FROM CLIMATE RISK TO RESILIENCE: UNPACKING THE ECONOMIC IMPACTS OF CLIMATE CHANGE IN KENYA

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PREFACE

This report, focused on Kenya, forms part of "From Climate Risk to Resilience," a series of country studies that analyze and explore the potential economic and social impacts of climate change on Kenya, Malawi, Mozambique, and Zambia, focusing on climate-vulnerable and critical economic sectors. The series is produced by the International Food Policy Research Institute (IFPRI), as commissioned by the African Climate Foundation (ACF), with additional support from the CGIAR Research Initiative on Foresight.

Each report summarizes an extensive literature review and internal views and recommendations in four main areas. Section 1 unpacks recent and projected changes to the country's climate profile and patterns, including updated climate scenario analysis modelling. Section 2 considers the potential implications of these projected climate changes for key economic sectors and for the economy as a whole. It also touches on the fiscal, trade, and other macroeconomic implications of climate change. Section 3 provides an overview of each government's existing and planned climate adaptation measures and priorities, as well as key challenges. Section 4 concludes with strategic considerations and suggestions, informed by the country's specific circumstances, and the subsequent steps that could support mobilization of funding for climate adaptation and resilience measures.

The purpose of these reports is twofold. First, they serve as a starting point for further national comprehensive climate change assessments, backed by evidence and climate scenario analysis. Such assessments would facilitate the quantification of climate change impacts, offer a nuanced understanding of potential costs and losses, consider trade-offs across various development indicators, and therefore help governments in identifying and prioritizing strategic public investments in a climate change context (building on existing efforts and strategies). It is intended that the "From Climate Risk to Resilience" reports will lay the foundation for further engagement with respective governments, development institutions, the private sector, and nonprofit organizations.

Second, "From Climate Risk to Resilience" forms part of ACF's foundational work on the development of country-led national Adaptation and Resilience Investment Platforms (ARIPs). ARIPs aim to provide in-country support to assist African governments in adopting a transformative approach to climate adaptation (one that enhances both climate and economic resilience). In particular, ARIPs would mobilize funding at scale and in a sustainable manner for prioritized climate adaptation and resilience measures (for example, by funding national comprehensive climate change assessments, linking them to a pipeline of adaptation projects under an investment plan, and providing support for the necessary institutional arrangements and investor engagement). "From Climate Risk to Resilience" informs ACF's work on ARIPs by: (i) providing an overview to potential investors, donors, and other stakeholders on the need for climate adaptation measures in the in-scope countries; (ii) outlining background research and preliminary considerations for the strategic identification of ARIPs' potential funding priorities (to be further informed by national comprehensive climate change assessments); and (iii) guiding development of a collaborative approach to address climate change risks, involving various stakeholders at different societal and governmental levels, as well as regional and international stakeholders.

EXECUTIVE SUMMARY

Substantial model variability exists regarding the likely meteorological impact of climate change on Kenya, particularly with respect to future precipitation levels. Significant regional differences are expected, largely due to Kenya's diverse climate profile. Overall, temperatures are projected to increase while future precipitation levels are highly uncertain. Climate change is expected to significantly affect coastal areas, including because of sea level rise risks, stronger winds, and an overall warmer and drier climate. This will likely harm important ecosystems, including wetlands, mangroves, and coral reefs. Some models project that arid and semi-arid areas may become drier and hotter, which would exacerbate preexisting water scarcity and agricultural challenges for the already vulnerable communities living there. That said, these projections are not corroborated by all models. The climate change impact on other areas, particularly south and west of Mount Kenya, could generally be positive, as it would provide even better conditions for agriculture.

The key climate change risk for Kenya is from extreme events, in particular droughts and floods. The frequency and intensity of such events is likely to increase because of climate change. They also often lead to adverse knock-on effects, such as soil erosion, land degradation, and pest breakouts. Overall, Kenya's updated Nationally Determined Contribution (NDC) (2020) estimates that between 2010 and 2020, adverse climate change-related events led to annual socioeconomic losses of 3–5 percent of total gross domestic product (GDP).

The main channels through which climate change is likely to impact the Kenyan economy are the agriculture and water sectors, again with significant regional differences. The livestock subsector is expected to suffer significant losses due to heat stress from the projected increase in temperatures. This is likely to disproportionately affect pastoral communities in arid and semi-arid areas, as poverty rates in these regions are already high relative to the rest of the country. Water scarcity—including increased glacial loss and reduced river flows from Mount Kenya because of climate change—is likely to have a broad socioeconomic effect, with adverse consequences for agricultural irrigation, hydropower, and sanitation. The climate change impact on coastal areas is likely to have broader effects on the Kenyan economy, as damage to this region (such as to port infrastructure) would have ramifications for trade and tourism across the country. That said, climate change may lead to new opportunities in the agriculture sector, particularly in higher elevations. Indeed, average crop yields are projected to increase, to a large extent due to the concentration of agricultural activity in the regions where climate change may have positive effects. Downside risks exist primarily from the potential effect of extreme weather events, particularly for crops cultivated for subsistence purposes and for staple crops, such as maize (which is a core part of the food system in Kenya but is vulnerable to heat stress). In addition, climate change risks may be exacerbated by broader economic vulnerabilities. These include rising population, exposure to international price volatility (especially regarding food and petroleum prices), and fiscal challenges.

The Government of Kenya is a regional leader in addressing climate change risks albeit challenges remain. It published a National Adaptation Plan (2016) that is further advanced through additional climate change action plans and whose key messages are integrated in Kenya's broader development

strategy, Vision 2030, and Kenya's NDCs. A number of adaptation projects are being advanced, with focus on support for vulnerable communities and disaster risk management. However, their uptake is uneven across counties. More broadly, coordination and information sharing remain a challenge (including across government functions and between central and local governments). Mobilizing financing for adaptation is another key constraint. Despite these challenges, Kenya's adaptation efforts have led to improvement over recent years in Kenya's climate vulnerability index, although it remains quite low due to preexisting social and economic vulnerabilities.

This note recommends that an ARIP in Kenya facilitates a transformative approach to climate adaptation and resilience. This could involve advancing and updating climate scenario analysis assessments, with focus at the county level, to inform a strategic approach to development of the agriculture sector, including identifying (i) how production of key crops (such as maize, tea, cut flowers, and coffee) will need to adapt to changing weather conditions, and (ii) opportunities for diversification in the sector. A holistic consideration of the interaction between climate adaptation measures and measures that help risk management of extreme climate events (with focus on improving agricultural insurance practices and early warning systems) would also support adaptation efforts in Kenya. Effective water management, underpinned by strong regional and cross-departmental coordination on adaptation strategy development, could be an area of focus for an ARIP in Kenya, as it would help limit the risks of maladaptation and support economic growth. An ARIP could help move away from the current project-level financing approach and mobilize the scale of funding that transformative adaptation would require. To achieve that, it would be necessary not only to support the Kenyan government in further developing and updating its climate change action strategy but also to focus more on the process for effective adoption, reporting, monitoring, and evaluation, as detailed in this report.

LIST OF ACRONYMS

ATAR	Adaptation Technical Analysis Report
CCCF	County Climate Change Funds
CSA	Climate-smart agriculture
GCM	General Circulation Model
GDP	Gross domestic product
MTP	Medium Term Plan
NAP	National Adaptation Plan
NCCAP	National Climate Change Action Plan
NDC	Nationally Determined Contribution
ND-GAIN	Notre Dame Global Adaptation Initiative

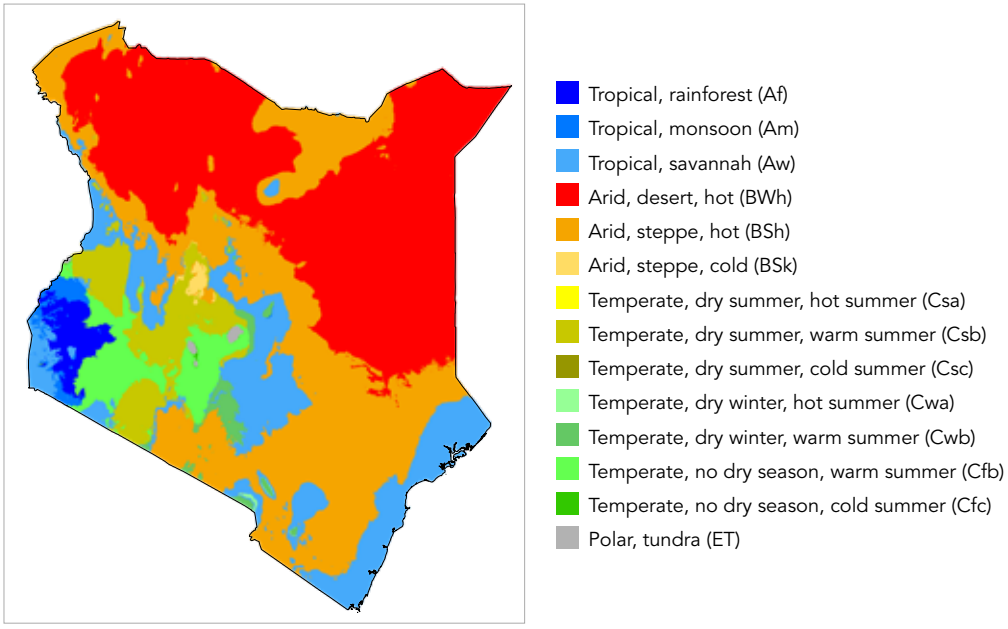
1. OVERVIEW OF CLIMATE CHANGE IMPACT ON KENYA

Climate profile

Kenya shares borders with Ethiopia, Somalia, Tanzania, Uganda, and South Sudan. It is considered highly vulnerable to climate change due to both the projected impact of climate change on its climate profile and preexisting economic and social vulnerabilities. It ranked 150 out of 185 countries on the 2021 Notre Dame Global Adaptation Initiative (ND-GAIN) index (GAIN 2021).

Kenya has a diverse climate profile. Temperatures vary dramatically, with the highlands experiencing considerably cooler temperatures than the coastal and lowland regions. The coastal areas (eastside) and the shores of Lake Victoria (southwest) have a tropical climate, with mean annual temperature between 23°C and 27°C (Celsius) and precipitation levels over 1,600 millimeters (mm) in the west. The highlands (mostly in the center and in the west) have a temperate climate, with a mean annual temperature of 15°C (GIZ 2021). The high rainfall zone, which receives more than 1,000 mm of annual rainfall, is productive agricultural land. It occupies less than 20 percent of the country's land area and is home to approximately 80 percent of the population (World Bank 2023a). The northern and eastern parts of Kenya have a much drier climate, with mean annual temperatures of up to 29°C and annual precipitation around 200 mm (GIZ 2021). Most of Kenya's land (85 percent) is classified as a fragile

Figure 1: Köppen-Geiger climate classification map for Kenya (1980–2016)



Source: Beck et al. (2018)

arid and semi-arid ecosystem, largely pastoral (Figure 1) (World Bank Group 2021). Kenya has two rainy seasons: long rains from March to May and short rains from October to December typically (GIZ 2021) (albeit some variability can arise), with monthly mean temperatures also higher during these months, particularly in the first quarter of the year (World Bank Group 2021).

Kenya is exposed to natural disasters, in particular droughts and floods. Since 2000, the number of natural disasters—meteorological, hydrological, and climatological—experienced in Kenya averaged 2.8 per year, up from 0.5 in the previous century (from 1964–1999).[1] Moderate floods or droughts take place every three to four years, while severe droughts typically occur every 10 years (World Bank Group 2021). Overall, droughts are estimated to affect more people than floods and to have a greater economic impact on Kenya (World Bank Group 2021). For example, Kenya suffered a major drought in 2008–2011 that slowed GDP by an average of 2.8 percent and resulted in US$12.1 billion in damages and losses (Kenya, Ministry of Finance 2012). In 2017 a drought, followed by a flood in 2018, displaced more than 300,000 people (UNOCHA 2018). More recently, torrential rains in the long rain season in 2020 resulted in flooding that affected more than 800,000 Kenyans, including 300 deaths and 100,000 people being displaced. The heavy rains in 2019 and 2020 also created conditions that led to severe desert locust outbreaks, which further damaged agricultural production, adversely impacted human health, and triggered conflicts between affected communities (Kenya, Ministry of Environment and Forestry 2021). These rains were followed by a drought (2020–2022) reported as the worst in four decades to take place in the Horn of Africa, surpassing previous droughts in terms of duration and severity and affecting 4.2 million in Kenya (as of October 2022) in 20 out of 23 arid and semi-arid land counties (UNFPA 2022). Arid and semi-arid areas are particularly exposed to periods of drought, while floods usually take place in the west and southeast of Kenya, near major rivers, such as the lower Tana River, the lower Nzoia River at Budalang'i Plains, and the lower Nyando River at Kano Plains (World Bank 2018a; Opere 2013). However, the recent floods in 2023 most severely affected the north, including the counties of Mandera, Wajir, Marsabit, and Isiolo, which are classified as arid and semi-arid areas and are not historically flood-prone (IFRC 2023).

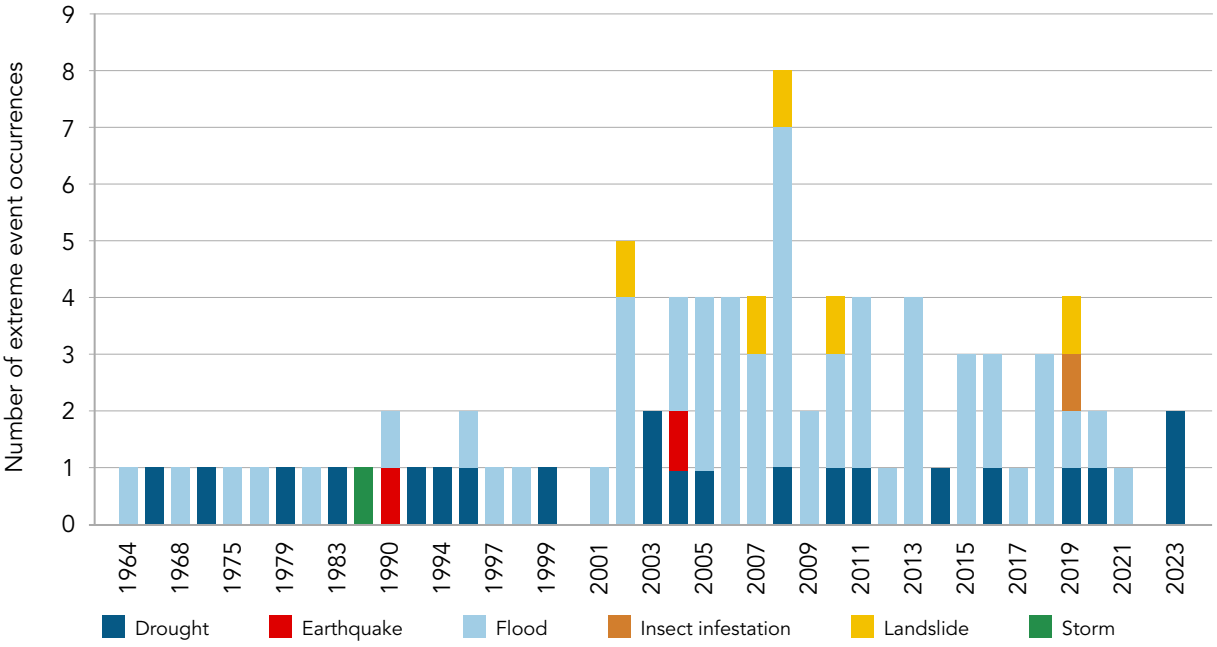
Recent trends

Between 1979 and 2021, temperatures in Kenya increased while precipitation declined. Temperatures in Kenya increased by 0.23°C per decade, which translates to an increase of nearly 1°C for the 43-year period of the dataset (Authors, based on AgERA5 by Climate Data Store 2022). The most significant rise in temperature was observed for the start of the long rainy season in the arid and semi-arid regions of the country (World Bank Group 2021 Yields of many crops are limited by high temperatures, so rising temperatures in the wettest months, during which crops are planted, can adversely affect productivity and agricultural potential. Moreover, the increase in temperature leads to land degradation, as soil organic matter is depleted (Kirschbaum 1995) Precipitation in Kenya decreased by 21 mm per decade, which over the 43-year period the dataset spans represents a reduction of over 2 mm per year (Authors, based on AgERA5 by Climate Data Store 2022).Sea levels rose 5.8 centimeters (cm) from 1932 to 2001 and glacial volume loss was more than 66 percent over the past 100 years, with Lewis Glacier (Mount Kenya) losing 90 percent of its volume since 1934 (USAID 2018).

The occurrence of natural disasters increased significantly over the past two decades. The section above highlighted that Kenya is typically exposed to floods and droughts. The most recent trend shows that floods are increasingly becoming the main driver of extreme natural events in Kenya (Figure 2). This is a regional trend: over the past 30 years, flood frequency in East Africa increased from an average of less than three events per year in the 1980s to approximately 10 events per year

1 Retrieved from: www.emdat.be

Figure 2: Number of extreme natural event occurrences in Kenya, 1964–2023 year-to-date



Source: EMDAT 2023

in the 2000s (Kenya, Ministry of Environment and Forestry 2018c). Furthermore, drought cycles in Kenya are occurring with an increased frequency: every 2–3 years instead of every 5–10 years (World Bank Group 2021). Droughts have also become longer and more intense since the 2000s, often disrupting rainy seasons (Kenya, Ministry of Environment and Forestry 2018c; NEMA-KENYA 2015).

