GROUNDSWELL AFRICA

DEEP DIVE INTO **INTERNAL CLIMATE MIGRATION** **IN UGANDA**

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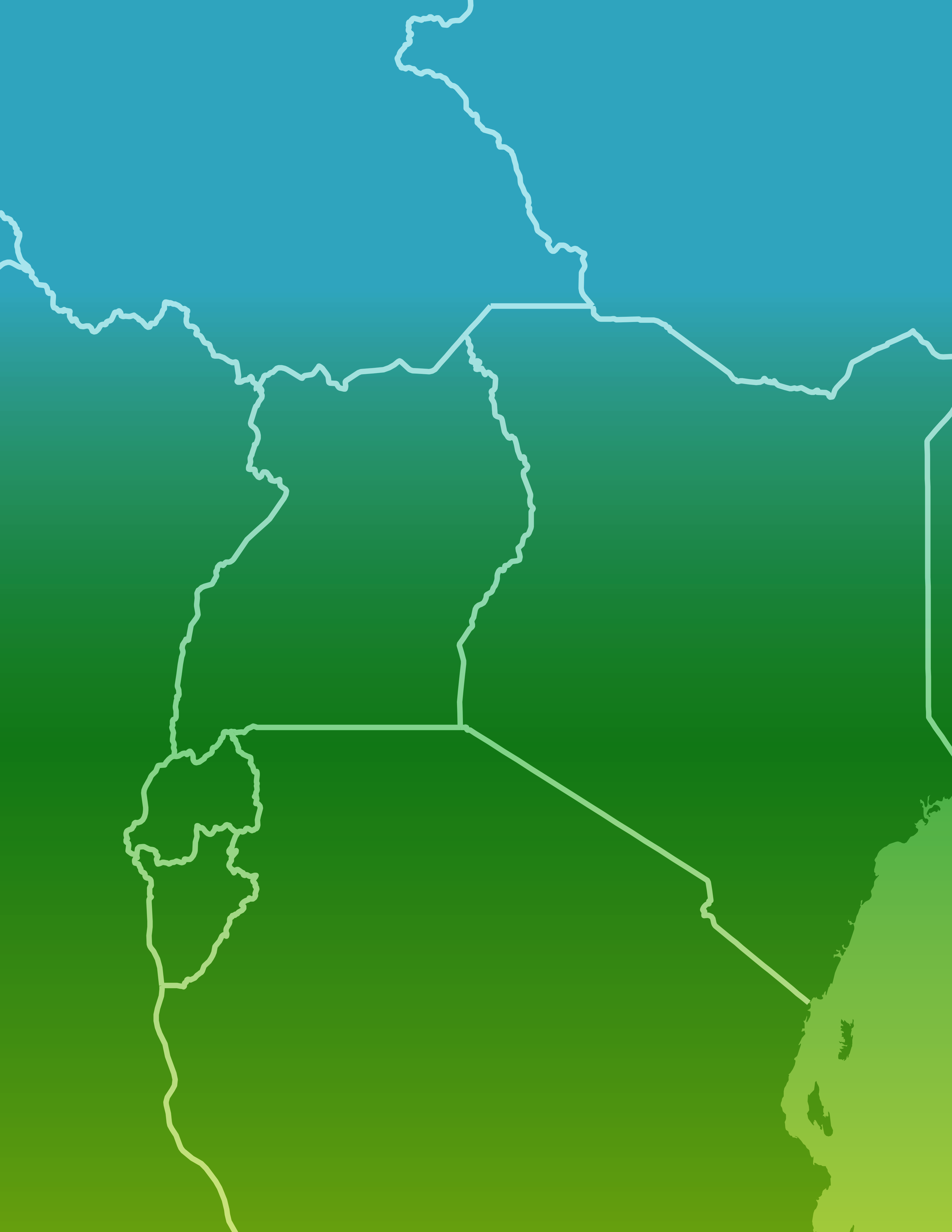

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Glossary

Adapt in Place: The cost of relocation in response to actual or expected climate change and its effect can often be high. Adapt in place is the process of adjustment without relocation.

Adaptation: Process of adjustment to actual or expected climate change and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate change and its effects.

Adaptive capacity: Ability of systems, institutions, humans, and other organisms to adjust to potential damage, take advantage of opportunities, and respond to consequences of climate impacts.

Agro-pastoralism: Combination of agriculture, crop-based livelihood systems, and pastoralism (see also pastoralism).

Anthropogenic biome: Anthropogenic biomes describe the terrestrial biosphere in its contemporary, human-altered form using global ecosystem units defined by patterns of sustained direct human interactions, for example, rainfed croplands.

Attractiveness: Desirability of a locale based on several factors including but not limited to economic opportunity, transportation infrastructure, proximity to family, the presence of social amenities, environment, and intangibles such as place attachment.

Biodiversity: Variety of plant and animal life in the world or in a particular habitat or ecosystem.

Biome: Large naturally occurring community of flora and fauna occupying a major habitat (for example, forest or tundra; see also **anthropogenic biome**).

Climate change: A change in the state of the climate that can be identified (for example, using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or because of human activity.

Climate change-induced migration (shorthand internal climate migration): In this report, climate change-induced migration is movement that occurs within countries that can be attributed largely to slow-onset impacts of climate change on livelihoods owing to shifts in water availability, crop and ecosystem productivity, flood risk, or sea level rise compounded by storm surge. The model also includes nonclimate factors: demographic factors (median age and sex) and conflict.

Climate in-migration hotspot: For the purposes of this study, climate in-migration hotspots are areas that will see increases in population in scenarios that take climate impacts into account relative to a population projection that does not take climate impacts into account. These increases can be attributed to in-migration, the “fast” demographic variable. Areas were considered to have increases in population when at least two of the three scenarios modelled had increases in population density in the highest 5th percentile of the distribution.

Climate migrant/migration (shorthand internal climate migrant/migration): In this report, climate migrants are people who move - within countries - because of climate change-induced migration (see above). The modeling work captures people who move at spatial scales of over 14 kilometers - within a country - and at decadal temporal scales. Shorter distance or shorter-term mobility (such as seasonal or cyclical migration) is not captured.

Climate out-migration hotspot: For the purposes of this study, climate out-migration hotspots are areas that will see decreases in population in scenarios that take climate impacts into account relative to a population projection that does not take climate impacts into account. These decreases can be attributed to out-migration, the "fast" demographic variable. Areas were considered to have decreases in population when at least two of the three scenarios modelled had decreases in population density in the highest 5th percentile of the distribution.

Climate risk: Potential for consequences from climate variability and change where something of value is at stake and the outcome is uncertain. Often represented as the probability that a hazardous event or trend occurs multiplied by the expected impact. Risk results from the interaction of vulnerability, exposure, and hazard.

Coastal erosion: Erosion of coastal landforms that results from wave action, exacerbated by storm surge and sea level rise.

Coastal zone: In this report, the coastal zone is land area within 5 kilometers of the coastline.

Conflict: Armed conflicts between groups. Armed Conflict Location & Event Data Project (ACLED) covers violent activity that occurs both within and outside the context of a civil war, particularly violence against civilians, militia interactions, communal conflict, and rioting.

Country Partnership Framework (CPF): Strategic document that guides the World Bank's country programs. The CPF identifies the key objectives and development results through which the World Bank intends to support a member country in its efforts to end extreme poverty and boost shared prosperity in a sustainable manner.

Crop productivity: Crop yield in tons per hectare on an annual time step.

Deforestation: Conversion of forest to non-forest.

Demographic dividend: The potential for economic growth made possible from shifts in a population's age structure.

Disaster Risk Reduction: The practice of reducing disaster risks through systematic efforts to analyse and reduce the causal factors of disasters.

Displacement: Forced removal of people or people obliged to flee from their places of habitual residence.

Distress migration: Movements from the usual place of residence, undertaken when an individual and their family perceive that there are no options open to them to survive with dignity, except to migrate. This may be a result of a rapid-onset climate event, other disasters, or conflict event, or a succession of such events, that result in the loss of assets and coping capacities.

Environmental mobility: Temporary or permanent mobility because of sudden or progressive changes in the environment that adversely affect living conditions, either within countries or across borders.

Extreme heat event: Three or more days of above-average temperatures, generally defined as passing a certain threshold (for example, above the 85th percentile for average daily temperature in a year).

Extreme weather event: Event that is rare at a particular place and time of year. Definitions of rare vary, but an extreme weather event would normally fall in the 10th or 90th percentile of a probability density function estimated from observations. The characteristics of extreme weather vary from place to place in an absolute sense. When a pattern of extreme weather persists for some time, such as a season, it may be classified as an extreme climate event, especially if it yields an average or total that is itself extreme (for example, drought or heavy rainfall over a season).

Flood Risk: The risk of inundation from flooding owing to extreme precipitation events, indicated in this modeling work by flood extent.

Forced migration: Forced migration generally implies a lack of volition concerning the decision to move, though in reality motives may be mixed, and the decision to move may include some degree of personal agency or volition.

GEPIC: The GIS-based Environmental Policy Integrated Climate crop model (see Appendix A of Rigaud et al. 2021a).

Gravity model: Model used to predict the degree of interaction between two places and the degree of influence a place has on the propensity of a population in other locations to move to it. It assumes that places that are larger or spatially proximate will exert more influence on the population of a location than places that are smaller and farther away.

Gross domestic product (GDP): The monetary value of all finished goods and services made within a country during a specific period.

HadGEM2-ES: Climate model developed by the Met Office Hadley Centre for Climate Change in the United Kingdom (see Appendix A of Rigaud et al. 2021a).

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

Immobility: Inability to move from a place of risk or choosing not moving away from a place of risk.

In-kind transfers: Unlike a cash transfer, it refers to the specific goods and services that migrants send back home.

Internal climate migrant (migration): In this report, climate migrants are people who move within countries because of climate change-induced migration (see above). The modeling work captures people who move at spatial scales of over 14 kilometers within a country, and at decadal temporal scales. Shorter distance or shorter-term mobility (such as seasonal or cyclical migration) is not captured.

Internal migration (migrant): Migration that occurs within national borders.

International migration (migrant): Migration that occurs across national borders.

IPSL-CM5A-LR: Climate model developed by the Institut Pierre Simon Laplace Climate Modeling Center in France (see Appendix A of Rigaud et al. 2021a).

Labor mobility: The geographical and occupational movement of workers.

Land degradation: The deterioration or decline of the biological or economic productive capacity of the land for present and future.

Landscape approach: An approach that advances multiple land uses and sustainable landscape management (SLM) to ensure equitable and sustainable use of land.

LPJmL: A global water and crop model designed by Potsdam Institute for Climate Impact Research to simulate vegetation composition and distribution as well as stocks and land-atmosphere exchange flows of carbon and water, for both natural and agricultural ecosystems.

Median Age: The age that divides a population into two numerically equal groups; that is, half the people are younger than this age and half are older.

Micro-watershed management: The management of land, water, biota, and other resources for ecological, social, and economic purposes with use of the micro-watershed as the unit of intervention (500-1000 ha).

Migration: Movement that requires a change in the place of usual residence and that is longer term. In demographic research and official statistics, it involves crossing a recognized political and administrative border.

Migration cycle: The three stages of migration process which can be leveraged for adaptation that is *adapt in place*, *enable mobility* and *after migration* support to host and migrant communities.

Mitigation (of climate change): Human intervention to reduce the sources or enhance the sinks of greenhouse gases.

Mobility: Movement of people, including temporary or long-term, short- or long-distance, voluntary, or forced, and seasonal or permanent movement as well as planned relocation (see also **environmental mobility, labor mobility**).

Moderate development: Shared Socioeconomic Pathway (SSPs) 2 scenario conceived by in O'Neill et al. 2014, in which developing countries achieve significant economic growth. Under an SSP2 scenario, lower-middle-income countries (LMICs) are characterized by moderate population growth, urbanization, income growth, and education; and have moderate challenges to adaptation.

More inclusive development: Scenario with SSP2 (moderate development) and Representative Concentration Pathway (RCP) 8.5 (high GHG emissions).

Nationally Determined Contributions (NDCs): The non-binding national plans by each country to reduce national emissions and adapt to the impacts of climate change enshrined in the Paris Agreement.

Net Primary Productivity (NPP): Measure of ecosystem productivity, that is, the productivity of a location's natural biome, including grassland biomes.

Other internal migrant: In this report, the term other migrant is used in reference to migrants who move within countries largely for reasons other than climate impacts.

Peri-urban: An area immediately adjacent to a city or urban area.

Planned relocation: People moved or assisted to move permanently away from areas of environmental risks.

Radiative forcing: Measurement of capacity of a gas or other forcing agent to affect the energy balance, thereby contributing to climate change.

Rainfed agriculture: Agricultural practice relying almost entirely on rainfall as its source of water.

Rapid-onset event: Event such as cyclones and floods which take place in days or weeks (in contrast to slow-onset climate changes that occur over long periods of time).

Representative Concentration Pathway (RCP): Trajectory of greenhouse gas concentration resulting from human activity corresponding to a specific level of radiative forcing in 2100. The low greenhouse gas concentration RCP2.6 and the high greenhouse gas concentration RCP8.5 employed in this report imply futures in which radiative forcing of 2.6 and 8.5 watts per square meter, respectively, are achieved by the end of the century.

Resilience: Capacity of social, economic, and environmental systems to cope with a hazardous event, trend, or disturbance by responding or reorganizing in ways that maintain their essential function, identity, and structure while maintaining the capacity for adaptation, learning, and transformation.

Riparian areas: The lands that occur at the interface between terrestrial and aquatic ecosystems.

Salinization: The accumulation of water-soluble salts in the soil which leads to substantial negative impact on plant productivity.

Sea level rise: Increases in the height of the sea with respect to a specific point on land. Eustatic sea level rise is an increase in global average sea level brought about by an increase in the volume of the ocean due to the melting of land-based glaciers and ice sheets. *Steric* sea level rise is an increase in the height of the sea induced by changes in water density due to the heating of the ocean. Density changes induced by temperature changes only are called *thermosteric*; density changes induced by salinity changes are called halosteric.

Sex Ratio: The number of males per 100 females in the population.

Shared Socioeconomic Pathway (SSP): Scenarios, or plausible future worlds, that underpin climate change research and permits the integrated analysis of future climate impacts, vulnerabilities, adaptation, and mitigation. SSPs can be categorized by the degree to which they represent challenges to mitigation (greenhouse gas emissions reductions) and societal adaptation to climate change.

Slow-onset climate change: Changes in climate parameters (temperature, precipitation, and associated impacts, such as water availability and crop production declines) that occur over long periods of time—in contrast to rapid-onset climate hazards, such as cyclones and floods, which take place in days or weeks.

Storm surge: The rise in seawater level during a storm, measured according to the height of the water above the normal predicted astronomical tide.

Stressor: Event or trend that has important effect on the system exposed and can increase vulnerability to climate-related risk.

Sustainable livelihood: Livelihood that endures over time and is resilient to the impacts of various types of shocks including climatic and economic.

Systematic Country Diagnostic (SCD): World Bank tool to identify the most important challenges and opportunities a country faces in advancing towards the twin goals to end extreme poverty and boost shared prosperity in a sustainable manner.

System dynamics model: A model which decomposes a complex social or behavioral system into its constituent components and then integrates them into a whole that can be easily visualized and simulated.

Tipping element: Subsystems of the Earth system that are at least subcontinental in scale and can be switched—under certain circumstances—into a qualitatively different state by small perturbations. See tipping point.

Tipping point: Particular moment at which a component of the earth's system enters into a qualitatively different mode of operation, as a result of a small perturbation.

Transformation: Strategies that can reduce the underlying causes of vulnerability to climate-induced migration.

Urban transition: Shift from rural to urban and from agricultural employment to industrial, commercial, or service employment.

Vulnerability: Propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.

Water Availability: The water sector model outputs represent river discharge, measured in cubic meters per second in daily/monthly time increments.

WaterGAP2: The Water Global Assessment and Prognosis (WaterGAP) Version 2 global water model developed by the University of Kassel in Germany Germany (see Appendix A of Rigaud et al. 2021a).

Abbreviations

ACLED	Armed Conflict Location & Event Data Project
CCDR	Country Climate Development Report
CIESIN	Center for International Earth Science Information Network
CMIP5	Coupled Model Intercomparison Project Phase 5
CPF	Country Partnership Framework
DRC	Democratic Republic of Congo
EAC	East African Community
ENSO	El-Nino Southern Oscillation
FAO	Food and Agriculture Organization of the United Nations
GCM	Global Compact for Safe, Orderly, and Regular Migration
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GIS	Geographic Information System
GRID	Global Report on Internal Displacement
IDMC	Internal Displacement Monitoring Centre
IDP	Internally Displaced Person
IGAD	Intergovernmental Authority on Development
IOM	International Organization for Migration
ISIMIP	Inter-Sectoral Impact Model Intercomparison Project
IUCN	International Union for Conservation of Nature
LIC	Low Income Country
LMIC	Low- and Middle-income Country
LVB	Lake Victoria Basin
MACS	Migration and Climate-informed Solutions
NGO	Non-governmental organization
NDC	Nationally Determined Contribution
NDP	National Development Plan
NPP	Net primary productivity
NEMA	Uganda National Environment Management Authority
OCHA	United Nations Office for the Coordination of Humanitarian Affairs
ODI	Overseas Development Institute
RAP	Resettlement Action Plan
RCPs	Representative Concentration Pathways
SCD	Systematic Country Diagnostic
SDGs	Sustainable Development Goals
SLM	Sustainable Land Management
SSP	Shared Socioeconomic Pathway
UBOS	Uganda Bureau of Statistics
UN DESA	United Nations Department of Economic and Social Affairs
UNFCCC	United Nations Framework Convention on Climate Change
UNHCR	United Nations High Commissioner for Refugees
UNICEF	United Nations Children's Fund
WaterGAP	The Water Global Assessment and Prognosis
WDI	World Bank Development Indicator
WMO	World Meteorological Organization

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Foreword

Uganda is a diverse and verdant country. From the volcanic mountains along the eastern and western borders to the densely forested wetlands of the Albert Nile River and the rainforests in the center of the country, Uganda encompasses many different ecosystems. These varying landscapes provide Ugandans with ample resources to capitalize on tourism, cultivate crops, and generate power.

