CLIMATE RISK COUNTRY PROFILE

KENYA

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1818 H Street NW, Washington, DC 20433
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This profile is part of a series of Climate Risk Country Profiles developed by the World Bank Group (WBG). The country profile synthesizes most relevant data and information on climate change, disaster risk reduction, and adaptation actions and policies at the country level. The country profile series are designed as a quick reference source for development practitioners to better integrate climate resilience in development planning and policy making. This effort is managed and led by Veronique Morin (Senior Climate Change Specialist, WBG) and Ana E. Bucher (Senior Climate Change Specialist, WBG).

This profile was written by MacKenzie Dove (Senior Climate Change Consultant, WBG). Additional support was provided by Fernanda Zermoglio (Senior Climate Change Consultant, WBG), Yunziyi Lang (Climate Change Analyst, WBG) and Jason Johnston (Operations Analyst, WBG).

Climate and climate-related information is largely drawn from the Climate Change Knowledge Portal (CCKP), a WBG online platform with available global climate data and analysis based on the latest Intergovernmental Panel on Climate Change (IPCC) reports and datasets. The team is grateful for all comments and suggestions received from the sector, regional, and country development specialists, as well as climate research scientists and institutions for their advice and guidance on use of climate related datasets.

CONTENTS

FOREWORD

Climate change is a major risk to good development outcomes, and the World Bank Group is committed to playing an important role in helping countries integrate climate action into their core development agendas. The World Bank Group is committed to supporting client countries to invest in and build a low-carbon, climate-resilient future, helping them to be better prepared to adapt to current and future climate impacts.

The World Bank Group is investing in incorporating and systematically managing climate risks in development operations through its individual corporate commitments.

A key aspect of the World Bank Group's Action Plan on Adaptation and Resilience (2019) is to help countries shift from addressing adaptation as an incremental cost and isolated investment to systematically incorporating climate risks and opportunities at every phase of policy planning, investment design, implementation and evaluation of development outcomes. For all IDA and IBRD operations, climate and disaster risk screening is one of the mandatory corporate climate commitments. This is supported by the Bank Group's Climate and Disaster Risk Screening Tool which enables all Bank staff to assess short- and long-term climate and disaster risks in operations and national or sectoral planning processes. This screening tool draws up-to-date and relevant information from the World Bank's Climate Change Knowledge Portal, a comprehensive online 'one-stop shop' for global, regional, and country data related to climate change and development.

Recognizing the value of consistent, easy-to-use technical resources for client countries as well as to support respective internal climate risk assessment and adaptation planning processes, the World Bank Group's Climate Change Group has developed this content. Standardizing and pooling expertise facilitates the World Bank Group in conducting initial assessments of climate risks and opportunities across sectors within a country, within institutional portfolios across regions, and acts as a global resource for development practitioners.

For developing countries, the climate risk profiles are intended to serve as public goods to facilitate upstream country diagnostics, policy dialogue, and strategic planning by providing comprehensive overviews of trends and projected changes in key climate parameters, sector-specific implications, relevant policies and programs, adaptation priorities and opportunities for further actions.

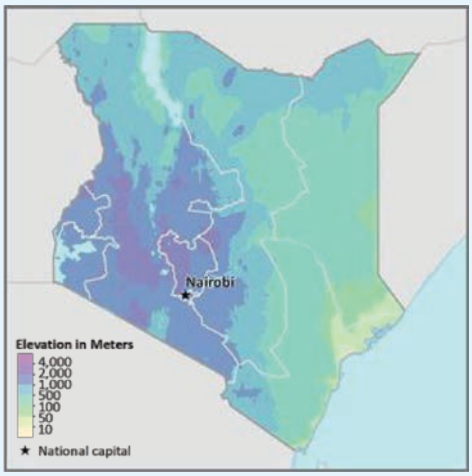
It is my hope that these efforts will spur deepening of long-term risk management in developing countries and our engagement in supporting climate change adaptation planning at operational levels.

Bernice Van Bronkhorst
Global Director
Climate Change Group (CCG)
The World Bank Group (WBG)

COUNTRY OVERVIEW

The Republic of Kenya, located in East Africa, covers a total land area of 582,646 kilometers square (km^2), which includes varied formations of plains, escarpments, and hills, as well as low and high mountains. Starting east along the coast, low plateaus run inland (west) to an elevated plateau and mountain ranges, marked by the Kenyan highlands in the southwest corner of the country. Kenya shares borders with Ethiopia to the north, South Sudan and Uganda to the northwest and west, and Tanzania to the south. The country's southeast coastline borders the Indian Ocean. Approximately 85% of Kenya's land area is classified as a fragile arid and semi-arid ecosystem, which is largely pastoral.[1] The country's highlands are home to the majority of the population and also host significant farm lands. Kenya's nature-based tourism industry is also a major land user, with wildlife protected areas covering 8.2% of the; and area. Protected land areas are also included as conservancies.[2] Highlands are relatively cool and agriculturally rich, and are largely dominated by commercial and small-holder farms. Principal cash crops include tea, coffee, flowers, vegetables, pyrethrum. Wheat and maize, as well as livestock production is also practiced across the highlands, which lie at 1,500 to 3,000 meters (m) above sea level. The Great Rift Valley bisects the highlands into an east and west region forming a steep sided trench of 48 to 64 km wide and 600 to 900 m deep[3] (**Figure 1**).

FIGURE 1. Topography of Kenya[4]



Kenya, while considered a lower middle-income country, has the largest economy in East Africa. It has a population of 52.6 million people (2019) and an annual population growth rate at 2.3%.[5] Approximately 27% of Kenya's population currently lives in urban areas. This is projected to increase to 33% and 46% of the population by 2030 and 2050, respectively.[6] Gross Domestic Product (GDP) in 2018 was US$95.5 billion and the economic annual growth rate 5.4% (2019).[7] Kenya had continued to implement significant economic and structural reforms, which have helped to sustain economic growth and political gains over the past decade. Key challenges continue to be seen in the country's inequality and poverty levels, which has increased the country's economic vulnerability to shocks[8] (**Table 1**).

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1 National Environment Management Authority (2015). Kenya- Second National Communication to the United National Framework Convention on Climate Change, Executive Summary. URL: https://unfccc.int/sites/default/files/resource/Kenya%20SNC_Executive%20Summary.pdf

2 Kenya Wildlife Service (2021). Parks/Reserves – Overview. URL: http://www.kws.go.ke/content/overview-0

3 National Environment Management Authority (2015). Kenya- Second National Communication to the United National Framework Convention on Climate Change. URL: https://unfccc.int/sites/default/files/resource/Kennc2.pdf

4 World Bank (2019). Internal Climate Migration Profile – Kenya.

5 World Bank Data Bank (2020). World Development Indicators, Kenya. URL: https://databank.worldbank.org/source/world-development-indicators

6 World Bank Data Bank (2020). Population estimates and projections, Kenya. URL: https://databank.worldbank.org/source/population-estimates-and-projections

7 World Bank Data Bank (2020). World Development Indicators, Kenya. URL: https://databank.worldbank.org/source/world-development-indicators

8 World Bank (2019). Kenya Overview. URL: https://www.worldbank.org/en/country/kenya/overview

TABLE 1. Data snapshot: Key development indicators[9]

Indicator	
Life expectancy at birth, total (2019)	66.7
Population density (people per sq. km land area) (2018)	90.3
% of Population with access to electricity (2018)	75%
GDP per capita (current US$) (2019)	$1,816.50

The ND-GAIN Index[10] ranks 181 countries using a score which calculates a country's vulnerability to climate change and other global challenges as well as their readiness to improve resilience. This Index aims to help businesses and the public sector better identify vulnerability and readiness in order to better prioritize investment for more efficient responses to global challenges. Due to a combination of political, geographic, and social factors, Kenya is recognized as highly vulnerable to climate change impacts, ranked 152 out of 181 countries in the 2019 ND-GAIN Index. The more vulnerable a country is the lower their score, while the more ready a country is to improve its resilience the higher it will be. For example, Norway has the highest score and is ranked 1st. **Figure 2** is a time-series plot of the ND-GAIN Index showing Kenya's progress.

FIGURE 2. ND-GAIN Index for Kenya

Kenya published its Second National Communication in 2015 and submitted its Updated Nationally-Determined Contribution to the UNFCCC in 2020, in support of adaptation and mitigation efforts, to improve the country's ability to prepare for and respond to natural disasters and increase its resilience to climate change. Additionally, Kenya aims to become a newly industrialized country by 2030, which will require expanding climate change resilience efforts while also increasing its domestic energy production; including through the use of renewable sources. Adaptation efforts are focused on the country's energy, infrastructure, land use and environment, health, water and irrigation, agriculture and tourism sectors. Kenya is working to meet these goals and adhere to its climate change strategies by investing in strategic actions such as afforestation and reforestation, geothermal energy production and other clean energy development, as well as climate smart agriculture, and drought management.[11]

[9] World Bank (2020). DataBank – World Development Indicators. URL: https://databank.worldbank.org/source/world-development-indicators

[10] University of Notre Dame (2020). Notre Dame Global Adaptation Initiative. URL: https://gain.nd.edu/our-work/country-index/

[11] Ministry of Environment and Natural Resources (2016). Kenya's Nationally Determined Contribution. URL: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Kenya%20First/Kenya_NDC_20150723.pdf

Green, Inclusive and Resilient Recovery

The coronavirus disease (COVID-19) pandemic has led to unprecedented adverse social and economic impacts. Further, the pandemic has demonstrated the compounding impacts of adding yet another shock on top of the multiple challenges that vulnerable populations already face in day-to-day life, with the potential to create devastating health, social, economic and environmental crises that can leave a deep, long-lasting mark. However, as governments take urgent action and lay the foundations for their financial, economic, and social recovery, they have a unique opportunity to create economies that are more sustainable, inclusive and resilient. Short and long-term recovery efforts should prioritize investments that boost jobs and economic activity; have positive impacts on human, social and natural capital; protect biodiversity and ecosystems services; boost resilience; and advance the decarbonization of economies.

CLIMATOLOGY

Climate Baseline

Overview

Kenya's diverse topography results in a wide range of climates. While the coast is typically hot and humid, inland areas are more temperate. The country's northern and north eastern areas are generally very hot and arid, the central highlands are cooler and are formed of a mix of tropical highlands, which become increasingly arid towards the country's interior. Kenya's climate is strongly influenced by the Inter Tropical Convergence Zone (ITCZ),[12] which drives rainfall in the country. The western, central and coastal regions, which occupy less than 20% of the country, houses nearly 90% of the country's population, and includes productive agricultural land which is principally rainfed. Kenya also has a diverse natural resource base, which includes forests, wetlands, dry lands, aquatic and marine resources. Kenya's natural resource base is under increasing strain due to population pressures, coastal erosion, deforestation, poor land management as well as seasonal variability and climate change. These pressures also threaten the country's unique biodiversity, as well as local livelihoods and long-term food security for a significant segment of the Kenyan population.