Projected climate trends

Future precipitation trends in Kenya are highly uncertain. Figure 3 and Figure 4 present potential changes in Kenya's climate (temperature and precipitation) at the half-degree pixel level for the period 2020 to 2050.[2] These changes are simulated by the five CMIP6 (sixth phase of the Coupled Model Intercomparison Project) climate models used by the Inter-Sectoral Impact Model Intercomparison Project (ISIMIP) for the RCP (Representative Concentration Pathway) 8.5 (that is, the Shared Socioeconomic Pathway (SSP) 5–85) global climate scenario—the highest emissions scenario. Two of the models (GFDL [Geophysical Fluid Dynamics Laboratory] and MRI [Meteorological Research Institute]) project a drier future for Kenya, with much of the northwestern quadrant projected to lose over 100 mm per year in the MRI model and the coast projected to lose that much in the GFDL model. The other three models project an increase in rainfall for Kenya, with the UK model (UK Earth Systems Model, UKESM1) projecting at least a 100 mm increase for the western half of the country, with parts receiving over 400 mm more rainfall per year. All of the wet models have small portions of the country projected to become drier, with IPSL (Institut Pierre-Simon Laplace) and UK projecting a drier coastline, and MPI projecting a drier northcentral region. In addition, USAID (2018) projects a likely increase in average rainfall (between –3 to +28 percent), mainly from October to May and in the coast and highlands. World Bank Group (2021) predicts likely increases in rainfall, particularly during

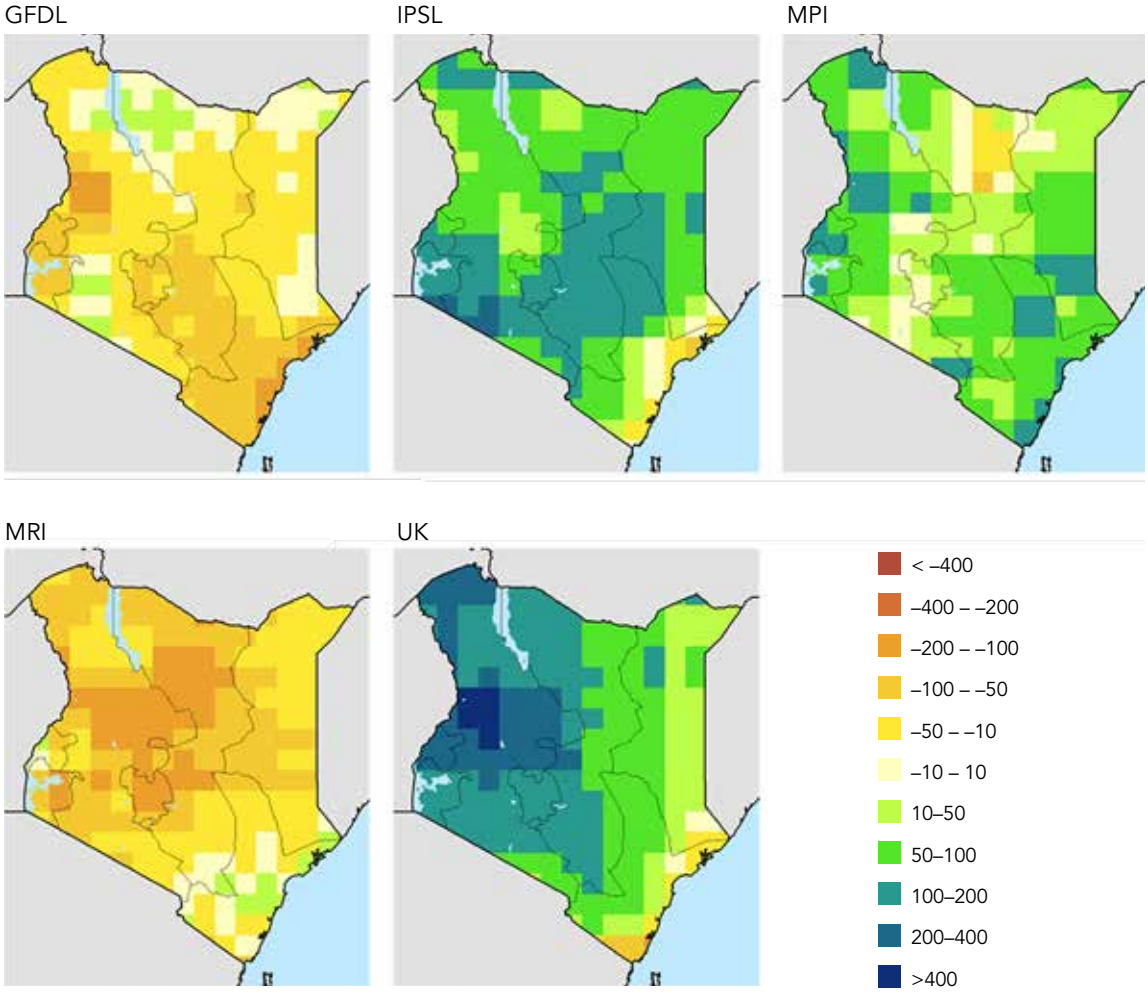
2 At the equator a half degree is roughly 55.6 kilometers.

the "short rains" between October and December,[3] but a general decrease in rainfall in the arid zones. The two studies highlight expected increased intensity and frequency of heavy rainfall events and increased interseasonal rainfall variability (USAID 2018), such as increased periods between heavy rainfall events (World Bank Group 2021). Moreover, USAID (2018) projects a likely decrease in the duration of dry spells but an increase in their severity (–2 to +27 percent).

The average temperature in Kenya is expected to increase but significant differences arise in the extent of projected warming across models. The UK climate model predicts the largest temperature rise of over 1.5°C for almost the entire country in just a 30-year period (Figure 4). This is a very large

3 This is corroborated by Palmer et al. (2023), who find a level of consensus across climate model projections that East African short rains will deliver more rainfall than the long rains by 2030–2040.

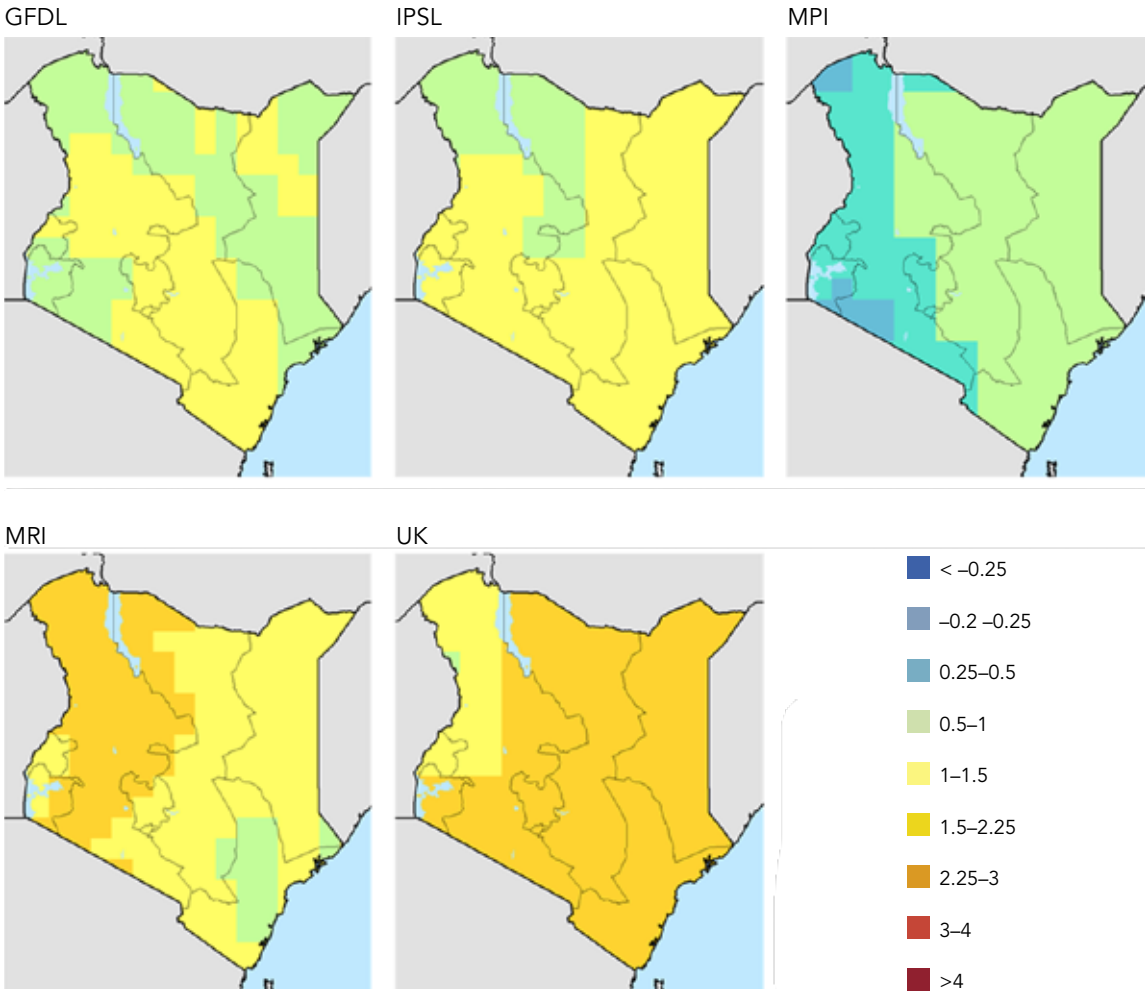
Figure 3: Changes in annual precipitation for 5 GCMs, RCP8.5, 2005 to 2050 (millimeters)



Source: Authors, based on AgERA5 (Boogaard et al. 2022)

increase. At the other extreme, the MPI model suggests that the country will not warm above 1°C over the same time period, with significant parts of the country not experiencing temperature increases of more than 0.5°C. The other models are in between, with the MRI the second hottest model, with the western part, where much of the nation's cropland is located, hotter than the rest of the country. The World Bank Group (2021) also expects rising temperatures to increase periods of aridity in the northwest. Similarly, USAID (2018) projects greater warming in the west, though it references a much greater magnitude of average temperature rise in Kenya: between 1.2°C and 2.2°C by 2050 and increased duration of heat waves (9–30 days). In addition, the number of hot days (that is, days with daily maximum temperature above 35°C) is projected to rise substantially and with high certainty, particularly over central and eastern Kenya (GIZ 2021), with "hot days" occurring on 19–45 percent of days by mid-century (World Bank Group 2021).

Figure 4: Changes in mean daily maximum temperature for 5 GCMs, RCP8.5, 2020 to 2050 (°C)



Source: Authors, based on AgERA5 (Climate Data Store 2022)

2. CLIMATE CHANGE IMPACT ON KEY ECONOMIC SECTORS

Climate change poses a particularly large threat to the Kenyan economy due to: (i) its dependence on natural resources, such as water for energy and food; and (ii) the country's exposure to climate-sensitive sectors, in particular agriculture and tourism. Agriculture accounts for 22 percent of total GDP,[4] and over 40 percent of employment (with more than 70 percent of the population working in the sector) (Central Bank of Kenya 2022).[5] Agricultural products comprise more than 65 percent of total exports (World Bank Group 2021). Tourism further comprised 10.4 percent of GDP in 2022, after a strong rebound following the COVID-19 period (Kenya, Ministry of Tourism, Wildlife & Heritage 2023). The energy sector is also vulnerable to climate change-related risks: in 2020, more than 40 percent of Kenya's power was sourced from hydropower (IEA 2022).

The rising frequency of extreme weather events is the main driver of climate change-related impact on the Kenyan economy. Kenya's updated NDC (2020) estimates that between 2010 and 2020, adverse climate change-related events led to annual socioeconomic losses of between 3–5 percent of total GDP. Furthermore, Kenya's Ministry of Environment and Forestry (2018a) estimates that the costs of floods and droughts create a long-term fiscal liability equivalent to 2.0–2.8 percent of GDP per year. The estimated costs of floods are about 5.5 percent of GDP every seven years, while droughts cost 8 percent of GDP every five years. Total costs of damages related to incidents have also increased, with average annual increases just over six times larger since 2000.[6]

Sea level rises due to climate change could pose further social and economic risks to various sectors. Sea level rises would lead to flooding, including saltwater intrusion and storm surges, and would adversely affect Kenya's coastal plains, islands, beaches, wetlands, and estuaries. This would have significant economic implications for tourism, agriculture (in particular production of mango, cashew, and coconut), and critical infrastructure. For example, Kebede et al. (2012) highlight that, absent adaptation measures, a 30 cm sea level rise[7] could result in an inundation that threatens 17 percent (4,600 hectares) of Mombasa, the second largest city in Kenya. As Mombasa is host to the biggest international seaport in East Africa, damages to the city's infrastructure could have knock-on effects to other sectors, as well as trade in the region. More broadly, sea level rises would affect water quality, food security, and important ecosystems (USAID 2018; World Bank Group 2021).

Water scarcity is another key challenge in Kenya. The country's water scarcity index is expected to continue worsening and to fall as low as 293 cubic meters (m^3)per capita by 2050, relative to the internationally acceptable threshold of 1,000 m^3 per capita (World Bank Group 2021). While

4 The share goes up to 27 percent when interlinkages with other sectors are accounted for.

5 More specifically, two-thirds of agrifood system value added comes from primary agriculture and one-third from off-farm components (one-half of which reflect agro-processing). Similarly, primary agriculture accounts for most (four-fifths) of the employment in the agrifood system in Kenya (Diao et al. 2023).

6 Calculated using EMDAT natural disaster total adjusted damage data.

7 This compares to a projected sea level rise of 16–42 cm by 2050 (USAID 2018).

population growth is the primary driver of this negative trend,[8] climate change is likely to compound it, with implications for various economic sectors. In particular, climate change is projected to lead to accelerated glacial loss and reduced river flows from Mount Kenya, increased flood damage to water supply and sanitation infrastructure, and increased rainfall variability (USAID 2018). Severe droughts have already led to declines in surface and groundwater recharge (Nthambi and Ijioma 2021). These channels could affect the availability and variability of water in Kenya for agricultural irrigation, hydropower, as well as sanitation.

Agriculture

Kenya's agriculture sector is highly vulnerable to climate change, as 98 percent of Kenyan agriculture is rainfed. This makes it susceptible to variations in temperature and rainfall, particularly as cropland exposure to drought is likely to increase due to climate change (GIZ 2021). A World Bank (2017) analysis shows that droughts negatively affect agricultural value added[9] and that this correlates linearly with changes to total GDP. In particular, the observed annual growth for value added in agriculture during years of drought in Kenya was: –1 percent (1991), -3 percent (1992), –3 percent (1993), –5 percent (2008), and –2 percent (2009) (Nthambi and Ijioma 2021). Real GDP in 2022 was also affected by drought: the agriculture sector contracted 1.6 percent, thus slowing down economywide growth to 4.8 percent (relative to 6.3 percent when agriculture is excluded) (World Bank 2023b). This disproportionately affects poorer people, as the areas most exposed to drought are largely rural, where poverty is concentrated. Droughts negatively affect access to credit for agriculture, as the value and availability of farm assets to serve as collateral decline (Nthambi and Ijioma 2021), further reducing farmers' ability to manage climate change-related risks.[10]

The agriculture sector comprises the crop, livestock, and fisheries subsectors. The most important crops include maize, tea, beans, potatoes, cowpeas, sorghum, cassava, wheat, and millet (FAO 2015b). The main irrigated crops are rice, vegetables, fruit, coffee, and maize (FAO 2015a). Kenya's top exports in 2021 were tea, cut flowers, and coffee. In fact, Kenya is the world's third largest tea producer and the fourth largest cut flower producer (OEC 2021). The tea sector generates 15–25 percent of total goods exports and up to 4 percent of GDP, and offers direct and indirect employment to over 10 percent of the population (OEC n.d.; Muoki et al. 2020). The country also depends on agricultural imports, in particular wheat, maize, and rice, among others (World Bank Group 2021). Kenya relies on imports of maize to ensure national food security, mostly from Uganda and Tanzania (Abodi, Kariuki, and Obare 2021; FAO 2015b). It is in fact the biggest maize importer in the region. That said, the current policy dialogue focuses on the need for diversification away from maize to improve nutrition and resilience (Laichena et al. 2022). The livestock sector is also very important to the national economy, although estimates of its size vary: from 42 percent of the agriculture sector (Kimani 2021) to at least 50 percent (KALRO n.d.; Nyariki and Amwata 2019). Its contribution to total GDP is estimated at about 10–15 percent (KALRO n.d.; Kimani 2021; Nyariki and Amwata 2019).[11] Moreover, livestock is a main source of livelihood for people in arid and semi-arid lands, where it accounts for 90 percent of employment and more than 95 percent of household incomes (Kimani 2021). At the national level, 70 percent of the livestock population lives in these areas (Kenya, Ministry of Environment and Forestry 2018c).

8 For example, only 3–4 percent of Kenya's land is composed of wetlands and the country is experiencing a loss of such territories by about 7 percent per year due to the expansion of agricultural production (Böhme et al. 2016).

9 The agricultural value added annual percentage growth describes the net value output of the agriculture sector obtained by summing up all the outputs minus intermediate inputs (Nthambi and Ijioma 2021).

10 Droughts also lead to increased use of pesticides, as moisture-deficient crops attract insects because they are unable to produce metabolites that protect them from pest attacks (Yihdego, Salem, and Muhammed 2018).

11 Nyariki and Amwata (2019) highlight the challenges in estimating the sector's economic value and the shortcomings of using its GDP contribution, as this measure does not account for nonmarketed products.

The projected changes in temperature and precipitation levels are expected to have a positive impact on crop yields in Kenya *on average*. We use the DSSAT (decision support system for agrotechnology transfer) crop model (Jones et al. 2003) together with CMIP6 climate models to assess the impact of climate change on key crops for Kenya by 2050. The results from the study show that under RCP8.5, for maize, sorghum, wheat, and rice, climate change at the national level causes an increase in yields (Table 1), due mostly to carbon dioxide (CO2) fertilization, but also to much of the cropping being done in higher elevations and to a projected increase in precipitation in several of the climate models.[12]

Table 1: Climate impact on yields in Kenya for selected crops, 2005–2050, under RCP8.5, CMIP6

Crop	Water	Hectares (SPAM2005)	Minimum	Median	Maximum
Maize	Rainfed	1 551 250	–11.9	9.4	13.4
Sorghum	Rainfed	135 794	–9.5	15.0	15.8
Potatoes	Rainfed	126 780	–9.2	–4.7	8.7
Wheat	Rainfed	154 074	–0.7	11.7	14.3
Groundnuts	Rainfed	20 336	–7.3	25.2	29.1
Rice	Irrigated	17 115	–0.3	0.3	3.3

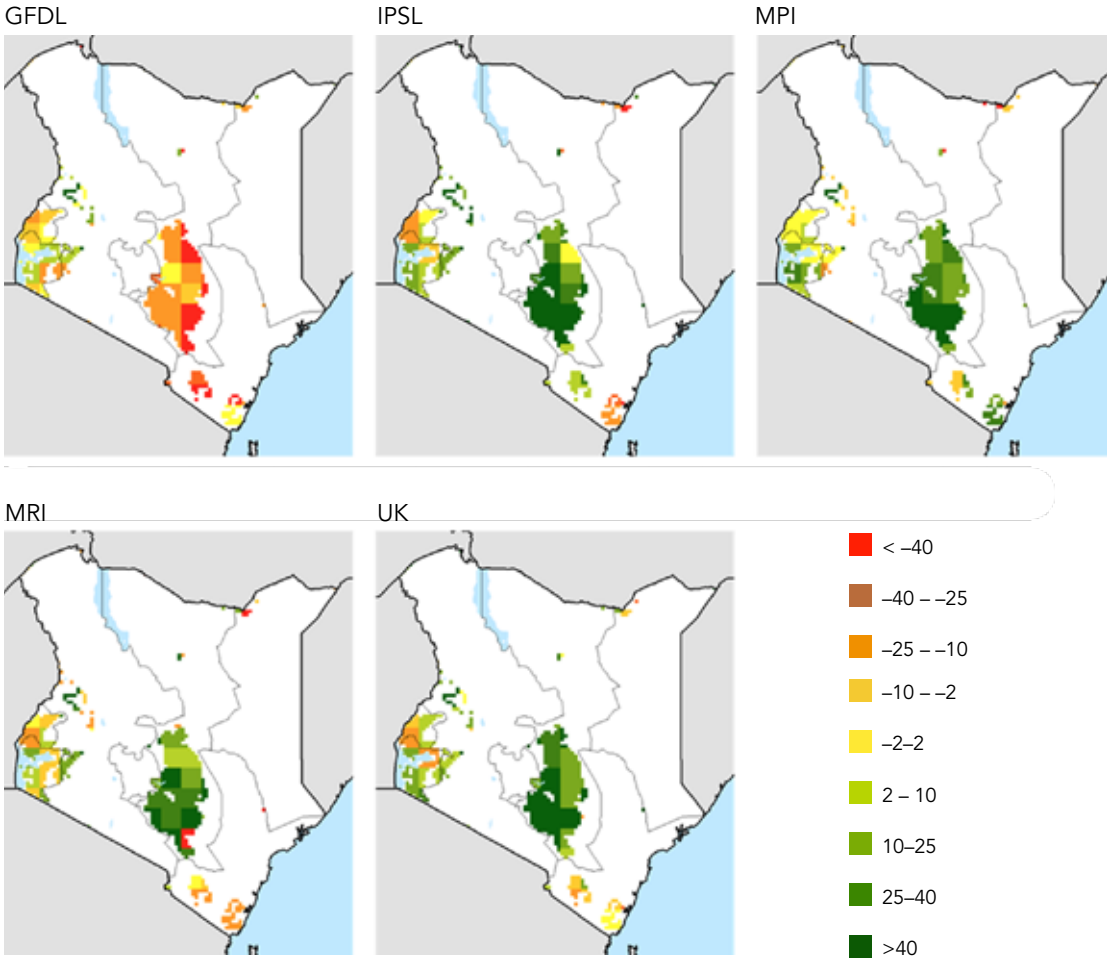
Source: Authors

Most models project maize yields to increase overall in Kenya, although climate change-related heat stress and prolonged droughts could pose risks to food security. Maize accounts for one-third of the caloric intake in Kenya and is an important source of employment and income for subsistence farmers (Mohajan 2014; Njeru et al. 2022). Figure 5 shows yield increases for maize for most of the climate models and in most parts of the country where maize is grown. As mentioned earlier, this is in part due to the concentration of maize production in relatively high elevations, where heat stress is expected to be lower. Maize can get damaged by high temperatures (particularly over 35°C), so some studies highlight threats to its production from increased risk of heat stress because of climate change (USAID 2018). During drought periods since the 1990s, low maize yields have led to an increase in maize prices and a knock-on effect on the prices of substitute foods (such as rice, wheat, and root crops) due to higher demand (Nthambi and Ijioma 2021). Table 1 further illustrates that under the climate model most detrimental to yields, while all yields are negative, maize yields are the most affected, with a possible reduction of almost 12 percent. Adverse impacts on maize production affect the livestock subsector, as maize accounts for over 80 percent of feed rations (Laichena et al. 2022). Overall, this means that climate change is more likely to have a positive effect on maize production in Kenya on average, but to potentially exacerbate the severity and risks to food security during "low yield" events.