These rich and beautiful landscapes, however, are under threat from climate change, which could have disastrous effects for Ugandans. As many as 12 million people, or 11% of the population, could move within the country by 2050 as a consequence of slow onset climate factors, without concrete climate and development action. Growing population pressures also fuel environmental degradation, thereby exacerbating the threat of climate change.

If unattended, climate induced migration could also deepen existing vulnerabilities across the country, potentially leading to greater poverty, fragility, and inequality.

Some areas will be more impacted than others, with "hotspots" of climate migration emerging in the coming years. The Lake Albert region, which already hosts a large refugee community, could witness people moving within countries due to declining water availability and low crop production, while the Lake Elgon region and the capital city, Kampala, are expected to receive large inflows of internal climate migrants. Moreover, with over 1.4 million refugees in 2021, Uganda currently hosts the largest refugee population on the African continent and is the third largest refugee hosting country in the world. This presents additional challenges to the nation's objective of more inclusive and sustainable development.

To protect communities from the negative impacts of unmanaged climate change migration and to promote equity in development outcomes, it is imperative that we ramp up collective global action in order to drastically cut greenhouse gas emissions and integrate climate resilience and adaptation into national planning. Doing so in Uganda could decrease the number of internal migrants by 35 percent—a significant reduction for a country that is already characterized by a large degree of mobility.

However, to achieve these goals, action is needed now. Acting early and focusing on improved management of forests and other landscapes, developing job opportunities, and providing basic services for both host communities and refugees will be important steps to help communities adapt well to the changing climate.

This deep dive in Uganda makes two things clear: Firstly, Uganda's development prospects will only be reached if the impacts of climate change are mitigated and actions are taken to adapt to inevitable changes, and secondly, the cost of inaction will be felt across all aspects of society, so we must protect people and communities to limit potential displacement and help lift people out of poverty.

Mark Lundell,
Regional Director for Sustainable Development
Eastern and Southern Africa

Mukami Kariuki,
Uganda Country Manager

Sarah Farhat/ The World Bank

Executive Summary

MESSAGE 1:
Uganda, one of the Lake Victoria Basin countries, is projected to exhibit high levels of internal climate migration, representing an amplification of current mobility patterns and trends.

The World Bank's Groundswell reports set out the potency for climate change to drive internal climate migration (Rigaud et al. 2018, Clement et al. 2021), with Sub-Saharan Africa being the most affected. An expanded and deeper analysis applied to the Groundswell Africa reports, focusing on the five Lake Victoria Basin (LVB) countries (Burundi, Kenya, Rwanda, Tanzania, and Uganda), reaffirms this finding (Rigaud et al. 2021a). The recent study projects that by 2050, without concrete climate and development action, the Basin countries could see as many 38.5 million people moving within their countries as a consequence of slow-onset climate impacts, including water stress, drops in crop and ecosystem productivity, and sea level rise compounded by storm surge. These spatial population shifts could represent up to 10.48 percent of the total population of the Basin countries in 2050 at the high end of the pessimistic scenario, which combines high emissions with unequal development. Understanding the scale and the patterns of these climate-induced spatial population shifts is critical to inform policy dialogue, planning, and action so as to avert, minimize, and better manage climate-induced migration for dignified, productive, and sustainable outcomes.

Internal migration is not a new phenomenon in Uganda—migration is one risk management strategy that communities use—but climate change is changing and amplifying historical mobility patterns. Nomadic pastoralism, conflict, and rural to rural and rural to urban migration represent important internal migration patterns in Uganda, and they are closely related to land use, livelihood, and resource conflicts. For example, the Karamoja pastoralists are migrating longer and further away due to dry spells and droughts. In some instances, they return to their origin areas in smaller numbers, while in other cases they do not return at all (Lwasa, Buyinza, and Nabassa 2017). There has been in-migration around Lake Victoria driven by the northern Ugandan conflict and because of climate-related drivers (Glaser et al. 2019; Rigaud et al. 2018). Environmental shocks and reduced agricultural yields, combined with population pressures, have further encouraged rural to urban migration in Uganda (MGSoG 2017).

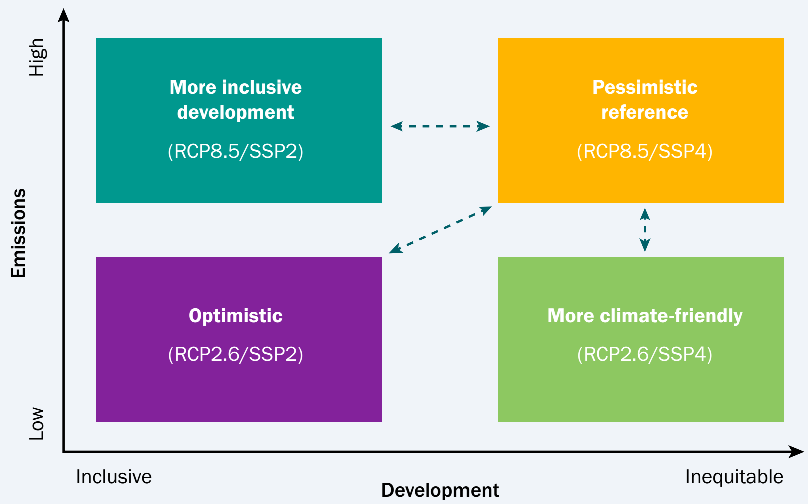
Climate change will continue to affect internal mobility in Uganda, where more than 70 percent of its population is engaged in agriculture (World Bank 2020b). Climate variations have increased soil erosion and reduced crop harvesting (Uganda MAAIF and MWE 2015; World Bank 2020a). Droughts and higher temperatures have challenged livestock production, and high temperatures in southwestern Rwenzori have reduced snow cover, affecting water flow in rivers and streams and biodiversity (USAID 2015; World Bank 2019 and 2020a). Extreme weather events and changes in temperature have accelerated the environmental degradation of Uganda's lakes and threatened the fisheries sector. Poor households and women are especially vulnerable to climate change because they often have lesser means to adapt to its effects.

Box ES.1 An Enhanced Groundswell Model

The results described in this study are based on the application of an enhanced version of the pioneering Groundswell model (Rigaud et. al. 2018). New features include the optimistic scenario, and additional climate (net primary productivity, flood risk) and nonclimate factors as variables.

A scenario-based approach—reflecting different combinations of future climate change impacts and development pathways—is used to characterize the scale and spread of climate migration by 2050.

Projecting Internal Climate Migration under Four Plausible Scenarios



Note:

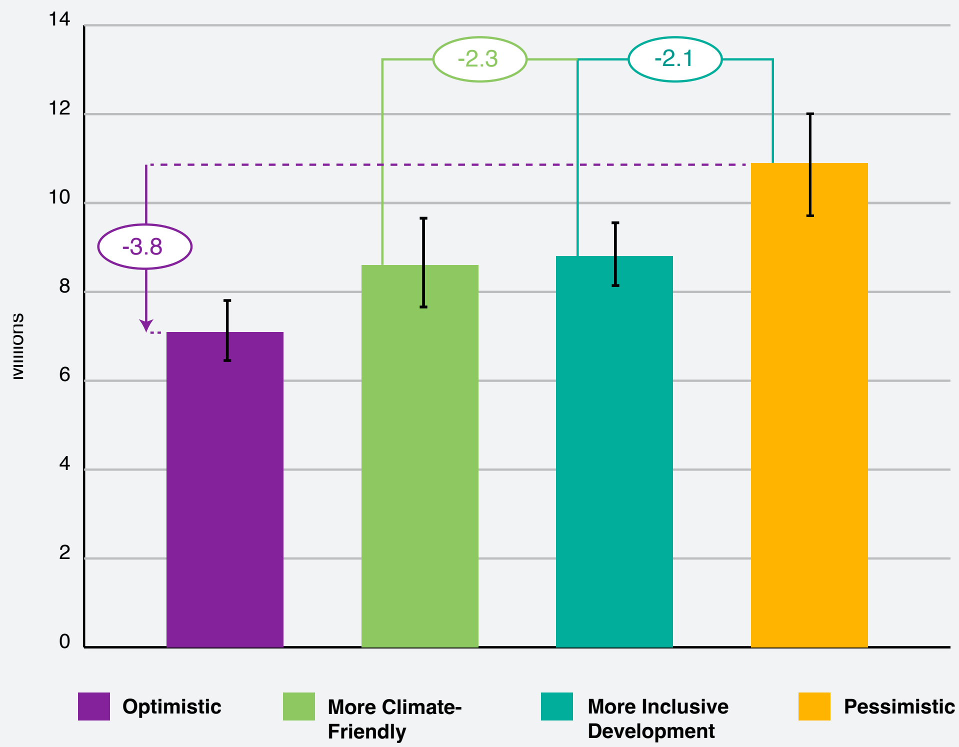
1. The scenarios are based on combinations of two Shared Socioeconomic Pathways—SSP2 (moderate development) and SSP4 (unequal development)—and two Representative Concentration Pathways —RCP2.6 (low emissions) and RCP8.5 (high emissions).

2. Estimates of climate migrants are derived by comparing these plausible climate migration (RCP-SSP) scenarios with development only (SSP) or the "no climate impact" scenarios

The expanded model provides a more granular analysis and is better placed to inform policy dialogue and action. To estimate the scale of internal climate migrants a population gravity model was used to isolate the portion of future changes in population distribution that can be attributed to climate change as a proxy for climate migration. To capture the effects of slow onset climate factors on internal migration, the methodology used state of the art simulations for crop, water, net primary productivity (NPP), flood risk models, and sea level rise with storm surge. Nonclimate factors were considered, including demographic variables (sex and median age) and conflict. This expanded model was also used to analyze internal climate migration in West African countries (Rigaud et al. 2021b).

Internal climate migrants in Uganda could reach up to 12 million by 2050, the second highest among the Lake Victoria Basin countries. This figure represents 10.72 percent of the population at the high end of the pessimistic scenario in 2050, which combines high emissions with unequal development. Tanzania is the only country in the Basin that could have higher numbers of internal climate migrants than Uganda under the high end of the pessimistic scenario, with up to 16.6 million by 2050. In alternative scenarios—more inclusive and climate-friendly—the scale of climate migration could be reduced. The greatest gains are realized under the optimistic scenario, which combines low emissions with moderate development pathways (figure ES.1). The number of climate migrants in Uganda could drop from a mean value of 10.9 million under the pessimistic scenario in 2050 to 7.1 million under the optimistic scenario, which translates into a reduction of 35 percent from the pessimistic scenario. This underscores the critical need for both inclusive development and low emissions to modulate the scale of climate migration—with greatest gains through early action. The results described in this study are based on the application of an enhanced version of the pioneering Groundswell modelling approach to the Lake Victoria Basin countries (Box ES.1).

Figure ES.1 Projected Total Internal Climate Migrants in Uganda by 2050



Note: The whiskers represent the lowest and the highest number of internal climate migrants in that scenario.

MESSAGE 2:
The upward trajectory of internal climate migration in Uganda exhibits stronger certainty across the modeled scenarios compared to other countries in the Lake Victoria Basin.

All the scenarios display an upward trend in the scale of internal climate migration in Uganda, but with important variation between scenarios. The number of internal migrants could see anywhere from a 3.7-fold increase (under the optimistic scenario) to a 4.9-fold increase (under the pessimistic scenario) between 2025 and 2050. There is a gradual increase in internal climate migration across the scenarios up to 2030; then it increases more rapidly to 2050.

The projections for Uganda reflect stronger agreement between the models and scenarios, which translates to greater certainty in the projections. No country is immune to internal climate migration, but the projections of climate migration depend on the demographic, economic, and climate trends in each country. With global emissions currently off-track, good development becomes even more important, providing opportunities to reduce or avert the scale of internal migration through inclusive development that is green and clean—with greatest gains through early action.

Climate could emerge as a dominant driver of internal migration in Uganda by 2050. By comparing population projections with and without climate factors, the assessment shows that the number of internal climate migrants increases progressively. By 2050, internal climate migrants could outpace the share of other internal migrants under the pessimistic scenario. These projections indicate Uganda's sensitivity to climate and the potency to drive future mobility.

The patterns and trends of internal climate-induced migration in Uganda will happen amid high fragility and conflict. Uganda is the third largest refugee-housing country in the world and the top in Africa, with 1.5 million refugees in 2021 (UNCHR Uganda Refugee Portal 2021). Extreme weather events are on the rise, with 40,000 new displacements due to environmental disasters in 2020 (IDMC 2021). While the scale of conflict-induced internal displacement has decreased significantly over the years, around 1,000 people were displaced due to conflict in Uganda in 2020, primarily due to disputes over land and water (IDMC 2021). Local and cross-border clashes have occurred around Lake Victoria because of the exploitation of fisheries (Glaser et al. 2019). It is critical to address the full range of mobility through a focus on the underlying causes to get ahead of the curve. Unattended climate impacts will continue to deepen existing vulnerabilities and low capacities, potentially leading to amplified impacts on poverty, fragility, conflict, and violence.

MESSAGE 3:
The emergence of internal climate migration hotspots—and their convergence with both impoverished areas and centers of economic growth—requires holistic and farsighted approaches to ensure sustainable and durable outcomes.

Climate in- and out-migration hotspots in Uganda will emerge as early as 2030 and continue to increase in strength and spread geographically (figure ES.2). These plausible hotspots represent areas where population movements are considered of high certainty across the scenarios modelled. These shifts are a response to the changing viability of ecosystems and landscapes to support livelihoods due to water stress, drops in crop productivity and ecosystem productivity. Given the rapid population growth in the region, very few areas will decline. Rather, the correct way to interpret these areas is that population growth will be dampened owing to climate impacts, particularly water availability, and crop productivity.

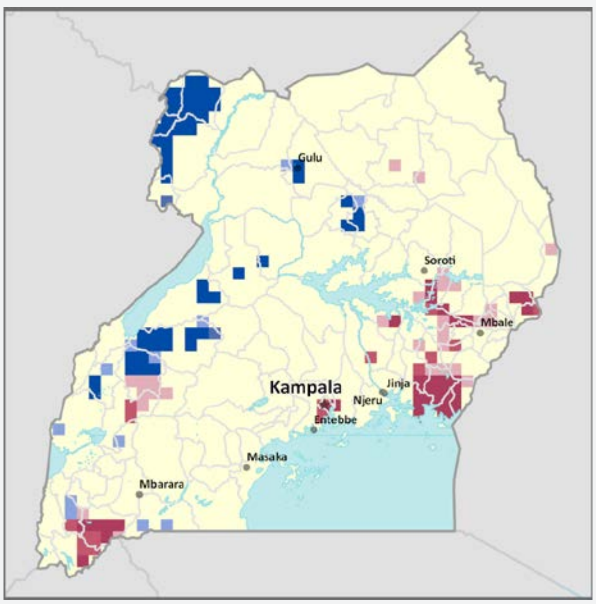
The southeastern locality of Mbale and its surroundings, Mount Elgon, the capital (Kampala), and the southwestern locality of Ntungamo, could be climate in-migration hotspots, primarily due to increases in water availability and crop production. Many of these places already face severe environmental challenges due to climate change, including landslides, flooding, droughts, and land degradation (Mafabi 2017; Mbogga 2012; Tumushabe et al. 2013; Uganda Department of Relief, Disaster Preparedness and Refugees 2016; Uganda NPA 2020; UN-Habitat 2011; World Bank 2015). They also face development challenges, including high poverty rates, informal human settlements, and weak services and infrastructures (Mafabi 2017). Focusing on these hotspots and considering the spatial dimension of the challenge will build resilience and readiness across time scales.

Peter Kapuscinski / World Bank

Figure ES.2 Projected Hotspots of Climate In- and Out-Migration, Uganda, 2030 and 2050

a. 2030

b. 2050



IN-MIGRATION

- High certainty in high levels of climate in-migration
- Moderate certainty in high levels of climate in-migration
- Low certainty in high levels of climate in-migration

OUT-MIGRATION

- High certainty in high levels of climate out-migration
- Moderate certainty in high levels of climate out-migration
- Low certainty in high levels of climate out-migration

Note: High, moderate, and low certainty reflects agreement across all four, three, and two scenarios modeled respectively. In- and out-migration hotspots are thus areas in which at least two scenarios concur on density changes. Data is for the top and bottom 5th percentile differences in the density distribution for climate in- and out-migration respectively.

By 2050, three major out-migration hotspots are projected to emerge mainly in northwest and west-central areas around Lake Albert due to decreases in water availability and crop production (figure ES.2). Some of these climate out-migration areas are highly dependent on agriculture and fisheries, and climate change is accelerating deforestation, flooding, reduction of fish stock, and biodiversity loss (Slotkin 2017; Speziale and Genaletti 2014; UBOS 2017; UN-Habitat 2020).[1] The out-migration hotspots near Lake Albert and Koboko host large numbers of refugees, reinforcing the need for early planning and adaption (Speziale and Genaletti 2014; UN-Habitat 2020). Effective planning and management efforts will be important to ensure sustained economic growth and prosperity.

Water stress and crop and NPP losses are key climate factors that will influence the patterns and scale of internal climate migration in Uganda over the next decades. In general, areas that see positive deviations in water and crop productivity experience more in-migration, as represented through spatial population distribution shifts. The coefficient for water availability in rural areas is around 2.8 times higher than that of crop production and 4.7 times that of NPP, illustrating the importance of water availability as a driver of migration. Some models indicate an increase in water availability, particularly in the east. Other models indicate a drying trend in the northwest and west-central areas. Several models show declines in crop production of up to 30 percent in central and western parts of the country. In the context of nonclimate factors, age and sex composition are not strong influencers of spatial population shifts in the region, and conflict-related fatalities are negatively correlated with population change showing stronger effect in urban areas.

More generally, Uganda is projected to see a population spatial shift from western to eastern Uganda because of climate change, particularly in response to increases in water availability and crop production. Across the four scenarios by 2050, the population change per square kilometer due to climate migration could be positive in eastern Uganda and in the southwest, and negative in the west. Eastern Uganda is a highly diverse region with the Karamoja pastoralists in the northeast, Mount Elgon—a key water tower—in the east-central, and large economic urban centers, such as Mbale, in the southeast. The projected increase in climate impacts could accelerate environmental degradation and biodiversity loss, trigger disputes over natural resources and land, and create water and services shortages. Dedicated management, conservation, and development interventions that can meet the realities of eastern Uganda are necessary to avert distress driven climate migration and harness migration for shifts to climate smart jobs and economic transitions.