Given its diverse topography, temperatures across the country vary significantly, with the highlands experiencing much cooler temperatures than coastal and lowland zones.[13] Little seasonal variation in temperatures has been observed, with average temperatures ranging between 18°C at the higher elevations to 26°C along the coast. Rainfall varies considerably across the country, with less than 250 millimeters (mm) falling in the arid zones of north, to over 2,000 mm per year in the west annually. Highland areas, where the majority of agriculture takes place,

[12] The Intertropical Convergence Zone, is the region that circles the Earth, near the equator, where the trade winds of the Northern and Southern Hemispheres come together. The intense sun and warm water of the equator heats the air in the ITCZ, raising its humidity and making it buoyant. Aided by the convergence of the trade winds, the buoyant air rises. As the air rises it expands and cools, releasing the accumulated moisture in an almost perpetual series of thunderstorms. Seasonal shifts in the location of the ITCZ drastically affects rainfall in many equatorial nations, resulting in the wet and dry seasons of the tropics rather than the cold and warm seasons of higher latitudes. Longer term changes in the ITCZ can result in severe droughts or flooding in nearby areas.

[13] Republic of Kenya (2013). National Climate Change Action Plan, 2013–2017: Vision 2030. URL: https://cdkn.org/wp-content/uploads/2013/03/Kenya-National-Climate-Change-Action-Plan.pdf

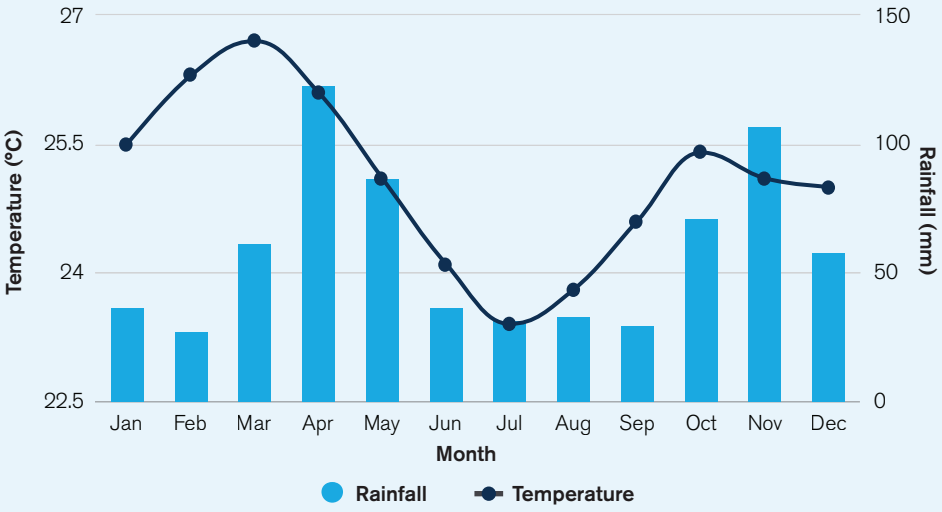
TABLE 2. Data snapshot: Summary statistics

Climate Variables	1901–2020
Mean Annual Temperature (°C)	**24.3°C**
Mean Annual Precipitation (mm)	**668.6 mm**
Mean Maximum Annual Temperature (°C)	**30.3°C**
Mean Minimum Annual Temperature (°C)	**18.3°C**

receives approximately 1,000 mm of rainfall each year.[14] The seasonal migration of the ITCZ define four distinct seasons in Kenya, dominated by two rainfall periods: January to March, which is generally considered the 'warm dry season', April to June known as the 'long wet season', July to September the 'cool dry season', and October to December as the 'short wet season'.

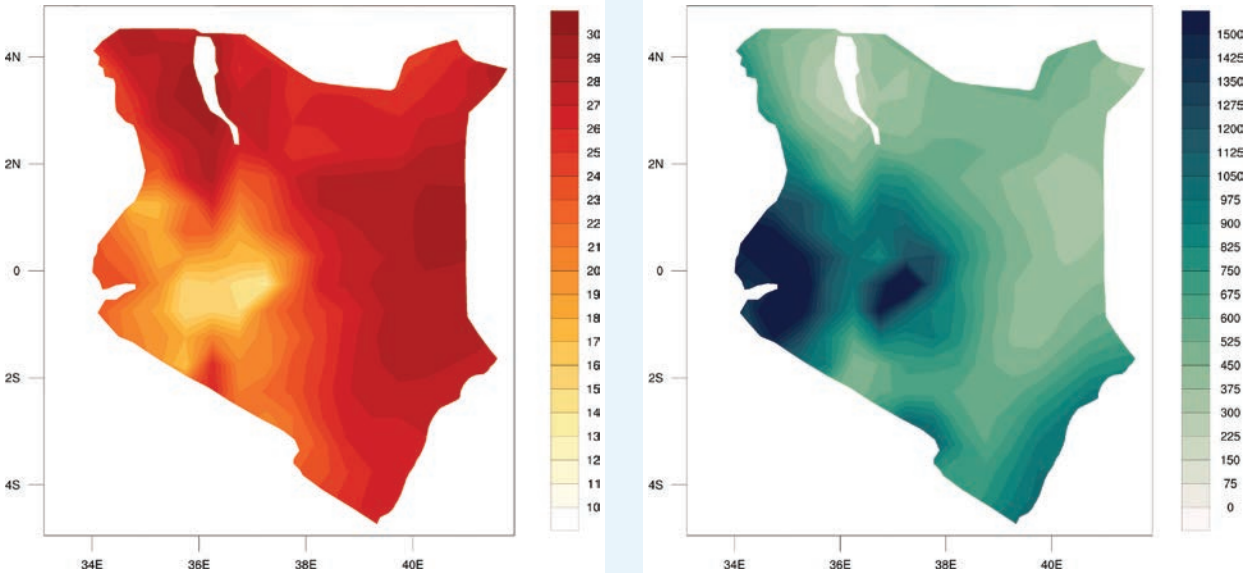
Analysis of data from the World Bank Group's Climate Change Knowledge Portal (CCKP) (**Table 2**)[15] shows Kenya's seasonal cycle for the latest climatology, 1991–2020. Mean annual mean temperatures for Kenya is 24.3°C, with average monthly temperatures ranging between 22°C (July) and 25.6°C (March). Mean annual rainfall is 668.6 mm. While rainfall does occur throughout the year, depending on area, the majority of rainfall is received between March and June and October to December (**Figure 3**).[16] **Figure 4** shows the spatial variation of observed average annual precipitation and temperature across Kenya.

FIGURE 3. Average monthly temperature and rainfall for Kenya, 1991–2020[17]



[14] National Environment Management Authority (2015). Kenya- Second National Communication to the United National Framework Convention on Climate Change. URL: https://unfccc.int/sites/default/files/resource/Kennc2.pdf
[15] WBG Climate Change Knowledge Portal (CCKP, 2020). Kenya URL: https://climateknowledgeportal.worldbank.org/country/kenya/climate-data-historical
[16] WBG Climate Change Knowledge Portal (CCKP, 2020). Kenya URL: https://climateknowledgeportal.worldbank.org/country/kenya/climate-data-historical
[17] WBG Climate Change Knowledge Portal (CCKP, 2020). Kenya URL: https://climateknowledgeportal.worldbank.org/country/kenya/climate-data-historical

FIGURE 4. Map of average annual temperature (left); annual precipitation (right) of Kenya, 1991–2020[18]

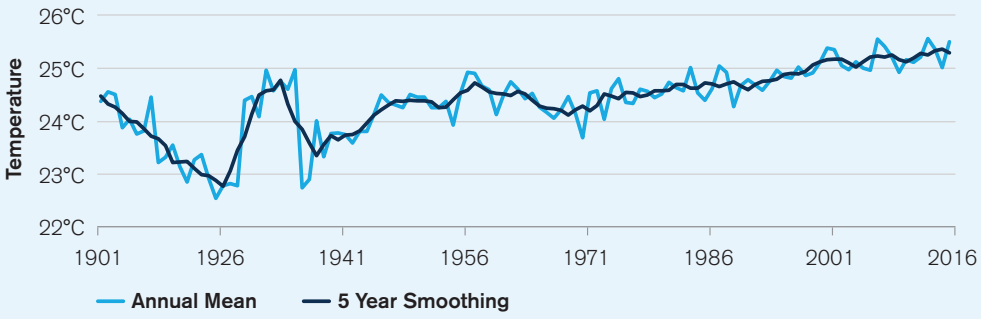


Key Trends

Temperature

While temperatures vary across Kenya, a distinct warming trend is evident, particularly since the 1960s, (**Figure 5**) with inland areas registering larger increases in minimum and maximum temperatures. During this time the annual mean increase has risen by approximately 1.0°C, at an estimated average rate of 0.21°C per decade.[19] The most significant rise in temperature was observed for the start to the primary rainy and humid, spring season (March to May), in the arid and semi-arid regions of the country.[20]

FIGURE 5. Observed temperature for Kenya, 1901–2020[21]



[18] WBG Climate Change Knowledge Portal (CCKP, 2020). Kenya, Historical Climate. URL: https://climateknowledgeportal.worldbank.org/country/kenya/climate-data-historical

[19] National Environment Management Authority (2015). Kenya- Second National Communication to the United National Framework Convention on Climate Change. URL: https://unfccc.int/sites/default/files/resource/Kennc2.pdf

[20] USAID (2018). Climate Change Risk Profile – Kenya. URL: https://www.climatelinks.org/sites/default/files/asset/document/2018_USAID-ATLAS-Project_Climate-Risk-Profile-Kenya.pdf

[21] WB Climate Change Knowledge Portal (CCKP, 2020). Kenya URL:https://climateknowledgeportal.worldbank.org/country/kenya/climate-data-historical

Precipitation

Precipitation trends for Kenya are highly variable, however there is significant geographical diversity in observed rainfall trends. Northern areas have become wetter, and southern areas have become drier since the 1960s, although this has had a high degree of variability. Extreme rainfall events are occurring with greater frequency and intensity. Increased aridity and droughts have also been observed, with moderate drought events recorded on average every three to four years and major droughts every ten years. Since 2000, prolonged droughts have become more common.[22]

Climate Future

Overview

The main data source for the World Bank Group's Climate Change Knowledge Portal (CCKP) is the CMIP5 (Coupled Inter-comparison Project No.5) data ensemble, which builds the database for the global climate change projections presented in the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC). Four Representative Concentration Pathways (i.e. RCP2.6, RCP4.5, RCP6.0, and RCP8.5) were selected and defined by their total radiative forcing (cumulative measure of GHG emissions from all sources) pathway and level by 2100. The RCP2.6 for example represents a very strong mitigation scenario, whereas the RCP8.5 assumes business-as-usual scenario. For more information, please refer to the RCP Database. For simplification, these scenarios are referred to as a low (RCP2.6); a medium (RCP4.5) and a high (RCP8.5) emission scenario in this profile. **Table 3** provides CMIP5 projections for essential climate variables under high emission scenario (RCP8.5) over four different time horizons. **Figure 6** presents the multi-model (CMIP5) ensemble of 32 Global Circulation Models (GCMs) showing the projected changes in annual precipitation and temperature for the periods 2040–2059 and 2080–2099.

