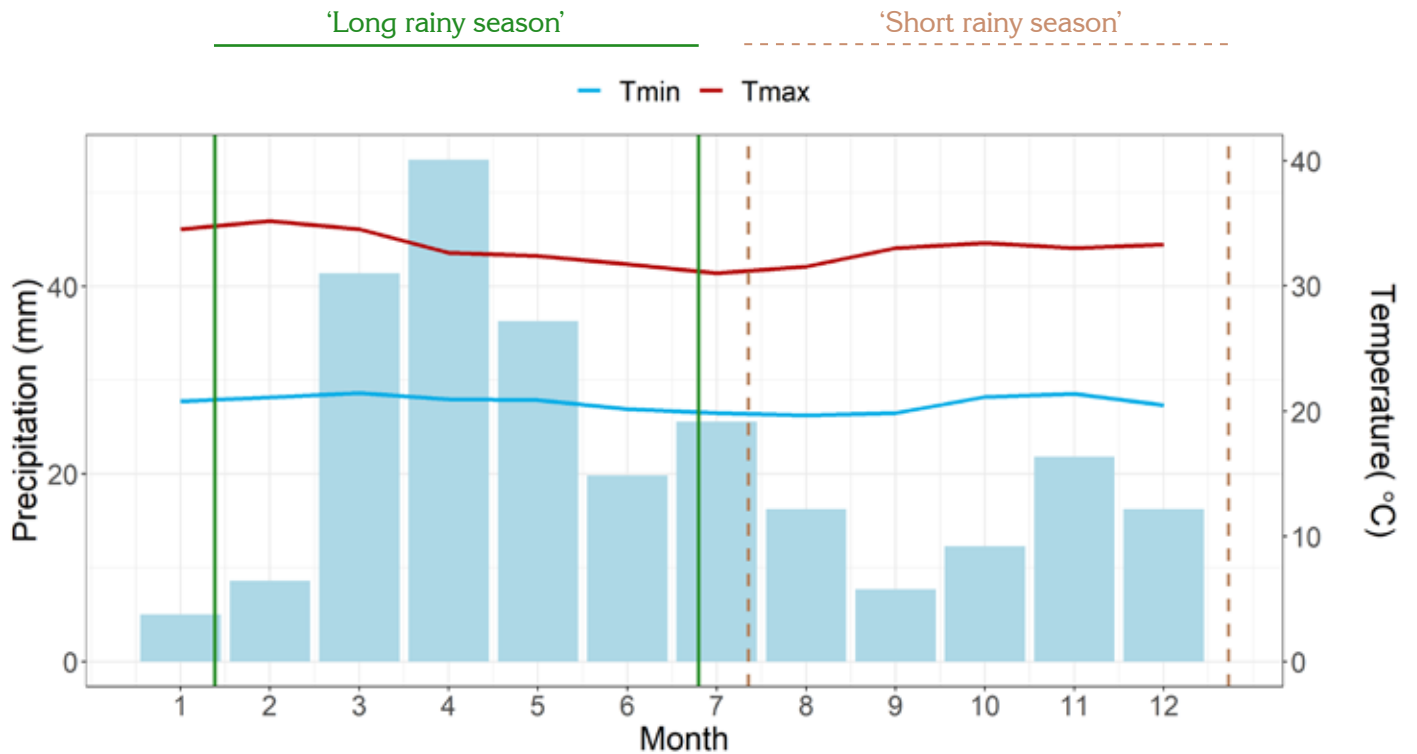


Figure 7: Historical monthly mean temperature and precipitation (average 1985-2015) in Turkana County. The long rainy season is the 100-day wettest period from January to June, while the second, short rainy season is the 100-day wettest period from July to December. Bars represent total monthly precipitation, whereas red and blue lines represent maximum and minimum monthly mean temperatures, respectively.

### Annual Total Rainfall Trends

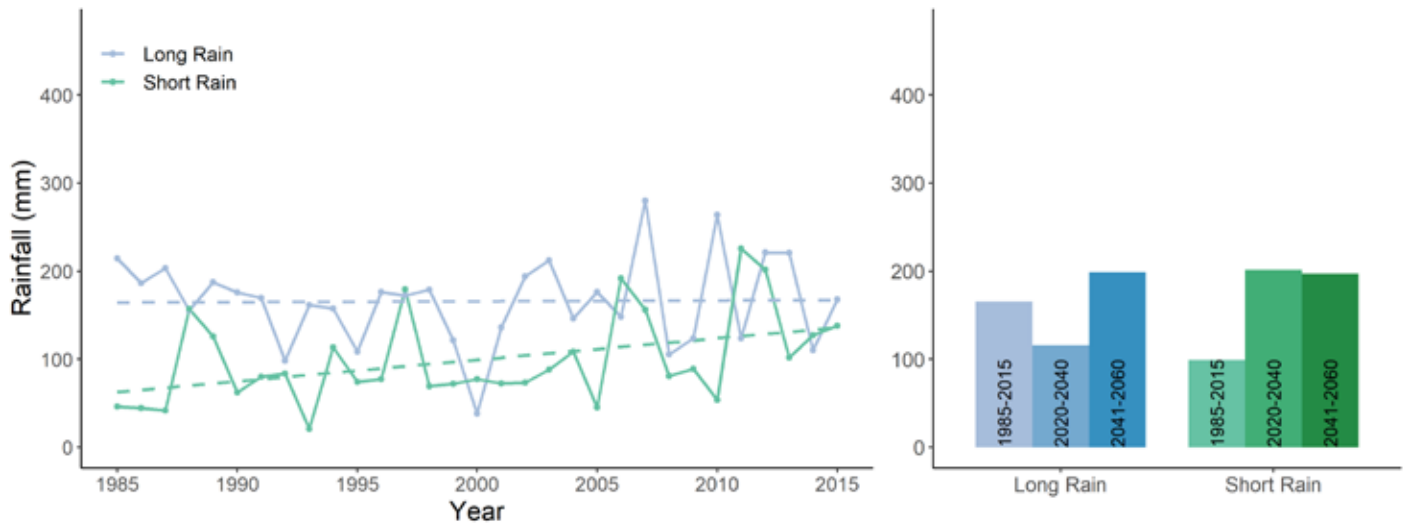


Figure 8: Annual total rainfall trends for the long and short rainy seasons in the past (1985-2015) and in the future (2020-2040 and 2041-2060)

