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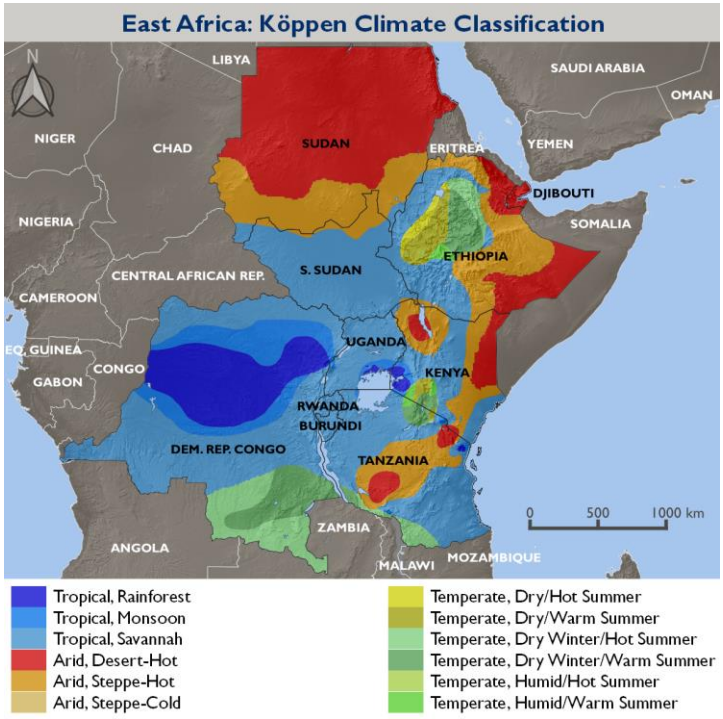
FACT SHEET

CLIMATE RISK PROFILE

EAST AFRICA

REGIONAL OVERVIEW

Climate variability and change pose major obstacles to resilience in East Africa, where increasing temperatures and shifting rainfall patterns are already affecting economic growth, livelihoods, food security, health, and ecosystems. The population of 421 million in the 10 countries covered in this profile stretch across 7.8 million km^2 of land — about a quarter of the African continent. The region is characterized by rapid urbanization at 4.0–6.2 percent annually for much of the region, higher than sub-Saharan Africa as a whole, which is one of the world's most rapidly urbanizing areas. More than 70 percent of the population, however, still live in rural areas where population growth continues and people rely heavily on climate-sensitive rainfed agriculture. Projections indicate that reduced crop productivity in much of the region is expected to increase poverty and food insecurity among populations where current poverty rates range from 21 percent (i.e., Djibouti, Uganda) to 64 percent (i.e., Burundi, Democratic Republic of the Congo [DRC]).



CLIMATE PROJECTIONS

- 0.5°C–3°C increase in temperatures by 2050
- Uncertain precipitation trends (with most models showing an increase) and shifts in intra-seasonal rainfall
- More frequent and intense heavy rainfall and flooding
- 16 cm to 46 cm rise in sea levels by 2050

KEY CLIMATE IMPACTS

Crop Production
Reduced yields, crop loss/failure, increased risk of pests and diseases, shifting production zones

Livestock
Reduced feed and water sources, increased physiological stress, increased risk of pests and diseases

Water Resources
Reduced water quality, damage, and flooding of infrastructure, increased risk of waterborne diseases

Human Health
Increased food insecurity, heat stress, flood-related mortality, and spread of vector-borne diseases

Infrastructure and Energy
Damage to roads, bridges, etc., coastal inundation, intensified structural overheating

Ecosystems
Shift in range of species, loss of habitat and biodiversity, loss of tourism revenue

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This combination of urbanization and declining agricultural productivity will affect livelihoods, health, infrastructure, and food security. In the Lake Victoria Basin, home to approximately 45 million people across areas of Burundi, Kenya, Rwanda, Tanzania, and Uganda, drought in recent years has already pushed more than 10 percent of the population toward chronic food insecurity. Climate-sensitive diseases like malaria are poised to expand into the warming East African highlands and Lake Victoria region. Within sub-Saharan Africa, the region is expected to see the most marked increase in areas of malaria suitability; by 2030, approximately 10–15 million additional people will be at risk in historically malaria-free areas. In Tanzania, for example, new cases are emerging in Tanga, Kilimanjaro, and the Arusha highlands; in the DRC, analysis suggests that by 2030 an additional 65,000–80,000 people will be at risk from endemic malaria in areas previously unsuitable for malaria transmission. (6, 7, 40, 41, 73, 72, 76, 74, 80)