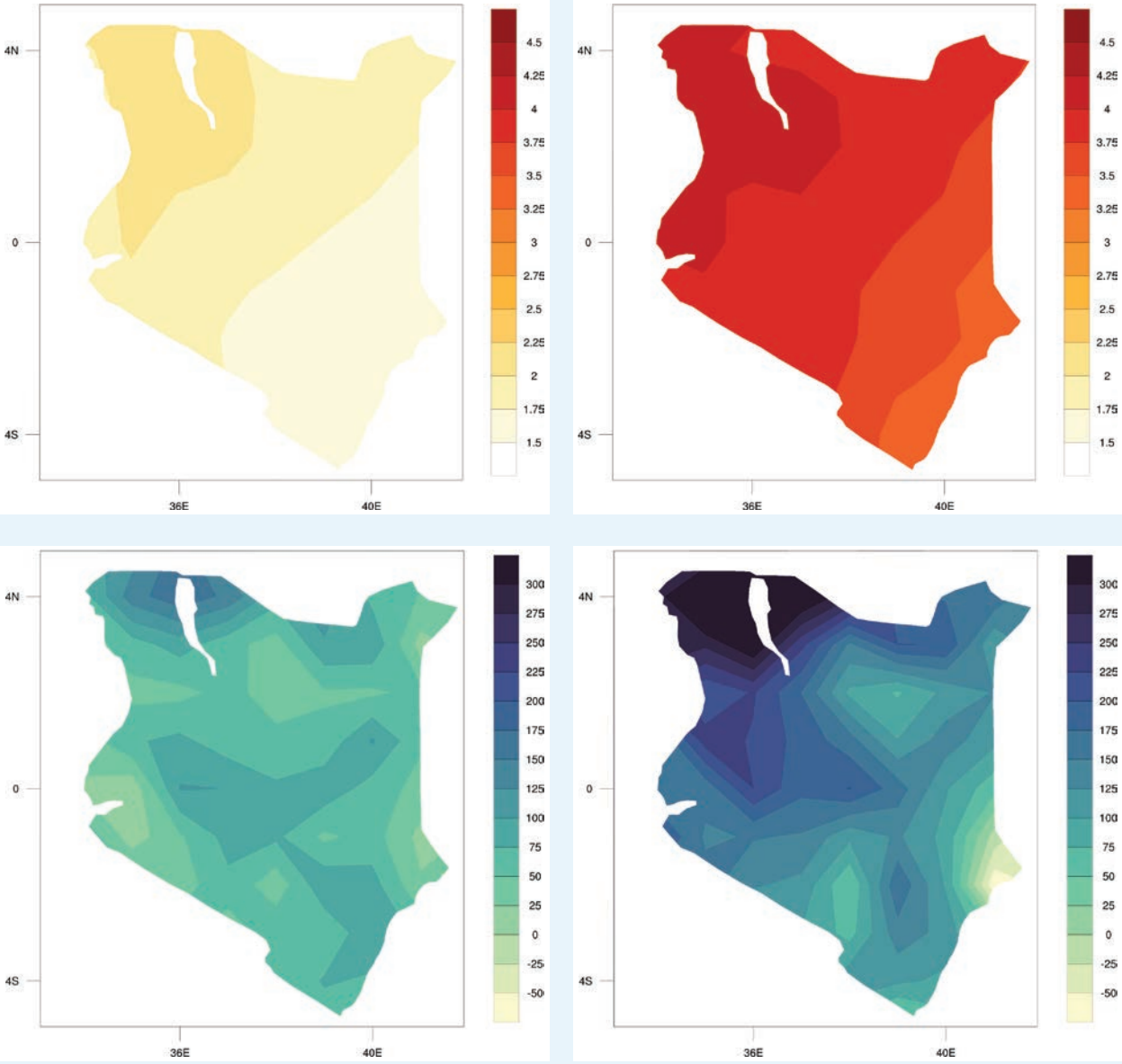
TABLE 3. Data snapshot: CMIP5 ensemble projections

CMIP5 Ensemble Projection	2020–2039	2040–2059	2060–2079	2080–2099
Annual Temperature Anomaly (°C)	**+0.5 to +1.4** (+1.0°C)	**+1.2 to +2.4** (+1.7°C)	**+2.0 to +3.7** (+2.5°C)	**+2.7 to +5.1** (+3.5°C)
Annual Precipitation Anomaly (mm)	**–13.7 to +21.6** (2.6 mm)	**–17.1 to +25.2** (3.5 mm)	**–17.0 to +34.0** (6.7 mm)	**–17.8 to +44.0** (10.5 mm)

Note: The table shows CMIP5 ensemble projection under RCP8.5. Bold value is the range (10th–90th Percentile) and values in parentheses show the median (or 50th Percentile).

[22] National Environment Management Authority (2015). Kenya- Second National Communication to the United National Framework Convention on Climate Change. URL: https://unfccc.int/sites/default/files/resource/Kennc2.pdf

FIGURE 6. CMIP5 ensemble projected change (32 GCMs) in annual temperature (top) and precipitation (bottom) by 2040–2059 (left) and by 2080–2099 (right), relative to 1986–2005 baseline under RCP8.5[23]



[23] WBG Climate Change Knowledge Portal (CCKP, 2020). Kenya Projected Future Climate. URL: https://climateknowledgeportal.worldbank.org/country/kenya/climate-data-projections

Key Trends

Temperature

Temperatures in Kenya are projected to continue rising by 1.7°C by the 2050s and by approximately 3.5°C at the end of the century.[24] Additionally, the number of hot days and nights will increase, with 'hot days' projected to occur on 19%–45% of days by mid-century. Hot nights are expected to increase more quickly, projected to occur on 45%–75% of nights by mid-century and on 64%–93% of nights by end of century. Cold days and nights are expected to become increasingly rare.[25]

Across all emissions scenarios, temperatures in Kenya will continue to rise. As shown in **Figures 7** and **8** below, under a high-emission scenario (RCP 8.5), average temperatures are expected to increase rapidly by mid-century. Increased heat and extreme heat conditions will result in significant implications for human and animal health, agriculture, and ecosystems.

FIGURE 7. Historical and projected average temperature for Kenya from 1986 to 2099[26]

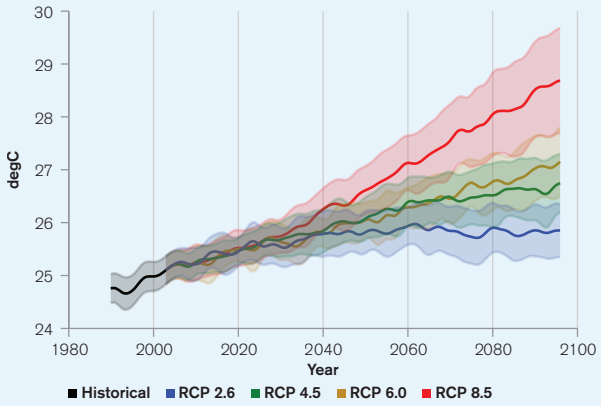
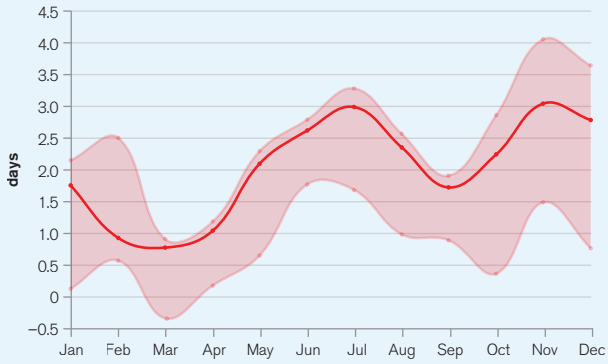


FIGURE 8. Projected change in summer days (Tmax >25°C)[27]



[24] Ministry of Environment and Natural Resources (2016). Kenya National Adaptation Plan, 2015–2030. URL: https://www4.unfccc.int/sites/NAPC/Documents%20NAP/Kenya_NAP_Final.pdf.

[25] National Environment Management Authority (2015). Kenya- Second National Communication to the United National Framework Convention on Climate Change. URL: https://unfccc.int/sites/default/files/resource/Kennc2.pdf

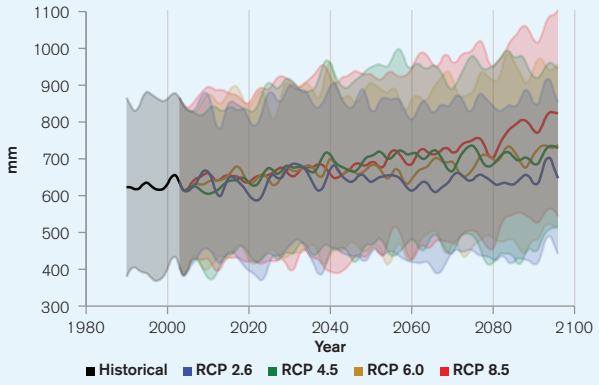
[26] WBG Climate Change Knowledge Portal (CCKP, 2020). Kenya Agriculture Dashboard. URL: https://climatedata.worldbank.org/CRMePortal/web/agriculture/crops-and-land-management?country=KEN&period=2080-2099

[27] WBG Climate Change Knowledge Portal (CCKP, 2020). Kenya Agriculture Dashboard. URL: https://climatedata.worldbank.org/CRMePortal/web/agriculture/crops-and-land-management?country=KEN&period=2080-2099

Precipitation

Precipitation in Kenya is projected to remain highly variable and uncertain, however average rainfall is expected to increase by mid-century, particularly during the 'short rains', which occur between October and December. Extreme rainfall events are also expected to increase in frequency, duration and intensity and the proportion of heavy rainfall that occurs in heavy events will increase. However, the period between heavy rainfall events may increase. Importantly, rainfall in the arid zones are generally projected to decrease.[28] As seen in **Figure 9**, annual average precipitation is expected to increase slightly by the of the century under a high emissions scenario (RCP8.5).