### Annual Mean Temperature Trends

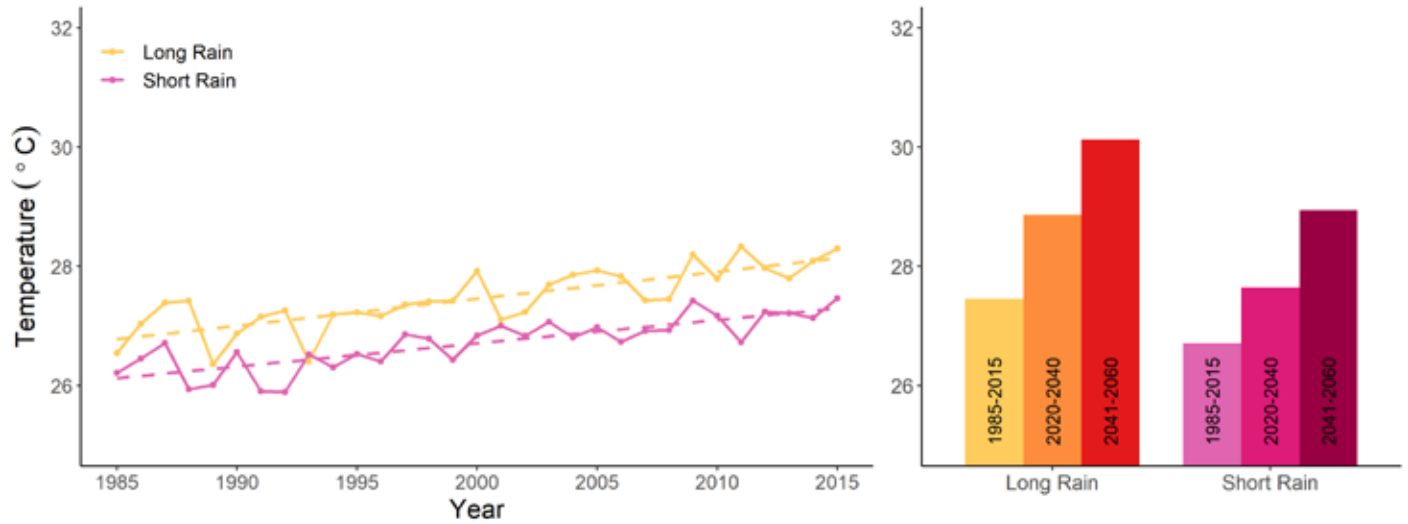
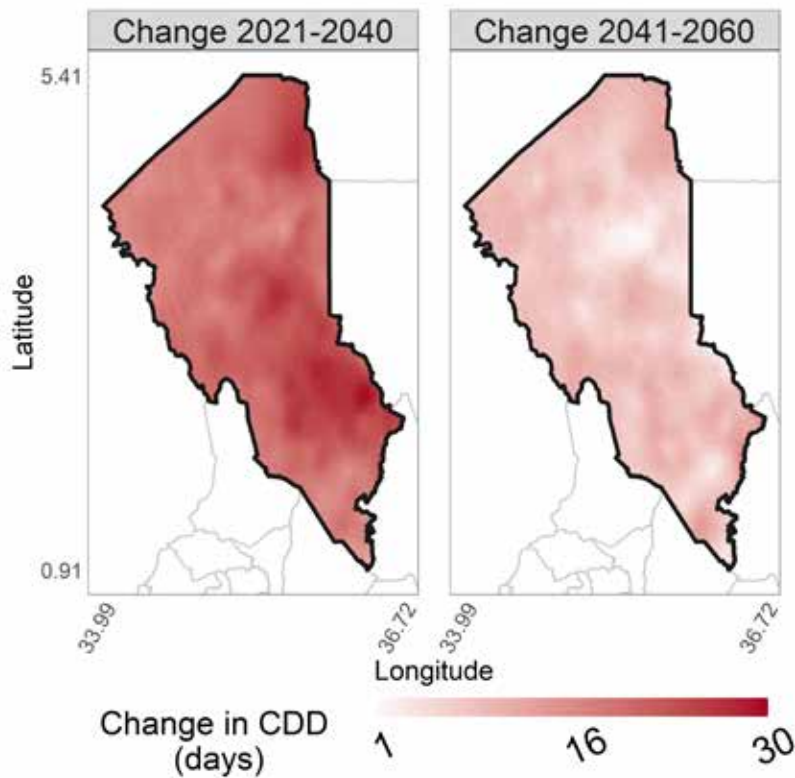
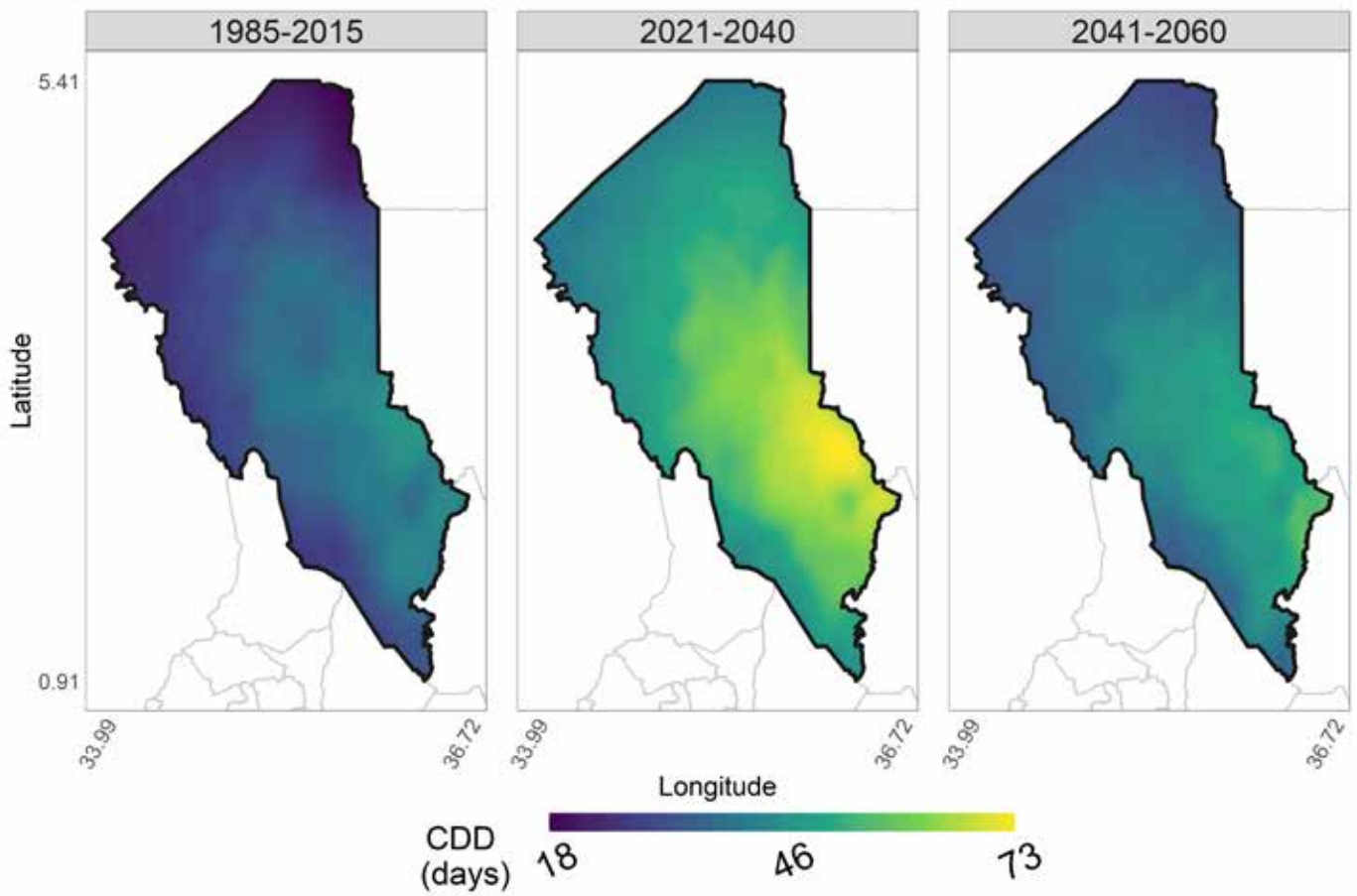