However, the climate impact on yields, including maize, is not uniform throughout the country due to Kenya's diverse climate profile. Figure 5 shows the projected yield changes for rainfed maize for the five general circulation models (GCMs) in ISIMIP. Only squares with at least 0.5 percent of the area in the crop are shown. Generally, the small area on the Ethiopian border in northcentral Kenya and the coastal area will experience the largest adverse consequences from climate change. The western part of the country in areas around Lake Victoria will likely experience modest negative consequences. Areas south and west of Mount Kenya will generally improve as a result of climate change, perhaps due to higher

12 Yields in 2050 are computed based on general circulation models (GCMs) from the CMIP6 program and downscaled by ISIMIP to half degree daily resolution. The values were bias corrected to Princeton Global Forcings (PGF) daily historical gridded data.

Figure 5: Yield change for rainfed maize for 5 GCMs, RCP8.5, 2005 to 2050 (percent)



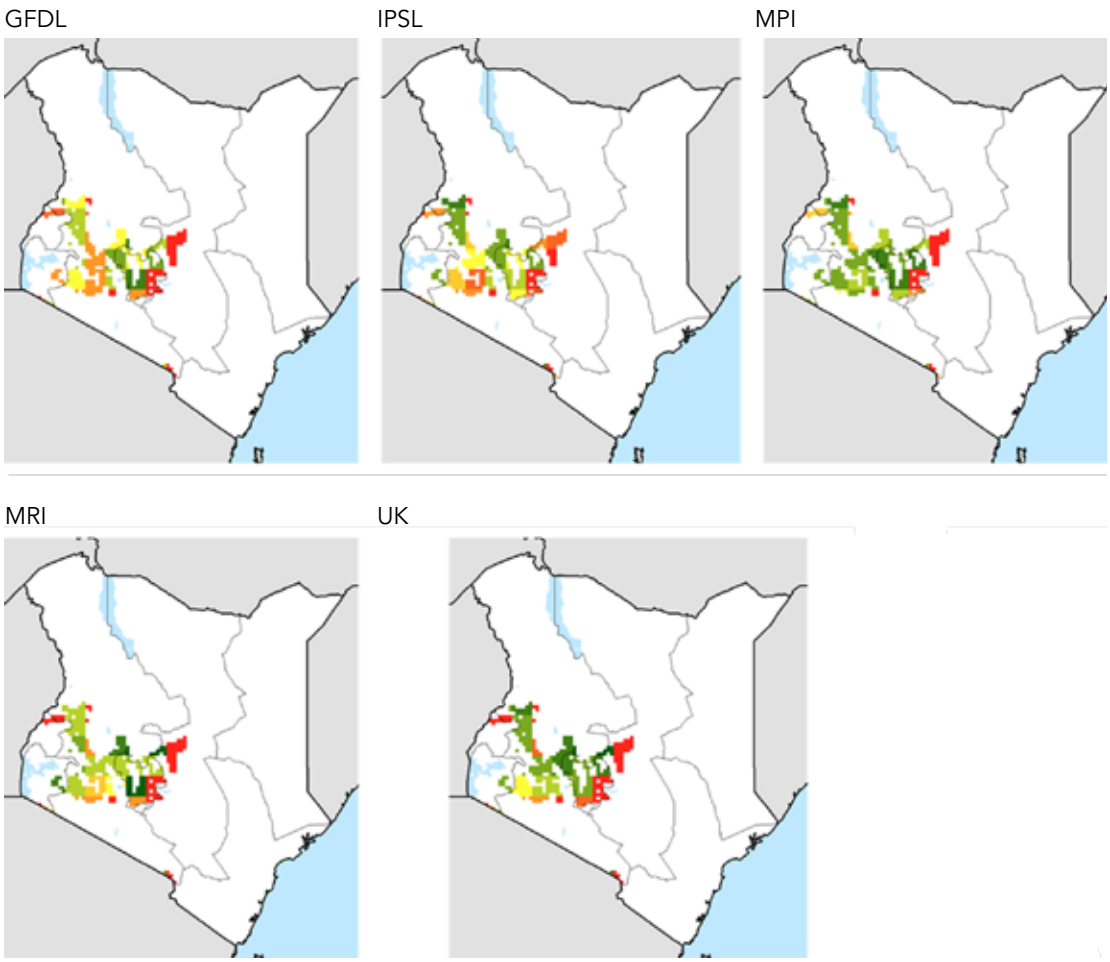
Source: Authors

temperatures in elevated areas, with mixed results north and east of Mount Kenya. Indeed, the specific topography of a region is a factor: USAID (2018) highlights that climate change could adversely affect maize production particularly in low elevation areas, and flags risks from heat stress and shifting rainfall patterns, especially in central Kenya. The GFDL GCM predicts the largest negative shocks to maize yields. Overlaying with changes in temperature and precipitation, it appears that GFDL may be influenced by lower rainfall in the central portion of the country. IPSL, MPI, and UK all are wetter in this region. However, MRI is drier, and yields do not appear as adversely impacted. Differences in seasonal rainfall can make large differences in yields that might not be detected from annual precipitation alone.

Impacts on sorghum yields (not presented) are similar to maize, as both are classified in the same crop group and tend to respond similarly to changes in climate. For potatoes, all model results show large yield losses in the easternmost portion of the potato-growing region. However, further west, the MPI climate model appears to be most favorable, while GFDL appears to be least favorable (Figure 6).

Various studies project an adverse impact on tea production from climate change in Kenya, which would have important implications given the role of tea in the Kenyan economy. Currently, tea is predominantly cultivated in high altitude areas east and west of the Great Rift Valley (Muoki et al. 2020). As highlighted above, future precipitation levels in Kenya are highly uncertain, with more models

Figure 6: Yield change for rainfed potatoes for 5 GCMs, RCP8.5, 2005 to 2050 (percent)



Source: Authors

suggesting an increase in average precipitation over the region but some projecting a decrease. The impact on tea yield is also, therefore, uncertain. Trisos et al. (2022) project a 10 percent decline (relative to 2000) if global warming reaches 1.8–1.9°C. Rigden, Ongoma, and Huybers (2020) estimate that rising temperature in isolation would result in a 10 percent decline in yield in 2040–2070 relative to 1990–2020 but that actual losses would be offset by increased soil moisture, such that yields would decrease by only 5 percent (ranging between –12 percent and +1 percent across 23 models). That said, there appears to be consensus that some parts of the currently cultivated areas will become unsuitable for tea production in the future. Trisos et al. (2022) project that the optimal habitat for tea production will decrease by 27 percent (under the study assumptions above). Muoki et al. (2020) expect a 22.5 percent decline in suitability of tea-growing areas by 2075 due to projected shifting rainfall patterns, and particularly insufficient rain in affected areas. The study highlights that tea production is very vulnerable to drought, which accounts for 14–20 percent loss in yield and 6–19 percent plant mortality. USAID (2018) similarly expects the areas suitable for tea production to shift to higher elevations as temperature increases—and that current production areas will be at risk from heat extremes and increasing pests and diseases.

That said, climate change may create some new opportunities for the agriculture sector in higher elevations in Kenya (where the majority of agriculture already takes place). This includes the temperate and tropical highlands, the Rift Valley, and high plateaus, where rainfall is largely projected

to increase and temperatures to be slightly warmer (NEMA-KENYA 2015). Such changes to the climate profile of these areas would make them suitable for a greater range of crops and support climate change adaptation in the sector.

Uncertainty around future precipitation levels leads to variations in the projected impact of climate change on crop production in arid and semi-arid lands. Notably, Kenya's National Climate Change Action Plan (2018–2022) highlights that the likely impact on crops in these areas would be from increased temperatures and lower precipitation. That, however, is not corroborated by all climate scenario analysis models, as highlighted above. Moreover, arid and semi-arid lands occupy large territories, including both highlands and lowlands, and cover various ecological zones. This means that the impact of climate change on agricultural production is unlikely to be uniform. Moreover, the preexisting vulnerability of the communities in these regions means that they will likely be disproportionately affected by increased climate variability and the occurrence of extreme events, even if the more adverse potential climate scenarios do not materialize. Furthermore, communities in these areas are largely pastoral, hence the impact of climate change on livestock production will be a key determinant of food security risks in the region.

Climate change is projected to materially affect the livestock subsector in Kenya. Kenya's National Climate Change Action Plan (2018–2022) identifies the following key risks to livestock production from climate change: deaths caused by drought, decline in production due to lack of pasture, reduced access to water and heat stress, and changes in disease patterns (Kenya, Ministry of Environment and Forestry 2018c). The impacts are already materializing, as droughts have forced an estimated 30 percent of livestock owners out of pastoralism over the past 20 years and elevated livestock mortality to 10–15 percent above historical trends in affected areas (Kenya, Ministry of Agriculture, Livestock and Fisheries 2017). More broadly, climate change and the rise in frequency of extreme events such as droughts affect the livestock sector through six broad impact channels: feed resources, diseases and parasites, water resources, heat stress, land, and labor (see Thornton, Mensah, and Enahoro 2022 for more detail). Thornton, Mensah, and Enahoro (2022) highlight that for cattle meat in Kenya the most damaging climate channels to production include impacts of diseases and parasites, feed, and water, although the authors note that the results are merely suggestive due to the methodology used. Using a static computable general equilibrium (CGE) model, Elnour et al. (2023) assess the impact of climate change on agricultural production, including livestock. Their findings suggest a 6 percent decrease in livestock production between 2019 and 2050 due to climate change (IPCC SSP 585 scenario) relative to their reference case (IPCC SSP 126 scenario).

Furthermore, regional variations are likely, with livestock production in arid and semi-arid lands likely to be disproportionately affected. The expected decline in agricultural productivity and livestock numbers in arid and semi-arid regions, alongside increasing water scarcity (NEMA-KENYA 2015), is particularly problematic, as poverty levels in these areas are already over 80 percent (USAID 2018). In these regions, drought already causes over 70 percent of livestock mortality. Climate change, and in particular droughts, are projected to significantly further affect cattle population in these regions by 2030, with the largest impacts expected in Garissa, Wajir, Tana River, and Turkana (Kenya, Ministry of Environment and Forestry 2018c). On the other hand, while Thornton et al. (2022) project that heat stress will become an increasingly serious challenge in cattle production systems across Kenya, the study does not expect this trend to significantly affect southwestern Kenya.

The fisheries subsector is exposed to risks from the projected increased intensity and frequency of extreme weather events. Heavy rainfall and droughts lead to water acidification, changes in sea temperatures, and new circulation patterns that adversely affect fish habitats. Coastal areas with coral reefs are particularly vulnerable to changes in temperature and acidity, with implications for food security (Kenya, Ministry of Agriculture, Livestock and Fisheries 2017).

Kenya's ability to take climate adaptation measures for its agriculture sector will require effective water management. Even though most agricultural production in Kenya is rainfed, water plays an important role in the production of rice, as well as for some of Kenya's key exports (coffee, vegetables, and fruits). Managing the adverse impacts of climate change will likely require increased use of irrigation, including for crops that have not been irrigated traditionally, such as tea (Muoki et al. 2020). About 80 percent of Kenya's total water demand is met by surface water, predominantly from Lake Victoria and the Tana River. Some studies project that climate change will reduce river flows from Mount Kenya (USAID 2018), which could adversely affect the Tana River. On the other hand, Muthuwatta et al. (2018) estimate that water yield in the river will increase progressively over the rest of the century due to increased rainfall across the basin, potentially creating development opportunities. The study, however, highlights that rainfall is likely to exhibit considerable spatial heterogeneity, and that projected declines in the natural flow regulation of the river, increased variability, and large increases in the frequency and severity of floods will pose challenges for effective water resource management in the Tana Basin. Moreover, as highlighted above, precipitation projections for Kenya vary considerably across models. The impact of climate change on the Tana River will be important for the country's economic and social development; the river provides vital irrigation in arid and semi-arid lands, as 36 percent of its basin is used for agriculture. The Tana River also supplies 80 percent of Nairobi's drinking water and around 70 percent of Kenya's hydropower energy, and is home to important ecosystems (Jenkins, Warren, and Price 2021).

The Nile Basin Initiative's (NBI) Strategic Water Resources Analysis projects that the Nile Basin is likely to face severe water stress and even a potential large water supply deficit (NBI 2023b). Growing populations in the region and the impacts of climate change are key drivers of these risks. The Nile Basin, which is situated in the western part of Kenya and includes Lake Victoria, provides about 52 percent of Kenya's water (NBI 2023a). Lack of regional coordination on the use of water from the Nile under relevant countries' development and climate adaptation plans could exacerbate water scarcity in some regions.[13]

Climate change could have other indirect adverse effects on agriculture in Kenya. A recent survey by the Central Bank of Kenya identifies transport costs, poor weather conditions, and input costs as key constraints to development of the sector (Central Bank of Kenya 2022). Climate change is likely to exacerbate these challenges—through expected damage to road infrastructure[14] and damage to production from extreme weather events and high interannual variability of precipitation, both domestically and regionally. In addition, climate change is expected to cause increased rates of runoff and soil erosion,[15] and increased crop losses from wildlife migrations and rising and novel infestations from insects, diseases, and weeds (NEMA-KENYA 2015). The high proportion of small-scale farmers, who drive 75 percent of production (USAID 2018; FAO and UNDP 2020), could pose further implementation challenges for measures to address these adverse effects.

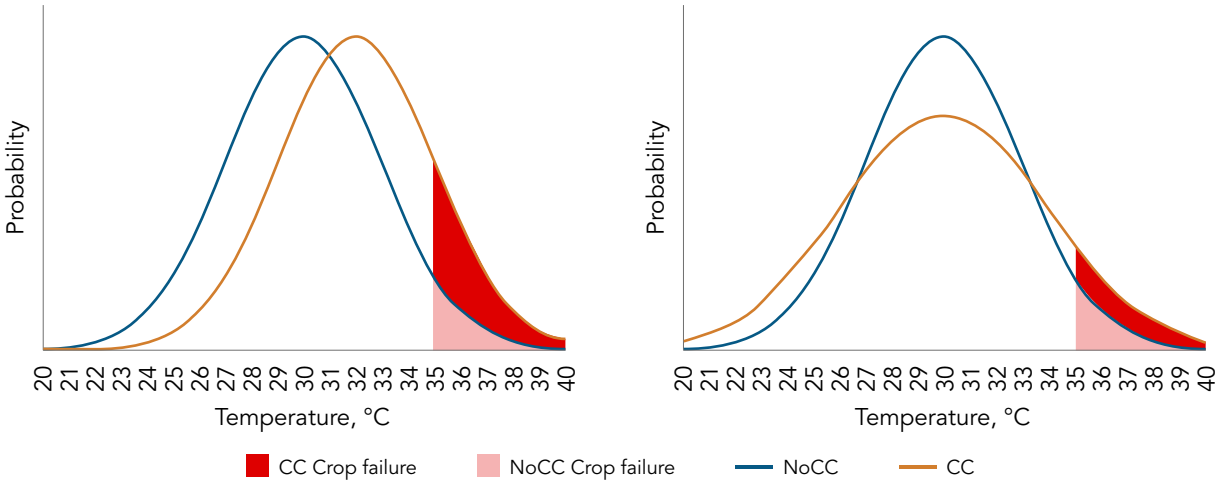
Overall, climate change is causing much uncertainty for the future, making agriculture—and other climate-related areas, such as hydropower or drinking water—riskier. Even if the mean impact of climate change on agriculture were neutral or slightly positive, higher uncertainty or variability increases the probability of extreme events (Figure 7). But rising temperatures themselves, with no increased variability, can increase the risk of extreme events, as some climate models for Kenya show (Figure 7).

13 Currently, the agriculture sector uses 80 percent of the Nile Basin's water. If countries implement their development plans without coordination, the region might need the water of 1.5 Niles by 2050 to keep up with growing demand (NBI 2023b).

14 For example, GIZ (2021) finds that transport infrastructure is particularly vulnerable to extreme weather events, while also essential for trading agricultural goods. The study finds that under a medium to high emissions scenario, the proportion of major roads exposed to river floods at least once a year could increase from 1.9 percent in 2000 to 2.3 percent by 2080. The report highlights the difficulties in predicting the location and extent of such exposure, largely due to the uncertainty of future projections of precipitation amounts and their spatial distribution.

15 Soil erosion in Africa by 2070, particularly in Kenya, as well as Cameroon, Ethiopia, and West Africa, is projected to be much higher than the global average (Borrelli et al. 2020).