FIGURE 9. Annual average precipitation trends and projections for Kenya, for 1986 to 2099[29]



CLIMATE RELATED NATURAL HAZARDS

Overview

Kenya is highly exposed to many natural hazards, the most common being floods and droughts. It is estimated that over 70% of natural disasters in Kenya are attributable to extreme climatic events. Typically, major droughts occur approximately every ten years, and moderate droughts or floods every three to four years. Repeating patterns of floods and droughts in the country have had large socio-economic impacts and high economic costs. For example, the 1998 to 2000 drought cost an estimated $2.8 billion, principally due to crops and livestock loss, as well as forest fires, damage to fisheries, reduced hydropower generation, reduced industrial production and reduced water supplies.[30] Droughts have affected more people and had the greatest economic impact (8% of GDP every five years). As many as 28 droughts have been recorded in the past 100 years, and these appear to be increasing in frequency. Droughts are often nation-wide, but normally have the most severe impacts in the country's highly arid zones.[31] Drought also remains a significant concern to Kenya's agricultural sector.[32] Arid and semi-arid areas comprise 18 or the 20 poorest counties and are particularly at risk from increased aridity and periods of drought.[33] While droughts

[28] WBG Climate Change Knowledge Portal (CCKP, 2020). Kenya Water Dashboard. Data Description. URL: https://climateknowledgeportal.worldbank.org/country/kenya/climate-sector-water

[29] WBG Climate Change Knowledge Portal (CCKP, 2020). Climate Data-Projections. Kenya. URL: https://climateknowledgeportal.worldbank.org/country/kenya/climate-sector-water

[30] National Environment Management Authority (2015). Kenya- Second National Communication to the United National Framework Convention on Climate Change. URL: https://unfccc.int/sites/default/files/resource/Kennc2.pdf

[31] Republic of Kenya (2013). Sector plan for drought risk management and ending drought emergencies, Second medium-term plan: 2013–2017. URL: https://www.ndma.go.ke/index.php/resource-center/send/43-ending-drought-emergencies/4271-ede-medium-term-plan-2013-2017

[32] Republic of Kenya (2013). National Climate Change Action Plan, 2013–2017: Vision 2030. URL: https://cdkn.org/wp-content/uploads/2013/03/Kenya-National-Climate-Change-Action-Plan.pdf

[33] World Bank (2018). Disaster Risk Management Development Policy Financing with a Catastrophe Deferred Drawdown Option. URL: http://documents.worldbank.org/curated/en/131661529811034069/pdf/KENYA-DDO-NEWPAD-2-05312018.pdf

affect the most people, floods have caused the greatest losses in terms of human lives. The districts of Baringo, West Pokot, Kisumu and Laikipia are some of the country's most disaster-prone areas and have required significant disaster risk investment.[34] Vulnerability from these hazards poses major challenges for economic stability and fiscal sustainability and have had adverse social and fiscal consequences. Indeed, lower-income populations reside in more hazard prone locations, with high potential for significantly increased exposure of already vulnerable populations.[35]

Data from the Emergency Event Database: EM-Dat database, presented in **Table 4**, shows the country has endured various natural hazards, including floods, landslides, wildfires, and storms.

TABLE 4. Natural Disasters in Kenya, 1900–2020[36]

Natural Hazard 1900–2020	Subtype	Events Count	Total Deaths	Total Affected	Total Damage ('000 USD)
Drought	Drought	16	196	52,911,500	1,500
Earthquake	Ground Movement	1	0	0	0
	Tsunami	1	1	0	100,000
Epidemic	Bacterial Disease	20	1,576	59,801	0
	Parasitic Disease	5	1,595	6,807,533	0
	Viral Disease	7	514	3,850	0
Flood	Flash Flood	8	245	193,500	500
	Riverine Flood	37	1,150	2,232,222	136,038
Landslide	Landslide	4	133	140	0
	Mudslide	1	20	6	0
Storm	Convective Storm	1	50	0	0

Key Trends

Climate change is expected to increase the risk and intensity of flood events, as well as increase average annual rainfall amounts, while also furthering drought likelihoods for some areas across Kenya. Intense rainfall and flooding may increase the likelihood of mudslides and landslides, particularly in mountainous areas. As the incidence of extreme rainfall rises, additional soil erosion and water logging of crops is likely to reduce yields and increase food insecurity. Rising temperatures are also likely to increase the periods of aridity in the northwest regions. Furthermore, as temperatures rise and droughts are prolonged, water storage capacities will likely be reduced. This may result in significant economic losses, damage to agricultural lands and infrastructure as well as human casualties. Additionally, land degradation and soil erosion, exacerbated by recurrent floods, will negatively impact agricultural productivity, disproportionately affecting the livelihoods of the rural poor. [37]

[34] Development Initiatives Kenya (2019). Tracking subnational government investments in disaster risk reduction in Kenya. URL: https://reliefweb.int/sites/reliefweb.int/files/resources/Tracking-subnational-government-investments-in-disaster-risk-reduction-in-Kenya.pdf

[35] Ministry of Foreign Affairs (2018). Climate Change Profile, Kenya. URL: https://reliefweb.int/sites/reliefweb.int/files/resources/Kenya_2.pdf

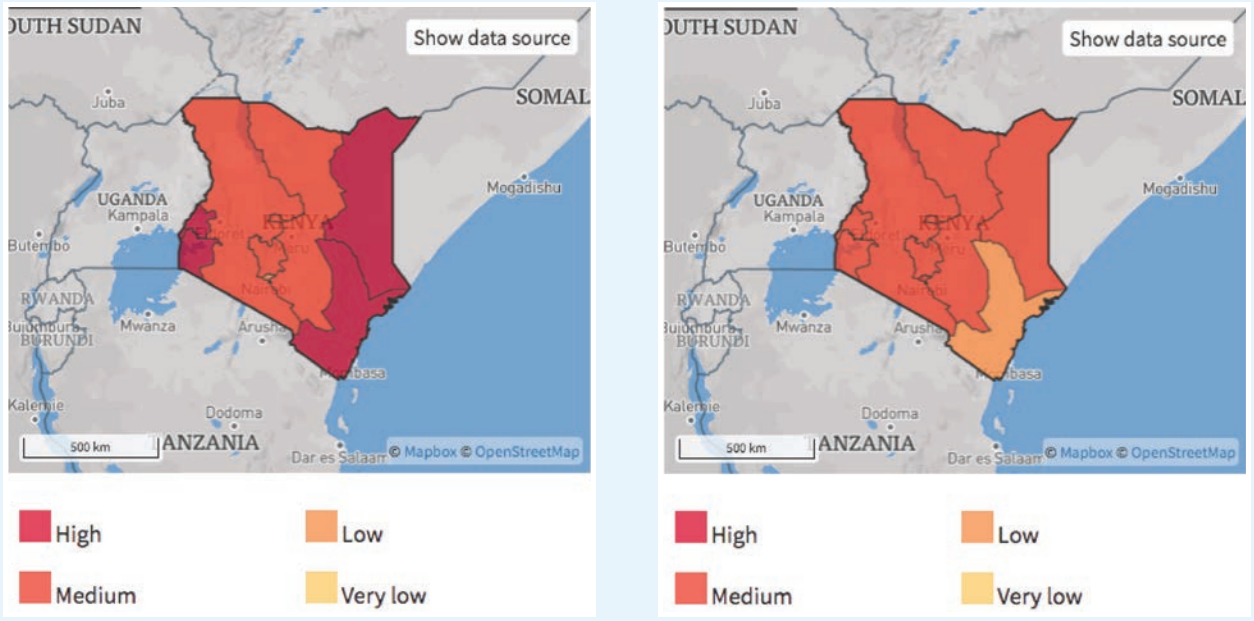
[36] EM-DAT: The Emergency Events Database - Universite catholique de Louvain (UCL) - CRED, D. Guha-Sapir, Brussels, Belgium. URL: http://emdat.be/emdat_db/

[37] Ministry of Environment and Natural Resources (2016). Kenya National Adaptation Plan, 2015–2030. URL: https://www4.unfccc.int/sites/NAPC/Documents%20NAP/Kenya_NAP_Final.pdf.

Recurring disasters, particularly droughts and floods, have significantly impacted livelihoods and the country's economic development agenda. Flood and drought events are becoming more frequent, with drought cycles occurring every 2–3 years instead of every 5–10 years. A severe and prolonged drought from 2008–2011 affected 3.7 million people, caused $12.1 billion in damages and losses, and cost over $1.7 billion in recovery and reconstruction needs.[38]

Additionally, deforestation, watershed degradation, land use changes, urbanization and poor management of settlements have exacerbated the likelihood of and impact from floods and droughts. These conditions contribute to water scarcity and pollution, which limit water for drinking, agriculture, and other uses. Heavy rainfall can also trigger riverine, coastal and flash floods. Flash floods are common in the country's high plateau areas and can also trigger mudflows. Increasing urbanization, particularly into flood plains and/or low-lying areas also has increased flood risk, as water drainage systems fail. Water stress may be further exacerbated as household consumption and agriculture continue to compete for limited supply. Increased heat will further strain water resources and impacts from changing rainfall patterns.[39] **Figure 10** shows different risks from river flooding and water scarcity.

FIGURE 10. Risk of river flood (Left)[40]; risk of water scarcity (R)[41]



[38] GFDRR (2020). Kenya Overview. URL: https://www.gfdrr.org/en/kenya
[39] Republic of Kenya (2013). Sector plan for drought risk management and ending drought emergencies, Second medium-term plan: 2013–2017. URL: https://www.ndma.go.ke/index.php/resource-center/send/43-ending-drought-emergencies/4271-ede-medium-term-plan-2013-2017
[40] ThinkHazard! (2020). Kenya River Flood. URL: http://thinkhazard.org/en/report/133-kenya/FL
[41] ThinkHazard! (2020). Kenya Water Scarcity. URL: http://thinkhazard.org/en/report/133-kenya/DG

Implications for DRM

The Government of Kenya is committed to increasing its coping capacity and resilience to natural hazards, reducing the potential impacts from climate change, and strengthening its disaster risk management strategies. Kenya's Disaster Risk Management (DRM) Authority is working at both the national and sub-national level to implement actions outlined in its Vision 2030 strategy.[42] The DRM Authority is responsible for DRM preparedness and response, however the Authority is also actively involved in bridging the gap between academic researchers and government departments, integrating research applications to appropriate ministries in an effort to better prepare for climate change adaptation.[43] All levels of the government in Kenya are also, at times, required to reallocate planed capital expenditures towards financing post-disaster reconstruction efforts. However, budget reallocations create delays and can often result in the scaling back of investment programs, while also slowing deployment of funds for recovery efforts. In order to support the government, key international donor support mechanisms have included damage and loss assessment after major disaster events. Specifically, following the 2008–2011 drought, the Global Facility for Disaster Reduction and Recovery (GFDRR), the World Bank, the EU, the UN, and other partners supported the Government of Kenya in conducting an assessment to estimate the drought's impact and provided recommendations for recovery and long-term resilience. Furthermore, GFDRR helped the Government of Kenya provide financial protection to vulnerable households affected. Kenya continues to strengthen the capacity of its DRM Authority, with a focus on increasing the resilience of poor segments of the population, especially communities reliant on agriculture and livestock.[44]

CLIMATE CHANGE IMPACTS TO KEY SECTORS

Kenya is highly vulnerable to seasonal variability and long-term climate change. Increasing vulnerability is expected to result in cumulative impacts across the country's social, economic and environmental systems, with a high likelihood to reverse much of the positive development progress the country has made. Droughts and floods can have devastating consequences on the environment, society and the wider economy. Significant impacts are expected for the country's water resources, agriculture, health, and forestry sectors, as well its coastal zones. Heavy rains, floods, droughts, soil erosion, and sea level rise put both urban and rural infrastructure at risk, particularly for poor and vulnerable groups. Environmental degradation, altered water resources, and loss of biodiversity and ecosystem services constitute serious obstacles to the country's continued development, of particular relevance to the country's tourism sector. In addition, rising temperatures will have a negative impact on key parts of the economy, e.g. forestry, agriculture, and livestock. Changes in precipitation patterns can have far-reaching consequences for ecosystems and biodiversity, food production, the water industry and rivers.[45]

[42] Republic of Kenya (2013). Sector plan for drought risk management and ending drought emergencies, Second medium-term plan: 2013–2017. URL: https://www.ndma.go.ke/index.php/resource-center/send/43-ending-drought-emergencies/4271-ede-medium-term-plan-2013-2017