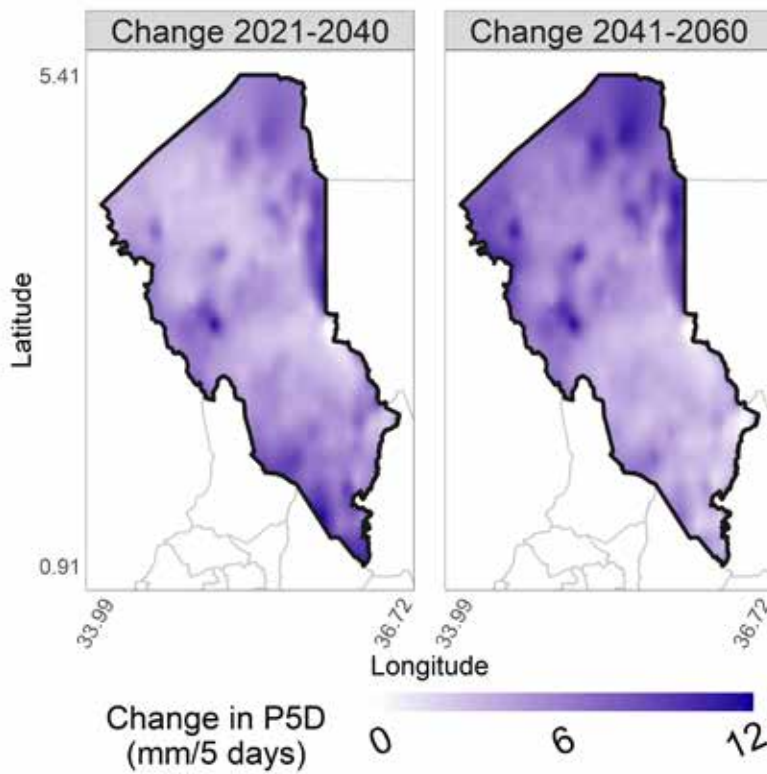
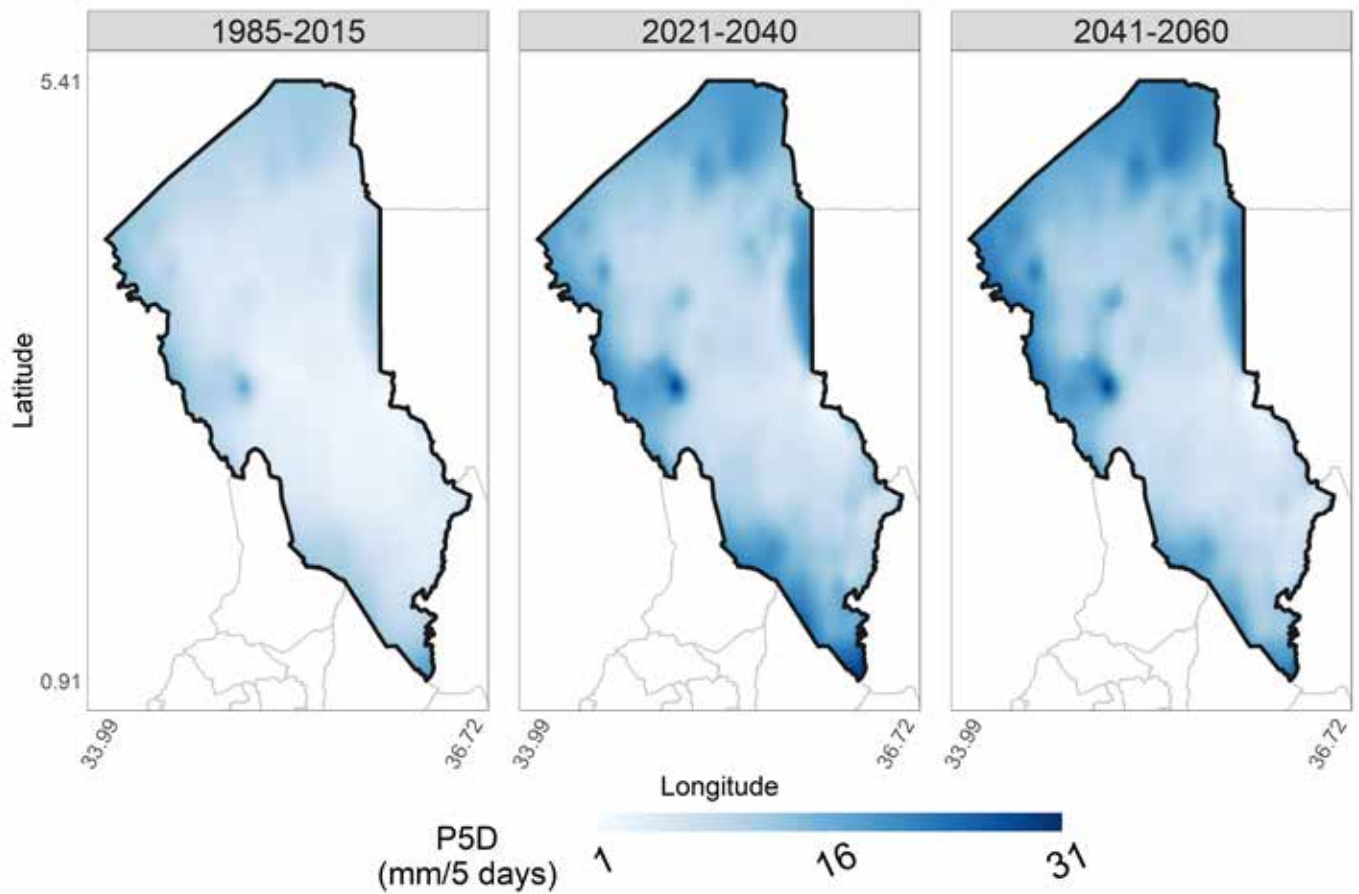
Figure 9: Annual mean temperature trends for the long rainy and short rainy seasons in the past (1985-2015) and in the future (2020-2040 and 2041-2060)





Alliance of Science and CAT

Figure 10: The average number of consecutive dry days for the long rainy season: historical (left), future projected (center), and projected change (right)



Alliance of Biodiversity and CLAT

**Figure 11:** The average maximum 5-day running average precipitation in mm for the short rainy season: historical (left), future projected (center), and projected change (right)

## 3.2 The Climate from Farmers' Perspectives

Farmers in Turkana County believe that climate change is a natural occurrence that has been aggravated by human activities. Some do not understand climate change, while others think that it is a curse. Climate change has brought drought, flooding, intense rainfall, moisture stress, uncertain planting seasons, and locusts to Turkana County.

Periods of drought and moisture stress have necessitated irrigation farming. This has resulted in a substantial increase in farming along rivers. This leaves farmers who live downstream with little or no water. Periods of water shortage periods have resulted in changing household roles - for example, men going to look for water or remaining behind to take care of the homestead and feed the children. Traditionally, these jobs are reserved for women.

On a positive note, farmers agreed that the increased rainfall, especially during the short rainy season, has resulted in increased pasture production. If this pasture is harvested and stored well, it can provide food for the livestock during drought periods. The warmer weather has also given rise to poultry farming; chicken does well in warm and hot weather.

## 3.3 Climate Vulnerabilities across Value Chain Commodities

Moisture stress, drought, extreme rainfall, floods, increased temperatures, and inconsistent seasons pose severe threats to Turkana County. The climate hazards that pose the worst threat to the county are drought, extreme rainfall, and floods. Moreover, the county has also in the recent past faced the locust invasion in the country. The locust plague that has been exacerbated by atypical weather patterns and which has been amplified by climate change has mostly hit Turkana South, followed by Turkana West, Turkana Central and Loima sub-counties. By devastating farmland and grazing areas, the crisis has dented the food security and livelihoods of a great number of residents in Turkana County.

The sections below highlight the major climate risks that they pose to the major value chains.

### 3.3.1 Sheep and Goats

The climate hazards that most effect the sheep and goats value chain are drought and flood. Sheep and goats require constant rainfall patterns to provide adequate pasture and water. During drought, feed availability is limited, and animals starve. Pests and diseases also proliferate during droughts. Most farmers do not have the capital to buy feed, medicine, and vaccines for their animals. Emaciated animals do not command good prices during droughts. In addition,

invasive pests like locusts are proliferate during drought and compete for the little vegetation that is available.

During floods, waterlogged soil affects the development of pasture. *Prosopis spp* (local name *Mathenge*), an invasive species that thrives in stagnant water, encroaches grazing land. In extreme cases, floods sweep away and destroy existing pasture and property, and drown livestock. Animals are affected by diseases like coughs and diarrhea during wet periods. Floods can also block roads. The county government usually sends out flood warnings through SMS. However, this is only useful to farmers who own mobile phones. Low yields reduce marketing and transport activities. This threatens many livelihoods.

The goats and sheep value chains have also been affected by the locust invasion in the county. By destroying vegetation and rangelands, there has been reduced pastures for the sheep and goats to graze on in the already arid region. It is estimated that the decimation of browse by the desert locusts has caused major harm to the residents, as the sheep and goats are an essential source of food, nutrition and financial security to the herding Turkana Community (Guardian 2020).

### 3.3.2 Local Chicken

Drought and floods affect the chicken value chain in Turkana County. Flooding reduces the availability and quality of poultry feeds and hinders production and transport. Floods also hinder feed production. Wet weather also makes chickens susceptible to coughs and diarrhea. This leads to increased chick mortality and reduced egg production. Veterinary services are hindered by impassible roads during floods. Farmers have fewer birds to slaughter and sell for profits during these times.

Drought also affects feed production through water shortage. Heat stress results in higher chick mortality. In addition, high temperatures may cause vaccines and chicken meat to spoil. Some farmer groups have freezers and fridges that use solar panels. Some farmers prefer to sun-dry their meat during droughts. Ultimately, droughts mean that farmers have fewer birds to sell for profit.

### 3.3.3 Sorghum

Drought and extreme rainfall affect the sorghum value chain. Although sorghum is a drought-tolerant crop, it requires moisture to sprout. During drought, hard pans form on the soil's surface, and farmers require additional labor and expensive equipment to break through. Poor farmers often lack the financial capacity to break through hard pans. Drought lowers sorghum production because of delayed planting.

Extreme rainfall destroys sorghum and washes away pollen. There is also a chance of severe water-logging and disruption during extreme rainfall events. Heavy rains also cause damage to fences and storage facilities and hinder transportation. Furthermore, intense rainfall causes damage to produce during transport and might cause rotting. Heavy rain can also destroy irrigation infrastructure and increases rates of pests and disease.