The climate migration hotspots in Uganda are not predestined, but the agreement across the scenarios on climate in- and out-migration underscores the need for farsighted and anticipatory approaches to avert, minimize, and plan for the consequences and opportunities of climate-induced migration. These approaches may require *adapt in place measures* to protect communities and assets and provide basic services and job opportunities. *Managed retreat* will be needed in areas that pose high levels of climate risks to enable and support mobility. Action has to span the entire migration life cycle: adapt in place, enable mobility, and *postmigration support* mechanisms, and over spatial and time scales.

1 See "Population & Culture" web page of the Koboko website, https://koboko.go.ug/lg/population-culture.

MESSAGE 4:
Global responsibility for swift action to cut greenhouse gas emissions is critical for significantly reducing the scale of internal climate migration.

Concerted action at the global level to reduce greenhouse gas (GHG) emissions is an imperative to reduce the climate pressures that drive people to migrate. Commitments to cut GHG emissions globally are off-track to meet the Paris targets. The latest Intergovernmental Panel on Climate Change (IPCC) report that, without immediate, rapid, and large-scale reduction in GHG emissions, limiting warming may be beyond reach (IPCC 2021). Beyond the threshold temperatures, extreme events will be on the rise and climate-related risks for natural and human systems will be higher, with disproportionate impacts on the poorest and most vulnerable (IPCC 2021; UNEP 2020). Current emissions from Sub-Saharan Africa are small but countries are stepping up action on this front. Uganda has committed to reducing GHG emissions in the energy supply, forestry, and wetland sectors by 22 percent in 2030 (Uganda MWE 2019). Most importantly, however, we need collective global action from high emitting countries to cut their GHG emissions, and avert an escalation of climate impacts that will continue to drive climate migration, even as we recognize that some of these impacts are already locked in. Climate change impacts are amplifying preexisting vulnerabilities of the lives, livelihoods, and economies of the poorest communities and in the poorest countries due to their reliance on climate-sensitive sectors. Major GHG emission countries must find direct and indirect ways to complement Uganda's efforts on climate-induced migration.

MESSAGE 5:
Internal climate migration in Uganda can be nurtured into a positive force through a proactive and dedicated focus on a core set of policy areas informed by domains of action.

Internal climate migration cannot be divorced from development, and as the human face of climate change, it must be addressed in a holistic and end-to-end manner. The Migration and Climate-Informed Solutions (MACS) framework (figure ES.3; box ES.2) brings together domains of action, buttressed by core policy areas, to reduce the scale of internal climate-induced migration, usher in social and economic transformations, and reduce vulnerabilities. Applying this anticipatory approach will ensure that Uganda's economy is braced not just for the challenges, but also the opportunities of internal climate migration.

The core policy areas, as advocated by the original Groundswell report, remain important:

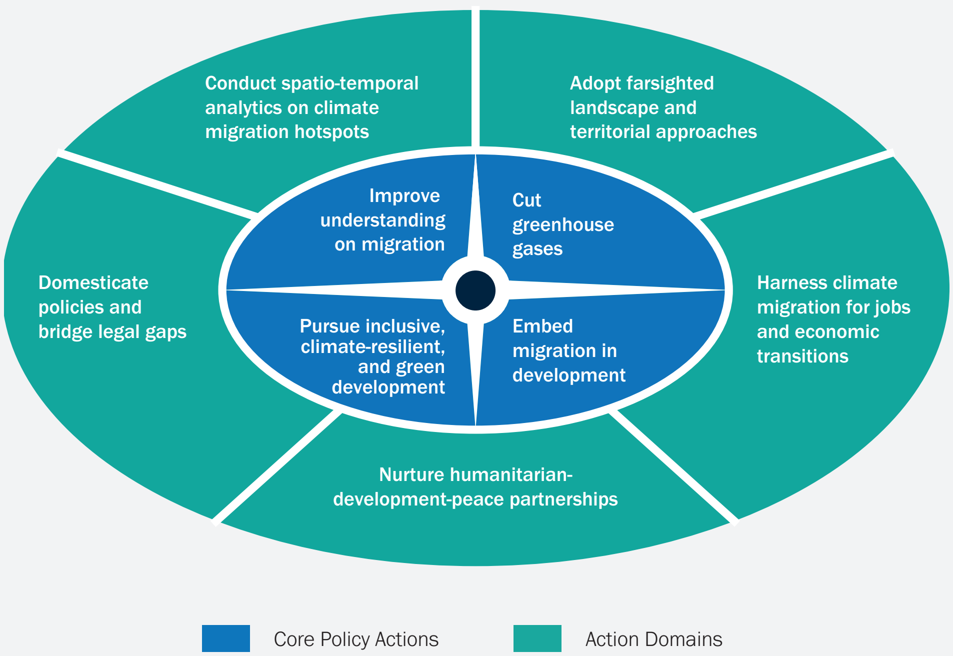
- Cut GHG now.
- Pursue inclusive, climate-resilient, and green development.
- Embed climate migration in development planning.
- Invest in an improved understanding of migration.

The diversity of contexts where internal climate migration will play out calls for focused attention and solidarity. It can be guided by these five action domains to avert migration driven by adverse impacts of climate change:

- Conduct spatio-temporal analytics to understand the emergence of climate migration hotspots.
- Adopt farsighted landscape and territorial approaches.
- Harness climate migration for jobs and economic transitions.
- Nurture humanitarian-development-peace partnerships.
- Domesticate policies and bridge legal gaps.

Action must be pursued through both dedicated local and national action and regional cooperation, as appropriate.

Figure ES.3 Migration and Climate-Informed Solutions (MACS)



a. MACS was derived as part of the two Groundswell Africa regional reports: *Groundswell Africa: A Deeper Dive into Internal Climate Migration in the Lake Victoria Basin Countries* (Rigaud et al. 2021a) and *Groundswell Africa: Internal Climate Migration in West African Countries* (Rigaud et al. 2021b).


Jeff Ackley / Unsplash

Box ES.3 MACS Framework

The MACS framework is the outcome of the World Bank's efforts through the Groundswell reports (Rigaud et al. 2018; Clement et al. 2021) and subsequent deeper dives via Groundswell Africa (Rigaud et al. 2021a and 2021b) to better understand the implications of climate-induced migration and mainstream this phenomenon into development plans, programs, and policies. It stems from the result of the abovementioned modeling exercise, contextualized against current and historical mobility patterns, peer reviewed literature, and multi-stakeholder consultations. A portfolio review of the design features of 165 World Bank projects operating at the climate-migration-development nexus further informs this framework (Rigaud et al. 2021c). MACS is flexible and adaptive, based on the premise that climate migration is linked to broader development challenges across spatial scales. It can guide policymakers and practitioners by offering critical information and insights related to development and policy implications of climate-induced internal migration. This reflects the call for anticipatory approaches over larger time and spatial scales to avert and minimize the adverse consequences of climate-induced migration and harness opportunities brought forth by migration.

Underpinned by the MACS framework and in support of a country's development vision and plans, the right set of climate and development policies can help avert adverse outcomes while harnessing the opportunities of climate-induced migration. The National Development Plan (NDP), and the World Bank's Systematic Country Diagnostic (SCD), and Country Partnership Framework (CPF) provide important platforms to prepare, plan, and respond to climate migration in Uganda. These include job diversification, land management, landscape programming, climate change resilience, and resource and environmental risk management (Uganda NPA 2020; World Bank 2015a and 2016). These platforms present untapped opportunities to further mainstream and embed climate migration through a multisectoral response that ensures short- and medium-term positive and sustainable environment, development, and social outcomes. Uganda's Nationally Determined Contributions (NDCs) provide ample opportunities to embed mitigation policies, such as carbon pricing, urban and land use planning, and innovations.

Uganda's refugee policy can yield important lessons to inform internal climate migration trends and the emerging climate in- and out-migration hotspots. Addressing the refugee inflow to Uganda calls for improved management of forest and other landscapes, job opportunities, and provision of basic services—for both the host community and refugees. The results in this study indicate that even under an optimistic scenario, the scale of internal climate migrants could exceed 7 million by 2050.

The development community is not starting from zero. For example, the World Bank (Rigaud et al. 2021c) carried out a portfolio review to draw actionable insights from 165 World Bank projects operating at the climate-migration-development nexus—with commitments amounting to US$197.5 billion (from 2006 to 2019). The portfolio review findings show that a more systematic and anticipatory approach in designing projects geared toward addressing climate migration is possible. Increasingly, projects not only address migrants' direct needs but support enabling interventions (early warning systems and social safety nets) and address underlying causes of mobility. There is a need to step up such interventions with great vigor and urgency—acting in partnership and engagement of those directly affected.

MESSAGE 6:
Uganda must act boldly and urgently on internal climate migration—delaying action will raise the stakes considerably.

The call for action on internal climate migration for Uganda is clear and compelling. The potential scale of the issue, trends, and emergence of climate migration hotspots as early as 2030 should have major implications on conceiving effective responses. The domains of action set out in the MACS framework provide a pragmatic and farsighted approach to addressing internal climate migration—delaying action will raise the stakes considerably. They can bolster the delivery of the core policies to reduce, avert, and minimize distress-driven internal climate migration.

Investing in iterative scenario modeling, grounded in new data and development progress, could support decision-making. These investments should try to facilitate long-term planning, such as adaptive capacity, to secure climate resilience. This will require not only action at the international and national level, but also locally.[2] One concrete example is the World Bank's Investing in Forests and Protected Areas for Climate-Smart Development Project (P170466), which focuses on improving the sustainable management of forests and protected areas and increase benefits to forest-dependent communities in the Albertine Region and the refugee-hosting areas in northern Uganda.

Landscape and territorial approaches could enable early planning and action across spatial and time scales in climate in- and out-migration hotspots. Climate change can change the desirability and comparative advantage of land and natural resource degradation, which could affect migration patterns. A holistic approach to addressing the underlying causes of the adverse consequences of climate migration, the role of land and water degradation, and the ability to support livelihoods will be important. Understanding and mapping climate impacts, community livelihoods (and adverse consequences), and emerging hotspots will be key. By 2050, the yields of Arabica coffee are projected to decline between 50 and 75 percent, and much of the land will be unsuitable for Arabica production (World Bank 2015c and 2020a). These changes could affect, for example, important coffee growing areas in Mount Elgon, which is projected as a plausible climate in-migration hotspot (Uganda MWE 2015; World Bank 2015c and 2020a). Closer attention to these hotspots and productive sectors or commodities, like coffee, which contributes 18 percent of the country's exports (Uganda MAAIF 2019)—could be important. Embracing landscape and territorial approaches to enable planning across spatial and time scales is an imperative for readiness and sustainable and durable outcomes.

Bringing foresight to rural and urban transitions could produce positive synergies between internal climate migration and the momentum for structural transformation. Uganda is one of the youngest countries in the world, with a median age of 16.7 in 2020, and almost three-quarters of young people are still employed in agriculture (UN DESA 2019; World Bank 2020b). Given that Uganda's population is projected to almost double by 2050, and the sensitivity of crop productivity to climate across Uganda, planning and readiness to absorb labor and the large youth bulge into value-added, end-to-end agriculture is important. At the same time, nurturing transitions to nonagricultural and less climate-sensitive sectors for future shifts in populations in response to climate need to be prioritized. Combining these goals with anticipatory planning with a lens to climate in-migration to secondary cities

2 The findings of this report can serve as a useful guidance tool to hold on-the-ground dialogue with stakeholder groups and develop concrete policy responses that cater to the local context.

or peri-urban areas near Mbale and Kampala could lay their foundation as growth poles in place of sprawling slums steeped in poverty. The government's plan to declare 15 new cities provides the scope to plan at territorial levels while harnessing plausible climate migration futures (Mbabazi and Atukunda 2020).

Cooperation among the development, humanitarian, and peace communities working across the mobility continuum could support Uganda to achieve holistic and durable solutions to climate-induced migration and displacement. This approach can benefit from the comparative advantage of different actors to strengthen local capacity. Ultimately, holistic approaches are geared to reduce risk and vulnerability through well-aligned short-, medium-, and longer-term contributions by humanitarian and development actors. World Bank financing instruments and other technical support modalities could provide support for development opportunities and policies to drive structural and economic transitions and address more near term engagements to support adaptation and development priorities to avert distress driven mobility.

Implementing a well-defined and equitable legal architecture could bring clarity, protect affected individuals and communities, and reconcile international funding and local decision-making. It will ensure that migration acts as a force of good for all strata of the society. Ensuring that existing legal frameworks are in line with the Kampala Convention, the Intergovernmental Authority on Development (IGAD) Free Movement Protocol, and international frameworks, such as the Guiding Principles on Internal Displacement, will bolster the legal architecture to address climate-induced migration.

While a potent and daunting challenge, climate-induced migration presents an opportunity for Uganda to advance its socioeconomic goals. It presents a policy challenge that cannot be wished away but should be tackled holistically and effectively through evidence-based, participatory action. Inclusive development can significantly reduce the scale of internal climate migration and serve as the first line of defense. The country can embark on a green, resilient, and inclusive path for development by exploiting new economic opportunities, recognizing that structural transformations must be informed by and responsive to climate change. Anticipatory and transformative action, across the migration cycle, will help to ease people out of vulnerability and secure the foundation of a peaceful, stable, and secure Uganda. At the same time, the urgency for the global community to cut GHGs—rapidly, immediately, and at scale—cannot be postponed if the factors that drive internal climate migration are to be contained.

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Chapter 1

Introduction

1.1 BACKGROUND

Climate change has emerged as a potent driver of migration. In 2018, the World Bank launched the flagship report *Groundswell: Preparing for Internal Climate Migration* (Rigaud et al. 2018), which noted that without concrete climate and development action, the number of internal climate migrants in Sub-Saharan Africa could reach a high of 86 million by 2050. In East Africa, rapid population growth has contributed to land fragmentation and increased land degradation while also spurring rural to urban migration resulting in rapid urbanization. In addition, the region has had a history of internal displacement and refugee flow because of conflict. The Groundswell report showed the Lake Victoria Basin, which includes Burundi, Kenya, Rwanda, Tanzania, and Uganda, as an emerging hotspot of climate-in and climate-out migration.

Natural hazards and disasters have led to significant displacements in Sub-Saharan Africa. In 2020, around 4.3 million people in Sub-Saharan Africa had to flee their homes due to natural hazards, according to the latest Internal Displacement Monitoring Center (IDMC) Global Report on Internal Displacement (GRID) (IDMC 2021). Uganda has witnessed an increasing number of displacements in response to natural hazards and disasters. In 2020, heavy rainfalls during the rainy season caused localized floods and landslides, which triggered 40,000 displacements (IDMC 2021). Flooding and landslides displaced 87,000 people across the country in 2020. Flooding incidents triggered water rise levels in Lakes Albert, Kyoga and Bisina, displacing 8,700 people across Northern Uganda, Central Region of Uganda, and Western Uganda in August 2020, and an additional 10,815 new displacements in October 2020. [3] If unaddressed, poverty, vulnerability, conflict, and climate change could put more people at risk in the region. Other stressors are high population growth and increasing urbanization rates, predicted to increase

3 See https://erccportal.jrc.ec.europa.eu/Echo-Flash/ECHO-Flash-old/ECHO-Flash-List/yy/2020/mm/11

dramatically in the coming decades. The steady increase in conflicts that spill over borders, and the intensifying impacts of climate extremes, aggravate this situation. The growing number of people on the move is straining current systems and will have long-term impacts on host countries. Inflows of migrants could undermine and reverse much of the development progress achieved in the past two decades.

Climate migration is emerging as an issue of critical importance in the face of escalating climate impacts. There is an urgent need to go beyond individual case studies and specific events to assess how the escalation of climate impacts could drive migration at scale in the coming decades. In particular, these data are needed to drive informed policy and planning. Concerted action on climate change mitigation and adaptation, together with inclusive development policies and embedding climate migration into policy and planning, could help to substantially reduce the number of internal climate migrants (Rigaud et al. 2018). Policy decisions made today will shape the extent to which the effects of climate change will be positive for migrants and their families.

Understanding when, where, and how climate migration will unfold is critical for countries and communities to pursue the right policies and targeted action. It is recognized that the drivers of displacement in the region are a complex overlap of social, political, economic, and environmental factors, particularly slow-onset hazards such as drought, desertification, coastal erosion, and land degradation.

1.2 SCOPE AND OBJECTIVE

The Lake Victoria Basin is a highly mobile region with various forms of voluntary mobility (economic, trade, nomadic pastoralism) and forced migration and displacement owing to natural disasters and conflicts in the Horn and the Great Lakes Region. For the five Basin countries—Burundi, Kenya, Rwanda, Tanzania, and Uganda—freedom of movement has been enshrined since 2007 under protocols of the agreements established under the East African Community (EAC). This enables citizens of these countries to live and work in any country in the region.

The Lake Victoria Basin has experienced and is likely to experience in the future some of the worst impacts of climate change, including rising temperatures, erratic rainfall, increasingly intense rainfall events, flooding, and coastal erosion caused by heightened storms and sea level rise. When coupled with the high dependence of the Basin countries on the agriculture and fisheries sectors and increasing loss of natural capital, the economy and livelihoods are highly vulnerable to climate variability and change.

This suggests that these impacts may trigger even higher rates of migration over the coming decades. These will be both migration in response to an adaptation to climate change to bring more stable livelihoods and higher incomes, and distress migration from intolerable situations that leave the migrants impoverished and with few other options. Understanding the scale of internal climate migration and the patterns of people's movements is critical to countries so they can plan and prepare.

The objective of this Uganda-focused report is to convey the potency of climate-induced migration within Uganda to inform policymakers and practitioners about the urgency for near and farsighted planning, policy, and action as an integral part of the development response.[4] This report provides a quantitative and qualitative understanding of plausible future climate migration scenarios and proposes core policy directions and action domains to better anticipate and prepare for this challenge. The importance of overarching policies that embed climate risks and opportunities, as well as climate migration into national and local development planning are paramount. Inaction would mean missing a vital opportunity to reconfigure where, when, and how climate resilient investments are made in support of robust economies.