[43] National Environment Management Authority (2015). Kenya- Second National Communication to the United National Framework Convention on Climate Change. URL: https://unfccc.int/sites/default/files/resource/Kennc2.pdf

[44] GFDRR (2020). Kenya Overview. URL: https://www.gfdrr.org/en/kenya

[45] National Environment Management Authority (2015). Kenya- Second National Communication to the United National Framework Convention on Climate Change. URL: https://unfccc.int/sites/default/files/resource/Kennc2.pdf

Gender

An increasing body of research has shown that climate-related disasters have impacted human populations in many areas including agricultural production, food security, water management and public health. The level of impacts and coping strategies of populations depends heavily on their socio-economic status, socio-cultural norms, access to resources, poverty as well as gender. Research has also provided more evidence that the effects are not gender neutral, as women and children are among the highest risk groups. Key factors that account for the differences between women's and men's vulnerability to climate change risks include: gender-based differences in time use; access to assets and credit, treatment by formal institutions, which can constrain women's opportunities, limited access to policy discussions and decision making, and a lack of sex-disaggregated data for policy change.[46]

Agriculture

Overview

The agricultural sector is critical to Kenya's economy and food security and is considered to be one of the most vulnerable to climate risks. The sector contributes approximately 28% of Kenya's GDP and accounts for more than 65% of exports, with crop, livestock, and fisheries sub-sectors contributing approximately 78%, 20% and 2% to the agricultural GDP, respectively. As of 2015, the agricultural sector provides about 80% of total employment and supports over 80% of the rural population.[47] Four sub-sectors are recognized: crops, livestock, fisheries and forestry.[48] The country's reliance on agriculture and dependence on imports (especially of wheat, maize, and rice, among others) underscores the need for sustainable, resilient increases in agricultural productivity for food security and economic growth.[49]

Climate Change Impacts

Climate change poses a serious negative impact on agriculture-based livelihoods in Kenya, challenging the sustainability of current arable, pastoral and fishing practices. The majority of Kenyan agriculture relies on seasonal rains for production and the projected changes in precipitation patterns are expected to directly increase the likelihood of short-term crop failures and long-term production declines. Rain-fed agriculture remains the dominant source of staple food production and is the foundation of livelihoods for the majority of the rural poor in Kenya.[50] The high inter-annual variability of precipitation is already having devastating consequences on rural livelihoods, with droughts and floods a frequent occurrence in both the arid and semi-arid lands and key agricultural zones. Additionally, indirect impacts, such as increased rates of runoff and soil erosion, and increased crop losses

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[46] World Bank Group (2016). Gender Equality, Poverty Reduction, and Inclusive Growth. URL: http://documents1.worldbank.org/curated/en/820851467992505410/pdf/102114-REVISED-PUBLIC-WBG-Gender-Strategy.pdf

[47] World Bank; CIAT (2015). Climate-Smart Agriculture in Kenya. CSA Country Profiles for Africa, Asia, and Latin America and the Caribbean Series. Washington D.C.: The World Bank Group. URL: https://climateknowledgeportal.worldbank.org/sites/default/files/2019-06/CSA%20KENYA%20NOV%2018%202015.pdf

[48] Ministry of Agriculture, Livestock and Fisheries (2017). Kenya Climate Smart Agriculture Strategy, 2017–2026. URL: https://www.adaptation-undp.org/sites/default/files/resources/kenya_climate_smart_agriculture_strategy.pdf

[49] World Bank; CIAT (2015). Climate-Smart Agriculture in Kenya. CSA Country Profiles for Africa, Asia, and Latin America and the Caribbean Series. Washington D.C.: The World Bank Group. URL: https://climateknowledgeportal.worldbank.org/sites/default/files/2019-06/CSA%20KENYA%20NOV%2018%202015.pdf

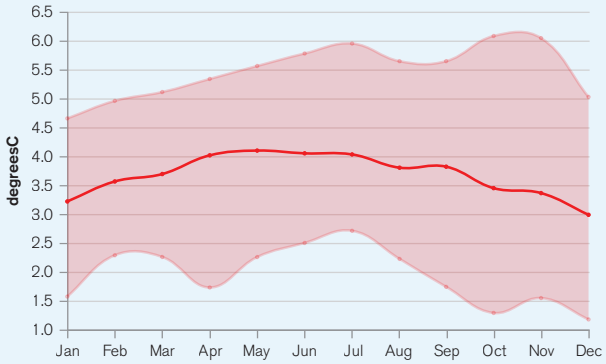
[50] Republic of Kenya (2013). National Climate Change Action Plan, 2013–2017: Vision 2030. URL: https://cdkn.org/wp-content/uploads/2013/03/Kenya-National-Climate-Change-Action-Plan.pdf

from wildlife migrations, rising and novel infestations from insects, diseases and weeds, could significantly magnify production losses.[51]

Some regions of Kenya may see a benefit from a changing climate, specifically the temperate and tropical highlands, the Rift Valley and high plateaus, as projected increases in rainfall and slightly warmer temperatures are likely to raise crop yields. However, the country's large semi-arid and arid land areas are projected to see a significant decline in agricultural productivity and livestock numbers, as water resources become increasingly scarce.[52] Given its exposure and sensitivity, the agriculture sector is one of the most vulnerable to climate change. Rising temperatures will likely alter the mix and distribution of agriculture and livestock pests, while the increased incidence of droughts, coupled with reduced rainfall projections for the arid and semi-arid regions, is expected to reduce yields in key crops: maize, wheat, rice, livestock and fisheries. Key cash crops such as coffee and tea are also likely to be highly affected due to temperature increases as well as the increased presence of pests and diseases.[53]

Warm temperatures during the day are critical to crop growth, however, there are temperature thresholds beyond which crop productivity is reduced or stalled. This threshold is different with each crop type. As temperatures rise, local trends in daily maximum temperatures may offer insights on these upper thresholds for specific crops, translating these potentially into changing yields (**Figure 11**). This is a critical indicator for agriculture, particularly given that the majority of agriculture is rain-fed. Reduced water availability could also reduce yields and reduce soil moisture availability, potentially altering the distribution of areas suitable for agriculture or the production of specific crops.

FIGURE 11. Average daily max temperature anomaly for Kenya[54]



Adaptation Options

Both the sensitivity of the agricultural sector to a changing climate and the high reliance of this sector on rainfall and limited water resources have important implications for Kenya's farmers, fishermen, women, and the wider economy. The sector will benefit from targeted research aimed at improving the knowledge base of specific climate change related impacts. Improved access to seasonal information is necessary to better inform farms and fisher-folk on decisions regarding planting and the timing of fishing activity. Improved water resources management, specifically increasing use of irrigation as an adaptive strategy, could improve production during reduced rainfall periods.[55]

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[51] National Environment Management Authority (2015). Kenya- Second National Communication to the United National Framework Convention on Climate Change. URL: https://unfccc.int/sites/default/files/resource/Kennc2.pdf

[52] National Environment Management Authority (2015). Kenya- Second National Communication to the United National Framework Convention on Climate Change. URL: https://unfccc.int/sites/default/files/resource/Kennc2.pdf

[53] Ministry of Environment and Natural Resources (2016). Kenya National Adaptation Plan, 2015–2030. URL: https://www4.unfccc.int/sites/NAPC/Documents%20NAP/Kenya_NAP_Final.pdf.

[54] WBG Climate Change Knowledge Portal (CCKP, 2020). Kenya Agriculture. Dashboard URL: https://climatedata.worldbank.org/CRMePortal/web/agriculture/crops-and-land-management?country=KEN&period=2080-2099

[55] World Bank (2015). Climate Smart Agriculture – Kenya. URL: https://climateknowledgeportal.worldbank.org/sites/default/files/2019-06/CSA%20KENYA%20NOV%2018%202015.pdf

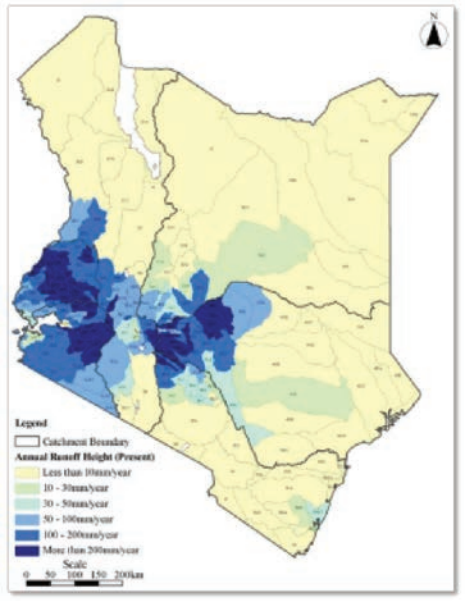
An opportunity exists to improve the horizontal integration of producers regarding the management of water, prioritizing the development of water management models at basin scales to improve water management tools. Implementing sustainable land management actions, as well as seasonally-appropriate cropping sequences, and livestock production systems that are environmentally sound can support the conservation of natural grasslands and native forests. Encouraging the use of both new agriculture technologies that are water and resource efficient (e.g. drip irrigation), or more resilient crop varieties would support a shift away from water-intensive crops and can also help farmers produce more food with fewer inputs.[56]

Water

Overview

In 1992, Kenya was categorized as a water scarce country, as available water resources were calculated at 647 m^3 per capita; below the international acceptable threshold of 1,000 m^3. The country's water scarcity index has worsened alongside its rapid population growth, and is expected to fall from approximately 586 m^3 per capita in 2010 to as low as 293 m^3 per capita by 2050. Kenya is thus critically exposed to the adverse effects of climate change. This has serious implications for Kenya's Vision 2030 as these impacts will be detrimental to the country's tourism, agriculture, industry, and energy sectors.[57] Freshwater resources in Kenya are already highly subject to the large inter-and intra-annual rainfall variability, including the extremes of floods and droughts (**Figure 12**). As rainfall patterns are further altered, and rising temperatures increase soil moisture deficits and lower lake levels.[58]

FIGURE 12. Distribution of renewable surface water resources across Kenya[59]



Climate Change Impacts

Already, cities in Kenya face significant challenges in water availability. For example, the city of Mombasa currently has only half of the water required to meet its needs, leading to rationing and the continued use of private sources. Rising temperatures and more variable rainfall will exacerbate these conditions.[60] In coastal locations, sea level rise

[56] Ministry of Agriculture, Livestock and Fisheries (2017). Kenya Climate Smart Agriculture Strategy, 2017–2026. URL: https://www.adaptation-undp.org/sites/default/files/resources/kenya_climate_smart_agriculture_strategy.pdf

[57] Republic of Kenya (2013). Sector plan for drought risk management and ending drought emergencies, Second medium-term plan: 2013–2017. URL: https://www.ndma.go.ke/index.php/resource-center/send/43-ending-drought-emergencies/4271-ede-medium-term-plan-2013-2017

[58] National Environment Management Authority (2015). Kenya- Second National Communication to the United National Framework Convention on Climate Change. URL: https://unfccc.int/sites/default/files/resource/Kennc2.pdf

[59] National Environment Management Authority (2015). Kenya- Second National Communication to the United National Framework Convention on Climate Change. p. 28. URL: https://unfccc.int/sites/default/files/resource/Kennc2.pdf