Furthermore, the locust invasion has affected sorghum production in the county reducing the gains made. FAO estimates that in the county, there was a 15 to 20 percent damage or reduction of the yield in the sorghum crop (FAO, 2020).

### 3.3.4 Fish

Drought and flood affect Turkana County’s fish value chain. Flooding cuts off road networks, making it difficult for farmers to receive supplies and aid. Flooding causes water pollution that destroys fish breeding grounds. Because of this, processing, packaging, transportation, grading, and marketing services are seriously affected during floods.

Persistent drought reduces water levels and compromises water quality, which reduces the number of fish produced. Drought also affects the availability of input. For example, raw materials such as timber for boat making are usually limited during drought periods due to low demand. Harvesting, cutting, washing, transportation, processing, packaging, grading, and marketing activities are all severely affected by this.

## 4. Adapting to Climate Change and Variability

### 4.1 Factors That Determine Future Vulnerabilities to and Impacts of Climate Change

Drought affects people differently based on their coping mechanisms (Mutu, 2017). Farmers who do not entirely depend on livestock are more likely to cope well. Farmers can cope with drought through rainwater by harvesting water and using water pans and dams. Male farmers who are in a position to educate themselves will be able to cope better than women and youth, who are traditionally excluded from education. Poor farmers are more vulnerable because they do not have the financial resources to invest in irrigation or water tanks, and because their houses often have grass roofs that render rooftop rainwater harvesting impossible.

The areas which are most vulnerable to flooding include the lowlands and river areas. Illiterate people are also more vulnerable to flooding, as they cannot read early warning bulletins. No policy helps pastoralists procure

vaccines, breeding, and deworming services during famine periods.

Youth and women are vulnerable to climate change, not only because they are major players in the local chicken value chain, but also because they lack the knowledge and financial resources to adapt to climate change. Men are more able to attend meetings, listen to the radio, and read newspapers. Women and youth spend most of their time on farm or in search of domestic resources. The less educated are also vulnerable, as they do not possess the knowledge required to adapt to climate change. Farmers who live in regions that are prone to extreme rainfall are also vulnerable. Resource-poor farmers are also vulnerable to climate change. The old and illiterate rural population cannot access off-farm employment and are therefore vulnerable.

In the fish value chain, men are vulnerable to the effects of climate change, as fishing gear artisans are predominantly male. Poor fishermen are also vulnerable, especially when they lose their fishing gear to floods or when their boats capsize during strong winds. Women and youth are also vulnerable, as they are the main players at the post-production and output stages.

## 4.2 Adaptation Options

### 4.2.1 Ongoing Practices

Turkana County is trying to curb some of the effects of climate change. Various county departments, non-governmental organizations, and private entities offer on-farm and off-farm aid services. One of the main ways to adapt to climate change effects is to ensure that Turkana County’s farmers are prepared. For example: farmers are now destocking and restocking their livestock accordingly and the county promotes feed production and conservation, water infrastructure development, and soil conservation.

Destocking and restocking livestock ensure that farmers can comfortably manage their herds during climate hazards. There are also breeding initiatives to introduce hardy animals to Turkana County’s farmers.

The Department of Water and some residents have drilled boreholes in Turkana County. Some residents use water pans and dams to store water. Additionally, water vendors play a key role in meeting the county’s demands for water. However, the water that they sell is expensive.

The Department of Agriculture encourages farmers to grow early-maturing, drought-tolerant, and pest and disease-resistant varieties of crops. Flood-based farming is also practiced in Turkana. Vegetable gardening is also increasing as a supplement to livestock rearing.

Turkana County farmers also practice soil conservation practices in order to protect their farms from erosion. These farmers construct rock or concrete-filled cages along riverbanks to curb wind and water erosion. These cages are constructed in collaboration with the Departments of Agriculture and Water. Tree-planting activities have also started to gain ground in Turkana County.

### 4.2.2 Potential Practices

Farmers, various government departments, the private sector, and different non-governmental organizations can reducing the effects of climate change through activities such as replanting forests, engaging in livestock management services and water management services, education, using climate and weather advisory services, protecting and conserving water resources, diversifying farms, and research and development.

Extension workers can incorporate advisories from the Kenya Meteorological Department into field days and demonstrations with farmers. The Kenya Meteorological Department frequently sends climate-based advisories to different departments and farmers through SMS and bulletins. This will help farmers plan their farming activities accordingly. This will also help people in the lowlands or areas that are prone to flooding move to higher and safer areas before floods begin. The National Drought Management Authority is also involved in early warning systems, and uses bulletins and radio adverts (Turkana County Government, 2018).

Extension services and education initiatives can be upscaled to include more farmers. Currently, the Ministry of Agriculture, Livestock, Fisheries, and Cooperatives offers services, but these services do not reach every farmer in the county, due to inadequate human and financial resources. The Agricultural Sector Development Strategy Program, the Food and Agriculture Organization of the United Nations, and the county government currently promote conservation agriculture and the use of drought-tolerant plants (ASDSP, 2014).







Pasture area has recently become significantly rarer in Turkana County, and farmers must find alternatives to feed their animals. The Turkana Rehabilitation Project, the National Drought Management Authority, and the Livestock Department and its partners offer feed-production ventures, pasture reseeding, and fodder production (Turkana County Government, 2018). However, these feeds can only support a minimal number of livestock. Another potential solution is storing sorghum and maize stems to use as fodder.

The Forestry Department, the Kenya Forestry Research Institute, and the Caritas Foundation are spearheading replanting efforts. These efforts educate members of the community on the importance of planting trees and sustainable tree harvesting. They also provide these community members with appropriate seedlings and show them how to plant. Replanting promotes developing microclimates and water-catchment areas. Trees also protect farms from heavy winds.

Some farmers in Turkana County have begun insuring their crops and livestock against climate hazards. Initially, the government used to buy index-based insurance for pastoralists in Turkana. Currently, the Kenya Livestock Insurance Program is encouraging more farmers to embrace voluntary insurance covers that protect their farming activities (Turkana County Government, 2018).

Research and development is also promising in Turkana County (Opiyo et al., 2015). Turkana University, the International Livestock Research Institute, and the Kenya Forestry Research Institute are major players in Turkana County's research and development. Researchers can also involve farmers in trials and demonstrations. The Livestock Department among other entities are also engaging in breeding research. To deal with the locust scourge, it is imperative to strengthen the surveillance capacity, have the necessary equipment and staff for aerial and ground spraying of chemicals to control and contain the locusts.