4 This report draws from the World Bank's *Groundswell Africa: Internal Climate Migration in the Lake Victoria Basin Countries* (Rigaud et al. 2021a) report, but undertakes a deeper dive on the analysis.

1.3 METHODOLOGY

This Uganda study, as part of the Lake Victoria Basin study (Rigaud et al. 2021a), applied the Groundswell model described in the World Bank report, Groundswell: Preparing for Internal Climate Migration (Rigaud et al. 2018) with several enhancements that are described below.

The Groundswell model uses a combination of empirical modelling and qualitative assessments of climate migration trends at the national and local levels to lay out a set of future climate scenarios.

Key elements of the Groundswell methodology include the following:

- The Groundswell uses a population gravity model to isolate the portion of future changes in population distribution, accordingly to the perceived attractiveness of different locales, to slow-onset climate factors over time.
- It develops plausible scenarios to characterize the scale and spread of internal climate migration using representation concentration pathways (RCPs) and shared socioeconomic pathways (SSPs). Under RCP2.6, greenhouse gas (GHG) emissions begin to decline by 2020 and radiative forcing peaks by midcentury, before declining to near current levels by 2100. RCP8.5 is characterized by increasing GHG emissions, leading to high atmospheric concentrations.
- The SSPs span possible future development pathways for the world and describe trends in demographics, human development, economy, lifestyles, policies, institutions, technology, the environment, and natural resources. The SSP2 (moderate development pathway) and SSP4 (unequal development pathway) used in the model reflect the degree to which the scenarios represent challenges to mitigation (GHG emissions reductions) and societal adaptation to climate change. SSP2 represent moderate challenges for both, and SSP4 represents high challenges for adaptation, low for mitigation (O'Neill et al. 2014).
- The model used the Inter-Sectoral Impact Model Intercomparison Project (ISIMIP) global crop and water simulations (state-of-the-art computer simulations of biophysical climate impacts, which are directly relevant to livelihoods outcomes) and sea-level compounded by storm surge data to capture the slow-onset climate factors.[5]
- Results are contextualized against current and historic mobility patterns in peer-reviewed literature, and a multistakeholder consultation in February 2021 (World Bank, unpublished) to further inform patterns of migration and the proposed response framework.

1.3.1 Four Scenarios

The Groundswell methodology used three scenarios based on combinations of SSPs and RCPs: pessimistic (reference), more inclusive, and climate friendly. The enhanced model added a fourth scenario, optimistic, which combines low emissions (RCP2.6) and an inclusive development pathway (SSP2).

The selected development scenarios include a "moderate development" and an "unequal development" scenario. Under the moderate development scenario, low- and middle-income countries (LMICs) are characterized by moderate population growth, urbanization, income growth, and education. Under the unequal development scenario, LMICs follow different pathways. Low-income countries (LICs) have high population growth rates and urbanization, and low gross domestic product (GDP) and education levels. Middle-income countries (MICs) have low population growth rates, high urbanization, moderate GDP, and low education levels. Inequality remains high both across and within countries, and economies are relatively isolated, leaving large, poor populations in developing regions highly vulnerable to climate change with limited adaptive capacity.

5 For details on the methodology, see Appendix 1 of *Groundswell Africa: Internal Climate Migration in the Lake Victoria Basin Countries* (Rigaud et al. 2021a).

The climate migration forecasts are based on two emissions scenarios. In the lower emissions scenario, temperatures peak at 0.25°C to 1.5°C above recent baseline levels by 2050 and then stabilize through the end of the century. This aligns with the Paris Agreement goals, in which countries reduce GHG emissions to zero within the next fifteen to twenty years (Sanderson et al. 2016). In the higher emissions scenario, temperatures rise by 0.5°C to 2°C by 2050 and by 3°C to 5.5°C by 2100.

While current emission pathways are unlikely to keep warming to below 2°C and are in fact closer to 3°C, the study has retained RCP2.6 as a lower bound in reference to the Paris Agreement. Two different development pathways, representing inclusive development (SSP2) and unequal development (SSP4) drive population and urbanization trends in a gravity model (WMO 2020).[6]

The scenarios used in this study are the following (box ES.1).

- A pessimistic (reference scenario) (SSP4 and RCP8.5), in which low-income countries reflect continued high emissions and have unequal development and are characterized by high population growth, high rates of urbanization, low GDP growth, and low education levels.
- A more climate friendly scenario (SSP4 and RCP2.6), has lower emissions which reduces climate impacts, but holds the development scenario consistent with the pessimistic scenario.
- A more inclusive development scenario (SSP2 and RCP8.5), which retains high emissions as they are in the pessimistic scenario but provides a development scenario that is more optimistic and the potential for adaptation is higher than under SSP4.
- An optimistic scenario (SSP2 and RCP2.6), combines the lower emission scenario which reduces climate impacts and provides a development scenario that is more optimistic.

For each climate migration scenario, the model produces estimates that reflect variation in the underlying inputs to the model, which in turn reflect scientific uncertainty over likely future climate projections and impacts and development trajectories. In any scenario, outcomes are a function of the global climate models and the sectoral impact models that drive climate impacts on population change.[7]

1.3.2 Slow and Rapid Onsets

For the first time, the Groundswell model used actual climate impact models for agriculture and water resources to understand how these would affect future population distributions, as well as sea level rise compounded by storm surge (Rigaud et al. 2018). The enhanced model also included another slow-onset impact (ecosystem impacts) and rapid-onset events (such as flood risk projections).

1.3.3 Coefficients

The Groundswell model included model coefficients that show the influence of the variable on the deviation between observed population change and projected population change (spatial shifts) based on historical calibration of climate signal from 1990 to 2000 and 2000 to 2010. The variables are crop production, water availability, net primary productivity (NPP), median age, sex ratio, conflict-related fatalities, and flood risk. While these models do not directly capture environmental or land degradation, which is driven by a range of other factors and exacerbated by climate change, the crop and water simulation models reflect the additional pressures induced by climate factors. Crop productivity and NPP are not included in the calibration for urban populations because these are not hypothesized to have an impact in those areas since their populations are not directly dependent on cropping or animal husbandry.

6 See: https://climateactiontracker.org/global/temperatures/ Accessed 4 May 2021

7 For details on the methodology, see Appendix A of *Groundswell Africa: Internal Climate Migration in the Lake Victoria Basin Countries* (Rigaud et al. 2021a).

The coefficients for the Lake Victoria Basin countries in Table 1.1 represent the average of the coefficients across the two decades for Tanzania, the only country with matching population and population growth rates at the same administrative level across the three-time steps from 1990 to 2010.[8]

Table 1.1 Model Coefficients for the Lake Victoria Basin, Based on Tanzania data

Predictor	(Parameter) Coefficient		Units
	Urban cells	Rural cells	
Crop production	n/a	0.793548	5-year deviation from historic baseline
Water availability	1.303542	2.261628	5-year deviation from historic baseline
New primary productivity*	n/a	0.477869	5-year deviation from historic baseline
Median age	-0.00534	0.002636	Median age of the population in years
Sex ratio	0.001975	-0.00424	Ratio of males/females
Conflict-related fatalities	-0.00465	-0.00027	Number of recorded fatalities
Flood risk	0.218818	0.020851	5-year likelihood of flood event

Note:
1. Calculations based on Tanzania data. n/a = not applicable.
2. Net primary productivity, which is intended to reflect impacts on pastoral populations, is included in the model only when crop production is not present.

Water availability is a key climate factor that will influence migration over the next few decades. The coefficient for water availability in rural areas is around 2.8 times higher than that of crop production and 4.7 times that of NPP. Critically, it is the only climate driver other than floods and sea level rise influencing future urban population distribution. Water availability is projected to have a far greater influence on future population distribution than most of the other climate variables. This means that greater water availability results in increasing attractiveness of a location and vice versa.

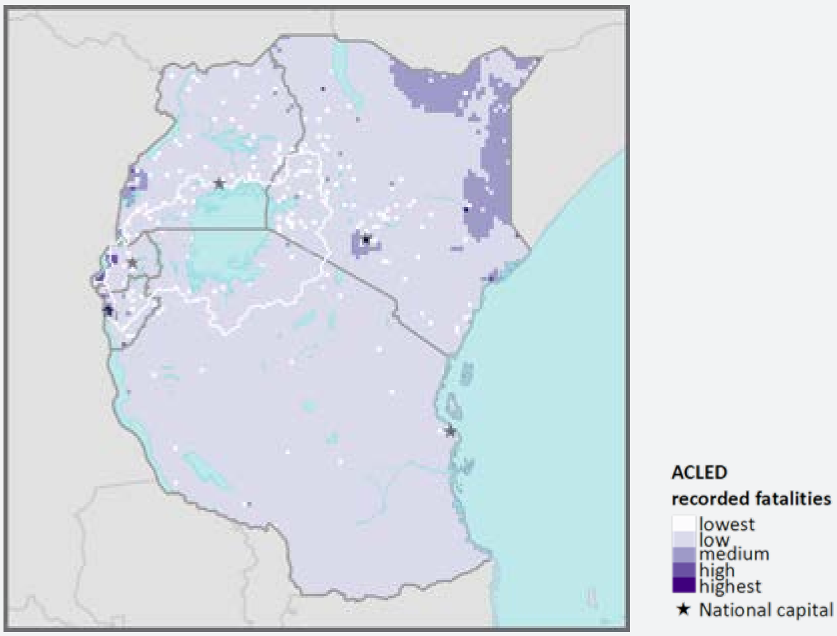
Demographic variables of median age and sex (gender) distribution were introduced in the enhanced model applied in this study. These impact the climate migration projections through their own relationship with population change (as derived through the spatial autoregressive calibration), and through their interaction with the climate drivers. In the case of Lake Victoria Basin countries, the alignment between these factors means that they amplify the impact of climate. In contrast, in the West Africa region, demographic variables mitigated or dampened climate migration (Rigaud et al. 2021b).

The flood risk analysis is based on projected flood depth simulated by a global flood model CaMa-Flood version 3.4.4 (Yamazaki et al. 2011). It primarily represents riparian (along rivers) rather than coastal flooding, although it does capture rivers emptying into the ocean. The input required by this global flood model is daily runoff simulated by multiple global hydrological models participating in the ISIMIP2b project (Frieler et al. 2017). These hydrological models are forced by bias-corrected climate model outputs (such as temperature, precipitation, radiation) from the Coupled Model Intercomparison Project Phase 5 (CMIP5) (Taylor et al. 2012). The model runs for RCP2.6 were used in the climate-friendly and optimistic scenarios and the model runs for RCP6.0 were used in the more equitable development and pessimistic scenarios.

8 Were calibration to be applied in countries without matching population and population growth rates at the same level, results would be spurious because changes in population could be due to the changing administrative units used to construct the population grids in each time period.

Spatial data on conflict occurrence from the Armed Conflict Location and Event Data (ACLED) database was interpolated through spatial kriging (Raleigh et al. 2010).[9] A spatial layer was developed of the point locations of every conflict event between 2009 and 2018, and the values at each point were the number of fatalities. Spatial kriging (a form of interpolation) was used to create a continuous surface that fill in the gaps between points, yielding a surface where each 1-kilometer pixel has a value associated with the relative amount of conflict fatalities (Figure 1.1). This surface was applied in model calibration to identify the impact of conflict on spatial population patterns. Conflict hotspots tend to be associated with slow or declining rural population growth and slightly more rapid urban growth because when civil conflicts break out people tend to flee rural areas in search of protection in urban areas.

Figure 1.1 Interpolated Conflict Surface, 2009-2018



Source: Rigaud et al. 2021a

1.3.4 Time and Resolution

Scenarios in the enhanced work were run in five-year increments and calibrated on data from 1990 to 2010. The future population projections incorporating climate impact scenarios were compared to future population projections without climate impacts to derive estimates of climate migration for 14-kilometer grid cells. Scenarios in the enhanced model run in five-year increments from 2010 to 2050 and are performed on population data at 1-kilometer resolution

9 See http://www.acled.org

1.4 HOW IS THE DOCUMENT STRUCTURED?

The country report is divided into four chapters.

This current section (Chapter 1) highlights the potency of internal climate-induced migration and displacement in Sub-Saharan Africa. It also presents the scope, objective, and methodology, consistent with the World Bank report *Groundswell Africa: Internal Climate Migration in the Lake Victoria Basin Countries* (Riguad et al. 2021a), which this study is part of.

Chapter 2 is based on the literature and takes a deeper dive into Uganda's population and development context. It includes the historical and current cross-border, regional and internal migration patterns, including environment-related migration and displacement. This section also draws attention to the changes in Uganda's climate and its current and future impact on Uganda's key economic sectors (agriculture, livestock, forestry, and fisheries).

Chapter 3 presents the modeling results of future internal climate migration patterns and trends in Uganda, which are based on the results of an expansion of the Groundswell model. The results present plausible shifts in spatial population distribution, as a reflection of internal climate migration, in response to climate factors by 2050, and the emergence of climate in- and out-migration across the country.

Chapter 4 proposes core policy directions and a set of key action domains. These can be leveraged to foster climate and development action that encompasses near and farsighted approaches to avert, minimize, and manage internal climate migration and displacement in Uganda for sustainable growth and resilient and inclusive outcomes. It presents a call to action on how to ensure Uganda's National Development Plan (NDP), Systematic Country Diagnostic (SCD), Country Partnership Framework (CPF), and other frameworks and tools can be used to mainstream climate migration into policy and planning. It also proposes language and policies to further embed climate migration and mainstream the policy recommendations outlined in the previous section.

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Chapter 2

Country Context

2.1 POPULATION AND DEVELOPMENT CONTEXT

Classified as a low-income economy, Uganda has shown a steady growth in gross domestic product (GDP) over the last 20 years, growing from US$5.8 billion in 2000 to US$27.4 billion in 2018 (in current dollars), with a short decline around 2015 due to internal political conflict. During the same period, the annual GDP growth averaged 6.3 percent, and the GDP per capita increased from US$261.7 to US$642.8 (in current dollars) (Table 2.1).

Table 2.1 Development Indicators for Uganda

Population	
Population (millions)	42.9
Annual population growth (%)	3.3
Population in 2050 under SSP2 (millions)	95.4
Population in 2050 under SSP4 (millions)	114.7
Urban share of population (%) (2020)	25
Employment in agriculture (% of total employment) (2018)	72.9
GDP	
GDP (current US$ billions) (2018)	27.4
Annual GDP growth (%) (2018)	6.3
GDP per capita (current US$) (2018)	642.9
Value added of agriculture (% GDP)	24.6
Poverty	
Poverty headcount ratio at US$1.90 a day (2011 PPP) (% of population) (2016)	41.7
Poverty headcount (%) (Uganda Bureau of Statistics) (2016/17)	21.4
Climate and disaster risk indexes – ND-GAIN Index (2017)	
Rank	155
Score	35.8

Source: WDI database;[10] ND-GAIN Country Index 2018

Note: The ND-GAIN Country Index, a project of the University of Notre Dame Global Adaptation Initiative (ND-GAIN), summarizes a country's vulnerability to climate change and other global challenges in combination with its readiness to improve resilience. A higher score is better. For more information on ND-GAIN, see: https://gain.nd.edu/

10 See the World Bank Development Indicators (WDI) database, https://datacatalog.worldbank.org/dataset/world-development-indicators

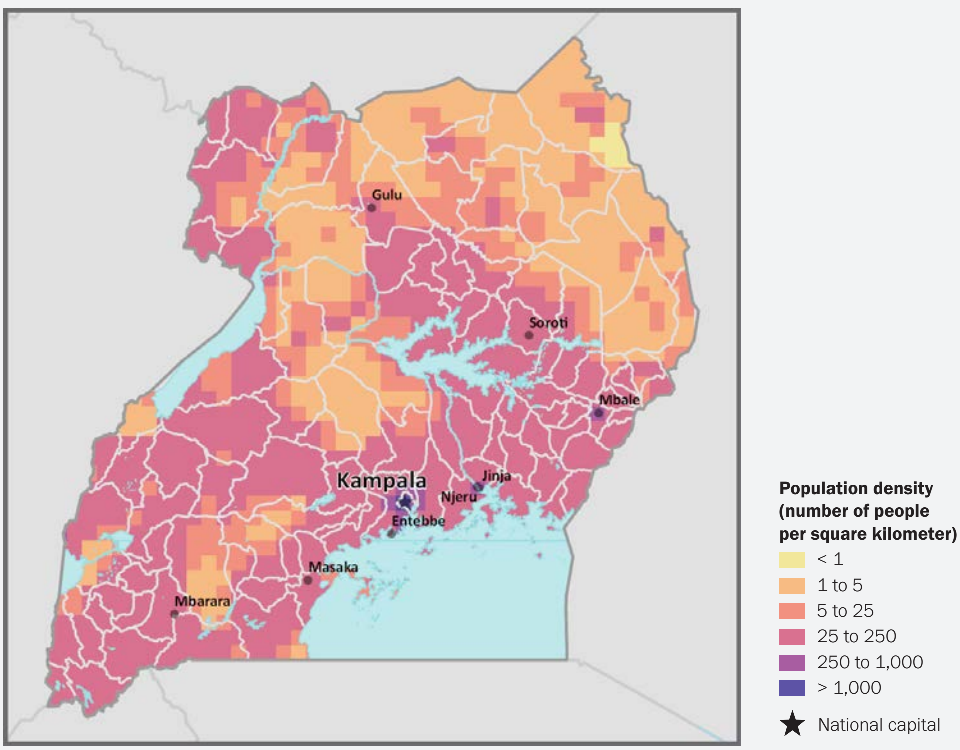
2.1.1 Population Facts

Uganda's current population is 45 million and this is growing every year at around 3.6 percent (UN DESA 2019). By 2050, Uganda's population could be 89.4 million. This population growth rate is quite high when compared with the global and African growth rates of 1.1 and 2.5 percent respectively. The population growth in Uganda is projected to gradually decline, with a growth rate lower than one percent by 2100 and a population of 136 million (UN medium variant) (UN DESA 2019).