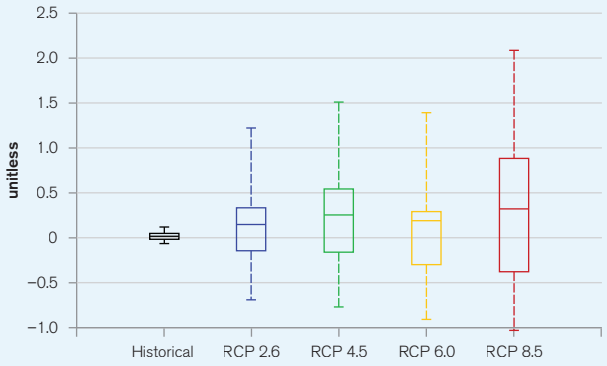
[60] Republic of Kenya (2013). National Climate Change Action Plan, 2013–2017: Vision 2030. URL: https://cdkn.org/wp-content/uploads/2013/03/Kenya-National-Climate-Change-Action-Plan.pdf

is likely to lead to even more acute water supply and salinization problems, as freshwater aquifers are contaminated. Changes projected in climate will increase water scarcity, particularly in the arid and semi-arid areas of the country. Rising temperatures will also likely exacerbate the drought conditions and may have a significant impact on water availability and general human well-being.[61]

The expected changes in rainfall, coupled with increased aridity and more severe droughts, are anticipated to increase existing vulnerabilities in agriculture, forests, urban areas, as well as in livestock and dryland water resource management. Conflict in Kenya's arid and semi-arid zones over limited water resources, which are already significant, are likely to increase. Rising temperatures are furthermore leading to accelerated glacial loss on Mount Kenya, further straining water resources and the flows of glacially-fed rivers.[62] Changes in precipitation patterns, particularly the projected annual decreases in rainfall will impact river flows, irrigation potential as well as water management and flooding.

Kenya's limited water storage capacity increases the country's dependence on unreliable rainfall patterns. As rainfall and evaporation rates change, so will rates of surface water infiltration and groundwater recharge. These changes can further reduce the reliability of unimproved groundwater sources and surface water sources during droughts or prolonged dry period. These can increase strain on pumping mechanisms, leading to breakdowns if maintenance is neglected. The figure below shows the projected annual Standardized Precipitation Evapotranspiration Index (SPEI) through the end of the century. The SPEI is an index which represents the measure of the given water deficit in a specific location, accounting for contributions of temperature-dependent evapotranspiration and providing insight into increasing or decreasing pressure on water resources. Negative values for SPEI represent dry conditions, with values below –2 indicating severe drought conditions, likewise positive values indicate increased wet conditions. This is an important understanding for the water sector in regards to quantity and quality of supply for human consumption and agriculture use as well as for the energy sector as reductions in water availability impacts river flow and the hydropower generating capabilities. As seen in **Figure 13**, Kenya, at a nationally aggregated scale is expected to experience an increase in rainfall, however this is likely to result from intense rainfall events for some areas as well as increased aridity for other areas of the country.

FIGURE 13. Annual SPEI drought index in Kenya for the period, 1986 to 2099[63]



[61] National Environment Management Authority (2015). Kenya- Second National Communication to the United National Framework Convention on Climate Change. URL: https://unfccc.int/sites/default/files/resource/Kennc2.pdf

[62] Kenya (2015). Common Program Framework for Ending Drought Emergencies. URL: http://extwprlegs1.fao.org/docs/pdf/ken152740.pdf

[63] WBG Climate Change Knowledge Portal (CCKP, 2020). Kenya Water Sector Dashboard. URL: https://climatedata.worldbank.org/CRMePortal/web/water/land-use-/-watershed-management?country=KEN&period=2080-2099

Adaptation Options

Promoting improved efficiencies in the use of water resources will contribute to the restoration of critical regenerative ecological and physical functions of water bodies in the near to long term and this can be done through improved water resource management. Currently the government is encouraging states, via Kenya's devolution structure, to enact adaptation strategies alongside sub-basin management plans.[64] These plans undoubtedly should take into account the sector's current and future needs and vulnerabilities. Targeted research should be undertaken to identify water resource challenges at community and regional level, with results used to inform adaptation efforts. Large-scale irrigation projects should use existing vulnerability assessments in order to appropriately coordinate with adaptation measures.[65]

Improved water management will likely provide a wide range of benefits for various sectors, including agriculture, safeguarding food security and water access. Implementing guidelines and mainstreaming activities identified in the National Water Master Plan further will support the joint work between institutions in charge of water resource management and to ensure there is available water for development and continued quality water for domestic consumption.[66]

Coastal Zone and Sea Level Rise

Overview

As sea surface temperatures rise alongside rising sea levels and coasts continue to erode, Kenya's coastal ecosystems, estuaries, beaches, coral reefs and marine biodiversity – including its fisheries sector - are at risk. Ports and transport infrastructure are particularly exposed to flooding, as are critical tourism assets and settlements situated close to the coast. Sea level rise is likely to affect coastal cities and low-lying land that may be under cultivation. The impact from sea level rise can be significantly compounded as storm surges become more pronounced, increasing the risks to coastal populations and infrastructure. Sea level rise in combination with extreme weather events is likely to intensify flooding as the majority of the coastland, including key tourism areas, cities, ports and infrastructure is low-lying.[67]

Climate Change Impacts

Sea level rise presents a risk to the five coastal counties (Kwale, Mombasa, Kilifi, Tana River, Lamu) and their populations. Sea level rise in combination with extreme weather events is likely to intensify flooding as most of the coastland is low-lying. The coastal city of Mombasa is particularly exposed, with an estimated area of 4-6 km^2 likely to be submerged with a rise in sea level of only 0.3 meters. In other coastal locations, sea level rise is likely

[64] Republic of Kenya (2013). Sector plan for drought risk management and ending drought emergencies, Second medium-term plan: 2013–2017. URL: https://www.ndma.go.ke/index.php/resource-center/send/43-ending-drought-emergencies/4271-ede-medium-term-plan-2013-2017

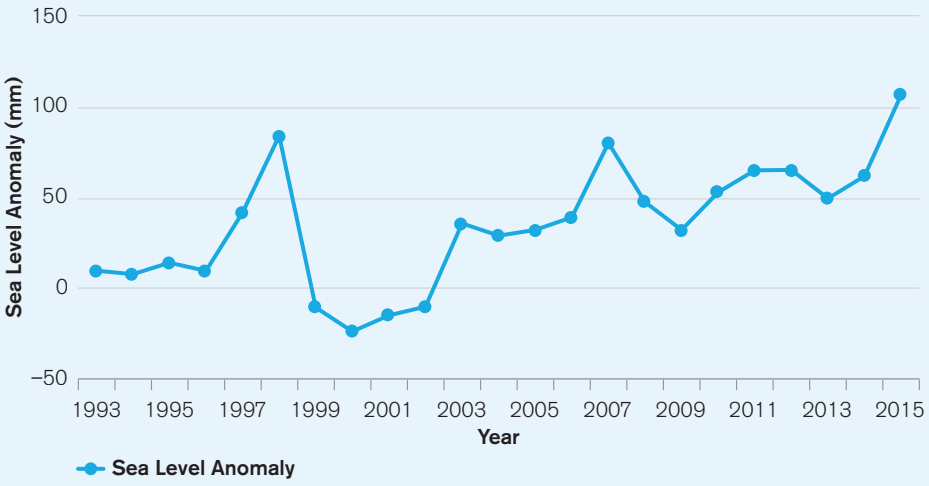
[65] Kenya (2015). Common Program Framework for Ending Drought Emergencies. URL: http://extwprlegs1.fao.org/docs/pdf/ken152740.pdf

[66] National Environment Management Authority (2015). Kenya- Second National Communication to the United National Framework Convention on Climate Change. URL: https://unfccc.int/sites/default/files/resource/Kennc2.pdf

[67] National Environment Management Authority (2015). Kenya- Second National Communication to the United National Framework Convention on Climate Change. URL: https://unfccc.int/sites/default/files/resource/Kennc2.pdf

to render more acute the current water supply and salinization problems, as freshwater aquifers are contaminated with saline water. Water logging of soils and the resulting salt stress might reduce crop production. Additionally, the health of coastal populations is at risk as saline intrusion affects coastal aquifers, and the permanent inundation of low-lying areas renders them uninhabitable. Kenya's broader economy is also at risk from rising seas as coastal and marine resources, all critical to economic development through tourism, fisheries, shipping and port activities, suffer. Tourism and shipping are the highest contributors to the coastal economy, while small scale fishing contributes 95% of the total marine catch. Rising sea levels will likely lead to damage and destruction of infrastructure including ship docking ports and industries located in the coast if no adaptation strategies are implemented. The agriculture sector along the coast will also be impacted with the loss of income of $ 472.8 million as exported mango, cashew nut and coconut harvests will be affected by a one-meter sea level rise.[68] **Figure 14** shows the change in sea level for Kenya since 1993.

FIGURE 14. Sea level anomaly of Kenya, 1993–2015[69]



Adaptation Options

Improving coastal zone management strategies is critical to safeguarding the coastal economies, communities and infrastructure. Capacity-building initiatives for ecosystem-based adaptation, both at national and local levels, would strengthen and hopefully restore coastal ecosystems, restoring the critical buffering and wave energy dissipation services they provide during extreme climate events. Vulnerability maps of coastal areas should be undertaken to pinpoint hotspots of risk along the coast. Adaptation strategies should be implemented to protect the port of Mombasa in light of its criticality with respect to the economy and livelihoods. Land use planning should be integrated with local infrastructure and development plans in order to incorporate climate change concerns into state policies for coastal protection and management.[70]

[68] Ministry of Environment and Natural Resources (2016). Kenya National Adaptation Plan, 2015–2030. URL: https://www4.unfccc.int/sites/NAPC/Documents%20NAP/Kenya_NAP_Final.pdf

[69] WBG Climate Change Knowledge Portal (CCKP, 2020). Kenya Impacts – Sea Level Rise. URL: https://climateknowledgeportal.worldbank.org/country/kenya/impacts-sea-level-rise

[70] Ministry of Environment and Natural Resources (2016). Kenya National Adaptation Plan, 2015–2030. URL: https://www4.unfccc.int/sites/NAPC/Documents%20NAP/Kenya_NAP_Final.pdf

Energy

Overview

Energy is a key component for the Kenyan economy, its development agenda and continued efforts to improve the population's standard of living. Kenya has achieved remarkable success in expanding generation capacity and overcoming the generation and energy shortfall that had plagued the country for several decades. The country has developed a well-diversified energy mix with close to 90% of energy being generated from clean sources (mainly geothermal, hydro, wind and solar). About 30% of installed generation capacity is owned and operated by independent power producers (IPPs) with mobilization of at least US$4 billion in private capital. Kenya has also been implementing one of the most successful electrification programs in Africa that has increased access to electricity increased to 70% in 2019 from both grid and off-grid options, from just 25% in 2010. Biomass (including wood fuel, charcoal, and agricultural waste), petroleum and electricity are the three main sources of primary energy consumption in the country. Biomass accounts for 68% of the country's domestic energy demand especially for cooking and heating, while petroleum accounts for 22% and electricity accounts for 9%. There is significant disparity between urban and rural households, with woodfuel and charcoal accounting for 63% and 86% of households' primary fuels respectively. The need for wood fuel has led to substantial deforestation and land degradation, and Kenya's forest cover of 4.22 million hectares (Ha) is less than 10% of its total land mass. Access to modern energy services is essential in reducing wood fuel dependency.[71] The main challenges facing the energy sector in Kenya include: improving the sector's competitiveness, reliability and quality of supply; risk of generation capacity surplus due to the large new generation capacity at various stages of development, which is not harmonized with realistic demand growth estimates, high initial capital outlay to continue electrification program as well as expand and strengthen the transmission and distribution network, high technical and commercial losses, weakening financial position of the Kenya Power & Lighting Company Ltd, which is the only distribution company and corner stone of the energy sector,[72] high cost of energy, low per capita incomes, and low levels of industrialization and of energy consumption.[73]