# Adaptation strategies used in selected value chains in Turkana County

Sorghum	Provision of Inputs 	On-Farm Production 	Harvesting Storage and Processing 	Product Marketing 
 Drought Consequences	Extension services provision greatly hampered - can only be given to small-scale farmers living along water sources; reduces tools and equipment supplies; negatively affects seed viability	High labor costs; water scarcity during planting causes crop failure; affects crop yield and may completely destroy produce	Lack of produce for processing; high import costs incurred for processors; most transporters will lose their jobs; high transportation costs and increased market prices	Reduced produce for sale; market price increases due to inadequate supply; breaching of contract between farmers and buyers; high expenses due to importation
Magnitude of Impact	<b>Moderate-Severe</b>	<b>Moderate-Severe</b>	<b>Moderate-Major</b>	<b>Major</b>
Farmers' Current Coping Strategies	Concentration of extension services in producing areas; late planting	Irrigation schemes and livestock feeding	Importing produce; transporters will transport commodities; buying small quantities of produce for survival	Buyers look for alternative grains and sellers generate less income; importing produce
Potential Adaption Options	Promoting extension services; creating awareness through TVs, radio etc.; promoting use of locally-made equipment e.g. jua kali; improving seed storage facilities to maintain long-term viability	Rely on weather-forecasting data; improving/ promoting irrigation; farmers' diversification to other livelihoods' sources	Encouraging large-scale production of sorghum through irrigation; improving/ promoting irrigation methods; livelihoods diversification	Encouraging intensive farming methods; enacting policies that control this trade; government and NGOs' intervention through importation; enhancing TV and Radio use
Underlying Factors	Seeds viability affected when drought persists leading to wastage(viability loss); drought causes seed dormancy during planting period especially among the poor who do not have storage facilities; tools' supply reduction; limited extension services.	Drought causes water scarcity thus affecting production and may lead to complete crop failure especially among poor who can't afford to drill boreholes; salts accumulation due to high evapotranspiration; water scarcity also affects sorghum regeneration especially among poor farmers who depend solely on sorghum; wasted labor costs for land preparation	Biophysical loss of ratooning ability in sorghum which greatly affects poor farmers; reduced production especially among farmers in rural areas; farmers far from water sources more vulnerable	Low yields leading to low returns especially for farmers living in rural areas, the poor and middle-class farmers
 Heavy Rainfall Consequences	Difficult for extension officers to reach farmers due to muddy roads; destruction of available infrastructure; low seed supplies	Poor land preparation; land compaction; accelerated weed growth; affects planting and weeding as extra labor is required to ensure proper growth; causes produce rotting; poor quality and risk of aflatoxin	Affects processing since it makes produce drying difficult and may cause rotting; causes produce wastage; affects produce and may lead to losses during food or cereals storage; hinders produce transportation from the farm to stores and markets which increases post-harvest losses	Leads to price increases; causes difficulty in transporting goods to market; limited shelf-life; poor may be unable to transport produce to markets where they command good prices
Magnitude of Impact	<b>Moderate-Minor</b>	<b>Moderate-Severe</b>	<b>Minor-Severe</b>	<b>Minor-Moderate</b>
Farmers' Current Coping Strategies	Phone calls made to ensure farmers get required information though in small-scale; using local methods or crop practices such as sticks to plant seeds; using available seeds especially from previous harvests	Zero tillage (direct planting is done); some done by government equipment; planting method chop and plant, using pangas to dig holes for planting and early-stage weed removal; harvesting by cutting and placing panicles in bags to minimize losses and contamination during harvesting	On-farm drying or processing by putting sorghum panicles into open store to allow time to dry; open storage; transporting using donkeys and women carrying produce	Selling is postponed
Potential Adaption Options	Promoting extension services; promoting localized trainers of farmers' models; early delivery of seeds, tools and equipment	Early land preparation; using herbicides; enhancing cutting and bulking	Using mechanical shelters and open drying in stores; using improved and well-ventilated stores; using hermetically sealable bags; improving roads from farms to markets	Promoting market delivery and linkages through middlemen; promoting contract farming; linking farmers to buyers; improving social networks
Underlying Factors	Poor infrastructure in some areas caused by heavy rains delays input supplies to farmers	Rain-fed farm areas like Turkana west and Kachaimeri	Transportation problem	Poor infrastructure in some areas

# Fish

Provision of Inputs



On-Farm Production

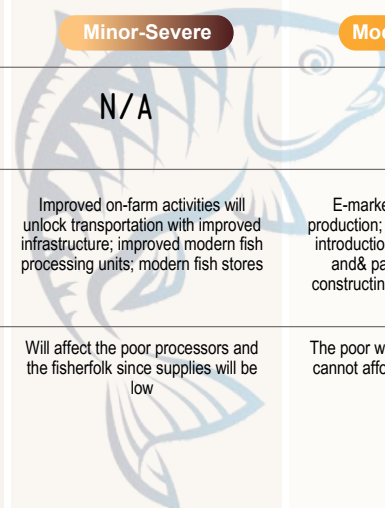


Harvesting Storage and Processing





Product Marketing

<p>Flood Consequences</p>	<p>Flooding will cut-off road network hence hindering supply of equipment (gear and vessels); restricts movement of extension staff; hampers transporting raw materials</p>	<p>Due to reduced fish production many youths and women lose jobs; compromises water quality hence affect fish hygiene after washing; destroys the gears mounted in the lake</p>	<p>Hampers transportation by cutting off roads; compromises water quality; destroy processing units; destroys packing units thus youth lose their jobs</p>	<p>Affects road networks and links between fisherfolk and buyers; lack of jobs for grading or weighing; aggregation store owners look for alternative markets</p>
<p>Magnitude of Impact</p>	<p>Major</p>	<p>Minor-Major</p>	<p>Major-Severe</p>	<p>Major</p>
<p>Farmers' Current Coping Strategies</p>	<p>Purchasing enough raw materials and ready gear stock; passing information through mobile phones - providing extension services through calls or SMS; using locally available materials like rafts</p>	<p>Do alternative jobs like weaving baskets; get alternative source of water from Napasinyan (Nakina wells); lending from the rich who own shops and pay using fish</p>	<p>No ongoing adaptation for fresh fish but dried fish are stored for later transportation; process the fish using traditional means like salting; youth seeking alternative livelihoods such as basket weaving</p>	<p>Linking viable mobile phone to reschedule dried fish deliveries; source for alternative jobs; rescheduling or postponing buying until they repair their stores</p>
<p>Potential Adaption Options</p>	<p>Enhancing gear &amp; vessels stocking ; Promoting / adopting digital extension services; Promoting &amp; supporting use of local raw materials</p>	<p>Introducing cage culture to boost fish production; Constructing modern fish bandas (structure) with piped water</p>	<p>Constructing modern fish processing units; improving road networks; Constructing modern processing units with clean water; Constructing packaging units on raised grounds that are flood resilient</p>	<p>Supporting electronic fish marketing information systems (EFMLS); Improving road infrastructure; Relocating flood-prone markets to safer ground</p>
<p>Underlying Factors</p>	<p>Poor fishermen who lose their gear during flooding require replacement; affects infrastructure; Illiteracy</p>	<p>The poor will be affected due to destruction of their gear and vessels by floods</p>	<p>Floods affect the poor &amp; the rich since road networks are destroyed hence transportation is hindered</p>	<p>Floods affects the rich &amp; the poor since they destroy the market infrastructure; floods affects fish supply hence affecting fish prices (Demand high &amp; supply low)</p>
<p>Persistent Drought Consequences</p>	<p>Reduced raw material supplies e.g. timber for boat making; affects knowledge and technology uptake; reduced artisanal boat and fishing gear making</p>	<p>Low fish quantities to process therefore youth job losses; low quantity and poor quality of water which affects fish quality; low fish production</p>	<p>Low quantity to transport hence affects those dependent on transport business; low water supply for processing affecting fish hygiene; low fish quantity to package hence job losses</p>	<p>Market shrinkage; low production causes grading job-losses; store owners lose income</p>
<p>Magnitude of Impact</p>	<p>Minor-Severe</p>	<p>Minor-Severe</p>	<p>Minor-Severe</p>	<p>Moderate-Major</p>
<p>Farmers' Current Coping Strategies</p>	<p>Use of alternative fiber-glass boats by the rich but not the poor</p>	<p>N/A</p>	<p>N/A</p>	<p>N/A</p>
<p>Potential Adaption Options</p>	<p>Promoting greater use of fiber-glass boats; extension services; promote farmer-to-farmer extension; promote and support use of locally available raw materials</p>	<p>Use of cages to boost production; restocking and construction of fish ponds along riverside ecosystems</p>	<p>Improved on-farm activities will unlock transportation with improved infrastructure; improved modern fish processing units; modern fish stores</p>	<p>E-marketing with improved production; tenders and contracts; introduction to modern weighing and packaging machines; constructing modern aggregation stores</p>
<p>Underlying Factors</p>	<p>Affects the poor who prioritize food over than buying input supplies (gears and vessels); persistent drought will bring about raw materials supply shortages such as timber for boat making</p>	<p>The poor who depend on fish production for their survival (malnutrition); windy conditions as a result of deforestation and this makes the lake rough and inaccessible to rich and poor fisherfolk</p>	<p>Will affect the poor processors and the fisherfolk since supplies will be low</p>	<p>The poor will be affected since they cannot afford the increasing prices</p>