Increasing temperatures and more frequent and intense extreme weather events are expected to lead to land degradation and infrastructure damage and destruction, with consequences for human health. In urban and periurban areas, increased flooding is already straining limited drainage and sanitation infrastructure, with implications for infrastructure integrity and water quality. In Rwanda, heavy rains in 2012 leading to extensive flooding caused an estimated loss of 1.4 percent of gross domestic product (GDP). Sea level rise and coastal erosion along the region's 3,000 km of coastline (i.e., Djibouti, Kenya, Sudan, and Tanzania) threaten coastal urban areas, ports, aquifers, agriculture, and ecosystems. In Tanzania alone, sea level rise is expected to cost about US$200 million per year by 2050 in lost land and flood damage. (6, 7, 40, 41, 73, 72, 76, 74, 80)

CLIMATE SUMMARY

East Africa's climate zones are diverse, ranging from arid to temperate to tropical (see map on p. 1). The varied geography spans coastal regions, deserts and savannas, vast forests, lakes including Lake Victoria, the second largest freshwater lake in the world, and mountainous areas including Africa's two tallest mountains, Mt. Kilimanjaro and Mt. Kenya. Temperatures are high and characterized by little seasonal variation across much of the region. Temperatures are lower in the highland regions of Ethiopia, Kenya, and Tanzania. Annual average temperatures range from as low as 6°C in high-elevation areas of Kenya and Tanzania to around 26°C in coastal areas and up to 30˚C in the northern interior (i.e., Sudan). There are three main rainfall regimes—in equatorial regions (much of the area described), there are two rainy seasons with peaks in October and April; in the north, the primary rainy season is June to August; and in the south the primary rainy season is December to February. These seasons are linked to the annual north–south movement of the precipitation-inducing Intertropical Convergence Zone, which shifts toward warmer air bringing rainy seasons in the respective warm months of areas north and south of the equator. Additionally, precipitation is periodically influenced (every two to seven years) by the El Niño Southern Oscillation, leading to alternate periods of above- and below-average rainfall. Annual rainfall averages from nearly 0 mm in parts of northwest Kenya to over 2,000 mm in highland areas and in the DRC. There is substantial interannual and interdecadal rainfall variability, and both droughts and floods are common. (14, 34, 45, 52)

CLIMATE TRENDS AND PROJECTIONS

There has been a clear trend of increasing average temperatures across East Africa since the 1960s, while precipitation trends have been weak and variable. Climate models indicate continued increases in average temperatures (and heat waves), as well as the frequency and intensity of heavy rainfall events. The future of overall precipitation changes is less certain, with the majority of models showing increased precipitation for much of the region (with the exception of southern Tanzania) but with shifts in seasonality. The table below outlines these shifts throughout the region. Despite potential precipitation increases shown in some models, droughts are expected to intensify in the 21st century due to longer dry spells combined with increased evaporation and a greater proportion of precipitation coming in heavy rainfall events. (6, 14,15, 20, 21, 22, 23, 24, 25, 35, 52, 71)

Areas	Periods with Projected Rainfall Increase	Periods with Projected Rainfall Decrease
Eastern (Ethiopia, Kenya, and Tanzania)	• October–December (short rainy season north of the equator) • January–February • July–September	• March–May (long rainy season north of the equator)
Western Ethiopia	• March–May (long rainy season north of the equator)	• June–September (rainy season)
Northern (Sudan)	• August–October (2nd half of rainy season) and November–January	• No projected rainfall decrease
DRC	• November–April (rainy season)	• No projected rainfall decrease

(19, 20, 21, 24, 25)

Historical Climate Trends	
Temperature	• Increased average temperatures of 1°C to 2.5˚C since the 1960s, with the greatest warming in the region's north and center (Sudan, South Sudan, and Uganda, have all warmed at over 0.5˚C per decade over the last 30 years) and least warming along coastal Kenya
Rainfall	• Precipitation trends are weak and variable across the region; however, evidence suggests a decrease in precipitation in the March–May period since the late 1970s in some areas (i.e., central Kenya, western South Sudan, and Uganda)
Heavy rainfall	• Increased frequency and intensity of heavy rainfall events
Drought and dry spells	• Increased frequency and severity of droughts since the 1990s (i.e., Kenya, Sudan, Tanzania, Uganda)
Glaciers	• Glacial surface area loss of 80 percent across Mt. Kenya (0.5 km^2 to 0.1 km^2), Mt. Kilimanjaro (6 km^2 to ~1 km^2) and the Ruwenzori Mountains (~10.6 km^2 to ~1.7 km^2) from 1900 to 2010
Sea level rise	• Sea level rise of 11.5 cm from 1955 to 2003 but with declining sea level in parts of Tanzania • From 1984 to 2016, observed average rise in sea level of 1.58 mm per year for Tanzania (Zanzibar) • From 1986 to 2016, observed average rise in sea level of 3.46 mm per year for Kenya (Mombasa)