Figure 7: Increasing either the mean or uncertainty (or variability) increases the risk of extreme events in this hypothetical case of crop failure when temperatures rise above 35°C



Source: Authors

Tourism

Climate change threatens Kenya's diverse ecosystems, upon which the tourism industry depends. Major tourist attractions and destinations are projected to be affected by climate change-related risks, including prolonged droughts in national parks, declines and shifts in wildebeest migration, and melting snowcaps on Mount Kenya (Nyamwange 2016). According to a dynamic global vegetation model, 54 species (6 percent of total species) living in the Greater Mara Ecosystem may not find the climate suitable by 2050, while 101 species (13 percent of total species) may no longer find the Maasai Mara National Reserve climatically suitable by 2050 (Coldrey and Turpie 2019). The climate change impact on arid and semi-arid areas will have implications for tourism, as 90 percent of the wildlife in Kenya resides in these regions (Kenya, Ministry of Environment and Forestry 2018c). The risks from climate change highlighted above to critical infrastructure could further affect the tourism sector in Kenya. Overall, climate change-related risks with implications for tourism in Kenya include reduced grassland productivity and degradation, increased severity of forest fires, reduced and shifted ranges for native species, biodiversity loss, and degradation/loss of coastal wetland habitats, mangroves, coral reefs, and fisheries (USAID 2018).

Hydropower

Climate change poses risks for Kenya's hydropower sector due to the expected more severe droughts and higher evaporation rates, as well as the risk to critical infrastructure from projected higher frequency of extreme weather events. Hydropower is currently an important contributor to Kenya's energy mix, accounting for about one-third of total electricity generation.[16] Kenya has significantly increased access to the power grid (from 32 percent of households in 2013 to 75 percent in 2022). However, further developing its electricity generation continues to be a main objective, given a growing population and recurring power outages. Climate change could result in reduced hydropower production and increased flooding and landslides that damage power generation. In drought years, hydropower production can be reduced by up to 40 percent, resulting in persistent power cuts and dependence on more expensive petroleum-based thermal generation (USAID 2018).

16 Electricity generation in 2021 came from geothermal sources (41 percent), hydropower (30 percent), wind (16 percent), thermal (10 percent), imports (2 percent), and solar (1 percent) (ITA 2022).

Effective water management and climate adaptation pose challenges to hydropower development. Dams on the Tana River generate hydroelectricity and support irrigation but have led to decreased wet season flows to downstream wetlands (USAID 2021). These challenges are exacerbated by the need to address climate change risks in the arid and semi-arid regions through which the Tana River passes. The uncertainty on future precipitation levels in the region, as highlighted in the section above, poses significant challenges for policymaking. The government plans to further develop dams and expand irrigation, which would help food security and would be a feasible strategy under projected wetter climate scenarios (Kenya, President of the Republic of Kenya 2023). However, not all models corroborate these expectations. In light of this, regulation, prudent water management (including a detailed consideration of the water demands in different regions), and a strategic approach to climate adaptation will be important to reduce the risks of over-abstraction and adverse impacts on downstream wetlands and communities (NBI 2023b; USAID 2021). Development of energy generation from solar, wind, biogas, and bio-ethanol and diesel value chains, as envisaged under Vision 2030, could help reduce the Kenyan economy's reliance on the use of water for hydropower (Kenya Vision n.d.). Kenya's priority adaptation measures include diversification of the energy sector, and in particular developing the country's geothermal energy capacity, to improve climate resilience (Kenya, Ministry of Environment and Forestry 2018b).

Broader macroeconomic impacts and vulnerabilities

Kenya's rising population poses challenges for sustainable development. In the 2010s, Kenya managed to sustain economic growth that exceeded population growth, which helped improve living standards and reduce poverty rates (World Bank 2018b). However, Kenya's population, which stood at 53 million in 2021, is projected to nearly double to 91 million by 2050 (GIZ 2021). This is expected to significantly intensify existing pressures on natural resources: the country's rapid demographic growth means there will be a need for further agricultural and settlement expansion, with implications for land degradation, deforestation, and water pollution.[17] This highlights the need for adaptation measures to protect biodiversity and fragile ecosystems and therefore limit nature-related risks (GIZ 2021). Moreover, climate change will likely exacerbate these adverse impacts, particularly as it is expected to reduce the land suitable for cultivation and grazing in some regions (NCPD 2018) and increase water scarcity issues. Land degradation, in turn, escalates the adverse impact of climate change, such as by increasing the risk of flooding. Overall, without a strategic climate adaptation and resilience response, a rising population, alongside climate change risks, could trap Kenya's economic development in a negative feedback loop, making sustaining the positive trends in poverty reduction significantly more challenging, or even reversing them.

Kenya has limited fiscal space. The Kenyan government has taken efforts to reduce the budget deficit, which stood at 6.2 percent in 2021/22, relative to 8.2 percent the previous fiscal year. The debt-to-GDP also stabilized at about 67.3 percent (World Bank 2022). The World Bank recently approved US$1 billion low-cost budget financing to support Kenya's fiscal consolidation, including strengthening debt management and protecting pro-poor expenditures, as well as its long-term goal of green and inclusive growth, with focus on agricultural exports and private sector inclusion (World Bank 2020). Despite these positive developments, Kenya continues to face fiscal challenges, which climate change could exacerbate. These include slowing economic growth, prolonging inflationary pressures, and increasing food security risks due to higher frequency of droughts and extreme weather events, both domestically and internationally. This in turn is likely to further constrain the government's ability to take and fund climate adaptation and resilience measures, making the need to act preemptively more urgent.

17 For example, Kenya's National Council for Population and Development (NCPD 2018) finds strong links between population, land use, and climate change, including evidence of land fragmentation, land degradation, expansion of cultivation in unsuitable areas, adverse impacts on wetlands (resulting in downstream shortages), and overharvesting of woody biomass (resulting in degradation of woodland and forest ecosystems).

Climate change could have significant implications for Kenya's trade balance and price stability. Kenya National Bureau of Statistics' (KNBS) Economic Survey (2023) estimates Kenya's current account balance at -5.1 percent of GDP for 2022. Import expenditure exceeded the growth in exports due to continued weakening of the Kenyan shilling against major trade partners and increased international prices of petroleum products. These dynamics highlight the exposure of Kenya's economy to international oil price volatility, particularly considering the challenges that climate change may pose to Kenya's hydropower sector (highlighted above) and that petroleum is Kenya's main import, comprising about 15 percent of total imports (OEC n.d.). This risk is higher in an unconstrained emissions scenario, as global mitigation policies are projected to relatively reduce fossil fuel prices (Bauer et al. 2016; Carney 2015).

Agricultural products represent a significant proportion of Kenya's exports, so measures to ensure sustained agricultural productivity, particularly for tea, cut flowers, and coffee, amid the forecasted climatic changes will be important for the country's current account balance and foreign exchange reserves. Similarly, adaptation measures to ensure food security will reduce risks from surging international food prices. Global staple food price increases could bring near one-to-one increases in the sales prices of highly imported staples, including for Kenya, albeit often with lags. While Kenya's food import dependency ratio is relatively balanced, food security risks—and therefore the need for food imports—will increase due to the occurrence of extreme weather events (Baptista et al. 2022). For example, Kenya's food import bill increased by 58 percent in the first quarter of 2023, reaching 92 percent of the value of food exports, according to KNBS (Zawya 2023). This was driven by high prices of wheat and edible oil, as well as the adverse impact of the prolonged drought in Kenya on national food production. Dependence on food imports will expose Kenya to inflation from weather shocks in regions where imports are produced. For example, Kenya imports maize mostly from Uganda and Tanzania, but yields in these countries are projected to decrease by 1.3–15.6 percent and 1.5–13.0 percent, respectively, by 2030 and 2050 (FAO 2016). This means that climate change is likely to affect regional trade, with implications for trade balances, price stability, food security, and socioeconomic development.

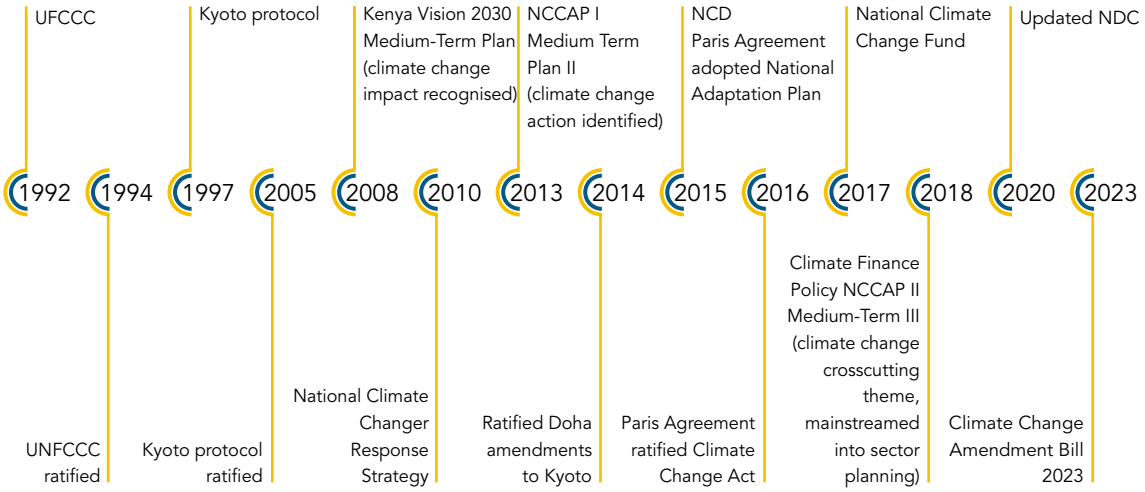
Potential damage to infrastructure from extreme weather events, nationally or regionally, is another channel through which climate change could affect Kenya's economy. Rising temperatures and sea levels in Kenya's coastal areas are projected to strengthen coastal winds and storms, which will affect ship navigation and port operations. Climate-related damage to the road infrastructure could adversely affect trade (KEPSA 2014). Weather events with regional impact and/or that increase the cost of transportation, such as damage to road infrastructure, are likely to drive up inflation, with costs passed on to consumers. The resulting high food-import costs can erode foreign reserves and weigh on exchange rates, contributing to more rapid price gains (Baptista et al. 2022).

3. KENYA'S CLIMATE ADAPTATION AND RESILIENCE PLANNING AND PREPAREDNESS

Government climate action

The Kenyan government is a leader in addressing climate change. Kenya was one of the first countries in Africa to enact a comprehensive law and policy to guide national and subnational climate action (USAID 2022). Climate change and its impacts on economic development in Kenya have been recognized by the government's enactment of several policies and measures, particularly since 2010 (Figure 8). This includes development of a National Adaptation Plan (2015–2030) and a National Climate Change Action Plan (NCCAP) (2018–2022), underpinned by an Adaptation Technical Analysis Report (ATAR) (2018–2022). Mainstreaming climate change adaptation in Vision 2030 and Medium Term and County Integrated Development Plans are key channels used for developing a climate-resilient society in the country. This is illustrated by the Medium Term Plan IV (2023–2027),[18] which includes drought and the rising risk of extreme events under climate change (including the number of occurrences and intensities of floods, landslides, and droughts, and the rising water level) as key challenges to address. For the 2023–2027 period, the Medium Term Plan IV aims to achieve three objectives in the fight to adapt to the impacts of climate change: building the resilience of communities to common hazards; enhancing the coordination of Disaster Risk Management; and strengthening the Integrated Early Warning, Information, and Knowledge Management System.

Figure 8: Timeline of government climate action in Kenya



Source: Adapted from Mutegi et al. (forthcoming)

18 The Medium Term Plan IV policies, programs, and projects aim at achieving the aspirations of the five sectors that form the core pillars of the government's manifesto, Sustainable Development Goals, Africa's Agenda 2063, and other regional and international economic development frameworks.

Kenya's most up-to-date adaptation goals are set out in its Updated NDC, submitted to the United Nations Framework Convention on Climate Change (UNFCCC) in 2020. The Updated NDC aims to: enhance the adaptive capacity and climate resilience across sectors at the national and county government levels; explore innovative livelihood strategies to enhance local community climate resilience through financing locally led climate change actions; enhance risk-based approaches to climate change adaptation through development and application of comprehensive climate risk management tools that help in addressing and adaptively managing climate risks; addressing residual climate change impacts, loss, and damage, especially in economically productive sectors; and enhance generation, packaging, and widespread uptake and use of climate information in decision making and planning across sectors and counties with robust Early Warning Systems (Kenya, Ministry of Environment and Forestry 2020). Several adaptation programs across 12 themes are identified as priorities in the Updated NDC. These programs (Annex A) were selected as they achieve a triple adaptation dividend, extending beyond just avoiding losses as a result of climate change but also realizing economic, social, and environmental benefits. The adaptation programs are estimated to cost US$44 trillion (to 2030), 90 percent of which will require international support in the form of finance, technology development and transfer, as well as capacity building (Kenya, Ministry of Environment and Forestry 2020).

As indicated above, climate policies have also been mainstreamed into particularly newer sector policies. Two such policies that link agriculture, nutrition, and food security with climate are the Kenya Climate Smart Agriculture Strategy (2017–2026) and the Kenya Climate Smart Agriculture Implementation Framework (2018–2027). "Greening" initiatives, some applicable to climate adaptation, have been implemented in sectors such as manufacturing, tourism, infrastructure, and health. Kenya's Ministry of Environment and Forestry (2021) provides some examples. The Kenyan government is developing a Green Fiscal Incentives Policy Framework (Kenya, The National Treasury and Economic Planning 2022). The Climate Finance Policy led to establishment of legal, institutional, and reporting frameworks to access and manage climate finance so that adaptation projects can be implemented on the ground (Chaudhury, Summerlin, and Ginoya 2020; Radeny et al. 2022). Regulatory bodies have helped facilitate the funding of climate projects, such as by setting up a Green Bond Programme in 2017 (Annex E provides more details). At the county level, on-the-ground projects are funded through County Climate Change Funds, which are partly funded through the National Climate Change Fund, as well as international climate funds, development partners, and the private sector. County Climate Change Funds are currently only in place in Isiolo, Garissa, Kitui, Makueni, and Wajir, although the unveiling of the Financing Locally Led Climate Action (FLLoCA) Program in 2021 resulted in nationally scaled local finance control for locally led adaptation across counties (Chaudhury, Summerlin, and Ginoya 2020; World Bank 2021).

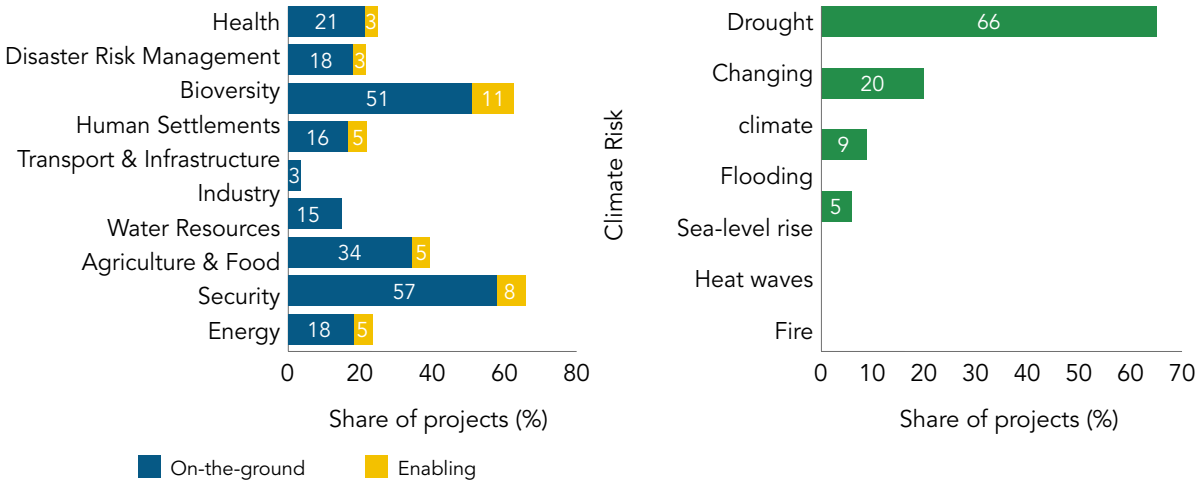
The Kenyan government's climate change response focuses on agricultural technology improvements, including bio-innovations and climate-smart agriculture (CSA) practices. The Updated NDC specifically highlights the mainstreaming of CSA as one of its prioritized adaptation programs (Kenya 2020). The Kenya National Climate Change Action Plan (Kenya, Ministry of Environment and Forestry 2018c) recognizes critical CSA practices such as agroforestry, conservation tillage, the limited use of fire in agricultural areas, cultivation of drought-tolerant crops, water harvesting, and integrated soil fertility management, among others. The main implementation of CSA in the country is through the Kenya Climate Smart Agriculture (CSA) Strategy 2017–2026 and the Kenya Climate Smart Agriculture Implementation Framework (KCSAIF) 2018–2027. With the World Bank, the government started the Kenya Climate Smart Agriculture Project, which aims to: upscale CSA practices; strengthen CSA research and seed systems; support agro-weather, market, and advisory services; support project coordination and management at both the national and county level; and support emergency responses to disasters (KCSAP n.d.). Kenya initiated the process to develop a Livestock Master Plan (LMP) to identify investment options in livestock value chains through evidence-based sector analysis. The priority livestock value chains include dairy, beef, camel, sheep, goat, pig, poultry, donkey,

apiculture, rabbit, and other emerging livestock (Kimani 2021). Annex C provides further detail on Kenya's climate change-related policy framework; Annex D sets out the country's governance arrangements for responding to climate change-related risks.

Climate adaptation projects

Climate adaptation projects in Kenya so far have prioritized supporting vulnerable communities in arid and semi-arid areas to manage drought risks, with focus on agriculture and food security. Mutegi et al. (forthcoming) summarize the climate project landscape in Kenya. They identify 157 mitigation, adaptation, and multipurpose climate projects implemented between 2000 and 2020. Their study shows that in Kenya, as is the case in many countries, more projects currently focus on mitigation rather than adaptation: of the 157 projects identified as climate projects, 61 percent focus on mitigation and 31 percent on adaptation. Only 8 percent of projects were identified as multipurpose projects, meaning they contain both mitigation and adaptation aspects. Of the adaptation projects identified, a larger number are implementation or on-the-ground projects rather than enabling projects, and focus on the agriculture and food security sector and biodiversity sector.[19] Figure 9 illustrates that 57 percent of implementation projects (and 8 percent of enabling projects) include an agriculture and food security focus. Very few projects focus on adaptation in the transport and infrastructure sector. Adaptation projects are also focused in certain areas of Kenya and address certain types of climate outcomes. The primary climate outcome targeted is the risk of drought and changing climate (that is, adaptation to climate change in general) (Figure 9). In terms of subnational focus, adaptation projects have been concentrated in arid and semi-arid regions such as Marsabit, Garissa, Baringo, and Turkana, due to the focus on the risk of drought. In climate projects that address multiple Sustainable Development Goals (SDGs), the most common goals are climate action (SDG 13), no poverty (SDG 1), responsible consumption (SDG 12), and zero hunger (SDG 2). To date, adaptation projects have mainly been funded by international funders, primarily the UNFCCC (Kyoto Protocol-related funding). None of the projects included in the study are funded by government, local private sector, or NGOs (nongovernmental organizations), although most implementation is done at the national government or local NGO or CBO (community-based organization) level. Annex B identifies the list of projects included in Mutegi et al. (forthcoming).