# Chicken (Local)



 <p><b>Drought Consequences</b></p>	<p>Reduced feed supply thus low production; inability to access veterinary services and poultry inputs e.g. drugs; chicken are susceptible to diseases; poor poultry reproduction due to inadequate feeds</p>	<p>Low chicken immunity therefore more vaccination required; inadequate feed thus low production &amp; productivity; heat stress and, chicken sheds not well ventilated will reduce chicken productivity</p>	<p>Increased cost of transporting chicken and its products; many farmers sell their chicken for processing since they have no feed to sustain them</p>	<p>Low prices; high chicken supply to the market; destocking</p>
<p><b>Magnitude of Impact</b></p>	<p><b>Moderate-Severe</b></p>	<p><b>Minor-Major</b></p>	<p><b>Minor-Moderate</b></p>	<p><b>Moderate-Major</b></p>
<p><b>Farmers' Current Coping Strategies</b></p>	<p>Destocking and feed storage; using native herbs and establishing community agro-vets (Naipi); supplying cockerels</p>	<p>Providing vaccines and supplements; providing feed supplements, kitchen refuse and other human food waste</p>	<p>Selling chicken as a producer group; feed supplementation with local feed and keeping live chickens at slaughterhouses; refrigeration to extend shelf-life and preservation</p>	<p>Traders buying in bulk and keeping live chickens; farmers accessing more market points for chicken sales; local communication through phones/verbal</p>
<p><b>Potential Adaption Options</b></p>	<p>Establishing feed stockists in every sub-county; government and development partners intervene through input subsidies provision (e.g. voucher system); strengthen community disease reporters through capacity building, establishing drug stores in each sub-county/ward; employing more government veterinary officers; providing incubator/hatcheries and introducing indigenous drought-resistant breeds</p>	<p>Establishing cold chains for vaccines in each sub-county; employing/ deploying more government veterinary officers; increase number of community disease reporters, and vaccination programmes; on-farm feed formulation and capacity building for farmers on better feeding programmes; constructing chicken houses suitable for dry areas and enhancing capacity building for farmers</p>	<p>Farmers to start aggregation centers and improving road networks; establishing cold chains (i.e. refrigeration, chilling etc.) and standard chicken slaughterhouses; establishing chicken meat processing plants</p>	<p>Establishing structured marketing systems; farmers forming marketing cooperatives for chicken and products; advertisement through radios, posters etc.</p>
<p><b>Underlying Factors</b></p>	<p>Reduced feeding due of high feed costs especially among the poor; low immaturity leading to susceptibility to diseases resulting in high treatment costs; illiteracy: most women and youth who are involved in this value chain are illiterate</p>	<p>Inadequate poultry housing predisposes chicken to heat thus affecting production and productivity; outbreak of disease due to low poultry immunity ; people living with disability and low income earners</p>	<p>Chicken meat seller affected as the stored meat goes bad quickly during drought (illiterate, poor, distance, poor road network)</p>	<p>The poultry farmer is affected- the chicken will weigh less thus affecting the price (poor and low income earners)</p>
 <p><b>Flood Consequences</b></p>	<p>Destroys road networks; limited access to veterinary services &amp; increased chicken diseases; low breeding rate</p>	<p>High demand for chicken vaccination; access to feed is cut-off; destroys housing infrastructure</p>	<p>Destroys transport networks; destroys slaughtering infrastructure e.g Kanam, Nakwanæ kudi; destroys processing facilities, and chicken butcheries</p>	<p>Nutrition programmes promotion; disruption of market linkages</p>
<p><b>Magnitude of Impact</b></p>	<p><b>Moderate-Severe</b></p>	<p><b>Major-Severe</b></p>	<p><b>Severe</b></p>	<p><b>Minor-Major</b></p>
<p><b>Farmers' Current Coping Strategies</b></p>	<p>Feed rationing</p>	<p>Feed rationing; transferring chicken to people houses for refuge</p>	<p>N/A</p>	<p>Local selling within the villages</p>
<p><b>Potential Adaption Options</b></p>	<p>Establishing feed reserves in higher safe places; establishing early warning systems; strengthening community diseases reporters; establishing drug stores on raised areas safe from flooding; establishing hatcheries/incubators on higher grounds; establishing early warning systems</p>	<p>High vaccination demand; establishing cold chains on safe raised ground; establishing early warning systems; establishing stores on raised ground, capacity building for farmers; constructing chicken houses on higher grounds; well-designed, firm raised floors</p>	<p>Building bridges by government; maintaining roads; establishing early warning systems; proper design and construction of chicken slaughterhouses on raised grounds; capacity building for slaughterhouse workers; proper design and construction of processing facilities in safe areas</p>	<p>Establishing groups and cooperative societies; using radio &amp; phone calls to promote chicken/chicken products; repairing road networks and strengthening local marketing systems at village level</p>
<p><b>Underlying Factors</b></p>	<p>Roads become impassable &amp; inputs e.g. veterinary services inaccessible; high input costs; low literacy</p>	<p>People living along rivers- elderly/with disability farmers who are not able to move to higher grounds; cultural beliefs that poultry are free rangers thus exposing them to floods</p>	<p>Roads inaccessibility for transportation</p>	<p>Roads become impassable thus farmers cannot access market</p>



# Small ruminants (Sheep and Goats)

Provision of  
Inputs



On-Farm  
Production



Harvesting  
Storage and  
Processing



Product  
Marketing

 <b>Drought Consequences</b>	<p>Water shortage; cover /vegetation loss ; land degradation (e.g soil erosion); lack of fodder; animal death and prevalence of pests and diseases; funds shortage due to reduced income-generating activities</p>	<p>Reduced breeding; death of high breed animals; reduced numbers of dewormed animals; reduced meat quality; death of animals in long term; increased vaccination demand due to high disease prevalence; delayed vaccination</p>	<p>Low productivity in terms of quality and quantity of meat; reduced income; reduced number of animals being transported, and increased transport costs; delayed bulking process due to scarcity of animals and increase in cost of bulking</p>	<p>Poor market price due to low quality of livestock; reduced income</p>
<b>Magnitude of Impact</b>	<p><b>Severe</b></p>	<p><b>Minor-Moderate</b></p>	<p><b>Moderate-Severe</b></p>	<p><b>Major-Severe</b></p>
<b>Farmers' Current Coping Strategies</b>	<p>Boreholes drilling; water harvesting; establishing water pans and dams; tree planting (fodder trees); developing/implementing Water Act policy; ekwar (use of enclosures); participating in rangeland management; feed storage; building peace across borders; cash transfers &amp; diversification (e.g. charcoal selling)</p>	<p>Using herbal medicine, and government intervention in deworming through scattered and intermittent; government intervention by vaccination</p>	<p>N/A</p>	<p>Coping mechanism e.g. feeding on livestock during drought; intermittent in supply to some stakeholders</p>
<b>Potential Adaption Options</b>	<p>Fast-track operationalization of Turkana county water act 2019 (Sand dam, boreholes, water pans and catchment protection); soil conservation intervention e.g. tree planting; enhancing existing adaptation strategy e.g. ekwar; conflict management within and across borders; planting drought-tolerant fodder trees &amp; shrubs e.g Ewoi, Ekunoi, Edome, Ekalale; enhancing participatory range management; policy- fast track formulation and operationalizing climate-change policy; enhancing cash transfers to reach a wider population, diversifying income e.g. bee keeping, producing gum arabic, and charcoal</p>	<p>Selective breeding of hardy species, capacity building on breeding to increase production, offtake of less adapted species (destocking); enhancing indigenous knowledge, enhancing government intervention within Turkana county e.g. extension services/ research; enhancing vaccinations across county; early warning systems (surveillance) and communication infrastructure e.g. safaricom, telecommunication lines</p>	<p>Using early warning systems, early destocking, constructing modernized meat-processing unit within the county; improving transport infrastructure (climate-smart roads) and mapping grazing routes for early access; mapping dry grazing areas for ease of access and increasing bulking areas within the county</p>	<p>Early destocking, policy (destocking), livestock insurance, enhancing market places within the county;</p>
<b>Underlying Factors</b>	<p>People purely dependent on animals and their products (pastoralists); the poor in the community highly affected due to low resilience; invasive species- e.g. desert locusts destroy feeds; land degradation due to soil erosion, and climate variability hence dry areas such as the Lake Zone, Kerio Delta and Central are highly affected compared to Loima and Turkana West.</p>	<p>The poor lack funds to treat their animals; Lack of climate-change policy to safeguard pastoralists during famine by provision of vaccination, breeding and deworming</p>	<p>The poor will be most affected by drought; no policy to buy emaciated animals; fragmented institutions</p>	<p>Low meat quality thus low prices; institutional fragmentation; animals dying before reaching market; no policy to buy emaciated animals at standard price</p>
 <b>Flood Consequences</b>	<p>Submerged grazing land; land degradation e.g. soil erosion; increase in invasive species such as prosopis (e.g. Mathenge); reduced fodder quality ; increased capital demand</p>	<p>Reduced livestock breeding; death of animals e.g. young stock; increase in low-quality animals; increased deworming services demand hence increased costs, and delayed deworming services; increase in diseases thus more demand for vaccination, and delayed vaccination services</p>	<p>Delays processing; poor network and impassable bridges; transportation delays; bulking process delays and increase in bulking costs</p>	<p>High prices because few animals accessing markets and reduced source of income</p>
<b>Magnitude of Impact</b>	<p><b>Moderate-Severe</b></p>	<p><b>Moderate</b></p>	<p><b>Minor-Major</b></p>	<p><b>Minor-Major</b></p>
<b>Farmers' Current Coping Strategies</b>	<p>Using prosopis which spread during floods; soil and water harvesting through gabions and water pan construction especially in lowland areas; introducing early warning systems; Introducing feed storage; diversifying cash crops and livelihoods</p>	<p>N/A</p>	<p>Constructing bridges (ongoing); improving access routes</p>	<p>Availability of markets at ward level</p>
<b>Potential Adaption Options</b>	<p>Enhancing prosopis control through utilization; fast-track formulation and operationalization of climate-change policy bill and regulation; operationalization of water act policy; establish early warning system, enhance feed storage ; re-seeding pasture land and tree planting; mapping wet and migratory routes and gazettement them; diversifying livelihoods e.g. beekeeping and poultry production</p>	<p>Establishing flood early warning systems and mapping flood prone areas or zones; enhancing indigenous knowledge and extension services; capacity building on pests and diseases; establishing early warning system on pests and diseases</p>	<p>Constructing modernized meat processing unit within the county; mapping flood prone areas; improving transport infrastructure (climate-smart roads) and early warning systems (enhancement of weather forecast); increasing bulking areas within the county and proper selection</p>	<p>Increasing market centers, improve early warning system; improve accessibility to markets by improved transportation and communication infrastructure; providing insurance policies for compensation of lost animals</p>
<b>Underlying Factors</b>	<p>Prosopis (Mathenge) invasion reduces pastoral land for lowland inhabitants e.g. Lake Zone, near riparian areas</p>	<p>Lowland dwellers will be more affected by floods compared to those in high land; pastoralists are mostly affected during migration; no insurance cover for animals affected by floods</p>	<p>No policy in place for improving rural accessible roads; people living in lowlands areas are greatly affected during floods</p>	<p>No policy to compensate for livestock loss</p>