(3, 4, 20, 21, 22, 23, 24, 25, 47, 65, 28, 29)

Climate Projections	
Temperature	• Increased average temperatures of 1°C–3°C by the 2050s (depending on location and global greenhouse gas emissions), with the largest increases in central and northern parts of the region • Increased frequency and duration of heat waves (+4–36 days), particularly in the northeastern part of the region (Djibouti, Ethiopia, Kenya, and Sudan) by 2050
Rainfall	• Uncertain trend for average annual precipitation; the majority of models point to an increase across the region by 2050, particularly during the northeast monsoon period (with the exception of southern Tanzania) and with the greatest potential increases for Ethiopia and Kenya • Shifts in rainfall seasonality for much of the region, including: increased precipitation during October–December (the short rainy season north of the equator) and decreased March–May precipitation (the long rainy season north of the equator)

Climate Projections	
	• An increase in interseasonal and interannual rainfall variability
Heavy rainfall	• Increased frequency and intensity of heavy precipitation events, especially in the central and northern parts of the region (Burundi, DRC, Ethiopia, Rwanda, and Tanzania)
Drought and dry spells	• Intensified drought occurrence
Glaciers	• Disappearance of the region's glaciers by 2050
Sea level rise	• Sea level rise of 16 cm to 46 cm by 2050

(13, 14, 18, 20, 21, 22, 23, 24, 25, 50, 52)

SECTOR IMPACTS AND VULNERABILITIES

CROP PRODUCTION

Warming temperatures and changing precipitation patterns are expected to decrease subsistence and cash crop production, which remain a critical source of livelihoods and economic activity across the region. Aside from Djibouti, DRC, and South Sudan, agriculture exceeds 24 percent of GDP in all countries. Small-scale farms account for up to 90 percent of crop production across the region and the main source of employment for the region's 297 million rural residents. The dominant crops are a cereal–legume mix that includes maize, millet, sorghum, wheat, and beans; major cash crops include coffee and tea. Already low yields resulting from low-input rainfed production with limited processing, storage, and transportation infrastructure make the vast majority of crop production highly vulnerable to changes in temperature and rainfall. Heat and water stress are expected to reduce maize, bean, banana, and plantain yields at lower elevations by the 2030s to 2050s. However, in higher elevations, temperature increases are projected to expand the areas for crop production potential. This expanded production potential could increase to cultivation pressure on mountain slopes and in protected areas with implications for ecosystem services and biodiversity. Maize, which accounts for nearly half of calories consumed in the region, is expected to experience yield reductions of 8–37 percent across East Africa by the 2090s. Lowland bean production, vital for nutritional security, is expected to become unviable due to rising temperatures sometime after midcentury, particularly affecting Tanzania and Uganda. In drier areas of East Africa (especially South Sudan and Sudan), even drought-resilient millet, sorghum, and cassava yields may become increasingly marginal. Wetter rainy seasons could prevent staple crops (e.g., maize, sweet potatoes) from maturing, although increased rainfall would be favorable for other crops (e.g., perennials and a range of fruits and vegetables). A warmer, wetter climate may also raise crop and postharvest losses due to heightened risk of mildew, leaf spot, and bacterial stem and root rot and increased fungus growth in stored seeds. (1, 8, 36, 51, 52, 63, 67, 80)

Climate Stressors and Climate Risks
CROP PRODUCTION

Stressors	Risks
Rising temperatures	Crop failure/loss, reduced yields and quality
Increased heat stress on crops	Changes in crop suitability due to shifting agroecological zones
Shifting seasonal rainfall patterns	Increased incidence of pest and diseases (e.g., maize stalk borer, coffee berry borer)
Increased frequency and intensity of heavy rainfall	Soil degradation from heavy rainfall, flooding, and erosion
Sea level rise	Saltwater intrusion, coastal erosion, storm surges, and inundation