Figure 9: Adaptation projects by sector targeted (left); Climate risk focus of adaptation projects (right)



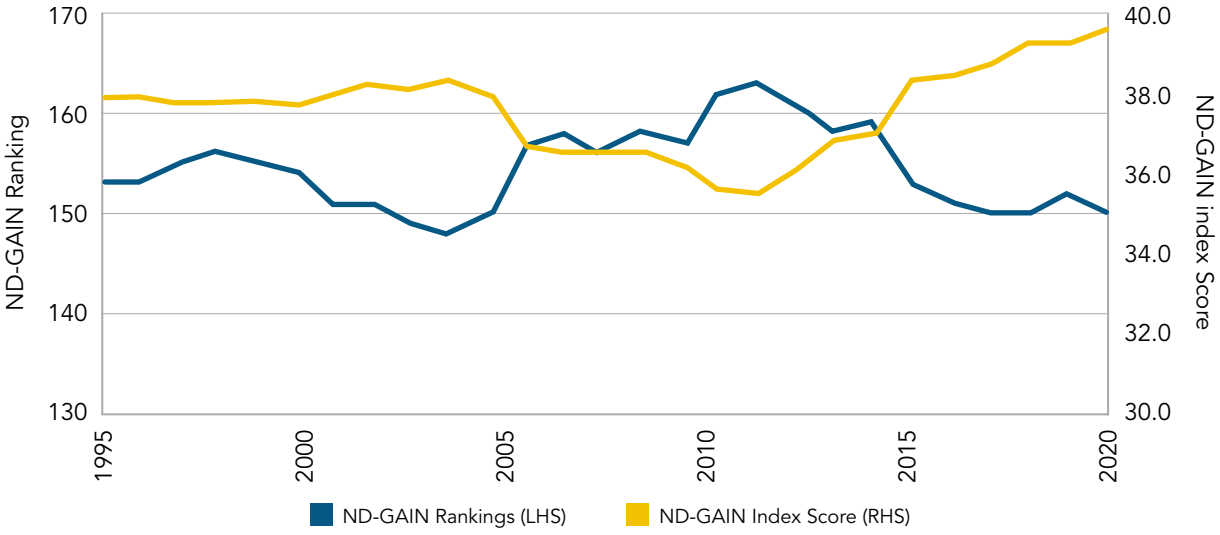
Source: Mutegi et al. (forthcoming)

19 Enabling projects include policy and strategy projects, capacity building, knowledge generation, and research-linked projects. On-the-ground projects are implemented in specific localities with clearly defined beneficiaries and activities intended to reduce emissions or address climate risks. Some capacity-building projects may be considered as implementation.

Progress on building climate resilience and integrating climate risks and actions into development planning has been uneven across Kenya. Some counties are moving ahead with planning and implementing adaptation actions, while others are moving more slowly (Chaudhury, Summerlin, and Ginoya 2020). Radeny et al. (2022) find that on-the-ground agricultural strategies and programs do not adequately address the realities of climate change. Chaudhury, Summerlin, and Ginoya (2020) highlight that integrating climate risks and actions into development planning across sectors and from the national to the local level is essential for making development more resilient to climate change. This can, however, be challenging if there is a lack of information on climate risks and limited capacity to integrate climate information into development planning.

Overall, Kenya's efforts to improve resilience to climate change have increased since 2010, as discussed above, but significant challenges remain. The country's ND-GAIN Index score improved over the last 10 years (Figure 10). Despite efforts, Kenya continues to rank high on vulnerability and low on resilience. In 2021, it ranked 150 out of 185 countries (2011: 162) on the combined index. The country scored particularly low on social and economic readiness. Social readiness, which captures the social factors that enhance the mobility of investment to be converted to adaptation actions, is reportedly the lowest across countries monitored, due to low scores on education (share of population enrolled in tertiary education) and innovation (number of patent applications by residents per capita) (GAIN 2021).

Figure 10: Kenya's ND-GAIN Index for 1995–2021



Source: Notre Dame Global Adaptation Initiative (ND-GAIN) Index, 2021.

Note: Chen et al. (2015) provide details on the methodology for calculating the ND-GAIN Index, including how it reflects a country's readiness and vulnerability assessments.

Challenges to country preparedness

Overall, Radeny et al. (2022) identify several other challenges to effective climate adaptation, including: the **large dependence on international financing; weak coordination between institutions** (for example, agriculture policies and climate policies); **limited progress on integrating policies and strategies in planning, budgeting, implementation, and monitoring processes; insufficient or inadequate indicators for monitoring and evaluation; limited capacity and knowledge to implement intervention; and gaps between national and local efforts**. These are aligned with the key challenges identified in Kenya's ATAR (Kenya, Ministry of Environment and Forestry 2018b) and by Kenya's Ministry of Environment and Forestry (2021, 2022), although weaknesses in monitoring, evaluation, and reporting are particularly highlighted.

Effective adoption of adaptation measures is another challenge, even where they are available. For example, Otieno et al. (2021) outline challenges in the adoption of new seed systems that could improve adaptation to climate change in Kenya, highlighting the complexity of integrating new seeds in formal and informal markets (that is, seed varieties offered through formal markets can have low adoption rates when farmers use informal markets to source their seeds). A majority of smallholder farmers in Kenya are growing varieties that were released more than 15 years ago and were not bred with current climate conditions in mind (De Groote and Omondi 2023; Kramer and Laiboni 2023).

The technical complexity of early warning systems presents a challenge for risk management of extreme weather events, such as floods. Kenya has a well-established system for the generation, process, and use of climate information through the Kenya Meteorological Department (KMD). However, development of strong early warning information systems has been challenging due to: the technical capacity for processing climate data and generating relevant climate information products; the mainstreaming of climate information into policies at national and subnational levels; coordination and sharing of climate information; and awareness of climate information and its importance. Information available has not necessarily been used to full effect due to the low capacity to collect, interpret, and package it suitably for various users such as farmers, conservationists, and policymakers, leading to low appreciation and valuing of the information generated in the various weather stations in the country (Ozor, Acheampong, and Nyambane 2021). The importance of timely and effective early warning information systems extends beyond the agriculture sector. Weak information systems can lead to misguided investments and wasted budgets, slow economic growth, and cause other unintended consequences to agrifood systems (IFPRI 2022). Further developing early warning systems in Kenya can be an effective measure to mitigate the effects of climate change on security, as they allow for communities to anticipate and plan for shocks (ICG 2023).

Moreover, Kenya continues to face significant challenges in mobilizing the necessary scale for climate adaptation and mitigation measures. This is despite the positive regulatory actions to stimulate the market, as highlighted above. Some key underlying barriers include the lack of a national green taxonomy, preexisting vulnerabilities in the financial sector, capacity and expertise limitations in the private and public sector, as well as the costs, complexity, and slow process associated with accessing the current climate finance architecture. The Kenya National Adaptation Plan (NAP) 2015–2030 highlights financing as one limitation to mainstreaming climate change adaptation, particularly in the water sector.[20] Annex E provides further details on the challenges to mobilizing finance for climate adaptation in Kenya.

20 Under the current climate finance architecture, Chaudhury, Summerlin, and Ginoya (2020) find that establishing County Climate Change Funds (CCCFs) is critical for mainstreaming climate adaptation into County Integrated Development Plans (CIDPs) in Kenya. This is because CCCFs enable county adaptation planners to receive training on how to integrate information on climate risks, hazards, and vulnerabilities into the plans, and how to align with national climate change policies while delivering on local adaptation priorities. Annex E provides more information on Kenya's CCCFs.

4. ADAPTATION STRATEGIES AND RECOMMENDATIONS

Despite successful implementation of adaptation actions in select sectors (for example, agriculture and water), more action is needed as many local communities remain or are more vulnerable to the impacts of climate change. An upscaling of efforts is needed as well as an expansion of efforts into other sectors, such as transport and infrastructure, and the mainstreaming of national- to county-level actions. Chaudhury, Summerlin, and Ginoya (2020) highlight the role of strong leadership and stakeholder consultation in the latter to both champion and share information about climate change and advocate that communities prioritize adaptation.

This report aims to support and inform the approach and design of Adaptation and Resilience Investment Platforms (ARIPs) that help mobilize funding for adaptation at scale. In Kenya, the findings of this analysis suggest that such platforms should prioritize:

Improving the understanding of the potential impact of climate change in Kenya, including at a more granular level. The report highlights the particular uncertainty and variations in forecasting of precipitation levels in Kenya, alongside the projected increased seasonal rainfall variability, more intensive rainfall, especially during the short rain season, and higher frequency and severity of extreme weather events, including flooding. Thus, a number of studies forecast a reversal of the historical trend of declining rainfall (Muthuwatta et al. 2018). Meanwhile, the national discourse on climate adaptation places more focus on drought (Laichena et al. 2022). Given the uncertainty in precipitation forecasts, the higher probability of extreme weather events, and the economic and social impacts of droughts, such preparations are appropriate. However, more precise examination of potential precipitation trends regionally and further consideration of flood risk in national adaptation planning would help Kenya manage more effectively the impact of climate change.

Indeed, Tesfaye et al. (2022) highlight the need for foresight studies as a key gap in the knowledge base of planning for the future of agrifood systems in East and Southern Africa. This is echoed by others (World Bank 2021; Kenya, Ministry of Environment and Forestry 2022, 2018b), including Chaudhury, Summerlin, and Ginoya (2020), who note the lack of information on climate risks as a challenge to integrating climate risks and actions into development planning across sectors and from the national to the local level. Thornton, Mensah, and Enahoro (2022) highlight the limited economic modelling of the interactions of climate change with livestock and livestock systems as an important gap in the literature for low- and middle-income countries given the importance of the sector for growth and food security. Foresight studies should include biophysical risks, as suggested by the World Bank Group (2021), but also economic and sector impact assessments to identify the most vulnerable parts of the economy where immediate actions are needed. Foresight studies should include county-level impacts to better understand subnational differences and thus inform best adaptation actions. The use of a climate uncertainty approach is particularly useful as it enables policymakers to account for the full risk in decision making.

Using more precise climate scenario analysis to inform a strategic review of the agriculture sector to ensure effective climate risk management and leveraging off the new opportunities that climate change may present in Kenya to support economic and social development. This could help inform a transformative approach to adaptation that involves an anticipatory, strategic climate change adaptation response, going beyond reactive measures, focused on disaster risk management and maintaining current practices. This could include considerations of how best to diversify the current crop mix at national level (including to inform a plan on diversification away from maize), as well as how the geographical distribution of key crops, such as tea, may need to change to reflect evolving conditions because of climate change. For example, Diao et al. (2023) explore which crops contribute the most to reducing poverty, increasing growth, generating jobs, and improving diets in Kenya. They find that value chains differ considerably in their effectiveness in achieving various development outcomes. For example, the coffee and tea value chains are highly effective at raising off-farm employment in agrifood systems, but have weak impacts on diet quality. Likewise, cattle and dairy have strong off-farm GDP effects within the agrifood system, but are relatively ineffective at reducing poverty. The study recommends pursuing several supply chains, with focus on the cattle and dairy, pulses and oilseeds, and fruits and nuts value chains to optimize against all four factors (assuming equal weight scoring). Further analysis could explore how the impact of these value chains may change because of climate change to inform what adaptation measures the agriculture sector should prioritize to support both climate resilience and broader development goals.

More effectively using agricultural insurance to manage catastrophic risks not targeted by adaptation measures. Agricultural insurance is one of the risk management options available to farmers to adapt to climate change and could help manage extreme events, such as droughts, which climate change is projected to exacerbate in Kenya. However, its uptake remains below 1 percent in the country (Kenya, Ministry of Agriculture, Livestock, Fisheries and Cooperatives 2021). Current challenges with the effectiveness of insurance products, including low coverage[21] and how they are sold,[22] prevent them from acting as an effective safety net for farmers. Thus, the response to climate change could consider how adaptation, alongside insurance, could more effectively help manage climate risks. For example, drought- or flood-resilient seeds (depending on the crop and region) could be promoted alongside insurance coverage for more extreme but infrequent weather events (which such seed varieties would not be designed to be effective against). This may need to include a government subsidy for small subsistence farmers, who would have both the least means and least access to other risk-coping mechanisms. The insurance sector could play a greater role in supporting climate adaptation by designing insurance products that help de-risk the investment in stress-tolerant seed variants (Cecchi et al. 2021). More engagement between the sector and government could support more effective and widespread implementation of such solutions.

Ensuring effective water management, which will be crucial to support economic and social development. The projected increase in frequency and severity of extreme weather events, such as drought, alongside a rising population (and energy needs), could create competition for water resources. Strategic consideration of regional impacts on water availability and interplay between different adaptation measures would help limit maladaptation risks. Improved coordination, at both local and regional level, will be particularly important—and is something that an adaptation and

21 The amount insured of existing insurance policies is typically also low, for instance insuring only seeds, while the total value of production exceeds that amount substantially (Kramer et al. 2022). However, providing farmers with a higher sum insured would increase insurance premiums, since the premium is a percentage of the sum insured, while farmers (particularly subsistence ones) have a low willingness and ability to pay for insurance.

22 Insurance programs appear to currently activate coverage only upon farmer investment (such as when they buy seeds). As a result, large-scale droughts that prevented farmers from buying seeds did not trigger large-scale payouts, because farmers never acquired insurance (Kramer et al. 2022). While insurance policies should not incentivize production in drought circumstances, as this would be ineffective, the existing practice implied that farmers lost the opportunity to be covered for the loss of income from farming and ability to grow food for an entire season, which is an enormous economic shock for these households.

resilience platform could help facilitate. For example, a holistic consideration of water needs across the different territories of the Tana River Basin could be supported, as the river passes through ecological zones that are likely to be affected differently by climate change, and given its huge economic, social and environmental importance. Improved regional coordination, such as of management of the Nile Basin, would also support effective climate adaptation.

Improving intergovernmental communication and cooperation on climate adaptation policy and strategy development, with emphasis on integrated solutions. In Kenya, as in other countries, climate change poses challenges to policymakers due to its cross-sectoral impact. However, consideration of the interplay between different climate measures is essential to ensuring effective resource management, minimizing adaptation costs, and limiting maladaptation risks. For example, Kenya's insurance policy could be further developed to reference the national policy on seeds and other resilience technologies and further reflect on how insurance needs to contribute to investments in other adaptation measures. The section above on water management provides another example of the need for an integrated cross-sectoral adaptation response, which an adaptation and resilience platform could facilitate.

Mobilizing funding at a sufficient scale and moving beyond the current project-by-project approach. As highlighted above, this is a key challenge in Kenya. While the increasingly proactive role of financial institutions, as detailed in Annex E, is positive, a government-led, national-level response will be necessary to ensure funding for adaptation at the scale needed. An adaptation and resilience platform could therefore help explore how to make investment in adaptation in Kenya more attractive (such as by developing an Investment Plan) and how financial pledges and commitments could be most effectively linked and disbursed to adaptation and resilience projects.

Ensuring effective implementation of adaptation measures and facilitating knowledge sharing and capacity building around the implementation of adaptation policies. As highlighted above, adoption of climate adaptation measures, such as use of climate-resilient seeds, is a substantial challenge. For such measures to have an impact on food security, innovative solutions are needed to increase adoption of drought-tolerant varieties. More research is needed to understand the behavioral drivers of varietal adoption. Even a combination of measures, such as providing experience through trial packs, de-risking investments through insurance, and improving access through a champion farmer distribution network, appears insufficient to ensure widespread adoption (Bikketi et al. 2022; Kramer et al. 2021; Trachtman, Kramer, and Demont 2022). Capacity building is needed at the county and ward level and should include training on how to apply climate information to planning processes, improve fund management, and enhance guidance on selecting and implementing appropriate adaptation measures (Chaudhury, Summerlin, and Ginoya 2020). Kenya's ATAR similarly highlights the importance of coordination on adaptation strategy and delivery, including between the national and county governments, as well as with key stakeholders, for effective adaptation implementation (Kenya, Ministry of Environment and Forestry 2018b).

Monitoring, reporting, and evaluation (MR&E) are key to ensuring effective implementation, including building on successes, learning from challenges, and scaling working climate adaptation actions. The information from such data is vital for identifying adaptation actions that have the greatest impact at the least cost and estimating the budgets required to implement such actions. This is particularly important in Kenya, given the highlighted uncertainty and variability of the projected climate change impact. However, Kenya's Ministry of Environment and Forestry (2021) reports several challenges to MR&E in Kenya, including: weak or nonexistent climate change coordinating units in the reporting institutions, especially at the county level; poor coordination, leading to the risk of double counting; inadequate financial resources; and low or no reporting by private sector entities and civil society organizations. The NAP 2015–2030 also did not include indicators for the priority subactions, and as

such baseline data have not been collected (Kenya, Ministry of Environment and Forestry 2022). Strengthening environmental monitoring capabilities for more robust and effective environmental management was identified by the World Bank Group (2021), with the need to include gender-disaggregated information highlighted. Citizen science and crowdsourcing techniques are an important tool for collecting high-frequency data, particularly in remote, conflict-prone, and difficult-to-reach areas. In Kenya, efforts have been made to implement such techniques, particularly in hydrological monitoring (Weeser et al. 2018). Overall, further adaptation strategy development at national level that takes into account MR&E and enables the necessary cross-country coordination and capability would help ensure both that (i) the implementation process is consistent with the national strategy, and (ii) the latter can effectively evolve in light of new information.