Figure 12: Adaptation Strategies Across Selected Value Chains in Turkana County

## 5. Policies and strategies on Climate Change

The development of policies and programs and their effective implementation play a key role in decision-making, since they affect actions and outcomes related to climate risk management and resource use. In response to climate variability and change, Turkana County has adopted several national policies in its implementation of climate change adaptation and mitigation interventions (Table 1).

**Table 1: National Policies that Target Climate Change**

Policy	Year	Objective(s)	Interventions	Challenges
<b>National Climate Change Policy</b>	2018	Facilitate a coordinated, coherent, and effective response to the challenges and opportunities presented by climate change	Strengthening disaster risk management Helping communities adapt to climate change Fortifying communities against climate hazards	Lack of strategy and implementation
<b>National Climate Finance Policy</b>	2016	Mobilizing climate change-related finance	Developing the Turkana County Climate Change Policy of 2020 Developing the Turkana County Climate Change Bill of 2020 Developing the Turkana County Action Plan	
<b>National Livestock Policy</b>	2013	Increase livestock productivity and production in a sustainable manner	Creating effective private, public and community partnerships Establishing medium and long-term emergency plans	Poor coordination and organization
<b>National Climate Change Action Plan</b>	2013-2017	Increase forest cover and rehabilitate degraded lands	Reclaiming riverbanks Formulating by-laws to control deforestation Planting trees Raising awareness among the community	
<b>National Climate Change Response Strategy</b>	2010	Ensure that climate change adaptation and mitigation measures are integrated into government planning	Recommending adaptations that minimize risks and maximizing opportunities Providing effective policy and a legal and institutional framework to combat climate change	Lack of political goodwill
<b>Climate Change Act</b>	2016	Provide a framework for funding climate change response initiatives at both the national and the county level.	Development of the Turkana County Climate Change Policy of 2020 Development of the Turkana County Climate Change Bill of 2020, which is in its final stages Turkana County Action Plan is in place Opened up discussions to allocate 2% of the county's budget to climate change mitigation and adaptation efforts	
<b>ASDSP</b>	2013-2020	Enhance productivity while conserving natural resources	Promotion sorghum, cowpea, fish, sheep, goats, and local chicken value chains	
<b>Water Act</b>	2016	Provide for the regulation, management, and development of water resources	Development of the Turkana County Water Act of 2019 to address county-specific water issues	

Policy	Year	Objective(s)	Interventions	Challenges
<b>Irrigation Act</b>	2019	Provide for the development, management, and regulation of irrigation	Irrigation infrastructure is being put in place in Turkana County	Poor coordination between the public and private sectors  Inconsistencies within the Kenyan Constitution
<b>Forest Act</b>	2005	Develop, manage, and conserve forest resources through sustainable tree harvesting	Large-scale harvesting must be accompanied by a harvesting plan Charcoal burning is only allowed from dead trees and twigs Allowed for gazettement of the Loima forest and of the Songot hills forest	Underdeveloped standards for goods
<b>Environmental Management and Coordination Act</b>	2015	Protect the environment	Protect riparian areas from encroachment e.g. along Turkwell and Kerio rivers Promotes conservation measures that protect soil and indigenous forests.	

## 6. Institutional capacity on Climate Change

In Turkana County, many institutions are working on issues related to climate change, agriculture, water or food security. Their interventions include research and extension, creating early warning systems, educating, providing farmers with technology, marketing, offering financial and credit services, providing farmers with supplies, and disease surveillance. Here are a sample of institutions that are currently supporting agriculture in Turkana County (Table 2).

**Table 2: Institutions that are currently supporting agriculture in Turkana**

Off-farm services	Institutions	Interventions	Challenges
<b>Agricultural Research and Aid</b>	The Department of Agriculture, Livestock, Fisheries, and Cooperatives	Provides services and inputs to farmers. Supports and promotes diverse value chains Introduces breeds that suit the harsh climatic conditions in Turkana County	Limited financial and human resources
	Department of Water, Environment and Mineral Resources	Constructs water infrastructure, including water pans and drill boreholes. Protects the environment through policy development Supports and promotes agroforestry and planting activities	Inadequate resources
	Kenya Maritime and Fisheries Research Institute	Aims to improve the fish value chain through research	Departments lack relevant expertise
	Kenya Forestry Research Institute	Researches better tree species and other resources for Turkana County's climate Works closely with farmers and community members who are interested in beekeeping, aloe vera, and sustainable charcoal burning	Turkana's size makes accessing every potential beneficiary almost impossible
	Turkana County Government	Develops retention dams to store water	
	National Environment Management Authority	Promotes sustainable environmental management through prioritizing environmental considerations in policies, plans, programs and projects	
	National Irrigation Authority	Provides water for irrigation	
	National Water Harvesting Authority	Promotes water-harvesting techniques like rooftop water catchment, water pans, and dams.	
	International Livestock Research Institute	Aims to improve various value chains through research	
	Turkana University	Involved in various research activities that contribute to understanding climate change	

Off-farm services	Institutions	Interventions	Challenges
Climate Information Services and Weather Advisories	Kenya Meteorological Department	Sends climate-based advisories to different departments and farmers	
	Kenya Meteorological Department	Issues warnings on disasters like mudslides and landslides	
Early Warning Systems and Participatory Scenario Planning	National Drought Management Authority	Reduces the effects of droughts through early warning drought-risk information, awareness campaigns, education initiatives, and bulletins	Hostile climate and terrain poses challenges
	Disaster Management Authority	Manages disasters, especially droughts and floods  Collaborates with other agencies to provide emergency food and rescue people and livestock during floods	No specific funds are allocated for climate-change mitigation
	Kenya Maritime Authority	Ensures safety by identifying dangerous areas that should not be accessed	
	Kenya Coast Guard	Provides security from attacks	
Non-financial Services	Africare, the Agency for Pastoralist Development, the Child Fund, the Food and Agriculture Organization, the International Rescue Committee, the Japan International Cooperation Agency, the Lutheran World Federation, Medical Relief International, Mercy Corps, Nyanza Reproductive Health Services, Oxfam-GB, Practical Action, the Red Cross, SNV World, Sun Bucket Energy Intervention, TCG Environment, the United Nations Children's Fund, the United Nations High Commissioner for Refugees, the United State African Development Foundation), Vétérinaires Sans Frontières - Belgium, the World Food Program, and World Vision	Aids in matters of food security, emergency response, and health	Financial and human resources are inadequate
			Poor coordination among county departments and organizations
Financial Services	Banks	Provides financial support to farmers	
	Savings and Credit Cooperative Societies and Mobile Banking Services	Helps farmers save their money and access credit	
Market Services	Trade Department and Chambers of Commerce	Help farmers to access markets Ensures proper pricing so that farmers are not exploited	

## 7. Synthesis and Outlook

The people of Turkana County secure their livelihood from agriculture. However, this way of life is challenged by inter-related issues that include climate change, population growth, persistent droughts and floods, and interpersonal conflicts. The area's natural resources are limited and often trigger conflict between neighboring countries and counties. Turkana County must address the issues of food security, safe water, poverty, malnutrition, education, gender inequities, and pollution in order to realize its environmental, economic, social, and political potential.