Climate Change Impacts

In the last 10 years, Kenya has developed adequate generation capacity that includes considerable renewable energy sources mainly geothermal, wind and solar. The installed generation capacity as at FY19/20 comprised hydro (30%), geothermal (28%), thermal (27%), wind (12%) and solar (2%). Kenya's successful development of geothermal resource for power generation stands at 820 MW has not only placed the country in the 8th position globally with geothermal development but has also transformed the country's generation mix that was dominated by hydro and thermal sources. Being baseload, geothermal and hydro account for (46.7%) and 32% of generated energy while the other renewable energy source-wind and solar contributed to 11% and 0.8% respectively. Thermal contributes to less than 8% of generated energy. Going forward, continued development of geothermal resources, wind and solar sources provide a unique opportunity for Kenya to meet its electricity needs fully from renewable energy sources.[74]

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[71] Ministry of Energy (2020). Bioenergy Strategy 2020–2027. Kenya.

[72] Nationally Appropriate Mitigation Action Plan (2015). Nationally Appropriate Mitigation Action for Accelerated Geothermal Electricity Development in Kenya, NAMA Profile #5. URL: https://unfccc.int/files/cooperation_support/nama/application/pdf/kenyanp.pdf

[73] Ministry of Energy and Petroleum (2015). National Energy and Petroleum Policy. URL: https://www.ketraco.co.ke/opencms/export/sites/ketraco/learn/maps/Legal_Documents/National_Energy_and_Petroleum_Policy.pdf

[74] Wood, J. (2018). Kenya is aiming to be powered entirely by green energy by 2020. World Economic Forum. [December 5, 2018]. URL: https://www.weforum.org/agenda/2018/12/kenya-wants-to-run-entirely-on-green-energy-by-2020/

Extreme weather events such as heavy rains can damage infrastructure, roads, communication networks and disrupt supply lines. An increase in the frequency of heat waves in urban centers like Nairobi or Mombasa could translate into higher demand for air conditioning and cooling systems, putting power plants under severe stress and reducing their efficiency. In coastal areas, sea level rise and storm surge threaten water and electricity infrastructure with inundation and salinity damage.[75] Given increasing temperatures and the increased energy demand that will coincide, change in cooling degree days provides insight into the potential for extended seasons of power demand or periods in which cooling demand (power demands) might increase.

Cooling Degree Days (**Figure 15**) show the relationship between daily heat and cooling demand, typically sourced through a form of active cooling or an evaporative process. The change in cooling degree days provides insight into the potential for extended demands for power or periods in which cooling demand (power demands) might increase. As seen in **Figure 16**, seasonal increases for cooling demands are projected, extending cooling demands in the hot season. The Warm Spell Duration Index represents the number of days in a sequence of at least six days in which the daily maximum temperature is greater than the 90th percentile of daily maximum temperature. As shown in the figure below, warm spells are expected to sharply increase in the second half of the century.

FIGURE 15. Change in cooling degree days (65°F) in Kenya for the period 2040–2059[76]

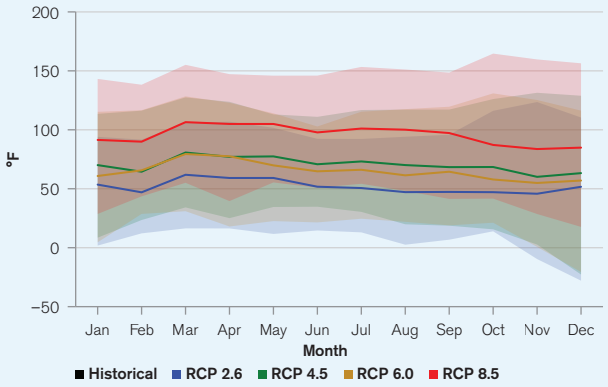
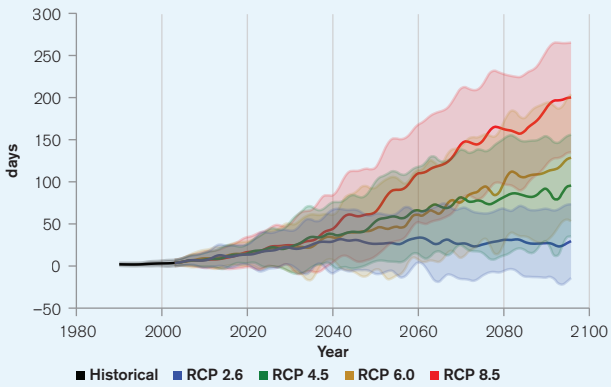


FIGURE 16. Warm spell duration index in Kenya for the period 1986 to 2099[77]



Adaptation Options

Electricity generation in Kenya is liberalized with several licensed electric power producers, although KenGen accounts for approximately 70% of all installed capacity. Kenya's National Energy Policy (2014), formulated within the framework of Vision 2030, encourages diversification of electricity sources. Kenya has developed a Least Cost Power Development Plan (LCPDP) that is periodically updated. However, the demand for growth assumed under the recent LCPDPs has proven to be overly ambitious – based on new development projects (mining and processing of iron and steel, irrigation by electricity, electrification of trains, and the development of new economic

[75] Ministry of Foreign Affairs (2018). Climate Change Profile, Kenya. URL: https://reliefweb.int/sites/reliefweb.int/files/resources/Kenya_2.pdf

[76] WBG Climate Change Knowledge Portal (CCKP, 2020). Kenya – Energy. URL: https://climateknowledgeportal.worldbank.org/country/kenya/climate-sector-energy

[77] WBG Climate Change Knowledge Portal (CCKP, 2020). Kenya Energy Sector Dashboard. URL: https://climatedata.worldbank.org/CRMePortal/web/energy/oil-gas-and-coal-mining?country=KEN&period=2080-2099

zones), which have not materialized as expected. However, generation capacity has continued to be contracted, exposing the sector to a high risk of large generation capacity surplus that is not sustainable. The Ministry of Energy is currently reviewing the LCPDP and the generation capacity pipeline to harmonize generation expansion with realistic demand growth. The review presents an opportunity for Kenya to assess and drop the planned development of 1,920 MW coal plant given the successes already being made with development of renewable energy sources (geothermal, wind, and solar) and advancement of these technologies including in battery storage.[78]

Kenya has also developed a National Energy Efficiency and Conservation Strategy (KNEECS) and Bioenergy Strategy, both launched in 2020 as part of its roadmap towards climate change adaptation. Previously the government launched the Kenya National Electrification Strategy (KNES) in 2018, as a roadmap for electrification through on-grid and off-grid options.

These strategies collectively target: (i) adoption of energy efficiency technologies that require less energy for the same functionality; (ii) energy conservation by encouraging change in the behavior of electricity consumers behaviors; (iii) adaptive policy, planning and investments for sustainable bioenergy use; and (iv) deployment of solar PV systems in off-grid electrification towards universal electricity access through renewable-energy based distributed systems, which may include productive uses (reducing and/or avoiding diesel-based power supply options).[79]

Health

Overview

Kenya is highly vulnerable to adverse impacts on the health of its citizens as temperatures rise and rainfall patterns change. While the country has made progress tackling communicable diseases such as HIV-AIDS, tuberculosis and malaria, this is likely to be undermined by projected changes in climate. The government has identified malaria, Rift Valley fever, malnutrition, water borne diseases (such as cholera), scabies, jiggers and lice infestations as some of the most negative impacts in Kenya's near to long term future. Additionally, the incidence and seasonality of other critical stressors including: heat stress, air pollution, asthma, vector-borne diseases (i.e. malaria, dengue, schistosomiasis, and tick-borne diseases), water-borne and food-borne diseases, and diarrheal diseases are also expected to increase.[80]

Climate Change Impacts

Higher temperatures, land and water scarcity, flooding, drought and displacement, will negatively impact agricultural production, causing breakdown in food systems. This will disproportionally affect most vulnerable people, who are already face hunger and food insecurity. Vulnerable groups risk further deterioration of available food and nutrition when exposed to extreme climate events. More severe and frequent flooding may displace communities and increase the risk of water-borne diseases, and higher temperatures may threaten food and nutritional security, agricultural livelihoods, and increase heat-related deaths, specifically in the elderly.[81] Rising temperatures also

[78] Ministry of Energy and Petroleum (2015). National Energy and Petroleum Policy (Draft). URL: https://renewableenergy.go.ke/asset_upld s/files/National%20Energy%20and%20Petroleum%20Policy%20August%202015.pdf
[79] Ministry of Energy (2020). Bioenergy Strategy 2020–2027. Kenya.
[80] National Environment Management Authority (2015). Kenya- Second National Communication to the United National Framework Convention on Climate Change. URL: https://unfccc.int/sites/default/files/resource/Kennc2.pdf
[81] Ministry of Health (2014). Kenya Health Policy 201–2030. URL: http://publications.universalhealth2030.org/uploads/kenya_health_policy_2014_to_2030.pdf

remain of significant concern, although it is often overlooked as a public health risk. Under a high emissions scenario (RCP 8.5), heat-related deaths in the elderly (65+ years) are projected to increase to about 45 deaths per 100,000 by 2080 compared to the estimated baseline of under 2 deaths per 100,000 annually between 1961 and 1990.[82] Warmer and drier conditions can lead to a rise in respiratory illnesses and specifically urban air pollution (Nairobi, Mombasa) causing respiratory problems.

In Kenya, rising temperatures are of increasing concern. The annual distribution of days with a high-heat index provides insight into the potential health hazard of heat. **Figure 17** shows the expected Number of Days with a Heat Index >35°C for the 2090s; showing a sharp increase under a high-emission scenario by end of the century. It also shows that tropical nights, or the night-time temperatures (>20°C) are expected to rapidly increase in a high-emission scenario. Increased health threats can be projected and monitored through the frequency of tropical nights. Tropical Nights (**Figure 18**) represents the projected increase in tropical nights for different emission scenarios to demonstrate the difference in expected numbers of tropical nights.