REFERENCES

Abodi, M., I. Kariuki, and G. Obare. 2021. "An Analysis of the Determinants of Maize Import Volumes in Kenya." *Theoretical Economics Letters* 11 (2): 320–337. https://doi.org/10.4236/tel.2021.112022

AfDB (African Development Bank). 2023. "Kenya Economic Outlook." Retrieved July 19, 2023, from https://www.afdb.org/en/countries-east-africa-kenya/kenya-economic-outlook

Baptist, D., M. Farid, D. Fayad, L. Kemoe, L. Lanci, P. Mitra, T. Muehlschlegel, et al. 2022. *Climate Change and Chronic Food Insecurity in Sub-Saharan Africa*. Washington, DC: International Monetary Fund. https://www.imf.org/en/Publications/Departmental-Papers-Policy-Papers/Issues/2022/09/13/Climate-Change-and-Chronic-Food-Insecurity-in-Sub-Saharan-Africa-522211?utm_medium=email&utm_source=govdelivery

Bauer, N., I. Mouratiadou, G. Luderer, L. Baumstark, R.J. Brech, O. Edenhofer, and E. Kriegler. 2016. "Global Fossil Energy Markets and Climate Change Mitigation–An Analysis with REMIND." *Climate Change* 136 (1): 69–82. https://doi.org/10.1007/s10584-013-0901-6

Beck, H.E., N.E. Zimmermann, T.R. McVicar, N. Vergopolan, A. Berg, and E.F. Wood. 2018. "Present and Future Köppen-Geiger Climate Classification Maps at 1-km Resolution."*Scientific Data* 5: 180214. https://doi.org/10.1038/sdata.2018.214

Bikketi, E., T. Gumucio, F. Cecchi, B. Kramer, L. Waithaka, and C. Waweru. 2022. *Championing Gender in Agricultural services in Kenya. Promoting Stress-Tolerant Varieties at Scale – Kenya Project Note*. Washington, DC: International Food Policy Research Institute (IFPRI). https://doi.org/10.2499/p15738coll2.136519

Böhme, B., M. Becker, B. Diekkrüger, and G. Förch. 2016. "How is Water Availability Related to the Land Use and Morphology of an Inland Valley Wetland in Kenya?" *Physics and Chemistry of the Earth, Parts A/B/C* 93: 84–95. https://doi.org/10.1016/j.pce.2016.03.005

Borrelli, P., D. Robinson, P. Panagos, E. Lugato, J. Yang, C. Alewell, D. Wuepper, L. Montanarella, and C. Ballabio. 2020. "Land Use and Climate Change Impacts on Global Soil Erosion by Water (2015–2070)." *Proceedings of the National Academy of Science of the United States of America* 117 (36): 21994–22001. https://www.pnas.org/doi/10.1073/pnas.2001403117

Carney, M. 2015. "Breaking the Tragedy of the Horizon – Climate Change and Financial Stability." Speech given at Lloyd's of London, September 29. https://www.bankofengland.co.uk/speech/2015/breaking-the-tragedy-of-the-horizon-climate-change-and-financial-stability

CAT (Climate Action Tracker). 2020. *Climate Action Tracker Climate Governance Series: Kenya*. Cerlin: CAT. https://climateactiontracker.org/documents/836/2020_12_CAT_Governance_Report_Kenya_KvUzQNR.pdf

Cecchi, F., J. Chegeh, D.J. Aredo, B. Kivuva, B. Kramer, L. Waithaka, and C. Waweru. 2021. *Climate-Smart Crop Insurance to Promote Adoption of Stress-Tolerant Seeds: Midterm Findings from a Cluster Randomized Trial*. Washington, DC: IFPRI. https://doi.org/10.2499/p15738coll2.134938

Central Bank of Kenya. 2022. *MPC Agriculture Survey July 2022*. Nairobi, Kenya: Central Bank of Kenya. https://www.centralbank.go.ke/2022/07/29/mpc-agriculture-survey-july-2022/

Chaudhury, M., T. Summerlin, and N. Ginoya. 2020. "Mainstreaming Climate Change Adaptation in Kenya: Lessons from Makueni and Wajir Counties." Working Paper. World Resources Institute, Washington, DC. https://files.wri.org/d8/s3fs-public/mainstreaming-climate-change-adaptation-kenya_1.pdf

Chen, C., I. Noble, J. Hellmann, J. Coffee, M. Murillo, and N. Chawla. 2015. *University of Notre Dame Global Adaptation Index*. Country Index Technical Report. Notre Dame, IN: University of Notre Dame. https://gain.nd.edu/assets/254377/nd_gain_technical_document_2015.pdf

Climate Data Store. 2022. "Agrometeorological Indicators from 1979 to Present Derived from Reanalysis, Version 1.0." Climate Change Service (CS3), last updated September 9, 2023. https://doi.org/10.24381/cds.6c68c9bb

Coldrey, K., and J. Turpie. 2019. *Climate Change Vulnerability and Adaptation Assessment for the Greater Mara Ecosystem*. Anchor Environmental Consultants Report. Cape Town, South Africa: Anchor Environmental. https://wwfke-giscoe.wwfkenya.org/portal/sharing/rest/content/items/dd0a6daacdf748c7b85632f443ccd789/data

CPI (Climate Policy Initiative). 2021. *The Landscape of Climate Finance in Kenya: On the Road to Implementing Kenya's NDC*. San Francisco: CPI. https://www.climatepolicyinitiative.org/wp-content/uploads/2021/03/The-Landscape-of-Climate-Finance-in-Kenya.pdf

De Groote, H., and L.B. Omondi. 2023. "Varietal Turn-over and Their Effect on Yield and Food Security – Evidence from 20 Years of Household Surveys in Kenya." *Global Food Security* 36. Available at: https://doi.org/10.1016/j.gfs.2023.100676

Diao, X., K. Pauw, J. Smart, and J. Thurlow. 2023. "Kenya's Agrifood System: Structure and Drivers of Transformation." CGIAR. KSSP Working Paper No. 1. https://doi.org/10.2499/p15738coll2.136604

EGF (Equity Group Foundation). n.d. Green Initiatives. Retrieved July 22, 2023, from https://equitygroupfoundation.com/green-initiatives/

Elnour, Z., H. Grethe, M. Guyo, S. Kakungu, A. Orango, S. Abdul-Jalil, M. Bar, et al. 2023. *Climate Change Impacts across Agroecological Zones on Agriculture in Kenya: An Economy-Wide Analysis*. Berlin: Thaer-Institute of Agricultural and Horticultural Sciences. https://www.agrar.hu-berlin.de/de/institut/departments/daoe/ihe/Veroeff/6-policy-brief_cc-impacts-on-agriculture_kenya.pdf

EMDAT. 2023. EM-DAT Public. Accessed June 6. https://public.emdat.be/

FAO (Food and Agriculture Organization of the United Nations). 2015a. *Irrigation Market Brief: Kenya*. Rome: FAO. https://www.fao.org/publications/card/en/c/a2d48373-5431-42dc-9f32-b3bd2ed016f1/

FAO. 2015b. *Socio-Economic Context and Role of Agriculture*. Rome: FAO. https://www.fao.org/3/i4911e/i4911e.pdf

FAO. 2016. *The State of Food and Agriculture: Climate Change, Agriculture and Food Security*. Rome: FAO. https://www.fao.org/3/i6030e/i6030e.pdf

FAO and UNDP (United Nations Development Programme). 2020. Assessing Agroforestry Practices and Soil and Water Conservation for Climate Change Adaptation in Kenya: A Cost-Benefit Analysis. Rome: FAO. https://reliefweb.int/report/kenya/assessing-agroforestry-practices-and-soil-and-water-conservation-climate-change

GAIN (Global Adaptation Initiative Network). 2021. "Kenya." Retrieved August 3, 2023, from https://gain-new.crc.nd.edu/country/kenya

GCF (Green Climate Fund). 2021. *Accreditation Master Agreement: Between the Green Climate Fund and KCB Bank Kenya Limited*. Incheon, South Korea: GCF. https://www.greenclimate.fund/sites/default/files/document/ama-kcb.pdf

Genga, B. 2021. "Kenya's Biggest Bank Plans Nation's First Green Bond by a Lender." Bloomberg, November 18. https://www.bloomberg.com/news/articles/2021-11-18/kenya-s-biggest-bank-plans-nation-s-first-green-bond-by-a-lender

GFP (Green Finance Platform). 2019. "The Kenya Green Bond Programme." Retrieved August 3, 2023, from https://www.greenfinanceplatform.org/policies-and-regulations/kenya-green-bond-programme

GIZ (German Corporation for International Cooperation). 2021. *Climate Risk Profile: Kenya*. Bonn, Germany: GIZ. https://www.google.com/url?q=https://www.adaptationcommunity.net/wp-content/uploads/2021/01/GIZ_Climate-risk-profile-Kenya_EN.pdf

ICG (International Crisis Group). 2023. *Absorbing Climate Shocks and Easing Conflict in Kenya's Rift Valley*. Briefing No. 189. Brussels: ICG. https://www.crisisgroup.org/africa/east-and-southern-africa/kenya/b189-absorbing-climate-shocks-and-easing-conflict-kenyas-rift

IEA (International Energy Agency). 2022. "Energy Statistics Data Browser." Last updated August 18. https://www.iea.org/data-and-statistics/data-tools/energy-statistics-data-browser?country=KENYA&fuel=Energy%20supply&indicator=ElecGenByFuel [Accessed: 06/06/23]

IFPRI (International Food Policy Research Institute). 2022. *2022 Global Food Policy Report: Climate Change and Food Systems*. Washington, DC: IFPRI. https://doi.org/10.2499/9780896294257

IFRC (International Federation of Red Cross and Red Crescent Societies). 2023. *DREF Operation: Kenya Floods*. Geneva: IFRC. https://adore.ifrc.org/Download.aspx?FileId=663088

ITA (International Trade Administration). 2022. "Kenya – Country Commercial Guide." Last updated August 19. https://www.trade.gov/country-commercial-guides/kenya-energy-electrical-power-systems

Jenkins, R., R. Warren, and J. Price. 2021. "Addressing Risks to Biodiversity Arising from a Changing Climate: The Need for Ecosystem Restoration in the Tana River Basin, Kenya." *PLoS ONE* 16 (7): e0254879. https://doi.org/10.1371/journal.pone.0254879

Jones, J., G. Hoogenboom, C. Porter, K.J. Boote, W.D. Batchelor, L.A. Hunt, P.W. Wilkens, U. Singh, A.J. Gijsman, and J.T. Ritchie. 2003. "The DSSAT Cropping System Model." *European Journal of Agronomy* 18 (3–4): 235–265. https://doi.org/10.1016/S1161-0301(02)00107-7

KALRO (Kenya Agricultural and Livestock Research Organisation). n.d. "Livestock." https://www.kalro.org/divisions/livestock/

KCSAP (Kenya Smart Agriculture Project). n.d. Retrieved July 18, 2023, from https://www.kcsap.go.ke/

Kebede, A.S., R.J. Nicholls, S. Hanson, and M. Mokrech. 2012. "Impacts of Climate Change and Sea-Level Rise: A Preliminary Case Study of Mombasa, Kenya." *Journal of Coastal Research* 8 (1A): 8–19. https://doi.org/10.2112/JCOASTRES-D-10-00069.1

Kenya, Ministry of Agriculture, Livestock and Fisheries. 2017. Kenya Climate Smart Agriculture Strategy 2017–2026. Nairobi, Kenya: Ministry of Agriculture, Livestock and Fisheries. https://www.fao.org/faolex/results/details/en/c/LEX-FAOC169535/

Kenya, Ministry of Agriculture, Livestock, Fisheries and Cooperatives. 2021. National Agricultural Insurance Policy (NAIP). Nairobi, Kenya: Ministry of Agriculture, Livestock, Fisheries and Cooperatives. https://kilimo.go.ke/wp-content/uploads/2021/06/reviewed-draft-National-Agriculture-Insurance-Policy-29-04-2021-with-comments.pdf

Kenya, Ministry of Environment and Forestry. 2018a. National Climate Change Action Plan (NCCAP) 2018–2022. Nairobi, Kenya: Ministry of Environment and Forestry. Available at: https://faolex.fao.org/docs/pdf/ken190169.pdf

Kenya, Ministry of Environment and Forestry. 2018b. Adaptation Technical Analysis Report (ATAR). National Climate Change Action Plan (NCCAP) Volume II. Nairobi, Kenya: Ministry of Environment and Forestry. https://issuu.com/boonigor/docs/atar_final_august_24__2020

Kenya, Ministry of Environment and Forestry. 2018c. National Climate Change Adaptation Plan II 2018–2022. Nairobi, Kenya: Ministry of Environment and Forestry. http://www.kcckp.go.ke/

Kenya, Ministry of Environment and Forestry. 2020. Submission of Kenya's Updated Nationally Determined Contribution. Nairobi, Kenya: Ministry of Environment and Forestry. https://unfccc.int/sites/default/files/NDC/2022-06/Kenya%27s%20First%20%20NDC%20%28updated%20version%29.pdf

Kenya, Ministry of Environment and Forestry. 2021. National Climate Change Action Plan: Second Implementation Status Report for the FY2019/2020. Nairobi, Kenya: Ministry of Environment and Forestry. https://napglobalnetwork.org/resource/kenya-nccap-2018-2022-second-implementation-status-report/

Kenya, Ministry of Environment and Forestry. 2022. Review of the Implementation of Kenya's National Adaptation Plan 2015–2030. Nairobi, Kenya: Ministry of Environment and Forestry. https://napglobalnetwork.org/wp-content/uploads/2023/01/napgn-en-2023-review-implementation-kenya-agriculture-national-adaptation-plan-2015-2030.pdf

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

Kenya, Ministry of Environment, Climate Change and Forestry. 2023. Draft Strategic Plan (2023–2027). Nairobi, Kenya: Ministry of Environment, Climate Change and Forestry. https://www.environment.go.ke/wp-content/uploads/2023/05/MoECCF-Strategic-Plan-Draft-07.05.2023-updated.pdf

Kenya, Ministry of Finance. 2012. Kenya Post-Disaster Needs Assessment (PDNA): 2008–2011 Drought. Nairobi, Kenya: Ministry of Finance. https://reliefweb.int/report/kenya/post-disaster-needs-assessment-pdna-2008-2011-drought

Kenya, Ministry of Tourism, Wildlife & Heritage. 2023. Annual Tourism Sector Performance Report – 2022. Nairobi, Kenya: Ministry of Tourism, Wildlife & Heritage. https://www.tourism.go.ke/wp-content/uploads/2023/02/ANNUAL-TOURISM-SECTOR-PERFORMANCE-REPORT-2022-2.pdf

Kenya, The National Treasury. 2016. National Policy on Climate Finance. Nairobi, Kenya: The National Treasury. https://faolex.fao.org/docs/pdf/ken190011.pdf

Kenya, The National Treasury and Economic Planning. 2022. Draft National Green Fiscal Incentives Policy Framework. https://www.treasury.go.ke/wp-content/uploads/2023/01/Draft-Green-Fiscal-Incentives-Policy-Framework.pdf

Kenya, The National Treasury and Planning. 2018. Third Medium-Term Plan 2018–2022: Transforming Lives: Advancing Socio-Economic Development through the "Big Four." Nairobi, Kenya: The National Treasury and Planning. https://vision2030.go.ke/wp-content/uploads/2019/01/THIRD-MEDIUM-TERM-PLAN-2018-2022.pdf

Kenya, The National Treasury and Planning. 2022. Fourth Medium Term Plan 2023–2027 – Concept Note. Nairobi, Kenya: The National Treasury and Planning. https://www.planning.go.ke/wp-content/uploads/2022/02/Final-MTP-2023-2027-Concept-Note-1-Final.pdf

Kenya, President of the Republic of Kenya. 2023. "Government to Invest in Dams Construction to Boost Food Production." Office of the President of the Republic of Kenya, April 6. https://www.president.go.ke/government-to-invest-in-dams-construction-to-boost-food-production/

Kenya, Republic of Kenya. 2023. Organization of the Government of the Republic of Kenya. Executive Order No. 1 of 2023. Nairobi, Kenya: Republic of Kenya. https://www.president.go.ke/wp-content/uploads/Executive-Order-No.-1-of-2023-Organization-of-the-Government-of-Kenya.pdf

Kenya Vision 2030. n.d. "Development of New and Renewable Sources of Energy." Retrieved July 20, 2023, from https://vision2030.go.ke/project/development-of-new-and-renewable-sources-of-energy/

KEPSA (Kenya Private Sector Alliance). 2014. "Climate Change and Trade." Climate Change and Your Business Briefing Note Series. KEPSA, Nairobi, Kenya. https://cdkn.org/sites/default/files/files/Climate-Change-and-Trade.pdf

Kimani, J. 2021. "The Kenya Livestock Master Plan Process Initiated to Enhance Sustainable Development and Investment in the Sector." *ILRI News*, May 24. https://www.ilri.org/news/kenya-livestock-master-plan-process-initiated-enhance-sustainable-development-and-investment

Kirschbaum, M.U.F. 1995. "The Temperature Dependence of Soil Organic Matter Decomposition and the Effect of Global Warming on Soil Organic C Storage." *Soil Biology and Biochemistry* 27 (6): 753–760. https://doi.org/10.1016/0038-0717(94)00242-S

KNBS (Kenya National Bureau of Statistics). 2023. "Economic Survey 2023." Retrieved July 12, 2023, from https://www.knbs.or.ke/download/economic-survey-2023/

Kramer, B., P. Hazell, H. Alderman, F. Ceballos, N. Kumar, and A.G. Timu. 2022. "Is Agricultural Insurance Fulfilling its Promise for the Developing World? A Review of Recent Evidence." *Annual Review of Resource Economics* 14: 291–311. https://doi.org/10.1146/annurev-resource-111220-014147

Kramer, B., C. Waweru, L. Waithaka, J. Eyase, J. Chegeh, B. Kivuva, and F. Cecchi. 2021. *A New Model for Inclusive Seed Delivery: Lessons from a Pilot Study in Kenya: Leveraging Champion Farmers' Entrepreneurial Know-How to Reach the Last Mile*. Project Note. Washington, DC: IFPRI. https://doi.org/10.2499/p15738coll2.134491

Kramer, B., and G.M. Laiboni. 2023. "Innovative Approaches Towards Agricultural Risk Management." *Kenya Microsite*, January 18. https://kenya.ifpri.info/2023/01/18/innovative-approaches-towards-agricultural-risk-management/

Laichena, J., E. Kiptoo, S. Nkanyani, S. Mwamakamba, I. Jacobs-Mata, and I. Ires. 2022. *Kenya National Policy Dialogue Summary Report*. Montpellier, France: CGIAR. https://www.iwmi.cgiar.org/Publications/Other/PDF/kenya_national_policy_dialogue_summary_report.pdf

Lewis, I. 2022. "Equity Group Gets $165m Credit Facility to Support MSMEs across Africa." *Impact Investor*, May 13. https://impact-investor.com/equity-group-gets-165m-credit-facility-to-support-msmes-across-africa/

Marketscreener. 2022. "KCB Issues Sh336 Billion to Support Green Projects." *Marketscreener*, October 18. https://www.marketscreener.com/quote/stock/KCB-GROUP-PLC-6493488/news/KCB-Issues-Sh336-Billion-To-Support-Green-Projects-42023807/

Mohajan, H.K. 2014. "Food and Nutrition Scenario of Kenya." *American Journal of Food and Nutrition* 2 (2): 28–38. http://pubs.sciepub.com/ajfn/2/2/3/

Mooldijk, S., and K. Lütkehermoller. 2021. *Kenya: Transforming the Finance Sector with Technical Assistance*. SNAPFI Case Study. Cologne, Germany: NewClimate Institute. https://newclimate.org/wp-content/uploads/2021/06/SNAPFI.-Transforming-Kenyas-Financial-Sector.pdf

Muoki, C.R., T.K. Maritim, W.A. Oluoch, S.M. Kamunya, and J.K. Bore. 2020. "Combating Climate Change in the Kenyan Tea Industry." *Frontiers in Plant Science* 11: 339. https://doi.org/10.3389/fpls.2020.00339

Murphy, D., and V. Orindi. 2017. *sNAPshot: Kenya's County Climate Change Funds*. Country Brief 2B. Winnipeg, Canada: NAP Global Network. https://napglobalnetwork.org/wp-content/uploads/2018/01/napgn-en-2017-snapshot-kenya-county-climate-change-funds.pdf

Mutegi, G., Mark, N., Nadine, M., Sibanda D., Odoom E., Odera, O., Manda, D., Mwabu, G., Muriithi, M., Wambugu, A., Kipruto, S., Oleche, M., and Samoi, P. Forthcoming. "Country Report: Systematic Mapping of Reported Climate Change Projects in Kenya." Transforming Social Inequalities Through Inclusive Climate Action (TSITICA) Working Paper. African Climate & Development Initiative, University of Cape Town, Cape Town, South Africa.