Several value chains are important to Turkana County's vulnerable populations of the poor, youth, and woman such as sheep and goats, local chicken, sorghum, and fish. These value chains are more resilient to climate change than others. However, limited rainfall and high temperatures threaten these value chains. The county government supports farmers by promoting water harvesting, pasture development and conservation, drought-resistant crops and livestock, irrigation, and processing, and increasing market access.

Drought, intense rainfall, and flooding threaten agriculture in Turkana County. Farmers need to adapt

appropriately to these threats. Many farmers do so by cultivating drought-resistant crops, rearing drought-resistant livestock, diversifying their farms, and engaging in irrigation, soil and water conservation; rainwater harvesting, and research and development. Some of these adaptation strategies are expensive. Financial and technical support, training, and education from various institutions will help farmers succeed. These institutions must prioritize the needs of the poor and illiterate through the use of local TV and radio stations, SMS, brochures translated into local languages, meetings conducted in the local language, and more.

Turkana County houses various institutions that help farmers adapt to climate change. They provide advice, information, and supplies for farmers. Most of these institutions suffer from a lack of human and financial capital. Therefore, proper resource allocation and training will go a long way to ensuring their success. The Turkana County Climate Change Bill 2020 is in its final stages. This bill will allocate 2% of the county budget towards climate change mitigation.

## 8. Works Cited

**ASDSP. (2014).** Turkana County. Nairobi, Kenya: Government of Kenya

**Concern Worldwide, International Rescue Committee, Ministry of Health, Save the Children International, World Vision International. Kenya. (2019).** Turkana Health and Nutrition SMART Survey June 2019. Available online at <https://bit.ly/3fBMNeP>

**FAO (2020).** Kenya beats back desert locust upsurge for now, but East Africa remains at risk. Nairobi, Kenya. Available online at <https://bit.ly/2TxLOUf>

**GoK. (2019).** Kenya Population Census Analytical Report. Nairobi, Kenya: Government of Kenya.

**GoK. (2015).** Economic Review of Agriculture (ERA). Government of Kenya. Ministry of Agriculture, Livestock and Fisheries, Nairobi, Kenya.

**GoK, UNDP. (2013).** Kenya National Development Report; Climate Change and Human Development, Harnessing emerging opportunities. Government of Kenya, United Nations Development Program. Nairobi.

**Guardian (2020).** Kenya's pastoralists face hunger and conflict as locust plague continues. Nairobi, Kenya. Available online at <https://bit.ly/3i7prPJ>

**KMD. (2020).** State of the Climate in Kenya 2020.

**KNBS. (2014).** Kenya Demographic and Health Survey. Nairobi, Kenya.

Poor policy limits farmers' ability to respond to climate change. For example, policies often contradict each other, posing problems for those that try to adhere to them. Policies are often ignored, due to a lack of enforcement. Oftentimes, policies are confusing or the county government is unable to enforce the policy. Policy creators must involve all relevant stakeholders in their work in order to ensure harmony, effectiveness, and consistency.

Responding to climate change must become a priority at the county level. This requires an appropriate political framework that can effectively combine economic, social, and environmental factors in a coherent, complementary, and interlinked manner. The county's agriculture sector should aim to increase efficiency and decrease fault. Climate-change analysis should include analysis of markets, institutions, and the government. Finally, the county government must ensure that the farmers and residents of Turkana County are involved in climate change management plans.

**KNBS. (2019a).** Kenya Population and Housing Census Volume I: Population by County and Sub-County. Kenya National Bureau of Statistics, Nairobi, Kenya. Available online at <https://bit.ly/3vEPxxt>

**KNBS. (2019b).** Kenya Population and Housing Census Volume II: Distribution of Population by Administrative Units. Kenya National Bureau of Statistics, Nairobi, Kenya. Available online at <https://bit.ly/3p3y5jW>

**KNBS. (2019c).** Kenya Population and Housing Census Volume III: Distribution of Population by Age, Sex and Administrative Units. Kenya National Bureau of Statistics, Nairobi, Kenya. Available online at <https://bit.ly/3wMoosE>

**Mutu, Paul. (2017).** Causes of Drought Vulnerability and Indigenous Drought Early Warning Methods among the Turkana Nomadic Pastoralists of Ilemi Triangle Region of Northern Kenya. Research in Health Science. 2. 209. 10.22158/rhs.v2n2p209.

**Navarro-Racines, C., Tarapues, J., Thornton, P. et al.(2020)** High-resolution and bias-corrected CMIP5 projections for climate change impact assessments. Sci Data. 7, 7.

**NDMA. (2016).** Turkana County Hazard Atlas. Nairobi, Kenya.

**Ojwang W.O., Obiero, K.O., Donde, O.O., Gownaris, N., Pikitch, E. K., Omondi, R., Agembe, S., Malala, J., Avery, S.T. (2016).** Lake Turkana: World's Largest Permanent Desert Lake (Kenya). The Wetland Book pp 1-20. Springer, Dordrecht. Available online at <https://bit.ly/2SD5XYJ>

**Opiyo F, Wasonga O, Nyangito M, Schilling J, Munang R. (2015).** Drought Adaptation and Coping Strategies Among the Turkana Pastoralists of Northern Kenya. *International Journal of Disaster Risk Science*. Volume 6, Issue 3, pp 295–309.

**Taylor, K.E., Stouffer, R.J., & Meehl, G.A. (2012).** An overview of CMIP5 and the experiment design. *Bulletin of the American Meteorological Society*, 93: 485-498.

**Turkana County Government. (2013).** Turkana County Integrated Development Plan 2013 - 2017. Nairobi, Kenya: Government of Kenya

**Turkana County Government. (2018).** Turkana County Integrated Development Plan 2018 - 2022. Nairobi, Kenya: Government of Kenya.

**Turkana County Government. (2019).** Turkana County SMART Survey, 2019. Nairobi, Kenya: Government of Kenya.

**Wiesmann, U., Kiteme, B., Mwangi, Z. (2014).** Socio-Economic Atlas of Kenya: Depicting the National Population Census by County and Sub-Location. KNBS, Nairobi: CETRAD, Nanyuki: CDE, Bern.

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# 10. Annexes

## 10.1 Glossary

**Climate change:** refers to a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings such as modulations of the solar cycles, volcanic eruptions, and persistent anthropogenic changes in the composition of the atmosphere or in land use (IPCC, 2018).

**Climate risk:** The potential for consequences where something of value is at stake and where the outcome is uncertain, recognizing the diversity of values. Risk is often represented as probability of occurrence of hazardous events or trends multiplied by the impacts if these events or trends occur. Risk results from the interaction of vulnerability, exposure, and hazard (IPCC, 2018).

**Climate hazard:** The potential occurrence of a natural or human-induced physical event or trend or physical impact that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems, and environmental resources (IPCC,2018).

**Climate variability:** Variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc.) of the climate on all spatial and temporal scales beyond that of individual weather events (IPCC, 2018).

**Absolute poverty:** a lack of basic human needs, mainly food, shelter, clothing, water, education and health care.

**Food Poverty:** Not having the means to acquire enough food to live a normal healthy life. When a population cannot consistently afford the minimum amount of recommended nutritional food, it suffers from food poverty.

**The Representative Concentration Pathways (RCPs):** Four greenhouse gas concentration (not emissions) trajectories adopted by the IPCC for its Fifth Assessment Report (AR5). The four RCPs, RCP2.6, RCP4.5, RCP6.0, and RCP8.5, are named after a possible range of radiative forcing values in the year 2100 (of 2.6, 4.5, 6.0, and 8.5 W/m<sup>2</sup>, respectively).

**Green House Gases:** Atmospheric gases responsible for causing global warming and climate change. The major GHGs are carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub> ) and nitrous oxide (N<sub>2</sub> O). Less prevalent but very powerful greenhouse gases are hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and Su

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