FIGURE 17. Days with a heat index >35°C[83]

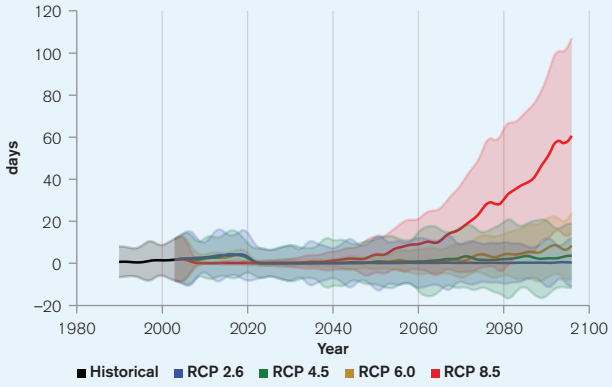
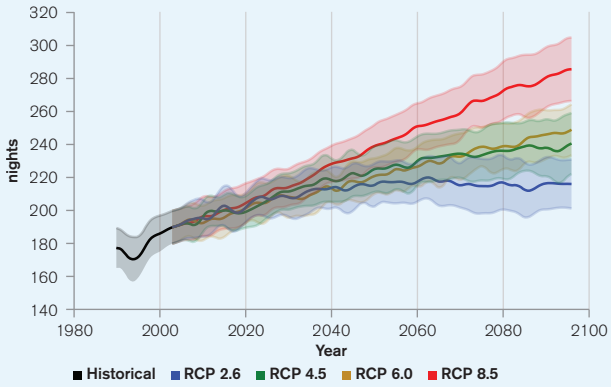


FIGURE 18. Number of tropical nights (Tmin >20°C)[84]



Adaptation Options

Kenya's recent improvements in malaria control, water-borne diseases, infant mortality and malnutrition are vulnerable to set backs as the climate changes. Impacts on water quality, water resources, changes in disease and vector habitat, as well as the prolonged exposure of vulnerable groups who suffer from limited access to improved sanitation are all areas for concern. These impacts require not only continued investment and focus on climate sensitive health issues, but also full integration of climate change into Kenya's many existing health programs and policies. More action and support are required to achieve Kenya's development goals and protect vulnerable populations.[85]

[82] WHO (2015). Climate and Health Country Profile – Kenya. URL: https://apps.who.int/iris/bitstream/handle/10665/246133/WHO-FWC-PHE-EPE-15.23-eng.pdf?sequence=1

[83] WBG Climate Change Knowledge Portal (CCKP, 2020). Kenya Health Sector Dashboard. URL: https://climatedata.worldbank.org/CRMePortal/web/health/systems-and-service?country=KEN&period=2080-2099

[84] WBG Climate Change Knowledge Portal (CCKP, 2020). Kenya Health Sector. URL: https://climateknowledgeportal.worldbank.org/country/kenya/climate-sector-health

[85] Ministry of Health (2014). Kenya Health Policy 2014–2030. URL: http://publications.universalhealth2030.org/uploads/kenya_health_policy_2014_to_2030.pdf

The government is currently undertaking a climate vulnerability and risk assessment of the impacts of climate change and variability on human health. Efforts are ongoing to increase public awareness on climate change and impacts on health. Kenya has also undertaken efforts to design and implement appropriate measures for surveillance and monitoring of climate change related diseases in order to enhance health early warning systems. These systems should include the enhancement of existing databases on health sector indicators amongst others.[86] Additionally, health care system personnel are not fully aware of the relationship between climate change, seasonal variability and health impacts. Increases in training and capacity can improve the level of knowledge and skills to prevent diseases connected with climatic factors, however this knowledge remains relatively limited among the general population.[87]

ADAPTATION

Institutional Framework for Adaptation

The Government of Kenya is developing a policy and institutional framework to support the country reach its low carbon, climate resilient goals. The government has implemented a number of actions in the National Climate Change Action Plan 2013–2017, including improved drought management and the promotion of renewable energy. The Ministry of Planning and Devolution has included indicators to track progress in mainstreaming climate change in its Second Handbook of National Reporting.[88] The National Climate Change Council, established in 2016 and housed in the Ministry of Environment and Forestry, is responsible for the coordination of climate change actions, including mainstreaming climate change in national and county budgets, plans and programs. The Kenya Meteorological Department, a semi-autonomous government department, is responsible for generating national and subnational information regarding forecasts, seasonal variability, early warnings and agrometeorological bulletins. This information is delivered to the general public and to the climate Change Council and key government institutions such as the Disaster Risk Management Authority.[89] The drafted Climate Change Framework Policy and a National Policy on Climate Finance are expected to provide guidance on mainstreaming to national departments and country governments.[90] To support climate change adaptation, mitigation and resilience pathways, the country can access climate financing through the National Environment Management Authority, which is a National Implementing Entity for the Adaptation Fund and accredited by the UNFCCC Green Climate Fund.[91]

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[86] Ministry of Environment and Natural Resources (2016). Kenya National Adaptation Plan, 2015–2030. URL: https://www4.unfccc.int/sites/NAPC/Documents%20NAP/Kenya_NAP_Final.pdf

[87] National Environment Management Authority (2015). Kenya- Second National Communication to the United National Framework Convention on Climate Change. URL: https://unfccc.int/sites/default/files/resource/Kennc2.pdf

[88] Republic of Kenya (2013). National Climate Change Action Plan, 2013–2017: Vision 2030. URL: https://cdkn.org/wp-content/uploads/2013/03/Kenya-National-Climate-Change-Action-Plan.pdf

[89] CDKN (2012). National Climate Change Action Plan – Adaptation - Technical Analysis Report. URL: file:///Users/cmdove/Downloads/1.-adaptation-technical-analysis-report%20(2).pdf

[90] National Environment Management Authority (2015). Kenya- Second National Communication to the United National Framework Convention on Climate Change. URL: https://unfccc.int/sites/default/files/resource/Kennc2.pdf

[91] USAID (2018). Climate Change Risk Profile – Kenya. URL: https://www.climatelinks.org/sites/default/files/asset/document/2018_USAID-ATLAS-Project_Climate-Risk-Profile-Kenya.pdf

Policy Framework for Adaptation

Kenya has served as a leader in addressing climate change issues nationally and across the region and was one of the first countries in Africa to enact a comprehensive law and policy to guide national and subnational climate action. The Climate Change Act and the National Climate Change Policy Framework of 2016 provide guidance for low-carbon and climate-resilient development. These efforts are reinforced by the country's Second National Communication to the UNFCCC, submitted in 2015, its Nationally-Determined Contributions to the UNFCCC submitted in 2016, and its National Adaptation Plan was completed in 2016.[92] Kenya's climate change adaptation strategies focus on the preparation and strengthening of institutional frameworks for responsible environmental management, improved management of climate change effects and economic development targets. Furthermore, established institutions and mechanisms are in place to monitor the reduction in greenhouse gas emissions, to address vulnerabilities which will be exacerbated by climate change, and to strengthen the country's social and economic structures against vulnerability.[93]

National Frameworks and Plans

- The Landscape of Climate Finance in Kenya (2021)
- Updated Nationally-Determined Contribution (2020)
- Climate Smart Agriculture Implementation Framework 2018–2027 (2018)
- National Climate Change Profile (2018)
- National Adaptation Plan (2016)
- Nationally Determined Contributions (2016)
- Second National Communication on Climate Change (2015)
- National Energy and Petroleum Policy (2015)
- Common Program Framework for Ending Drought Emergencies (2015)
- National Health Policy 2014–2030 (2014)
- Second Medium Term Plan (2013–2017), Transforming Kenya (2013)
- National Climate Change Action Plan 2013–2017, Vision 2030 (2013)
- National Climate Change Action Plan: Adaptation Technical Analysis (2012)
- National Policy for Disaster Risk Management (2009)

Recommendations

Research Gaps

- Develop a better understanding of the occurrence and magnitude of climate change events and natural hazards
- Increase understanding of climate change related impacts on key vulnerabilities, related developmental impacts, and the country's possible adaptation responses
- Strengthen environmental monitoring capabilities for strengthened and more effective environmental management[94]

[92] Ministry of Environment and Natural Resources (2016). Kenya's Nationally Determined Contribution. URL: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Kenya%20First/Kenya_NDC_20150723.pdf

[93] Ministry of Environment and Natural Resources (2016). Kenya National Adaptation Plan, 2015–2030. URL: https://www4.unfccc.int/sites/NAPC/Documents%20NAP/Kenya_NAP_Final.pdf

[94] Ministry of Environment and Natural Resources (2016). Kenya National Adaptation Plan, 2015–2030. URL: https://www4.unfccc.int/sites/NAPC/Documents%20NAP/Kenya_NAP_Final.pdf

- Enhance Kenya's adaptive capacity through continuing investment in weather stations and expanding the Kenya Meteorological Department's (KMD) national hydro-meteorological and seismological monitoring system for improved networking for the measurement of climate parameters[95]
- Improve awareness and understanding of projected climate change impacts within key sectors and with policy makers, commission risk assessments, and expand early warning systems, specifically for public health[96]

Data and Information Gaps

- Improve observational data through by acquiring weather stations and hydro-meteorological, seismological instrumentation and mapping[97]
- Improve technical capacity to analyze and interpret hydro-met data in support of impact assessments across sectors; specifically monitoring sea level rise
- Establish institutional capacity for providing timely early warning systems to farmers for improved decision making and understanding seasonal variability throughout Kenya's key agricultural zones. This should be coordinated with KMD's agrometeorological bulletins[98]
- Increase understanding of water resource threats and groundwater risks to improve long term management and improve water use efficiency in agriculture and urban management[99]

Institutional Gaps

- Ensure integration of National Energy Strategy goals are developed within sectoral and regional plans
- Implementation of cross-sectoral climate-smart solutions at national and subnational levels
- Integrate climate change concerns into relevant policies and planning processes at the state and national levels[100]
- Integrate seasonal forecasts and long-term climate change trends into healthcare policy and planning for improved and more prepared public health service in Kenya[101]

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[95] Republic of Kenya (2013). National Climate Change Action Plan, 2013–2017: Vision 2030. URL: https://cdkn.org/wp-content/uploads/2013/03/Kenya-National-Climate-Change-Action-Plan.pdf

[96] National Environment Management Authority (2015). Kenya- Second National Communication to the United National Framework Convention on Climate Change. URL: https://unfccc.int/sites/default/files/resource/Kennc2.pdf

[97] Ministry of Environment and Natural Resources (2016). Kenya National Adaptation Plan, 2015–2030. URL: https://www4.unfccc.int/sites/NAPC/Documents%20NAP/Kenya_NAP_Final.pdf

[98] Ministry of Agriculture, Livestock and Fisheries (2017). Kenya Climate Smart Agriculture Strategy, 2017–2026. URL: https://www.adaptation-undp.org/sites/default/files/resources/kenya_climate_smart_agriculture_strategy.pdf

[99] Republic of Kenya (2013). National Climate Change Action Plan, 2013–2017: Vision 2030. URL: https://cdkn.org/wp-content/uploads/2013/03/Kenya-National-Climate-Change-Action-Plan.pdf

[100] National Environment Management Authority (2015). Kenya- Second National Communication to the United National Framework Convention on Climate Change. URL: https://unfccc.int/sites/default/files/resource/Kennc2.pdf

[101] Ministry of Health (2014). Kenya Health Policy 2014–2030. URL: http://publications.universalhealth2030.org/uploads/kenya_health_policy_2014_to_2030.pdf

CLIMATE RISK COUNTRY PROFILE

KENYA

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