Uganda has a young population, with a median age of 16.7 years in 2020 (UN DESA 2019). As population growth slowly declines and life expectancy increases, the median age is projected to reach 24.8 years by 2050 and 38.9 years by 2100 (UN DESA 2019). There is a need for farsighted planning to harness labor and the large youth bulge to drive jobs and the economic transition. In terms of gender distribution, the sex ratio (males per 100 females) was 97.2 in 2020, lower than the global ratio of 101.7 but close to the African ratio of 99.9 (UNDESA 2019).

Uganda is a densely populated country with clusters of higher densities in the southwest, northeast, and southeast, and surrounding Lake Victoria. The largest agglomeration is the national capital Kampala, with 3.3 million inhabitants in 2020 (including the surrounding cities of Kira, Makindye Ssabagabo and Nansana) with densities of between 250 and 1,000 people per square kilometer[11] (UNDESA 2018) (Figure 2.1). Lowest densities are found in the northeast and some areas in the west-central part of the country with between one and five people per square kilometer.

Figure 2.1 Uganda Population Density Map, 2010 (baseline)



11 Based on these statistics, a threshold for maximum rural population densities of 1,000 persons per square kilometer was applied, along with a 50,000-person square kilometer threshold for urban areas. These thresholds were applied to groups of 15 square kilometer pixels, so that while any one 1 km pixel may exceed the level, on average the threshold could not surpass 1,000 persons per square kilometer for rural areas and 50,000 for urban areas. For futher information, see *Groundswell Africa: Internal Climate Migration in the Lake Victoria Basin Countries* (Rigaud et al. 2021a).

Uganda is a predominantly rural country with 23 percent of its population residing in urban areas, but the urban growth rate is increasing (UN DESA 2018). In the 2015-2020 period, the Ugandan urban growth rate was 5.7 percent per year (the world rate is below two percent), and the proportion of urban population is projected to reach 44 percent by 2050 (UNDESA 2018).

Migration from rural areas contributes significantly to the rapid growth of cities (World Bank 2015e). While urbanization has the potential to speed development and improve well-being, the sudden inflow of people in urban and peri-urban areas across Uganda often overwhelms infrastructure and the delivery of basic services and contributes to the expansion of informal settlements and poor air and water quality and waste management (World Bank 2015e).

2.1.2 Importance of Rural Economy

Agriculture is the largest contributor to the country's GDP, representing 24 percent of GDP in 2018.[12] While the contribution of agriculture to GDP continues to decline in relation to manufacturing and services, over 70 per cent of Ugandans, and 80 per cent of the rural population, is still employed in the sector (FAO and UNDP 2020; World Bank 2018a). More than 95 per cent of cropland is rainfed and based on subsistence farming, making it especially vulnerable to climate hazards, weather variability, and climate change (CIAT, BFS, and USAID 2019). Improved performance in the agricultural sector has been one of the main drivers behind the overall decline in poverty.

Women play an important role in Uganda's rural agricultural sector, particularly farming. Since 1980, women's employment in agriculture has increased around 45 percent in Sub-Saharan Africa, partly due to rural men migrating to urban centers in search for employment opportunities, and women needing to take a predominant role in agriculture (Adenugba and Raji-Mustapha 2013). However, only 27 percent of women own land and less than 20 percent control their agricultural outputs and proceeds (World Bank 2016). The agricultural productivity of women's plots is also 13 percent lower than that of men or jointly managed with other family members, corresponding to losses of about 1.6 percent of Uganda's agricultural GDP (or about USD58 million) or 0.42 percent of the total GDP (nearly US$67 million) (UN Women et al. 2016). This stark difference in agricultural productivity is mainly caused by women's lack of access to "technologies, knowledge, information and other extension services, including financial opportunities, credit and insurance," which limits women's adaptation to climate impacts (Acosta et al. 2015).

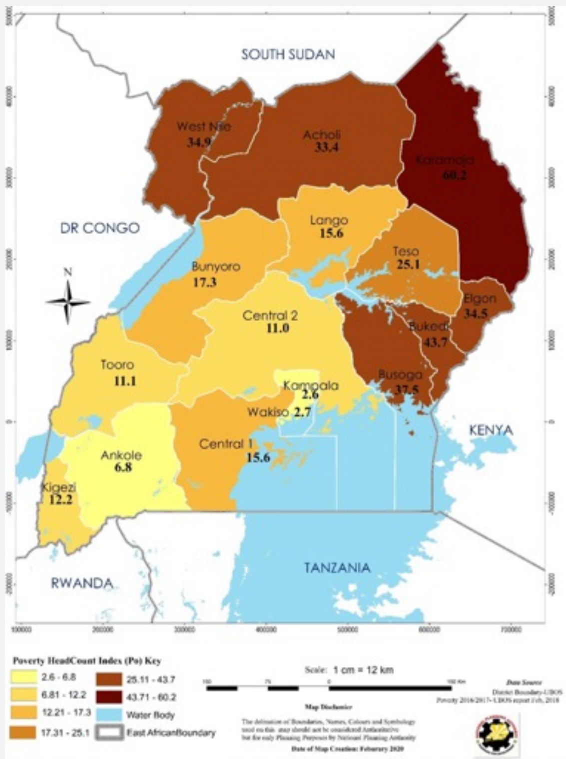
Outside of agriculture, the fisheries industry around Lake Victoria plays a key role in Uganda's economy and nutrition. It represents 1.8 percent of the country's GDP, and Uganda's fisherfolk accounted for 28 percent of all Lake Victoria fishers in 2016 (LVBC and GRID-Arendal 2017). Fish is an important source of protein. Fish consumption in Uganda (12.5 kilograms per person per year) is higher than the average fish consumption in African countries (10 kilograms per person per year) (Obiero et al. 2019). Fish also accounts for 30 percent of the animal protein intake, which is higher the world average (17 percent) and that of African countries (18 percent) (Obiero et al. 2019).

12 See the World Bank Development Indicators (WDI) database, https://datacatalog.worldbank.org/dataset/world-development-indicators

2.1.3 Poverty

Poverty incidence in Uganda is uneven and the country continues to face critical development challenges, including insufficient job creation, lower human capital productivity, and public health threats (including Ebola and COVID-19).[13] While the national poverty incidence was 21.4 percent (2016/2017; according to the national poverty line), it was significantly higher in the East, estimated at 60.2 percent in Karamoja and 43.7 percent in Bukedi. In the South it was lower with estimates in Wakiso at 2.7 percent and Kampala at 2.6 percent (Uganda NPA 2020) (Figure 2.2). Uganda's human capital development (at 38 per cent)[14] continues to lag the global average (56 percent) and that of the Sub-Saharan African region (40 percent) (World Bank 2020d).

Figure 2.2 Poverty Estimates Based on the Uganda National Household Survey 2016/17



Source: Uganda NPA 2020.

13 See the World Bank Development Indicators (WDI) database, https://datacatalog.worldbank.org/dataset/world-development-indicators

14 This means that a child born in Uganda would attain 38 percent of their potential on average if she had full health and a complete education.

2.1.4 COVID-19 Pandemic

The COVID-19 pandemic is deepening the poverty disparities and contributing to reversing rural to urban migration patterns. The number of poor people in Uganda is projected to increase by 2.6 million in the short-term due to the pandemic (UNDP 2020). A study in rural western Uganda found that the total household income decreased by 60 percent, and adult equivalent expenditure by 44 percent, since the COVID-19 lockdown—one of the strictest in the world–was imposed (Mahmut and Riley 2020). The economic shocks related to the pandemic are projected to increase food insecurity, especially among poor households. This is expected to increase rural to urban migration, and less likely international migration due to the high costs associated with cross-border mobility (Smith and Wesselbaum 2020). Other factors that have led to increased urban to rural migration have been the job losses and reduced economic opportunities.[15] The economic shocks of COVID-19 are expected to be more severe in the East and Northern part of the country where the poverty incidence is higher.

2.2 CURRENT AND HISTORICAL MIGRATION PATTERNS

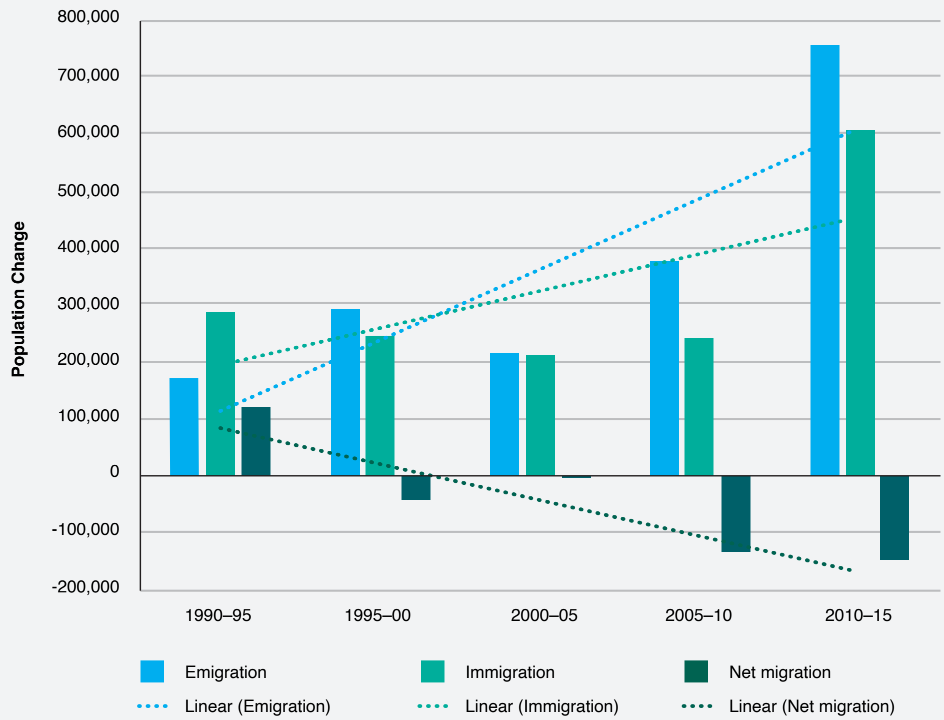
2.2.1 Cross-border and International Migration

Migration flows in Uganda have tripled in the last decade with a consistent pattern of emigration being more prevalent than immigration since the 1990s (Figure 2.3). The 1999 freedom of movement agreement in the East Africa Community (EAC) has facilitated regional mobility. Prevalent push factors driving Ugandan emigration include high population growth, lack of attractive jobs, unemployment, natural disasters, and limited access for youth to natural resources ownership (IOM 2015; MGSoG 2017). Unclear land rights, weak institutional capacities of land administration agencies, and limited land sales make it difficult for youth to purchase land in Uganda (World Bank 2015c). As a result, demand for skilled and unskilled labor in other countries represents a major pull factor (IOM 2015; MGSoG 2017). As of mid-2020, the stock of international migrants from Uganda was 781,440, most of them in South Sudan, Kenya, Rwanda, and Democratic Republic of Congo (DRC). For those emigrating beyond Africa, Great Britain was the main destination (UN DESA 2020). Gender gaps in labor migration, irregular migrants, and of less-qualified workers remains poorly understood.


Jeff Ackley / Unsplash

15 See: https://environmentalmigration.iom.int/blogs/climate-change-adaptation-under-pressure

Figure 2.3 International Migration Flows from and towards Uganda



Source: Abel and Cohen 2019

There are now more than 1.5 million refugees in Uganda from neighboring countries as migration nearly doubled the emigration stock in 2020 (World Bank and FAO 2020a; UNCHR Uganda Refugee Portal 2021). These include refugees fleeing conflict in South Sudan, insecurity and ethnic violence in the DRC, and political instability and human rights violations in Burundi (UN DESA 2020). Between 2010 and 2019, the South Sudan-Uganda bilateral corridor saw the third largest increase in the annual number of international migrants, primarily refugees, after the Syria-Turkey and Syria-Lebanon corridor (UN DESA 2020). By mid-2020, Uganda had a total stock of 1.72 million international migrants including these refugees with a median age of 15.7 (UN DESA 2020). This represented 3.8 percent of the total Ugandan population.

Uganda is currently the third biggest refugee-housing country in the world and is praised for having the most progressive refugee policy in Africa (REACH, WFP and UNHCR 2020). Upon their arrival to Uganda, refugees can choose whether to be self-settled or live-in organized settlements in villages. They have the right to move freely, work, open their own businesses, access public services, and obtain travel documentations (World Bank 2017). As of April 2021, only six per cent of refugees are self-settled in urban centers, primarily Kampala. The rest live in settlements close to the border of the country they came from (UNHCR 2020b). The presence and growth of refugee settlements has increased the demand for wood and cooking fuel, which has added to significant existing pressure on the environment (World Bank and FAO 2020b). While relation between refugees and host communities in Uganda is favorable compared to other East African countries, tensions have emerged over land, access to government services, and employment.

2.2.2 Internal Migration and Displacement

Internal displacement is not a new phenomenon in Uganda. It is rooted in diverse historical migration patterns that continue with increasing intensity. These include pastoralism, conflict, and rural to rural and rural to urban migration. These patterns are closely related to land-use, livelihood, and resource conflicts.

Pastoralists have historically moved internally—and sometimes across borders—as part of their seasonal and voluntary mobility system to access water and grazing lands for their livestock. Sedentary policies, political instability, and disputes among pastoralists over land are slowly disintegrating the traditional nomadic livelihood systems of Ugandan pastoralists. However, around 10 per cent of Ugandans (between 3 and 3.5 million) are still engaged in pastoralism, particularly the Karamojong cluster (Byakagaba et al. 2018; Waiswa et al. 2019). Located in the semi-arid north-eastern part of the country with variable rainfall and limited vegetation growth, the Karamojong herdsmen traditionally move their cattle during the dry seasons over long-distances to more favorable pastures with water (Quam 1997). However, these patterns have changed considerably over time. Mobility, due to regular seasonal changes, is shorter and more frequent, and often restricted within the administrative borders of the district (Waiswa et al. 2019).

Conflict-induced internal mobility has been another historical migration pattern. Since the British colonial rule, there has been economic, political, and military imbalances between the northern and southern ethnic groups that continued after Uganda's independence (Auletta-Young et al. 2015; ICG 2004; Lomo and Hovil 2004). These tensions fueled a conflict between 1986 and 2006 in Northern Uganda that forcibly displaced between 1.5 and 2 million people to central and southern regions (Dunovant 2016; NRC and Global IDP Project 2005; World Bank 2015a). The government forced internally displaced persons (IDPs) to reside in designated urban centers and camps constructed within the affected districts to end the conflict (NRC and Global IDP Project 2005; Rugadya, Nsamba-Gayiiya and Kamusiime 2008). By the early 2000s, close to 95 percent of the rural Acholi population was living in IDP camps (FAO and Tufts University 2019). The number of IDPs reduced significantly in 2006 after the Ugandan government announced the free movement of IDPs. The scale of conflict-induced internal displacement has reduced, but it continues to be an important driver of displacement. The number of conflict induced IDPs dropped from close to two million during the Northern Ugandan conflict to around 1,000 in 2020 (IDMC 2020).

Internal mobility between rural areas, and towards urban centers, is an important feature of internal mobility in Uganda. Rural-urban income differences in formal and informal sectors, employment opportunities, security concerns, and lack of access to social services such as education, health services, water and sanitation are major push factors of internal migration (World Bank 2012). Rural-rural mobility is primary in response to labor demands for commercial crops—such as tea and sugar plantation areas (De Brauw, Mueller, and Lee 2014). High population growth and intense internal migration has been linked to conflicts (sometimes violent) over land in host communities, including evictions, which in turn has affected crop productivity (Mwesigye and Matsumoto 2016). Research about the relation between internal migration and poverty in other countries suggest that internal migration can contribute to poverty reduction, but this area is underdeveloped in the context of Uganda.

2.2.3 Environment-related Migration and Displacement

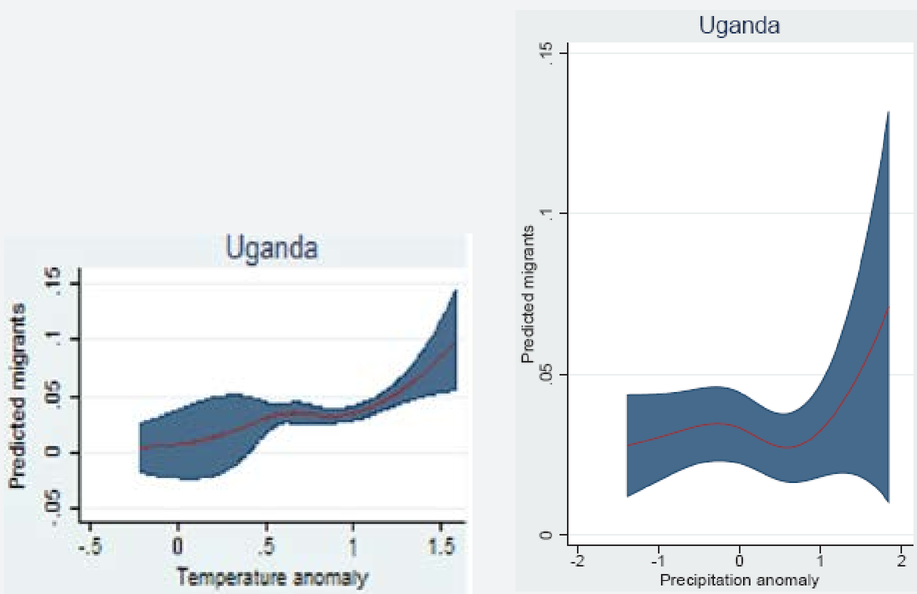
Climate variabilities and extreme weather events have amplified these internal migration patterns. Extended dry spells and droughts have forced the Karamoja pastoralists to migrate longer and farther away, and in some instances, they return to their origin areas in smaller numbers while in other cases they do not return at all (Lwasa, Buyinza, and Nabassa 2017). Erratic rainfall and prolonged dry spells have increased the likelihood of violence through pressures on natural resources, particularly land and water.[16] For example, local and cross border clashes have been observed around Lake Victoria over the exploitation of fisheries (Glaser et al. 2019). The increase of fishing in this area coincides with the in-migration of displaced populations from the northern Ugandan conflict, in part as a response to the other climate-related drivers (Glaser et al. 2019; Rigaud et al. 2018). Environmental shocks have also reduced agricultural yields in some regions, which combined with rapid population growth, has further encouraged rural to urban migration (MGSoG 2017).