Increasing heat and pest stress (e.g., coffee berry borer) are expected to diminish the area suitable for coffee and tea production by 20 to 40 percent across Burundi, Ethiopia, Kenya, Rwanda, and Uganda by 2100. However, the areas suitable for coffee production are expected to expand into higher elevations as well, which has negative environmental implications (e.g., deforestation, reduced water availability, nutrient loading in streams). For East Africa's water-intensive cut flower industry, heat and water stress, heavy rainfall resulting in soil degradation, and growing tensions over access to limited water resources threaten production. Along the coast, sea level rise is expected to increase water logging, salinization, and inundation of agricultural lands with particular risk for mango, cashew, and coconut harvests. (1, 11, 32, 52, 55)

LIVESTOCK

Rising temperatures, shifting rainfall patterns, drought, and increased heavy rainfall events are the most significant stressors facing the region's main livestock species: cattle, sheep, goats, camels, and poultry. East Africa's livestock are integral for the region's culture, as well as food security and livelihoods, particularly in arid and semi-arid lands, and contribute significantly to annual GDP, including approximately 20 percent and 25 percent in Ethiopia and Kenya, respectively. Livestock provide critical sources of meat and milk production, income, investment, credit, and savings. As climate variability and change, including heat and water stress, make crop production more tenuous, livestock production is expected to replace areas of mixed crop–livestock systems in some coastal and mid-elevation areas by the 2050s. While typically more resilient to climate variability and shocks than crops, livestock are susceptible to heat stress, and their viability is affected by the productivity and availability of pasture, feed production, water availability, and pest and disease dynamics. Recurrent climate-related shocks are already leading to critical livestock losses. During Kenya's 2008–2011 droughts, the country's economy lost an estimated US$12.1 billion, with livestock losses accounting for more than two-thirds of the total. Heavy rains across the region from March to May 2018 led to extensive flooding and livestock deaths, including the loss of 20,000 livestock in Kenya and 700 in Rwanda. (30, 41, 52, 57, 58, 59, 60, 61, 70, 73, 77)

Climate Stressors and Climate Risks LIVESTOCK

Stressors	Risks
Increased temperature and heat waves	Reduced livestock reproduction, growth rates, and milk production due to heat stress
	Increased milk spoilage due to warmer temperatures
Shifting seasonal rainfall patterns	Reduced feeding options due to rangeland degradation and diminished fodder crops
	Early drying or loss of seasonal water sources
Increased frequency and intensity of heavy rainfall	Altered pastoral mobility and increased conflict over scarce resources
	Increased occurrence and outbreaks of some livestock diseases

Livestock are also susceptible to heat stress that reduces feed intake, reproduction rates, milk production, and longevity. Rising temperatures and flooding could also increase the incidence of diseases, such as anthrax and Rift Valley Fever, and expand the range of ticks carrying diseases such as East Coast Fever. Increased seasonal and drought-related water stress, alongside warming trends, have already impacted pastures, fodder crops, and water availability in some areas, including the Lake Victoria Basin. For pastoralist communities, climate-related changes in pasture and water availability could alter pastoral mobility, exacerbating tensions over land and water resources in the region. Drought years in Ethiopia's Borana Zone, for example, are linked to an increase in violent conflict over grazing areas, water points, cattle theft, and boundary disputes. (37, 40, 41, 52, 67, 72, 75)

WATER RESOURCES

Increasingly severe flooding and drought, in addition to rising evaporation rates and shifting rainfall patterns, will diminish East Africa's water quality and reduce water availability. For example, this could occur when rapid runoff from heavy rainfall, rising evaporation rates, and drought offset increases in rainfall. While access to water and sanitation in East Africa continues to improve, unsafe drinking water and inadequate sanitation remain critical health concerns, particularly in rural and rapidly growing periurban areas. Projected increases in flood and drought occurrence exacerbate these challenges and threaten progress toward sector development goals. Low access to basic sanitation—less than 50 percent of the population across all 10 countries and just 20 percent in rural areas— increases the risk of water contamination during heavy rainfall events. Population growth combined with heavy rainfall events is increasingly contaminating the Lake Victoria Basin with waste from neighboring countries. Research also suggests that more frequent heavy rainfall events and warming water temperatures will lead to a greater incidence of waterborne disease outbreaks (e.g., typhoid, cholera, schistosomiasis, and diarrhea). The risk factor is exacerbated by the fact that less than half of the region's urban population has access to clean and safe water supplies. Diarrheal diseases are already a leading cause of mortality in children and adults, with surges in cases linked to flooding. The expected increase in consecutive dry days may also lead to longer water storage times, further increasing the risk of contamination and pathogen growth during storage. (15, 38, 52, 53, 56, 68)