Muthuwatta, L., A. Sood, M. McCartney, N.S. Silva, and A. Opere. 2018. "Understanding the Impacts of Climate Change in the Tana River Basin, Kenya." *Proceedings of the International Association of Hydrological Sciences* 379: 37–42. https://doi.org/10.5194/piahs-379-37-2018

Napier, M. n.d. "What's Next for Green Bonds in Africa." *FSD Africa Blog*. Retrieved July 19, 2023, from https://fsdafrica.org/blog/whats-next-for-green-bonds-in-africa/

NBI (Nile Basin Initiative). 2023a. "Kenya." Retrieved July 6, 2023, from https://www.nilebasin.org/index.php/kenya

NBI. 2023b. "Strategic Water Resources Analysis." Retrieved July 6, 2023, from http://ikp.nilebasin.org/en/action-area/strategic-water-resources-analysis

NCPD (National Council for Population and Development). 2018. *Effects of Population Growth and Uncontrolled Land Use on Climate Change in Kenya*. Policy Brief No. 60. Nairobi, Kenya: NCPD. https://ncpd.go.ke/wp-content/uploads/2021/02/60-PB-Effects-of-polpulation-Growth-on-climate.pdf

NEMA-KENYA (National Environment Management Authority). 2015. *Kenya – Second National Communication to the United National Framework Convention on Climate Change*. Nairobi, Kenya: NEMA-KENYA. https://unfccc.int/sites/default/files/resource/Kennc2.pdf

Nicholson, K., T. Buso, C. Bann, S. Mutimba, C. Smith, S. Patel, and P. Steele. 2023. *Kenya Climate and Nature Financing Options Analysis: Final Report*. London: International Institute for Environment and Development (IIED). https://thedocs.worldbank.org/en/doc/7580561ec99e5e3c7adc68efebfab1dc-0320052023/original/kenya-climate-and-nature-financing-options-analysis.pdf

Njeru, F., S. Mwaura, P.M. Kusolwa, and G. Misinzo. 2022. "Maize Production Systems, Farmers' Perception and Current Status of Maize Lethal Necrosis in Selected Counties in Kenya." *All Life* 15 (1): 692–705. https://doi.org/10.1080/26895293.2022.2085815

NSE (Nairobi Securities Exchange). n.d. "Green Bonds." Retrieved July 19, 2023, from https://www.nse.co.ke/green-bonds/

Nthambi, M., and U.D. Ijioma. 2021. "Retracing Economic Impact of Climate Change Disasters in Africa: Case Study of Drought Episodes and Adaptation in Kenya." In *African Handbook of Climate Change Adaptation*, eds. W.L. Filho, N. Oguge, D. Ayal, L. Adeleke, and I. da Silva, 1007–1031. Cham, Switzerland: Springer. https://doi.org/10.1007/978-3-030-45106-6_66

Nyamwange, M. 2016. "Impacts of Climate Change on Tourism in Kenya." *Journal of Geography and Earth Sciences* 4 (2): 1–10. https://doi.org/10.15640/jges.v4n2a1

Nyariki, M., and D. Amwata. 2019. "The Value of Pastoralism in Kenya: Application of Total Economic Value Approach." *Pastoralism: Research, Policy and Practice* 9: 9. https://doi.org/10.1186/s13570-019-0144-x

Obare, R. 2022. "Kenya Needs a Green Taxonomy to Enhance Environmental Sustainability." *Vellum*, July 22. https://vellum.co.ke/kenya-needs-a-green-taxonomy-to-enhance-environmental-sustainability/

Odhengo, P., J. Atela, P. Steele, V. Orindi, and F. Imbali. 2019. "Climate Finance in Kenya: Review and Future Outlook." Discussion Paper 2019. ADA Consortium, Nairobi, Kenya. http://site.adaconsortium.org/wp-content/uploads/2022/09/16-08-2019-Final-Kenya-climate-finance-paper-5.pdf

OEC (Observatory of Economic Complexity). 2021. "Kenya." Retrieved July 19, 2023, from https://oec.world/en/profile/country/ken

Opere, A. 2013. "Chapter 21 – Floods in Kenya." *Developments in Earth Surface Processes* 16: 315–330. Available at: https://doi.org/10.1016/B978-0-444-59559-1.00021-9

Otieno, G., T. Recha, C. Fadda, R. Vernooy, M. Halewood, and O. Spellman O. 2021. *A Synthesis of Policy Issues and Recommendations Towards Enhancing Access to and Utilization of Agricultural Genetic Resources for Climate-Change Adaptation in East Africa: Report of a Regional Policy Workshop, 1–2 April 2021, Kisumu, Kenya*. Rome: Bioversity International. https://cgspace.cgiar.org/bitstream/handle/10568/116203/A%20synthesis_Otieno_2021.pdf?sequence=1&isAllowed=y

Ozor, N., E. Acheampong, and A. Nyambane. 2021. "Climate Information Needs and Services for Climate Change Mitigation and Adaptation in Cameroon, Kenya, Malawi, Nigeria and Tunisia." *Agro-Science* 20 (4): 8–21. https://www.ajol.info/index.php/as/article/view/216635

Palmer, P.I., C.M. Wainwright, B. Dong, R.I. Maidment, K.G. Wheler, N. Gedney, J.E. Hickman, et al. 2023. "Drivers and Impacts of Eastern African Rainfall Variability." *Nature Reviews Earth & Environment* 4: 254–270. https://www.nature.com/articles/s43017-023-00397-x

Radeny, M., D. Amwata, S. Hunt, C. Mungai, M. Tumbo, Z. Eshetu, A. Tolo, L. Butare, J. Auma, and D. Solomon. 2022. "Review of Policies and Frameworks on Climate Change, Agriculture, Food and Nutrition Security in Eastern Africa." Accelerating Impacts of CGIAR Climate Research in Africa (AICCRA): Nairobi, Kenya. https://cgspace.cgiar.org/handle/10568/119747

Reuters. 2022. "Kenya Cancels Eurobond Sale, Blames Surging Yields, Local Media Report." *Reuters*, June 10. https://www.reuters.com/world/africa/kenya-cancels-eurobond-sale-blames-surging-yields-local-media-report-2022-06-10/

Rigden, A., V. Ongoma, and P. Huybers. 2020. "Kenyan Tea is Made with Heat and Water: How Will Climate Change Influence its Yield?" *Environmental Research Letters* 15 (4): 044003. https://doi.org/10.1088/1748-9326/ab70be

Tadesses, T. 2016. "Strategic Framework for Drought Risk Management and Enhancing Resilience in Africa." Paper presented at the African Drought Conference 2016, Windhoek, Namibia, August 15–19. https://www.unccd.int/sites/default/files/relevant-links/2018-04/DRAPA_strategic_framework_final_ttadesse2.pdf

Tesfaye, K., F. Hartley, T. Thomas, S. Gbegbelegbe, and S. Gabriel. 2022. "What Do We Know about the Future of Agri-Food Systems in Eastern and Southern Africa?" *CGIAR News*, December 19. https://www.cgiar.org/news-events/news/what-do-we-know-about-the-future-of-agri-food-systems-in-eastern-and-southern-africa/

Thornton, P., C. Mensah, and D. Enahoro. 2022. "Modelling the Effects of Climate Change on Livestock: Towards Identifying the Priorities." ILRI Discussion Paper 45. International Livestock Research Institute (ILRI), Nairobi, Kenya. https://www.ilri.org/knowledge/publications/modelling-effects-climate-change-livestock-towards-identifying-priorities

Thornton, P., G. Nelson, D. Mayberry, and M. Herrero. 2022. "Impacts of Heat Stress on Global Cattle Production during the 21st Century: A Modelling Study." *The Lancet Planetary Health* 6 (3): e192–e201. https://www.sciencedirect.com/science/article/pii/S254251962200002X

Trachtman, C., B. Kramer, and M. Demont. 2022. *Behavioural Market Intelligence and its Implications for Seed Systems Development*. Market Intelligence Brief Series 3. Montpellier: CGIAR. Available at: https://hdl.handle.net/10568/128427

Trisos, C.H., I.O. Adelekan, E. Totin, A. Ayandale, J. Efitre, A. Gemeda, K. Kalaba, et al. 2022. "Africa." In: *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*, 1285–1455. Cambridge, UK and New York: Cambridge University Press. https://doi.org/10.1017/9781009325844.011

UNFPA (United Nations Population Fund). 2022. *Horn of Africa Drought Crisis*. New York: UNFPA. https://www.unfpa.org/resources/unfpa-response-plan-horn-africa-drought-crisis-2022-2023

UNOCHA (UN Office for the Coordination of Humanitarian Affairs). 2018. *OCHA: Flash Update #6: Floods in Kenya*. New York: UNOCHA. https://reliefweb.int/report/kenya/ocha-flash-update-6-floods-kenya-7-june-2018

USAID. 2018. "Kenya Climate Risk Profile." Last updated July 27. https://www.climatelinks.org/resources/climate-risk-profile-kenya

USAID. 2022. "Kenya Climate Change Country Profile." Last updated November 14. https://www.usaid.gov/climate/country-profiles/kenya

Weeser, B., K.J. Stenfert, S.R. Jacobs, N. Njue, Z. Kemboi, A. Ran, M.C. Rufino, and Breuer. 2018. "Citizen Science Pioneers in Kenya – A Crowdsourced Approach for Hydrological Monitoring." *Science of the Total Environment* 631–632: 1590–1599. http://doi.org/10.1016/j.scitotenv.2018.03.130

World Bank. 2017. Climate Knowledge Portal for Development Practitioners and Policymakers. Retrieved August 3, 2023, from https://climateknowledgeportal.worldbank.org/

World Bank. 2018a. *Disaster Risk Management Development Policy Financing with a Catastrophe Deferred Drawdown Option*. Washington, DC: World Bank. http://documents.worldbank.org/curated/en/131661529811034069/pdf/KENYA-DDO-NEWPAD-2-05312018.pdf

World Bank. 2018b. Poverty Incidence in Kenya Declined Significantly, but Unlikely to be Eradicated by 2030. Retrieved September 29, 2023, from https://www.worldbank.org/en/country/kenya/publication/kenya-economic-update-poverty-incidence-in-kenya-declined-significantly-but-unlikely-to-be-eradicated-by-2030

World Bank. 2020. "World Bank Approves $1 Billion Financing for Kenya to Address COVID-19 Financing Gap and Support Kenya's Economy." *World Bank News*, May 20. https://www.worldbank.org/en/news/press-release/2020/05/20/world-bank-approves-1-billion-financing-for-kenya-to-address-covid-19-financing-gap-and-support-kenyas-economy

World Bank. 2021. "Kenya Moves to Locally Led Climate Action." *World Bank Blogs*, October 27. https://blogs.worldbank.org/nasikiliza/kenya-moves-locally-led-climate-action

World Bank. 2022. *Kenya Economic Update, December 2022: Continued Rebound, but Storms Cloud the Horizon – Policies to Accelerate the Productive Economy for Inclusive Growth*. Washington, DC: World Bank Group. http://documents.worldbank.org/curated/en/099400212072220291/P1797690ba796602b092ba0149f48220ed7

World Bank. 2023a. "Climate Data Historical – Kenya." Retrieved June 23, 2023, from https://climateknowledgeportal.worldbank.org/country/kenya/climate-data-historical

World Bank. 2023b. *Kenya Economic Update – Securing Growth: Opportunities for Kenya in a Decarbonizing World*. Washington, DC: World Bank Group. http://documents.worldbank.org/curated/en/099060523141041477/P17976900a185c0a608fc8057aefbd0539d

World Bank Group. 2021. *Climate Risk Country Profile: Kenya*. Washington, DC: World Bank Group. https://climateknowledgeportal.worldbank.org/sites/default/files/2021-05/15724-WB_Kenya%20Country%20Profile-WEB.pdf

Yihdego, Y., S.H. Salem, and H.H. Muhammed. 2018. "Agricultural Pest Management Policies during Drought: Case Studies in Australia and the State of Palestine." *Natural Hazards Review* 20 (1): 05018010. https://doi.org/10.1061/(ASCE)NH.1527-6996.0000312

Zawya. 2023. "Kenya's Food Import Bill Surged 58% to $575mln in Q1 2023." *Zawya*, July 7. https://www.zawya.com/en/economy/africa/kenyas-food-import-bill-surged-58-to-575mln-in-q1-2023-e3t2jfw0

ANNEX A:
UPDATED NDC PRIORITIZED ADAPTATION PROGRAMS

Table 2 is taken from Kenya's Updated Nationally Determined Contribution (Kenya, Ministry of Environment and Forestry 2020) and highlights the prioritized adaptation programs as identified by the Ministry of Environment and Forestry. These programs are intended to enhance the country's adaptation ambition and bridge implementation gaps. Furthermore, the programs are expected to attain the triple adaptation dividend (that is, avoided losses, economic benefits, and social and environmental benefits). Some programs may also lead to mitigation co-benefits.

The key adaptation sectors outlined in Kenya's NDC match those of the ATAR (2018–2022) under the NCCAP (2018–2022). The ATAR provides more detail on the different types of actions, as well as five-year projections for the budget costs of the actions proposed in Kenya's NAP in each priority sector (Kenya, Ministry of Environment and Forestry 2018b).

Table 2

SECTOR	ADAPTATION PROGRAM
Disaster risk reduction	P1: Drought risk management including drought early warning, preparedness, and response for enhanced drought resilience.
	P2: Flood risk management incorporating nature-based solutions.
Agriculture (crops, livestock and fisheries)	P3: Mainstream CSA towards increased productivity through value chain approach to support the transformation of agriculture (crops, livestock and fisheries) into an innovative, commercially oriented, competitive and modern sector.
	P4: Build resilience of the agriculture (crops, livestock and fisheries) systems through sustainable management of land, water and other natural resources as well as insurance and other safety nets.
	P5: Strengthen communication system on CSA extension and agro-weather issues.
Environment	P6: Rehabilitation and conservation of degraded forests.
	P7: Establish at least 2,000 ha to promote nature-based (no-wood forest products) enterprises across the country.
	P8: Establish 150,000 ha of commercial private forest plantations.
	P9: Plant 350,000 ago-forestry trees in farmlands established.
	P10: Greening of 14,000 ha of infrastructure (roads, railway lines, dams).
	P11: Enhance/strengthen governance of community structures in participatory resource management in coastal ecosystems.
	P12: Conduct blue carbon readiness assessment for full integration of blue carbon/ ocean climate actions into NDCs.

SECTOR	ADAPTATION PROGRAM
Environment	P13: Develop maritime spatial planning and outline sustainable management approaches.
	P14: Promote and expand opportunities for nature-based enterprises including seaweed farming, and mangrove ecotourism.
	P15: Integrate the use of nature-based solutions, including the implementation of national mangrove management plan, into nation and county development plans.
	P16: Strengthen early-warning and tailor-made climate information services through institutional strengthening of KMD and other information user institutions.
	P17: Roll out Early Action Protocols for forecast-based financing.
Infrastructure (energy)	P18: Develop and adopt guidelines on how to climate proof energy infrastructure using vulnerability risk assessments.
	P19: Enhance climate proofing of energy infrastructure along the renewable energy supply chain.
	P20: Increase the number of companies participating in energy-efficient water-use initiatives by 40% from the baseline.
Infrastructure (roads)	P21: Upscale the construction of roads to systematically harvest water and reduce flooding.
	P22: Enhance institutional capacities on climate proofing vulnerable road infrastructure through vulnerability assessments.
	P23: Promote the use of appropriate designs and building materials to enhance resilience of at least 4,500km of roads to climate risk.
Water and sanitation	P24: Conduct and implement recommendations on climate and risk assessments on water, sanitation and irrigation infrastructure.
	P25: Build resilience infrastructure for the protection of dams and dykes and river lines.
	P26: Promote water harvesting and storage and country and household levels.
	P27: Mainstream climate change into water catchment management plans.
Heath	P28: Conduct a vulnerability and risk assessment of different climate risks on human health.
	P29: Develop a public awareness and social mobilisation strategy on climate change and health impacts.
	P30: Develop health programs, protocols and guidance to management new climate change-related diseases and risks.
	P31: Reduce the incidence of malaria, other vector-borne disease and other health conditions.
Population urbanisation and housing	P32: Introduce nature-based solutions in flood control, especially around informal settlements and selected urban areas.
	P33: Strengthen the enforcement of green building codes by national and county governments.
	P34: Conduct climate risk and vulnerability assessment of building/housing infrastructure, especially to flooding, and sea level rise.

SECTOR	ADAPTATION PROGRAM
Tourism	P35: Develop and adopt guidelines on how to integrate adaptation across the tourism sector.
	P36: Conduct and climate risk and vulnerability assessment of the tourism sector.
	P37: Develop climate resilient action plans for the sector
Gender, youth and other vulnerable groups	P38: Develop social safety net structures for women, youth and other vulnerable groups within the CCCFs.
	P39: Strengthen access of women, youth and other vulnerable groups to enterprise funds, climate finance and credit lines.
	P40: Promote gender-responsive technologies and innovations in the private sector, through financing capacity building and start-up services.
	P41: Consolidate successful technologies and develop a transfer strategy to women, youth and other vulnerable populations.
Private Sector	P42: Mobilize financial resources from capital markets and other financial instruments for green investments and implementation of the Green Business Agenda.
	P43: Eco-label industrial products to promote green procurement, especially by public procurement agencies.
	P44: Climate proof waste management infrastructure for waste management facilities in SEZ (effluent treatment plants).
	P45: P45: Increase the number of companies participating in efficient water-use initiatives.
Devolution	P46: Develop and adopt country adaptation guidelines for integration in CIDPs.
	P47: Build the capacities of County CCUs on adaptation.
	P48: Conduct vulnerability and risk assessments in counties.
	P49: Develop county adaptation plans for the counties with CCCFs.
Adaptation	P50: Refine and operationalize the adaptation M&E system at national and county levels.

ANNEX B:
CLIMATE ADAPTATION PROJECTS

Mutegi et al. (forthcoming) used a systematic mapping of documented climate change projects over a 20-year period, from 2000 to 2020, to gain a better understanding of the status of Kenya's climate change projects. Their report was guided by four questions that focused on Kenya's current climate change efforts, the extent to which the reported climate change projects align with existing national and sectoral climate change policies, multidimensional poverty, and inequality, and whether climate change projects explicitly or implicitly address poverty and inequality. The mapping exercise aimed to identify "on-the-ground" and enabling projects focusing on mitigation, adaptation, and multipurpose activities. In total, 157 projects from various international and national climate change project databases were mapped – as listed in Table 3.