16 World Bank Internal Paper. "Issues Paper - Contribution on Climate Change for the Uganda SCD Update."

Climate anomalies are the primary environment-related stressor to internal migration in Uganda. Increased frequency and intensity of heavy rainfall and increased flooding and drought frequency and severity are exacerbating land degradation, on top of population growth, land conversion, urbanization, refugee inflows, and industrialization. Land degradation through soil nutrient depletion, soil erosion, deforestation, and destruction of wetlands can exacerbate internal migration drivers given its negative impact on the economy, poverty reduction, and food insecurity. Gray (2011) found that high quality soils increase non-labor permanent out-migration in a sample of households in the eastern, central and western regions of Uganda. However, in a more recent work based on a longitudinal study of 850 households, Call and Gray (2020) found that climate anomalies, rather than land degradation, are the primary contributors to environmental migration in Uganda.

Both temperature and precipitation anomalies impact internal migration patterns in Uganda in a non-linear pattern (Gray and Wise 2016) (Figure 2.4). Consistent with research in other African countries, heat stress is a particular issue. Short-term hot spells increase temporary migration, an element of a diversified household livelihood strategy, while long-term heat stress induces permanent migration through an agricultural livelihoods' pathway. These effects are significant for internal migration (especially for non-labor female migrants) but not for international migration (Gray and Wise 2016). Climate variability may also impact temporary mobility in Uganda. However, at least one study found that these effects are only significant in urban areas, and not in rural areas (Mueller et al. 2020).

Figure 2.4 Uganda: Nonlinear Effects of Temperature and Precipitation on Migration



Source: Gray and Wise 2016.

Notes:

The graphs depict the non-linear relationship between predicted number of migrants and temperature and precipitation anomalies in Uganda. In both cases, there are shifts in the curves and the effects on the predicted migrants seem to increase when anomalies are larger than one.

Using retrospective migration information (2004-2009) from the World Bank's African Migration and Remittances Surveys, this research applied negative binomial regression to model the number of migrants per household per year as a function of climate variables and controls.

The scale and recurrence of rapid-onset events is increasing (IOM 2020). In 2020, there were 40,000 new internal displacements due to environmental disasters, while the stock number of IDPs due to environmental disasters was slightly lower at 33,000 (IDMC 2021). Flooding and landslides left 87,000 displaced across the country in 2020. In particular, flooding incidents have triggered water rise levels in Lakes Albert, Kyoga and Bisina, displacing 8,700 people across northern, central, and western Uganda in August 2020, and an additional 10,815 newly displacements in October 2020.[17]

2.3 CLIMATE CONTEXT AND IMPACTS

2.3.1 Historical, Current, and Future Climate

Landlocked in the Great Lakes of East Africa, Uganda has a tropical climate and fertile soils (USAID 2012). Its humid and warm weather is highly determined by the large-scale Indian Monsoon, Congo air mass, Indian Ocean Dipole, and the Inter Tropical Convergence Zone systems (World Bank 2020a). Uganda also experiences the El Niño—Southern Oscillation (ENSO) phenomena, which further impacts the country's annual rainfall variability (World Bank 2020a).

Like the greater Lake Victoria Basin, Uganda has climatic variations across its three ecological zones. The northern region is located outside the tropical belt. It has an annual rainfall of 1,123 millimeters and average temperatures around 24°C with one prolonged rainy season from March to October. The southern region (1,323 millimeters per year and average temperature of 22°C) and the Lake Victoria Basin (1,027 millimeters per year and average temperature of 22°C) have an additional short wet season from October to December (AFDB 2018; World Bank 2020a).

Uganda has experienced a statistically significant reduction in annual and seasonal rainfall. Annual precipitation has decreased by around 3.5 percent per decade since 1960, with more marked declines in rainfall levels during the long rainy season in the northern areas such as Gulu, Kitgum, and Kotido (World Bank 2020a). Estimates of future rainfall levels vary with some projections estimating a continued decrease of up to 7 percent by the 2030s, while others suggest an increase of up to 14 percent (USAID 2012).

Uganda has seen an increase in the frequency and severity of extreme weather events, such as droughts, flooding, and landslides. Droughts have become more frequent and longer in Uganda (World Bank 2020a). There were nine severe droughts between 1990 and 2020, which affected almost five million people (Table 2.2).[18]

Yet, while the overall annual and seasonal rainfall has decreased, mountain regions and nearby districts such as Mbale in the Mount Elgon region have recorded an increase of precipitation over the years. These have resulted in mudslides, landslides, and flooding (Uganda MAAIF 2019). Uganda recorded a total of 29 major flooding from 1990 to 2020 (4 and 15 flash and riverine floods respectively) 8 eight landslides (Table 2.2).[19] The Teso district in the mid-eastern part of the country, in particular, recorded in 2007 the largest rainfall in the past 35 years, resulting in severe flooding and affecting around 50,000 households (Uganda MAAIF 2019). In 2020, flash flooding affected 64 out of the 111 districts in Uganda, leaving close to 90,000 people currently displaced across the country.[20]

17 See https://erccportal.jrc.ec.europa.eu/Echo-Flash/ECHO-Flash-old/ECHO-Flash-List/yy/2020/mm/11)
18 See EM-DAT: The Emergency Events Database - Universite catholique de Louvain (UCL) - CRED, D. Guha-Sapir, Brussels, Belgium. http://emdat.be/emdat_db/
19 See EM-DAT: The Emergency Events Database - Universite catholique de Louvain (UCL) - CRED, D. Guha-Sapir, Brussels, Belgium. http://emdat.be/emdat_db/
20 See https://erccportal.jrc.ec.europa.eu/Echo-Flash/ECHO-Flash-old/ECHO-Flash-List/yy/2020/mm/11

Table 2.2 Natural Disasters in Uganda 1990-2020

Population	Subtype	Events Count	Total Deaths	Total Affected	Total Damage ('000 USD)
Drought	Drought	9	194	4,975,000	1,800
Earthquake	Ground Movement	5	115	58,100	71,500
Epidemic	Bacterial Disease	28	3,204	237,665	0
	Viral Disease	10	466	108,036	0
Flood	Flash Flood	4	76	8,614	0
	Riverine Flood	15	267	1,051,945	6,871
Storm	Convective Storm	1	23	47	0
Landslide	Landslide	8	540	151,546	0
	Mudslide	1	51	0	0

Source: EM-DAT: The Emergency Events Database - Universite Catholique de Louvain (UCL) - CRED, D. Guha-Sapir, Brussels, Belgium. http://emdat.be/emdat_db/ Cited in World Bank 2020a

The average annual temperature increased around 1.3° between 1960 and 2012 (USAID 2012). Minimum and maximum temperatures have increased 0.5-1.2°C and 0.6-0.9°C respectively during this period (World Bank 2020a). The average annual temperature is 22°C, ranging from 0°C in the ice-capped Rwenzori Mountain Range and Mount Elgon to 30°C in the north-eastern areas of Gulu, Kitgum and Moroto (World Bank 2020a). The temperature increase has resulted in the melting of the permanent ice caps in the Rwenzori Mountain Range, and a 49 percent reduction in ice between 1987 and 2003 (Uganda MWE 2014).

Temperatures in Uganda are projected to increase by an additional 1° by the 2030s. Under high-emission scenario, temperatures are expected to increase by 1.8° for the 2050s and by 3.7° by the 2090s (World Bank 2020a). The coolest season from June to September is projected to experience the highest temperature increase (between 1.5° to 5.4°) by the end of the century (World Bank 2020a). The repercussions of increased temperatures will look different according to ecological zone and season. During dry periods, warmer temperatures could exacerbate drought. During wet periods, warmer temperatures may contribute to more severe storms, flooding, and the spread of diseases like malaria. Increased temperature is projected to result in ice loss. By 2040, the Rwenzori Mountain Range is projected to lose all its ice (Uganda MWE 2014).

2.3.2 Climate Impact on Key Sectors

Temperature and rainfall changes, combined with extreme weather events, are already having serious consequences on livelihoods and key sectors in Uganda, and these are projected to further intensify in the future. The agricultural sector is especially sensitive to climate changes, and given its contribution to Uganda's economy and livelihoods, current and future weather variabilities place the country at high risk.

Poor households are specifically vulnerable, as they depend on agriculture for their main source of income. Around 53 per cent of households in the bottom two quintiles and 40 per cent of those in the top three quintiles depend on agriculture (World Bank 2016). More than 95 per cent of cropland is rainfed and based on subsistence farming, making it especially vulnerable to climate hazards, weather variability, and climate change (CIAT, BFS, and USAID 2017). Considering Uganda's trends towards higher temperatures and lower water availability, four of Uganda's agricultural sub-sectors, that is crop, livestock, forestry, and fisheries, are particularly at risk.

Crops

Climate variations may increase soil erosion and challenge the harvesting of key food crops, which contribute around 12 percent to Uganda's GDP (Uganda MWE 2015b). Higher temperatures and decreased water availability are likely to increase evapotranspiration, which reduces yields and areas available for crop production (Uganda MAAIF and MWE 2015; World Bank 2020a). By 2050, productivity of food crops like cassava, potato, and sweet potato could decline by 40 percent (Uganda MWE 2015b). The total food crop losses are estimated to be around US$1.5 billion by 2050 (World Bank 2020a).

Major cash crop exports like coffee are also vulnerable to climate variabilities, having an impact on the country's economy and livelihoods. Coffee production has dropped over the last 30 years, primarily due to droughts, landslides, and floods, as well as poor management practices (Uganda MWE 2015a). By 2050, the yields of Arabica coffee are projected to decline between 50 and 75 percent and much of the land will be unsuitable for Arabica production (World Bank 2015d and 2020a). The coffee sector contributes to 18 percent of the country's exports (Uganda MAAIF 2019; World Bank 2020). One of the regions the most vulnerable is Mount Elgon, which heavily depends on coffee production as a source of income (Uganda MWE 2015a).

In addition, rising temperatures foster favorable conditions for the spread of crop diseases and pest infections, as evidenced by the recent and worst desert locust outbreak in Uganda in 25 years.[21] Pest infections can result in crop loss, putting at risk agriculture-based livelihoods and food security.[22] The 2020 locust outbreak infested six sub-regions in Uganda, and resulted in a US$215 million loss in staple cross production, the third highest in East Africa after Ethiopia (US$785 million) and Sudan (US$534 million) (World Bank 2020c).

21 World Bank Internal Paper. "Issues Paper - Contribution on Climate Change for the Uganda SCD Update."
22 World Bank Internal Paper. "Issues Paper - Contribution on Climate Change for the Uganda SCD Update."


Mick Haupt / Unsplash

Livestock

Livestock production in Uganda contributes 17 percent of agricultural value added and 4.3 percent of GDP (FAO 2019b). Around 4.5 million Ugandan households (71 per cent of total households) raise some form of livestock (World Bank 2019c). Droughts, higher temperatures, and pests and diseases are a major cause of livestock mortality in Uganda due to lack of water and pasture (World Bank 2019c). The 2010 and 2011 droughts triggered a US$111.0 million and US$231.5 million in livestock losses, respectively (PARM 2015). Similarly, livestock pests and diseases—which are more prevalent due to abnormal climate variations—can reduce annual livestock profits by as much as US$76.5 million (PARM 2015).

Extreme events, such as heat waves, particularly affect beef and dairy cattle—the main source of livestock in the country (World Bank 2020a). Uganda's drylands area, commonly referred to as the 'Cattle Corridor', from Rakai in southwestern Uganda through Sembabule, Luwero, and Soroti to Karamoja in the northeast, is especially prone to drought. This can lead to livestock losses with severe consequences on livelihoods and food security (World Bank 2018b and 2020a) (Figure 2.5).

Figure 2.5 'Cattle Corridor' in Uganda with the Karamoja Region Highlighted in Green

Source: Stark 2010

Hennie Stander / Unsplash

Forestry

Forestry is a key sector that contributes around 4 percent to the Ugandan GDP and employs around one million people formally and informally (UBOS 2016; Uganda MWE 2016). Forests also provide most of the Uganda's energy demand (88 per cent in 2019), primarily as firewood and charcoal (World Bank 2020f). In addition, the overall energy demand for wood fuels is projected to increase by 4.2 percent per year due to high population growth, urbanization, and development (UBOS 2018).

However, between 1990 and 2015, Uganda lost 23 percent of forests and 70 percent of woodlands (World Bank 2020i). The major drivers of deforestation and vegetation loss are agricultural expansion in forests, livestock grazing, human settlements, urbanization, firewood harvesting, and charcoal and timber production (FAO 2017; NEMA 2009). Indirect drivers are high population engaged in agriculture and high demand for forestry resources (FAO 2017). Forest reserves are projected to be highly impacted, particularly the Bujawe and Kyamugongo central forestry reserve near Lake Albert, and the woodlands around Lake Kyoga (Uganda MWE 2015a).

Climate change can also weaken the capacity of forested water catchments to maintain water cycle and recharge groundwater, as already seen in Mt. Rwenzoni (USAID 2014). Between 1995 and 2011, high temperatures in the south-western Rwenzori reduced its snow cover by 40 percent affecting water flow into the rivers and streams (USAID 2015). This can affect biodiversity on which many Ugandans depend on for their livelihood.

Fisheries

While the fisheries sector only contributes 1.6 percent to the country's GDP, it employs 700,000-1.2 million people (eight percent of Uganda's labor force) and is the second largest Ugandan export (UBOS 2016; World Bank 2020a). Yet, extreme weather events and changes in temperature are accelerating the environmental degradation of Uganda's lakes and threaten the fisheries sector and its contribution to Ugandan's livelihoods, economy, and food security.

Lakes across Uganda face a combination of challenges related to resource over-exploitation, pollution, and habitat degradation among others. Higher temperatures speed up eutrophication and spread disease vectors across the lakes (World Bank 2018b) and increased frequency and severity of floods and droughts exacerbates erosion and sediment runoff (World Bank 2018b and 2020a). Lake Victoria has seen considerable environmental degradation during the last 40 years (World Bank 2018b). Yet, Lake Victoria is the largest lake in Uganda and was the second largest fish supplier in the country between 2017 and 2008 with 40 per cent of the total national fish catch, after Lake Albert which contributed to 43 percent (NEMA 2021). Therefore, these climate pressures on Lake Victoria could significantly impact the fisheries sector (NEMA 2015; World Bank 2020a).

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Chapter 3

Modelling Results: Future Internal Climate Migration Patterns and Trends

3.1 CLIMATE IMPACT PROJECTIONS

Figure 3.1, 3.2, and 3.3 present the average projected changes in water availability, crop production, and net primary productivity (NPP) for the 2010-2050 period. Appendix A has projections for the 2050–2100 period. These projections represent the inputs for the estimation of future population shifts induced by climate change and a proxy of climate migration.

3.1.1 Water Availability

Water availability is a key climate factor that will influence migration in Uganda over the next few decades. This implies that greater water availability results in increasing attractiveness of a location and vice versa. The coefficient for water availability in rural areas is around 2.8 times higher than that of crop production and 4.7 times that of NPP. Critically, it is the only climate driver other than floods influencing future urban population distribution.

The average projected water availability from the ISIMIP model runs for the 2010-2050 period suggest that Uganda is likely to become wetter, particularly in the east (Figure 3.1). The IPSL-CM5A-LR Climate model projects an increase in water availability across most of the country, particularly in the eastern, southeastern (Mbale), and southwestern (Ntungamo) areas. However, the HADGEM2-ES climate model predicts drying in the northwest (Koboko) and west-central areas (Lake Albert) localities.

3.1.2 Crop Production

For crop production, the LPJmL model shows relatively consistent patterns, with declines up to 30 percent in the central and western portions of the country (Figure 3.2). The GEPIC crop model is spottier, but also shows declines particularly under the IPSL-CM5A-LR climate model. The model predicts crop production decreases of 30 percent in the west-central areas, and about 50 percent in the north-east around Koboko under the high emission scenario. These areas coincide with reduced water availability under some of the models (Figure 3.1 and Figure 3.2).