Higher temperatures that increase evaporation, shifting rainfall patterns, and longer dry spells will also impact the region's numerous transboundary water resources. Arid and semi-arid lands, particularly in the north of the region, already experience high levels of baseline water stress where water withdrawals approach the total amount of fresh water available. Evaporation and precipitation trends combined with irrigation and hydropower development are expected to reduce river flows and exacerbate water stress in the socioeconomic and geopolitically important Nile River Basin. Research estimates that Nile Basin flows may increase through the 2030s but decline after the 2050s. In contrast, increasing rainfall is expected to balance or outweigh rising evaporation rates, resulting in a negligible change in total runoff in the Congo basin and increased runoff in the Lake Victoria Basin, including for the Mara and Nyando rivers. In coastal aquifers, reduced freshwater flows during longer dry spells may increase the risk of saline intrusion, which will be further exacerbated by sea level rise. (32, 33, 41, 52, 81)

Climate Stressors and Climate Risks
WATER RESOURCES

Stressors	Risks
Increased temperature and heat waves	Reduced river flow and increased water shortages in some areas (i.e., Nile Basin after 2050) and during some seasons
Shifting seasonal rainfall patterns	Decreased water quality due to heavy rainfall events resulting in pollution and sedimentation
Increased frequency and intensity of heavy rainfall	Increased risk of waterborne diseases (e.g., typhoid, cholera, bilharzia, diarrhea)
Intensified drought occurrence	Increased flood damage to water supply and sanitation infrastructure
Increased consecutive dry days	Saltwater intrusion into coastal aquifers (e.g., Dar-es-Salaam)
Sea level rise	

HUMAN HEALTH

Rising temperatures and shifting rainfall patterns are likely to impact numerous health outcomes. Climate change and variability increases both direct health risks (e.g., the risk of respiratory diseases and dehydration due to more intense heat waves) and indirect risks (e.g., changing the incidence of infectious diseases). A warmer climate is expected to increase the incidence of vector- and waterborne diseases, including malaria, dengue, and cholera, with 45–65 million more people at risk from malaria in East Africa by the 2050s. Some areas 2000 m above sea level, historically unsuitable for malaria, are expected to shift toward endemic (year-round) suitability as early as 2030. Dengue is expected to increase in much of the region, particular in the DRC and neighboring countries, but potentially decrease in some areas that exceed temperature and dryness thresholds (e.g., areas of eastern Ethiopia and Sudan). Rising temperatures and longer heat waves are linked to increased mortality rates and the worsening of cardiovascular and respiratory diseases. (42, 46, 52,70, 76)

Climate Stressors and Climate Risks
HUMAN HEALTH

Stressors	Risks
Increased temperature and heat waves	Increased mortality and morbidity related to heat stress
Shifting seasonal rainfall patterns	Increased drowning and displacement related to inland and coastal flooding
Increased frequency and intensity of heavy rainfall	Increased poverty, food insecurity, and malnutrition caused by crop loss/decreased yields, livestock loss, or rising food prices
Sea level rise	Increased risk of vector- and waterborne diseases, including malaria and cholera

Heat stress will particularly affect the elderly, children, and those in warmer lowland and dense urban areas (a number increasing with urbanization), such as informal settlements in Mombasa, Kenya, Dar-es-Salaam, Tanzania and Kampala, Uganda, where temperatures can rise dramatically due to the urban heat island effect. In Ethiopia, heat-related mortality among the elderly is projected to increase from 3 deaths per 100,000 people annually in 1990 to 65 per 100,000 annually by 2080. Outside of the region's highlands, the number of days with deadly heat annually is expected to increase from nearly zero in 2000 to between 50 and 350 by 2100. Increased flooding poses an additional risk to human health. In 2018, flooding across the region led to extensive loss of life, more extensive cholera outbreaks (e.g., DRC and Kenya) and critical crop and livestock losses. (2, 17, 44, 48, 49, 56, 57, 58, 59, 60, 61, 62, 66, 78, 79, 80)