Table 3
Adaptation: Enabling Projects
Seventh Operational Phase of the GEF Small Grants Programme in Kenya
Integrating Value Chain in Sustainable Solid Waste Management in Shimoni and Wasini Island, Kwale County, Kenya
Enhanced Communities Awareness & Technology Transfer for Sustainable Land Management in Laikipia West Sub-County
Agricultural Productivity and Sustainable Land Management
Developing Incentives for Community Participation in Forest Conservation Through the Use of Commercial Insects in Kenya
SIP: Mainstreaming Sustainable Land Management in Agropastoral Production Systems of Kenya*
Promoting Conservation of Endangered Fauna and Renewable Energy in North Western Mount Kenya*
Scaling Up Range Rehabilitation Project in Community Areas in Laikipia, Kenya
Improved Conservation and Governance for Kenya Coastal Forest Protected Area System*
Adaptation: Implementation Projects
Lake Turkana Wind Power Project
National Agricultural and Rural Inclusive Growth Project
Menengai Geothermal Development Project
Kenya Climate Smart Agriculture Project
Sustainable Biocultural Diversity Utilization and Management of the Mijikenda Sacred Kaya Forests of Coastal Kenya
Conservation of Ngong Forest: Bee Keeping for Slum Women

Adaptation: Implementation Projects
Conservation of Emsos River Water Catchment Area
Cultivation and Commercialization of Endangered Aloes in Baringo
Livelihood Improvement and Biodiversity Conservation Through Advancement of Sustainable Bee Farming and Establishment of an Efficient Honey Collection System
Transforming Traditional Medicinal Practice for Biodiversity Conservation, Knowledge Transfer and Livelihood Improvement
Towards Ending Drought Emergencies: Ecosystem Based Adaptation in Kenya's Arid and Semi-Arid Rangelands
Acumen Resilient Agriculture Fund (ARAF)
Marine Fisheries and Socio-Economic Development Project
Sustainable Management and Conservation of Marine and Coastal Resources in Vanga Location, Kenya
Planting Indigenous Trees in Mt Kenya Forest Using Women's Groups
Piloting Climate Change Adaptation to Protect Human Health in Kenya
Empowering Women to Lead Rangeland Conservation in Kenya and South Africa
Climate Resilient Community Conservancies Program
Adaptation to Climate Change in North-Eastern Kenya
Improving Livelihoods and Fighting Climate Change in Kenya*
The Livelihoods Mt Elgon Project*
Eldoret-Iten Water Fund for Tropical Water Tower Conservation*
Rehabilitation of Koleche Water Dam for Lusi Community, Bondo District Kenya*
The Kasigau Corridor Redd Project*
Chyulu Hills Redd+ Project*
Conserving Agriculture Through Promotion of Traditional High Value Crops
Kavuko Hills Rehabilitation Project
Empowering Women on Value Chain and Post-Harvest Trade of Coastal Women in Fisheries Entrepreneurship Development
Tana River National Primate Reserve Conservation Project
Lewa Wildlife Conservancy
Adaptation for Smallholder Agriculture Programme (ASAP)
Integrated Programme to Build Resilience to Climate Change and Adaptive Capacity of Vulnerable Communities in Kenya
Agricultural Climate Resilience Enhancement Initiative (ACREI) (Ethiopia, Kenya, Uganda)
Strengthening Drought Resilience for Smallholder Farmers and Pastoralists in the IGAD Region (Djibouti, Kenya, Sudan, Uganda)
Adapting to Climate Change in Lake Victoria Basin
Adaptation to Climate Change in Arid Lands (KACCAL)
Integration of Environmental Management and Conservation to Poverty Reduction at Kangaita and Castle Forest Areas of Mt Kenya Through Improved Agriculture and Energy Efficient Stoves*

Adaptation: Implementation Projects
Improved Beekeeping and Honey Production Systems in Lake Bogoria Landscape for Increased Production, Environmental Conservation and Social Well-Being (Kenya)
Kenya: Adaptation to Climate Change in Arid and Semi-Arid Lands (KACCAL)
Promote Adoption and Scaling Up of Solar Powered Milk-Cooling System for Improved Livelihoods of Small-Scale Dairy Farmers in Lake Bogoria Area, Baringo County*
Support to Low Carbon Climate Resilient Development for Poverty Reduction in Kenya*
Rehabilitation of Koleche Water Dam for Lusi Community, Bondo District Kenya*
Lake Victoria Environmental Management Programme Phase 3
Kenya Water Security and Climate Resilience Project
Mainstreaming Biodiversity Conservation into Marine Ecosystem & Fisheries Management in Kenya
Dryland Livestock Wildlife Environment Interface Project (DLWEIP)
Sustainable Management and Conservation of Marine and Coastal Resources in Vanga Location, Kenya
Cultivation and Commercialization of Endangered Aloes in Baringo
Kenya Integrated Climate Risk Management Project
Western Kenya Community Driven Development and Flood Mitigation Project
Coastal Region Water Security and Climate Resilience Project
Kenya Cereal Enhancement Programme Climate Resilient Agricultural Livelihoods Window

Source: Mutegi et al. (forthcoming).

*Note: * denotes multipurpose projects (that is, both adaptation and mitigation).*

ANNEX C:
KEY CLIMATE CHANGE-RELATED POLICIES AND STRATEGIES IN KENYA

Vision 2030: This is the long-term development blueprint to transform Kenya into a newly industrializing and middle-income country and provide a high quality of life to all its citizens by the year 2030. The plan is implemented through a series of Medium Term Plans (MTPs). The current MTP (MTP III), the third in the series, covers the years 2018–2022 (Kenya, The National Treasury and Planning 2018). There is a clear understanding of the impact of the increased frequency and intensity of climate change on sectors, thus a need to adopt climate action toward low-carbon and climate-resilient development across agriculture, infrastructure, manufacturing, health, and other greening initiatives in the MTP. The MTP recognizes the need to adapt the agricultural system, beyond disaster and risk management, to a changing climate. This is done through improved Climate-Smart Agriculture (CSA) technologies and practices, and the promotion of appropriate crop insurance products as a method of transferring climate-related risks. Kenya plans to add over 5 gigawatts to its power generation through a mix of geothermal, wind, and solar projects during this period, as well as, to a lesser extent, imports, coal, biomass, and hydropower. An updated MTP expected in 2023 for the period 2023–2027 will implement the remaining aspects of Vision 2030 and will incorporate best practices in climate change mitigation and adaptation (Kenya, The National Treasury and Planning 2022).

The National Adaptation Plan (2015–2030): This is the strategic framework guiding the country's efforts in adapting to the impacts of climate change, including: assessing vulnerability and identifying adaptation priorities; mainstreaming adaptation into planning processes; strengthening institutional and technical capacities; and promoting sustainable and climate-resilient development. It highlights short-, medium-, and long-term adaptation actions across sectors, such as: increasing small hydropower and geothermal power generation; rehabilitating water catchment areas for power production; climate-proofing roads, rails, maritime, and building infrastructure; adopting community-based adaptation strategies to reduce resource-based conflicts and water resource management; and strengthening resilience in the tourism sector. It outlines the promotion of adaptation in agriculture through weather insurance, indigenous knowledge, livestock diversification, grazing land restoration, agroforestry, and integrated soil management. The cost of implementing the NAP until 2030 is estimated at US$38,255,496,051 (Kenya, Ministry of Environment and Natural Resources 2016).

Nationally Determined Contribution (NDC) (updated December 2020): Beyond mitigation, the NDC has strong adaptation components, as listed in Annex A. It covers the: (i) uptake of adaptation practices and innovation; (ii) mechanism for adaptation, monitoring, and evaluation; (iii) climate-influenced decision making; and (iv) enhancement of community resilience and financing of climate action.

Draft Strategic Plan (2023–2027) of the Ministry of Environment, Climate Change and Forestry: Its five key objectives include: (i) strengthening of environmental, climate change, and forestry governance; (ii) conservation and restoration, including water management regarding Lake Victoria and Lake Naivasha Basins; (iii) climate change adaptation and mitigation, with focus on reporting, building capacity, and enhancing implementation of local climate action; (iv) agroforestry and commercial forestry management; and (v) sustainable financing. In particular, the plan includes: undertaking a study on the climate impacts of climate change in Kenya and a comprehensive national climate vulnerability and risk assessment; convening quarterly Adaptation and Mitigation Technical Working Groups; monitoring, reporting, and verifying climate action among sectoral actors; and developing and implementing the next version of NCCAP (see below). The draft report does not detail further specific adaptation actions planned.

The National Climate Change Action Plan (NCCAP II, 2018–2022): It focuses on: strengthening the country's path toward sustainable, climate-resilient development while simultaneously achieving low-carbon objectives, including risk reduction from climate disasters; increasing food security and agricultural resilience; enhancing the blue economy; increasing resilience in forestry, wildlife, and tourism; mainstreaming adaptation at the community level; and climate-proofing energy and transport infrastructure. The NCCAP is expected to be updated every five years (Kenya, Ministry of Environment and Forestry 2018c). The NCCAP II led to development of the National Climate Change Learning and Awareness Strategy and the National Long Term-Low Emission Development Strategy for 2050, and establishment of the Integrated Measurement Reporting and Verification System for Kenya (Kenya, Ministry of Environment, Climate Change and Forestry 2023). Moreover, the NCCAP was underpinned by an Adaptation Technical Analysis Report (ATAR) (2018–2030) that provides further detail on the government's planned adaptation actions, priority areas, and links to sustainable development goals (Kenya, Ministry of Environment and Forestry 2018b).

The National Policy on Climate Finance (2016): It creates the legal, institutional, and reporting structures to facilitate access to and management of climate finance in alignment with the framework established by the Climate Change Act of 2016. Its objectives are to: (i) improve public finance management for climate financing; (ii) establish mechanisms for mobilizing both internal and external climate finance; (iii) track and evaluate the sources and impacts of climate finance; (iv) enhance the country's capacity to access climate finance for sustainable development; and (v) encourage private sector involvement in climate-related financial opportunities. It forms the basis for establishment of the Climate Change Fund, a national climate finance platform for mobilization, coordination, and monitoring as well as supporting capacity building for the development of bankable projects (Kenya, The National Treasury 2016).

The Green Economy Strategy and Implementation Plan (2016–2030): This provides guidance to all development actors in adopting pathways that prioritize green growth, a cleaner environment, and enhanced productivity compared to business-as-usual scenarios. It will facilitate Kenya's transition to a low-carbon development trajectory by promoting economic resilience, resource efficiency, sustainable natural resource management, and the development of sustainable infrastructure, and by fostering social inclusion.

The Climate Change Act (2016): The Act has the objective of enhancing climate change governance and coordination structures. It delineates the important responsibilities of both public and private sector entities in addressing climate change. Additionally, the Act acknowledges the collaborative roles of national and county governments in tackling climate change issues.

Kenya Climate Smart Agriculture Strategy (2017–2026): This provides guidance for investments in and implementation of climate-smart agriculture (CSA) practices. The strategy aims to ensure agricultural productivity and food security while addressing the challenges of climate change through adaptation, mitigation, human resource capacity, and finance. For crops, the strategy will prioritize agroforestry, conservation tillage, and agricultural waste management through adaptive measures such as the use of drought-tolerant crops, water harvesting, integrated soil fertility management, index-based insurance, and price stabilization schemes. For livestock, it prioritizes improved management of grazing systems, biogas, livestock diversification, and improved breeding of animals. The adaptation actions for livestock include building strategic food reserves, incorporating sustainable natural resource management, and mainstreaming climate change into agricultural extension services. The strategy lists CSA-relevant institutions, regulatory bodies, research organizations, and other stakeholders.

Water Master Plan Towards 2030: It proposes irrigation development programs and financing, and establishment of an institutional arrangement for efficient management and coordination of irrigated agriculture.

Other sectoral policies and strategies related to climate adaptation: These include the National Climate Change Response Strategy (2010), the Forest Conservation and Management Act (2016), the National Forest Programme (2016–2030), the National Drought Management Authority Act (2016), the Water Act (2016), and the National Spatial Plan 2015–2045.

ANNEX D:
RELEVANT INSTITUTIONS RELATED TO CLIMATE CHANGE IN KENYA

The National Climate Change Council (NCCC) is responsible for overall coordination and oversight of all climate-related issues at the national level, including the mainstreaming and approval of NAPs and NCCAPs. The Council is chaired by the President of the Republic of Kenya.

The Ministry of Environment, Climate Change and Forestry (MoECCF) is responsible for the strategic implementation of climate change affairs, submission of NCCAPs for approval, and reporting the implementation status to the NCCC and the Parliament. The Ministry of Environment and Forestry was restructured as the MoECCF in 2023, to assume a more prominent mandate for climate change. Kenya (Kenya, Republic of Kenya 2023) created a **State Department for Environment and Climate Change** in the MoECCF in charge of national environmental management, natural environment conservation, and climate action. **The Climate Change Adaptation, Negotiations, and Resource Mobilization Directorate** is in charge of adaptation policy, climate negotiations, national- and county-level strategy and project implementation, and the coordination of a national registry, while **the Climate Change Mitigation and Knowledge Management Directorate** oversees mitigation-related issues (Kenya, Ministry of Environment, Climate Change and Forestry 2023). **The National Environment Management Authority (NEMA)** is mandated by the Act to monitor and enforce compliance on behalf of the NCCC.

Other ministries, departments, and agencies (MDAs) are involved in sectoral implementation (Kenya, Ministry of Environment and Natural Resources 2016; CAT 2020). The National Treasury and Planning is involved in integrating climate change considerations into financial planning and resource allocation; the Ministry of Agriculture, Livestock, Fisheries, and Cooperatives is responsible for implementation of the Kenya Climate Smart Agriculture Project (KCSAP), supported by the World Bank through a US$250 million concessional loan that was used to develop climate risk profiles for 31 counties and to scale up CSA awareness and practices (Kenya, Ministry of Environment and Forestry 2022). The National Disaster Management Unit is responsible for disaster risk management and implementation of the Sendai Framework for Disaster Risk Reduction. The National Drought Management Authority is tasked with addressing drought emergencies and promoting adaptation and mitigating climate risks along with stakeholders (Tadesse 2016).

County-level governments: The devolution of power allows county governments to implement climate initiatives at the subnational level by incorporating climate change actions into their County Integrated Development Plans (CIDPs). The NAP specifically allows counties to develop and implement county adaptation plans.

Local level: Community-based, nongovernmental, civil society, and faith-based organizations and the public are all encouraged to take climate action at the grassroots level.

ANNEX E:
KENYA'S CLIMATE FINANCE LANDSCAPE

The green bond market in Kenya has struggled to take off. Kenya launched a Green Bond Programme in 2017 to stimulate development of the market. Under the Programme, the Nairobi Stock Exchange and the Capital Markets Authority published in 2019: (i) a Policy Guidance Note on Green Bonds; (ii) a Revision of Listing Rules to include provisions on green bonds; and (iii) a Green Bond Issuer's Guide (GFP 2019). The Programme also identified KES 90 billion of investment opportunity in the manufacturing, transport, and agriculture sectors in Kenya (Napier n.d.). However, so far there has been only one green bond issuance by Acorn Holdings in 2019 for affordable and environmentally friendly student housing (NSE n.d.). KCB, one of Kenya's largest commercial banks, announced plans to issue a green bond in 2022 but the issuance has not yet materialized (Genga 2021). Similarly, the National Treasury, in partnership with the World Bank, began plans in 2019 to issue a green bond. While the partnership made progress by setting up a Green Bond Steering Committee and developing a framework, as well as onboarding underwriters, it has failed to issue the green bond, largely due to the Debt Management Office's fundraising plans and debt strategy (Nicholson et al. 2023).[23]

More broadly, the climate finance market in Kenya faces several key challenges to its development. Some inhibiting factors include: (i) the hurdles associated with international climate finance; (ii) inadequate capacity to conduct feasibility studies and develop new financial models for investment; (iii) lack of clear Measurement, Reporting, and Verification (MRV) of climate projects and finance; and (iv) limited institutional systems (at national and subnational levels) to coordinate, design, and implement projects (Odhengo et al. 2019). Mooldijk and Lütkehermoller (2021) observe that the Kenyan financial sector is aware of climate-related risks and investment opportunities but lacks technical expertise regarding green bonds. Furthermore, Kenya does not have a green taxonomy and the lack of clarity on what activities are considered "green" poses a barrier to scaling up its green finance market and could lead to implementation issues for green initiatives, such as the government's Green Fiscal Incentives Policy Framework (see more below). A taxonomy could help direct more financing toward adaptation measures (Obare 2022). Existing vulnerabilities in the Kenyan financial market—including the high nonperforming loans ratio (14 percent) and high credit risk concentration in agriculture, energy, water, and manufacturing—are likely to pose additional barriers to climate finance growth in the country (AfDB 2023). In addition, Kenya, The National Treasury and Planning (2018) and the CPI (2021) noted that allocation of climate change financial resources currently favors mitigation actions, highlighting the importance of achieving a balance between resource allocation for adaptation and mitigation efforts.

Despite these challenges, funding for green investments in Kenya is taking place, although not at the necessary scale. According to Kenya, The National Treasury and Planning (2018), the country has accessed climate funding from international sources including the Global Environment Facility (GEF), Green Climate Fund (GCF), and the Adaptation Fund (AF). As of 2018, about 60 percent of climate

23 Kenya also cancelled its plans for a US$0.9 billion Eurobond in 2022, citing surging yields across the globe (Reuters 2022).

investments came from public sources, with a little more than one-half of that coming from international public funders. The remaining capital invested in climate-related activities (just over 40 percent of total) was provided by the private sector, amounting to KES 98.9 billion (US$0.97 billion), with two-thirds of that from foreign private investors (CPI 2021). Furthermore, KCB became the first Kenyan financial institution to be accredited by the GCF, which will pave the way for more investments in green projects in the future (GCF 2021). In particular, KCB plans to increase its green portfolio to 25 percent by 2025, and has already secured a partnership with the International Finance Corporation (IFC) to support this, including a US$150 million loan to fund KCB's climate finance portfolio (Marketscreener 2022). Kenya's largest bank by total assets, Equity Bank Group, launched a green financing program for adaptation and mitigation measures, including climate-smart architecture and water resource management, backed by funding from the IFC and other development institutions to support small and medium enterprise (SME) lending (EGF n.d.; Lewis 2022).

The government is taking proactive actions to facilitate more green investing. The Climate Change Act enables the National Treasury to manage the National Climate Change Fund but with oversight from the NCCC. The National Treasury is also responsible for operationalization of the Climate Finance Policy, which required US$19 million between 2017–2022 (Odhengo et al. 2019). The County Climate Change Funds (CCCF) further facilitate access to financing at the subnational level. CCCFs identify, prioritize, and finance investments to reduce climate risk and achieve adaptation priorities, in line with the national-level priorities set out in Kenya's NAP. Their key objectives are to: promote the mainstreaming of climate change adaptation into local planning and budget systems; improve coordination and locally led implementation; and help blend financial resources from international climate finance, multilateral development banks, the private sector, the government (including by accessing the National Climate Change Fund), and local county budgets (Murphy and Orindi 2017). The government also began developing the Green Fiscal Incentives Policy Framework, which aims to: (i) direct government planning, budgeting, and spending/procurement toward green production and consumption; (ii) provide a framework for fiscal incentives to attract private sector investment into a low-carbon emission, climate-resilient, and environmentally sustainable economy; and (iii) provide a framework for generating additional revenue streams for the government. This will be achieved through a range of fiscal and economic tools including taxes, concessional loans, guarantees, and catalyzing private investments (Kenya, The National Treasury and Economic Planning 2022).

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