3.1.3 Net primary productivity rate

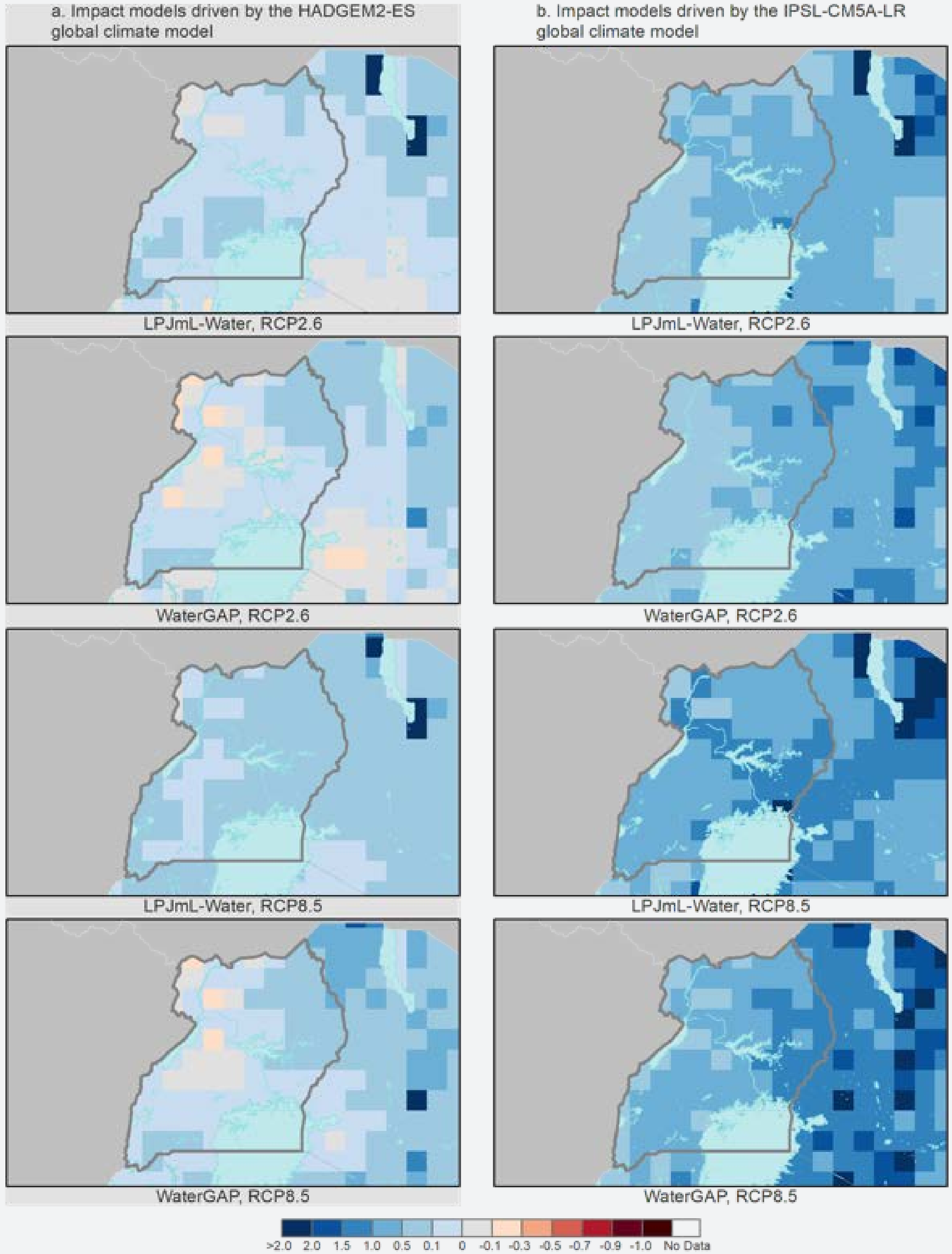
Net primary productivity rate (NPP) future trends are largely positive for Uganda (Figure 3.3). NPP is only used in the migration model to gap-fill areas where there is no crop production in rural areas. This does not apply to Uganda due to the prevalence of agriculture across the rural areas. There is an agreement across all models of an overall increase in NPP relative to the historical baseline, primarily driven by an overall increase in precipitation already seen in the ISIMIP models. Projected increases in NPP in the north-east, an area part of the 'cattle corridor,' could positively impact livelihoods and livestock in the form of more and richer vegetation. Increased NPP due to higher precipitation level can lead to a rise in the soil moisture and this can strengthen photosynthesis and improve the production of vegetation (Mohammed, Zhao and Fang 2018).

3.1.4 Future Floods

Future floods along Victoria Nile and Lakes Kwania and Kyogo—north of Lake Victoria and in the township of Jinna—could have a positive effect on population change for urban areas (Figure 3.4). Urban areas are often located in low lying areas near rivers (and coastlines) that have been attractive for settlements. The impact of flooding on rural population distribution on the other hand is negligible. While counterintuitive, this finding is consistent with longer term population growth trends in flood prone urban areas in many regions of the World. A new World Bank Study *The Ebb and Flow: Water, Migration and Development* (Borgomeo et al. 2021; Zeveri et al, 2021) also found that, on average, water deficits result in five times as much migration as do water deluges, even though floods are much more likely to gain national or international attention.

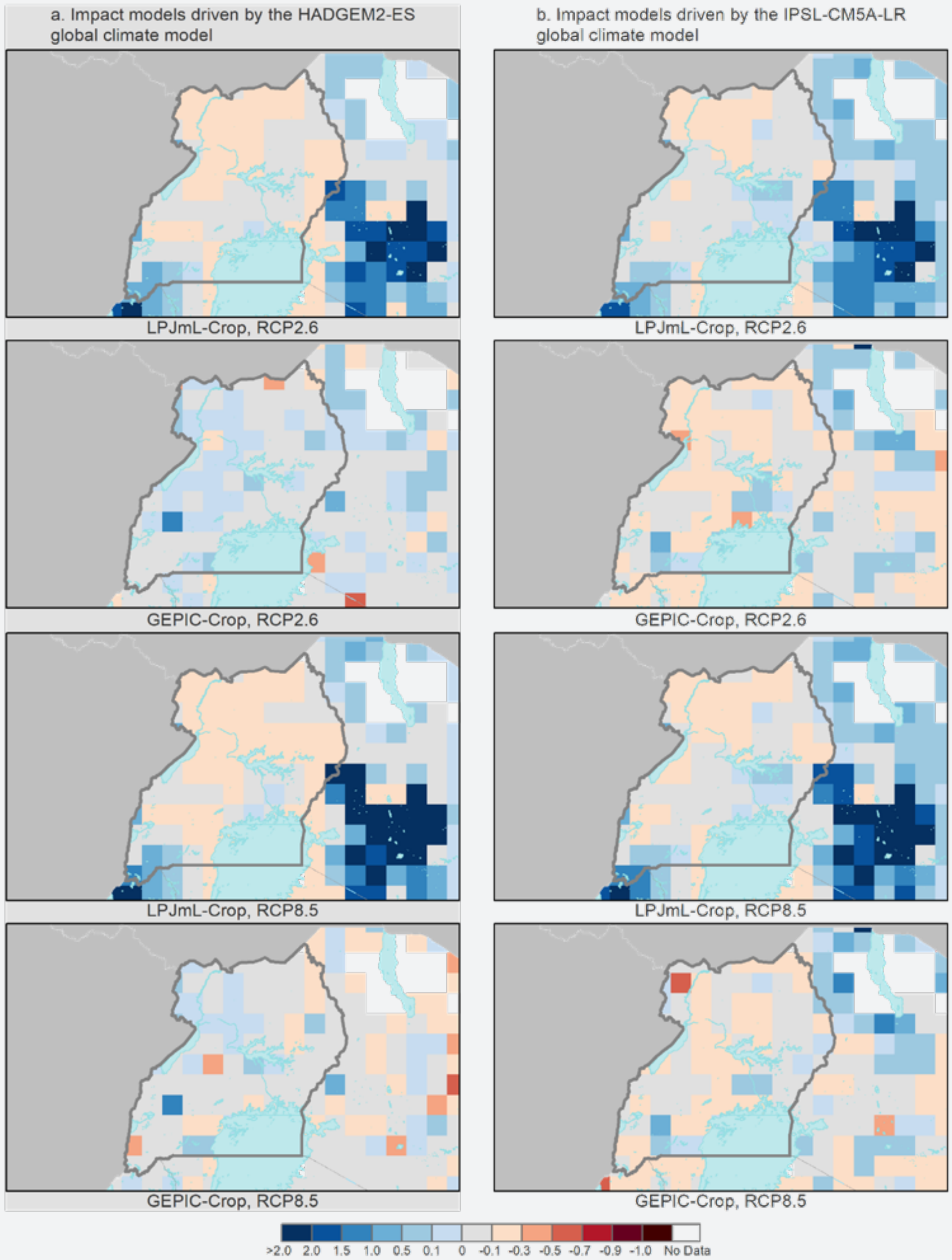
Climate impacts on the water and agriculture sectors, and future flood risk, will impact future population distributions. Each of these factors influences the attractiveness of a location by interacting with the local environment and in turn population distributions. Generally, areas that see positive deviations in water and productivity also see more in-migration, as reflected through spatial population distribution shifts.

Figure 3.1 ISIMIP Impact Models for Water Availability



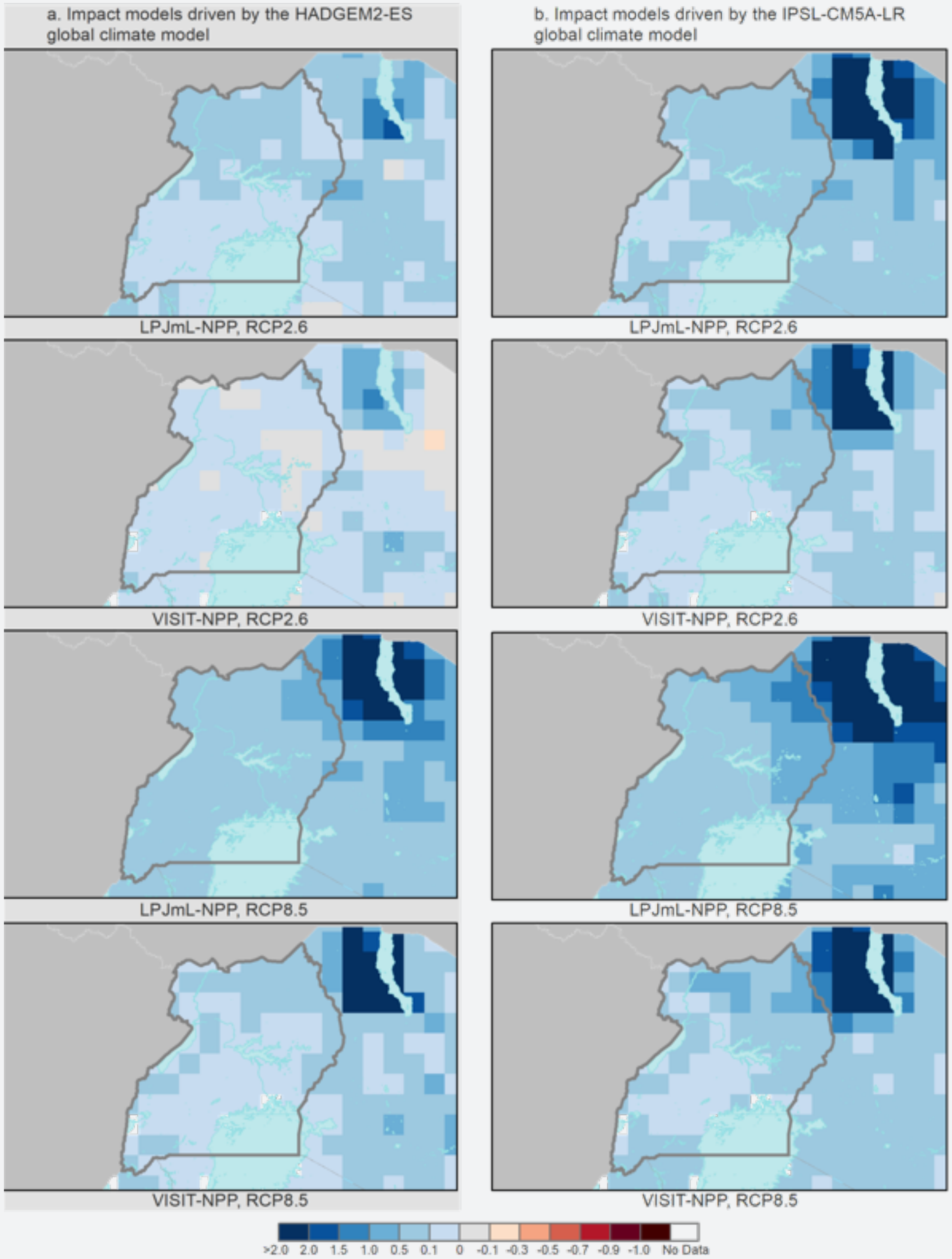
Note: ISIMIP average index values during 2010-2050 against 1970-2010 baseline for water availability, from LPJmL/water and WaterGAP, forced with the HadGEM2-ES climate model (left) and IPSL-CM5A (right) under RCP2.6 and RCP8.5. Blue areas indicate wetting relative to the historical baseline, and gray to tan to red areas indicate drying.

Figure 3.2 ISIMIP Impact Models for Crop Production



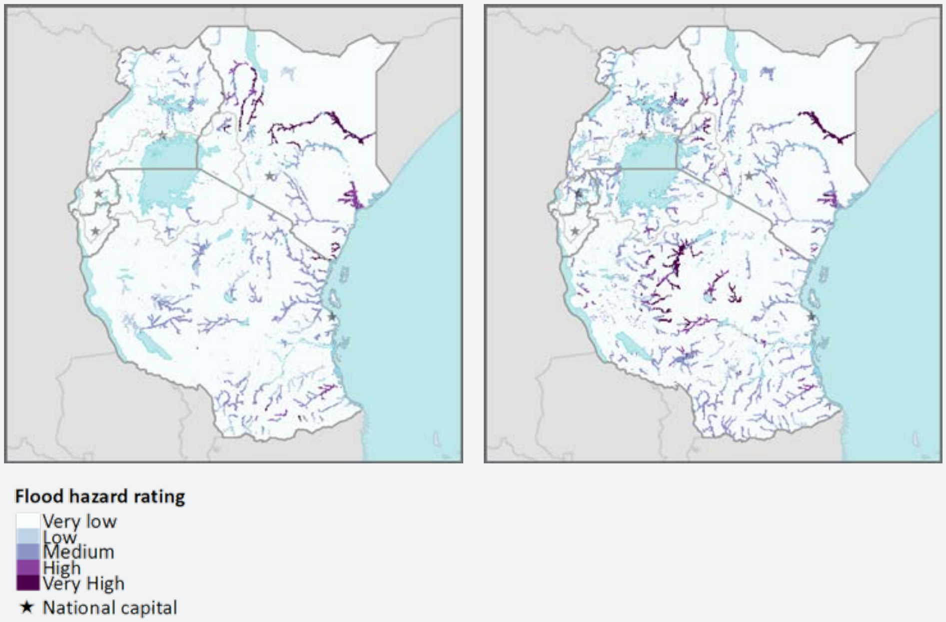
Note: ISIMIP average index values during 2010-2050 against 1970-2010 baseline for crop production. Blue areas indicate increased crop production relative to the historical baseline, and gray to tan to red areas indicate decreased crop production. White areas have no crop production and are gap-filled with NPP.

Figure 3.3 ISIMIP Impact Models for NPP



Note: ISIMIP average index values during 2010-2050 against 1970-2010 baseline for net primary production. Blue areas indicate increased NPP relative to the historical baseline, and gray to tan to red areas indicate decreased NPP. NPP is only used to gap-fill crop production, and therefore is not used to model future population distribution in Uganda.

Figure 3.4 Flood Hazard Rating for 2040, Under RCP2.6 (left) and RCP6.0 (right)



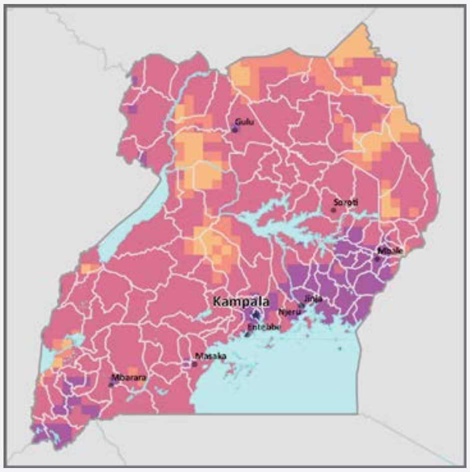
Source: Rigaud et al. 2021a

3.2 POPULATION CHANGE PROJECTIONS

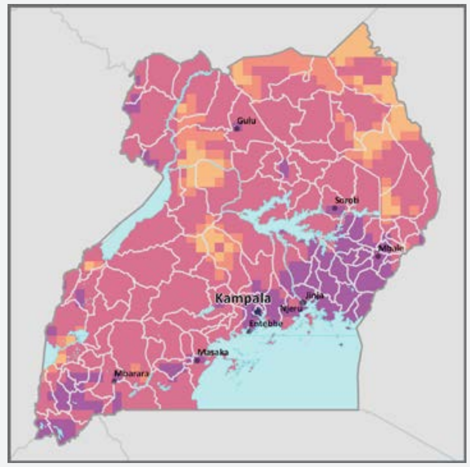
Uganda's population could more than double by 2050, with population densities increasing significantly over large areas in the country. By 2050, Uganda's population could increase from 42.7 million in 2018 to 93.3 million under SSP2, which represents a moderate development pathway. Under SSP4, which represents the unequal development pathway, the population could reach 112.3 million by 2050. Compared with Uganda's population density in 2010 (Figure 2.1), Figure 3.5 displays Uganda's projected population in 2050 across the four scenarios as a function of climate, demographic, and development trends as inputs into the model. Population density is expected to increase particularly in the north and north-east of Lake Victoria (Kampala, Busoka), the border with Kenya (Bukedi, Elgon) and in the southwestern corner (Ankole, Kigezi). These areas are projected to host between 250 and 1,000 people per square kilometer. Increased densities are also visible in the rural areas in the northern, central, and south regions.