The impacts of warming temperatures, shifting rainfall patterns, and sea level rise on agriculture are expected to exacerbate food insecurity and malnutrition in this region, where high rates of undernutrition and stunting in children under five persist (i.e., 43 percent and 56 percent in DRC and Burundi respectively). Across the drought-sensitive countries in the region, the number of undernourished people increased from 113 million in 2005 to 133 million in 2018. Additionally, from the mid-1990s onwards, higher incidences of child malnutrition have been correlated with periods of drought in the Horn of Africa (e.g., 2003, 2010); higher food prices that often occur as a result of drought-induced food shortages have also been associated with the prevalence of underweight children. Child undernutrition can have significant developmental and socioeconomic costs exacerbating long-term development challenges. For Rwanda, the total estimated annual losses associated with undernutrition are estimated at US$820 million, equivalent to 11.5 percent of GDP in 2012. In Ethiopia, child mortality associated with undernutrition has reduced its workforce by 8 percent. Prevailing dry conditions across the Horn of Africa in 2019, for example, led to sharply increased food prices, reduced water availability, and crop and livestock losses, all with implications for food security and human health. Somalia, the most drought-prone country in the region, has faced both chronic food insecurity and high levels of malnutrition since the 1970s; as a result of the 2008–2010 drought, for example, the country experienced a famine during which one-third of children in southern Somalia were malnourished. (2, 17, 44, 48, 49, 56, 57, 58, 59, 60, 61, 62, 66, 78, 79, 80)

INFRASTRUCTURE AND ENERGY

More frequent and intense heavy rainfall events are likely to increase the impact of floods and landslides on infrastructure and associated energy, water, and transportation services across East Africa. From March through August 2018, heavy rainfall across much of the region led to damage and destruction of critical infrastructure, including more than 100,000 houses as well as bridges, roads, dams, power lines, schools, health facilities, latrines, and markets. Hydropower provides a substantial portion of the region's power generation and has been affected heavily by drought events in recent years; projections of reduced river flow in the Nile Basin may exacerbate this trend. Heavy rainfall and subsequent soil erosion are further expected to increase siltation of reservoirs critical for hydropower production. In Kenya, hydropower production is reduced by up to 40 percent in drought years, leading to persistent power outages and reliance on more expensive petroleum-based thermal generation. Research shows that, if constructed, hydropower dams planned for East Africa before 2030 could put 70 percent of the region's electricity supply at risk from climate variability and change, as they rely on areas with similar rainfall patterns. Although most precipitation models project an overall increase in annual precipitation regionally, interannual erratic rainfall variability increases the risk of drought regionally. As a result, the increased frequency of drought could greatly reduce the water impounded in reservoirs supplying hydropower dams. (12, 26, 27, 29, 31, 43, 52, 57, 58, 59, 60, 61, 62)

Climate Stressors and Climate Risks
INFRASTRUCTURE AND ENERGY

Stressors	Risks
	Increased flood and landslide damage to buildings, bridges, roads, dams, powerlines, etc.
Increased temperature and heat waves	Buildings overheat and road surfaces are compromised by high temperatures
Increased frequency and intensity of heavy rainfall	Reduced river flows hamper hydropower production
	Increased siltation of reservoirs
Sea level rise	Sea level rise inundates low-lying coastal infrastructure and population centers; coastal erosion damages or washes away infrastructure

Along the coast, more than 40 million people are expected to live no more than 10 m above sea level by the 2060s, where sea level rise and coastal erosion will increasingly threaten infrastructure through damage and inundation. In Dar-es-Salaam alone, infrastructure assets of US$5.3 billion and the country's main port are increasingly at risk from coastal flooding. Mombasa and its port, Kilindini, are also sensitive to sea level rise, and models estimate assets of up to US$4.8 billion will be exposed to flooding and inundation from sea level rise by 2050. (26, 40, 49)

ECOSYSTEMS

While complex interactions among drivers of ecosystem structure, composition, and function make climate impacts difficult to predict, rising temperatures and shifting rainfall patterns are expected to further stress East Africa's rich biodiversity, which already faces pressure from human activities (e.g., deforestation, pollution, wildlife trafficking and poaching, expanding settlements, conversion to agriculture). Increasing heavy rainfall events and more intense droughts are expected to intensify land degradation and reduce vegetative cover across many of the region's diverse ecosystems that provide critical products and ecosystem services, including forestry, fishery, pastoral and tourism-based livelihoods, as well as critical fuel and food supplies and water regulation (e.g., filtration, groundwater recharge). Rising temperatures, storms,

and floods also pose increased threats to ecosystems through direct damage, shifted distributions of native and invasive species, increased physiological stress, disrupted predator–prey relationships, and increased wildfire risk. For example, an estimated 107 mammal, 199 bird, 31 fish, 34 amphibian, and 79 plant species in the Albertine Rift region (covering parts of Burundi, DRC, Rwanda, Tanzania, and Uganda) are highly vulnerable to climate change due to thermal sensitivity and/or projected changes in habitat suitability. Warming of the region's freshwater lakes, important for livelihoods and protein, has already led to decreased nutrient cycling and reduced fishery productivity in Lakes Victoria, Tanganyika, Kivu, Malawi, and others. (9, 32, 39, 52, 54, 69)

Meanwhile, shifts in agroecological zones may lead to agricultural expansion into previously intact forests and grasslands, particularly in highland areas. Shifting ecological zones may also change the suitable ranges of plant and wildlife species, themselves adversely impacting the endemic freshwater fish, hippos, and the endangered African wild dog, that depend on these species. Along the region's coastline, sea level rise, warming ocean temperatures, and ocean acidification are increasing coastal erosion and threatening mangrove habitat, coral reefs, coastal biodiversity, and fishery productivity. Ocean warming is expected to decrease the region's marine biodiversity and fishery catch potential by three or more times the global average by 2100. This has impacts on artisanal and industrial fisheries that also face increasing pressure from offshore fishing by foreign commercial vessels. In Tanzania, for example, fisheries provide more than 4 million jobs and an important protein source in coastal and inland regions; increasing ocean temperatures and sedimentation from heavy rains further threatens fisheries, with consequences for livelihoods and nutrition nationwide. Mangroves and coral reefs are critical for fisheries, storm surge protection, and the tourism economy. The region's coral reefs are highly susceptible to heat stress and have not yet fully recovered from the 1998 coral bleaching event. (5, 10, 16, 39, 52, 54, 64, 73)

Climate Stressors and Climate Risks ECOSYSTEMS

Stressors	Risks
Increased temperature and heat waves	Increased damage and degradation in forests, grasslands, and wetlands
Shifting seasonal rainfall patterns	Increased severity and extent of wildfires
Increased frequency and intensity of heavy rainfall	Reduced and shifted ranges for native plant and animal species leading to biodiversity loss
Sea level rise **Ocean warming**	Degradation/loss of coastal wetland habitats, mangroves, coral reefs, and fisheries

POLICY CONTEXT

INSTITUTIONAL FRAMEWORK

Regional cooperation is mainly coordinated through the Common Market for Eastern and Southern Africa (COMESA) and East African Community (EAC). Both institutions cooperate on climate change initiatives along with the Southern African Development Community (SADC). COMESA and EAC have both implemented climate change programming supported by a range of bilateral and multilateral donors, including the five-year Tripartite COMESA–EAC–SADC Climate Change Program which increased investments in climate-resilient and carbon-efficient agriculture. COMESA, a free trade area among 21 member states, engages member government ministries, parliamentarians, and civil society organizations to encourage participation in climate change adaptation and mitigation. COMESA aims to mainstream climate change throughout its work, and it houses a Climate Change Unit.

The EAC, an intergovernmental organization of six partner states, encourages regional integration among its members and aims to address climate change impacts. The EAC stated that it intends to reopen its Climate Unit, which closed in 2016 due to a lack of funds. The Lake Victoria Basin Commission (LVBC) of the EAC coordinates sustainable development and management of the Lake Victoria Basin. Additionally, in 2013, the United Nations Framework Convention on Climate Change (UNFCCC) and the East African Development Bank (EADB) signed a partnership agreement to establish a Regional Collaboration Centre (RCC) in Kampala, Uganda, to support national climate action and investments in sustainable development. The RCC fosters collaboration between Djibouti, Ethiopia, Kenya, Rwanda, South Sudan, Sudan, Tanzania, Uganda and 16 other African countries on adaptation and mitigation actions, and since 2015, has been tasked with supporting the implementation of countries' Nationally Determined Contributions (NDCs).

REGIONAL POLICIES AND STRATEGIES

- The COMESA Medium Term Strategic Plan (2016-2020) includes initiatives to mainstream climate risk analysis and resilience-building into COMESA-wide operations and specifically references climate-smart agriculture, environmental safeguards for climate risk, and early warning systems.
- The 5th EAC Development Strategy (2017-2021) recognizes regional climate-related risks, and the strategic objectives include enhancing regional mechanisms and strategies for climate change management.
- The EAC Vision 2050 (2016) aims to expand climate services, operationalize the EAC Climate Fund, and enhance climate change adaptation and mitigation among partner states.
- The EAC Climate Change Policy (2011) outlines the preparation and implementation of collective measures to address climate change in the region for partner states and other stakeholders.
- The EAC Climate Change Strategy (2011) guides the implementation of the EAC Climate Change Policy.
- The EAC Climate Change Master Plan (2011-2031) provides a long-term vision and basis for partner states to adapt to and mitigate climate change.
- The Lake Victoria Basin Climate Change Adaptation Strategy and Action Plan (2018-2023) presents a comprehensive roadmap for addressing and adapting to climate change impacts.

SECTOR-SPECIFIC INTEGRATED PLANS

A number of the EAC's sectoral strategies also support regional adaptive capacity. These include the One Health Regional Risk and Crisis Communication Strategy (2018-2023), Strategy to Combat Poaching, Illegal Trade and Trafficking of Wildlife and Wildlife Products (2017-2022), and Food Security Action Plan (2011-2015: a more recent version was not found). COMESA also houses relevant programs on regional livestock and fisheries. EAC and COMESA have both adopted the Comprehensive Africa Agriculture Development Program (CAADP) Regional Agriculture Investment Plan that aims to boost food security and agricultural productivity.

NATIONAL STRATEGIES AND PLANS

In addition to regional strategies, all countries in the region are addressing climate change at a national level (see table below). Each country has submitted at least two National Communications to the UNFCCC, except for South Sudan, which submitted its first National Communication in August 2019. As of August 2019, three countries (Ethiopia, Kenya, and Sudan) have submitted National Adaptation Plans (NAPs), and others are either a) in various stages of development, submission, and approval of Readiness and Preparatory Support proposals to the Global Climate Fund for NAP development, or b) have received support from the National Adaptation Plan Global Support Programme. Most countries also have dedicated climate change policies or have integrated climate change into national development or environment plans or legislation. In the case of Sudan, an aim of the country's National Adaptation Plan is to promote climate change integration into policy, which will likely be reflected in the country's forthcoming Five Year Economic Reform Program

(2020-2024). Additionally, some countries have integrated climate change into sectoral strategies, such as Uganda's Agriculture Sector Strategic Plan (2015-2020), Kenya's Draft Livestock Policy (2019), and Rwanda's National Policy for Water Resources Management (2011).

Country	Most Recent National Communication	National Adaptation Plan	Selected Climate Change-Related Plans, Strategies, and Laws
Burundi	NC2, 2010	-	Vision Burundi 2025 (2011)
DRC	NC3, 2015	-	Law No. 14/3 on Protection of Nature (2014)
Djibouti	NC2, 2014	-	Vision Djibouti 2035 (2014)
Ethiopia	NC2, 2016	2019	Ethiopia's Climate-Resilient Green Economy Strategy, Climate Resilience Strategy (2014)
Kenya	NC2, 2015	2017	National Climate Change Action Plan (2018-2022)
Rwanda	NC3, 2018	-	Green Growth and Climate Resilience Strategy (2011)
South Sudan	NC1, 2019	-	National Environment Policy (2015-2025)
Sudan	NC2, 2013	2016	-
Tanzania	NC2, 2015	-	National Climate Change Strategy (2012)
Uganda	NC2, 2014	-	National Climate Change Policy (2015)

SELECTED ONGOING EXPERIENCES

Below are selected projects in East Africa that include a focus on climate change adaptation. There are many more country-specific projects with an adaptation focus not listed here.

Selected Program	Amount	Donor	Year	Implementer
Programme for Climate-Smart Livestock	Not listed	GIZ	2018–2022	ILRI, WB
Agricultural Climate Resilience Enhancement Initiative (ACREI)	US$6.8 million	Adaptation Fund	2018–2021	IGAD, FAO, WMO
Adapting to Climate Change in Lake Victoria Basin	US$5 million	Adaptation Fund	2017–2020	UNEP, LVBC
Reducing climate vulnerabilities of the agriculture sector: Baselines and informed priority actions	Not listed	FAO	2019–ongoing	FAO
Horn of Africa-Groundwater Initiative	US$2.7 million	WB	2019–ongoing	IGAD
R4 Rural Resilience Initiative	Not listed	Multiple donors including USAID	2011–ongoing	WFP, Oxfam America
Policy Action for Climate Change Adaptation (PACCA) I and II	Not listed	CGIAR-CCAFS	2014–2017; 2018–2020	IITA, CIAT, and Utrecht University
Regional Pastoral Livelihoods Resilience Project	US$122 million	WB	2014–2019	IGAD, and numerous national entities
HYCRISTAL: Integrating Hydro-Climate Science into Policy Decisions for Climate-Resilient Infrastructure and Livelihoods In East Africa	Not listed	DFID	2015–2019	Future Climate for Africa
Planning for Resilience in East Africa Through Policy, Adaptation, Research and Economic Development (PREPARED)	US$40 million	USAID	2012–2018	Tetra Tech

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