Figure 3.5 Projected Population in 2050 Under the Four Scenarios

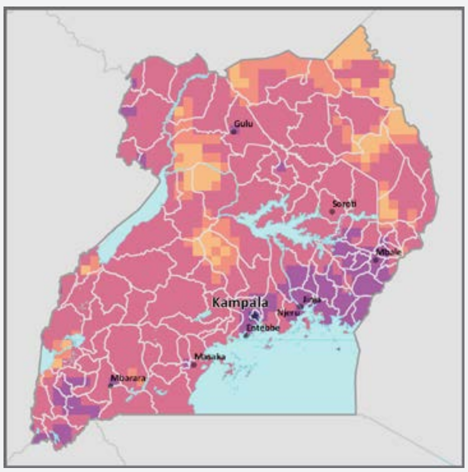
a. Inclusive development (SSP2 and RCP8.5)



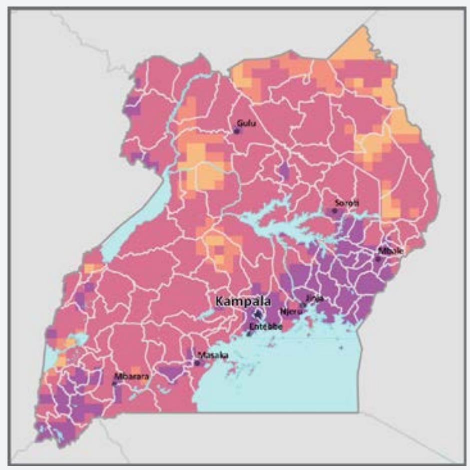
b. Pessimistic (reference) (SSP4 and RCP8.5)



c. Optimistic (SSP2 and RCP2.6)



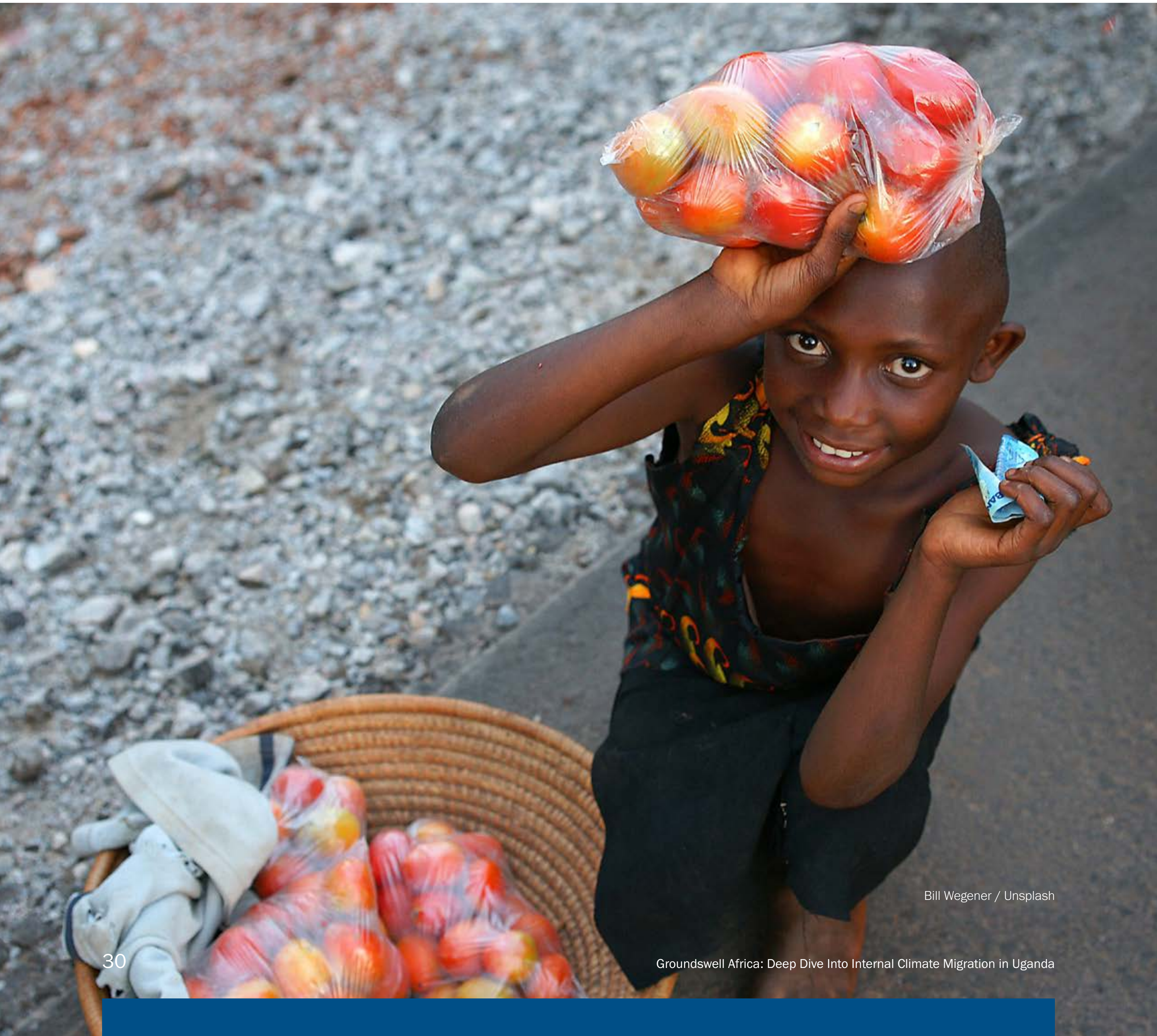
d. Climate-friendly (SSP4 and RCP2.6)



Population density
(number of people per square kilometer)

- < 1
- 1 to 5
- 5 to 25
- 25 to 250
- 250 to 1,000
- > 1,000
- ★ National capital

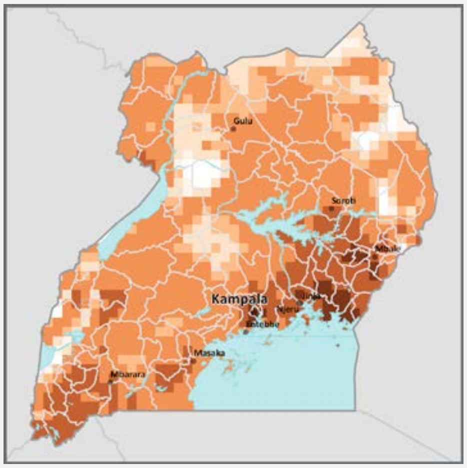
As a result, the projected change in population density in Uganda is expected to increase significantly over large parts of the country by 2050. Figure 3.6 shows the change in the total population per square kilometer between 2010 and 2050 under the four scenarios. The projected changes in population density follow a similar trajectory as the projected population density per square kilometer. As for the population increase, the biggest cluster of projected increase in population density surrounds Lake Victoria and the south-western corner. At the high end, population densities could increase to 500 people per square kilometer, with areas around Kampala, Busoga and Bukedi reflecting increases of 1,000 people per square kilometer. Small areas of modest declines are visible close to protected areas. These include: (1) the Murchison Fall National Park in the west near the north corner of Lake Albert; (2) Matheniko Game Reserve, Pian Upe Game Reserve, and Mount Elgon National Park in the east; (3) Queen Elizabeth National Park in the southwest; and (4) Kidepo Valley National Park in the northeast corner. Changes are more extensive in the pessimistic and climate friendly scenarios since the total projected population is higher under SSP4.



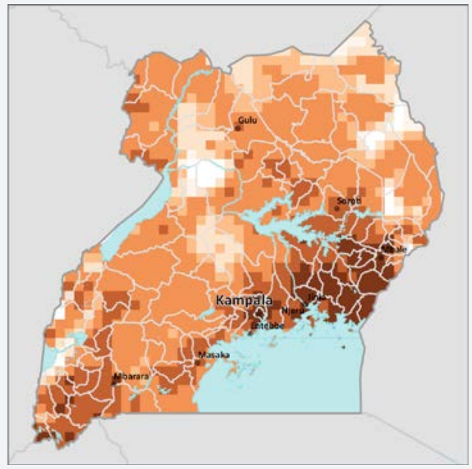
Bill Wegener / Unsplash

Figure 3.6 Change in Population Density Between 2010 and 2050 Under the Four Scenarios

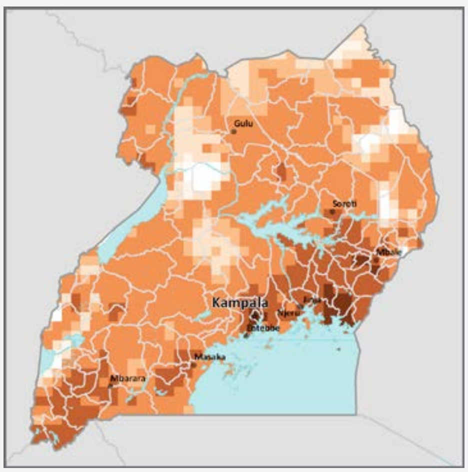
a. Inclusive development (SSP2 and RCP8.5)



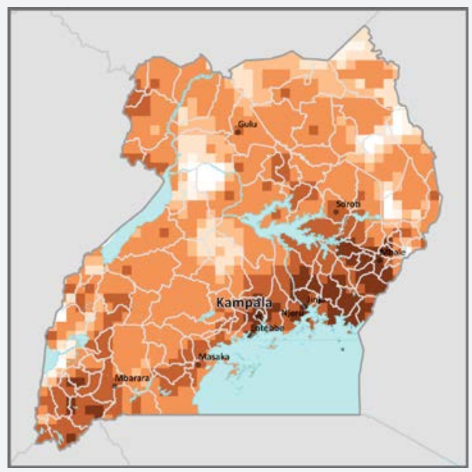
b. Pessimistic (reference) (SSP4 and RCP8.5)



c. Optimistic (SSP2 and RCP2.6)



d. Climate-friendly (SSP4 and RCP2.6)



Population change
(number of people per square kilometer)

- < 0
- 0 to 5
- 5 to 50
- 50 to 100
- 100 to 500
- 500 to 1,000
- > 1,000
- ★ National capital

3.3 INTERNAL CLIMATE MIGRATION PROJECTIONS

This section presents the estimated number of internal climate migrants and their future locations. This is done by comparing future population distributions under climate impacts with the same distributions under scenarios with no climate impacts.[23]

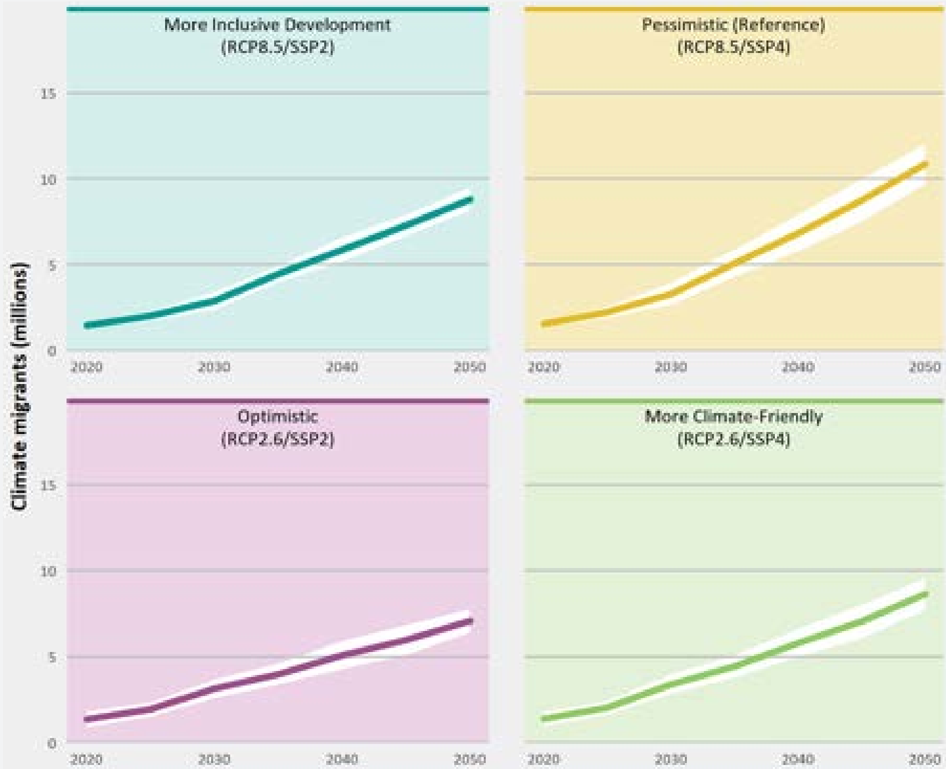
Population distributions have been and will, in the future, be influenced by climate impacts on the water and agriculture sectors, ecosystem impacts, future flood risk, and increasingly on sea level rises. All of these impacts influence the attractiveness of a location by interacting with the local environment. Generally, areas that see positive deviations in water and productivity also see more in-migration. Differences in population levels between scenarios that include RCPs and SSPs and those that only include development trajectories are interpreted as being driven by the "fast" demographic variable—namely migration. The white areas around the central trend line (Figure 3.7) represent the confidence intervals, which reflect the degree of agreement among the four model runs used to provide each estimate for each scenario. Narrower confidence intervals indicate greater agreement among the model runs comprising each scenario.

3.3.1 Scale and Trajectory of Internal Climate Migration

The number of internal climate migrants in Uganda are projected to follow an upward trend across all four scenarios, increasing almost five-fold from 2025 to 2050 under the pessimistic scenario. Uganda could see up to 12 million climate migrants by 2050 under the high end of the pessimistic scenario. Under the low end of the optimistic scenario, the number of internal climate migrants could reach 6.4 million (Figure 3.7, Table 3.1). The more climate-friendly and more inclusive development scenarios fall in between, with a mean value of 8.6 and 8.8 million internal climate migrants, respectively (Table 3.1). In terms of climate migrants as a percentage of the total population, the optimistic and more climate friendly scenarios have the smallest mean proportions (a mean percentage of 7.6 and 7.7 percent respectively), marginally higher than the more inclusive development and pessimistic scenarios (a mean percentage 9.45 and 9.68 percent). There is a strong agreement among the model runs for each scenario, as evidenced by the narrow white areas around the central trend line that represent the confidence intervals.

23 To produce these estimates, the total populations in each grid cell for the respective no climate impact (development only) population projections are subtracted from the three spatial population projection scenarios that include climate impacts—that is the pessimistic reference, more inclusive development, and more-climate-friendly scenarios. Then, all those grid cells that have positive totals in the region are summed to estimate the number of climate migrants. Demographic variables of births and deaths are already captured within the natural population growth patterns—as part of the baseline. For more details see Methodology section, Appendix A and Appendix B in *Groundswell Africa: Internal Climate Migration in the Lake Victoria Basin Countries* (Rigaud et al. 2021a).

Figure 3.7 Projected Total Internal Climate Migrants and Share of the Total Population, Uganda, 2020-2050



Climate migrants as a percentage of the total population

More Inclusive Development (RCP8.5/SSP2):

Year	2020	2030	2040	2050
%	3.27	4.83	7.7	9.45

Pessimistic (Reference) (RCP8.5/SSP4):

2020	2030	2040	2050
3.37	5.08	7.88	9.68

Optimistic (RCP2.6/SSP2):

Year	2020	2030	2040	2050
%	3	5.23	6.67	7.6

More Climate-Friendly (RCP2.6/SSP4):

2020	2030	2040	2050
2.94	5.24	6.68	7.7

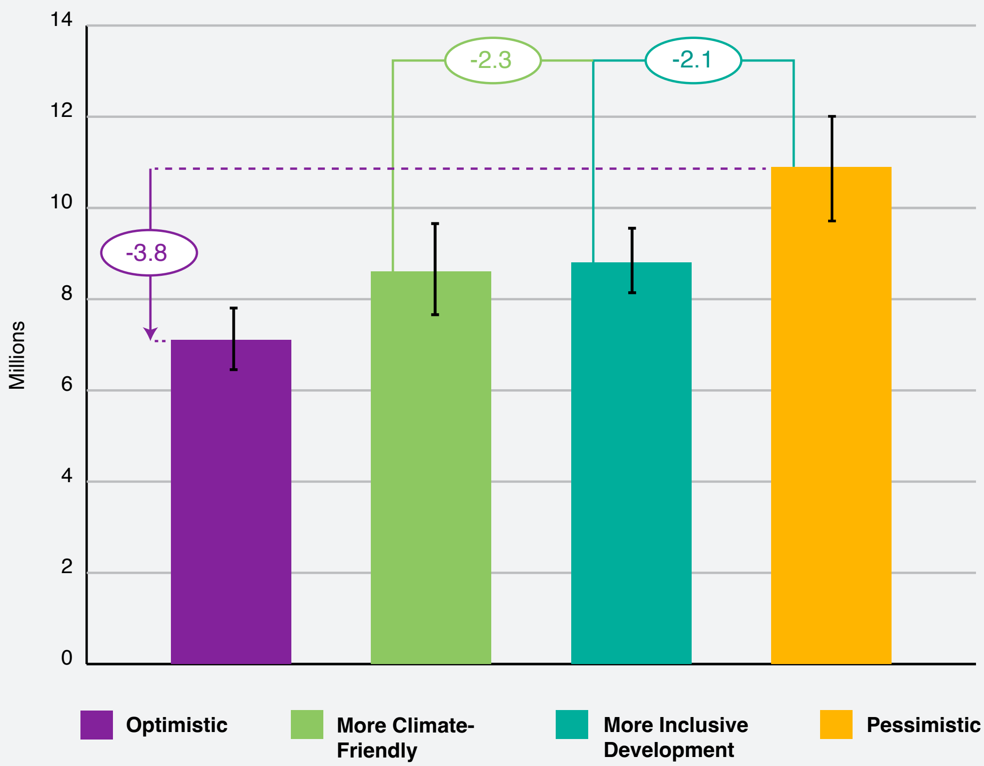
Note: The white areas around the central trend line represent the confidence intervals, which reflect the degree of agreement among the four model runs used to provide each estimate for each scenario. Narrower confidence intervals indicate greater agreement among the model runs in each scenario.

Table 3.1 Projected Total Climate Migrants, Uganda, 2050

	Scenario							
	Pessimistic Reference (RCP8.5; SSP4)		More Inclusive Development (RCP8.5; SSP2)		More Climate Friendly (RCP2.6; SSP4)		Optimistic (RCP2.6; SSP2)	
Average number of internal climate migrants by 2050 (million)	10.9		8.8		8.6		7.1	
Minimum (left) and Maximum (right) (million)	9.7	12.0	8.1	9.5	7.7	9.6	6.4	7.8
Internal climate migrants as a percent of population	9.68		9.45		7.7		7.6	
Minimum (left) and Maximum (right) (percent)	8.6	10.7	8.7	10.2	6.9	8.5	6.9	8.3

Both inclusive development and low emissions are critically important for modulating the scale of internal climate migration—with the greatest gains from early action. The more inclusive development scenario is projected to reduce the average internal climate migration by 2.1 million by 2050, while the climate-friendly scenario could reduce the average of internal climate migration by 2.3 million (Figure 3.8).The greatest gains are made when pursuing the optimistic scenario with low emissions together with more inclusive development, reducing the average internal climate migration by 3.8 million. This shows that climate and development factors, including demographic, economic, and adaptation ones, have the potential to alter the scale of internal climate migration in Uganda. It further stresses the need to rapidly pursue highly resilient policies and economic transitions and shift towards less climate sensitive sectors at scale. Most importantly, these plausible scenarios provide a roadmap that charts out urgent and concerted action characterized by inclusive development and climate friendly policies to reduce the adverse consequences of climate migration. At the same time, without collective global responsibility and action to meet the Paris target, some of these gains may become more difficult to realize.

Figure 3.8 Projected Reductions in Internal Climate Migrants, Uganda, by 2050 in comparison to the pessimistic scenario



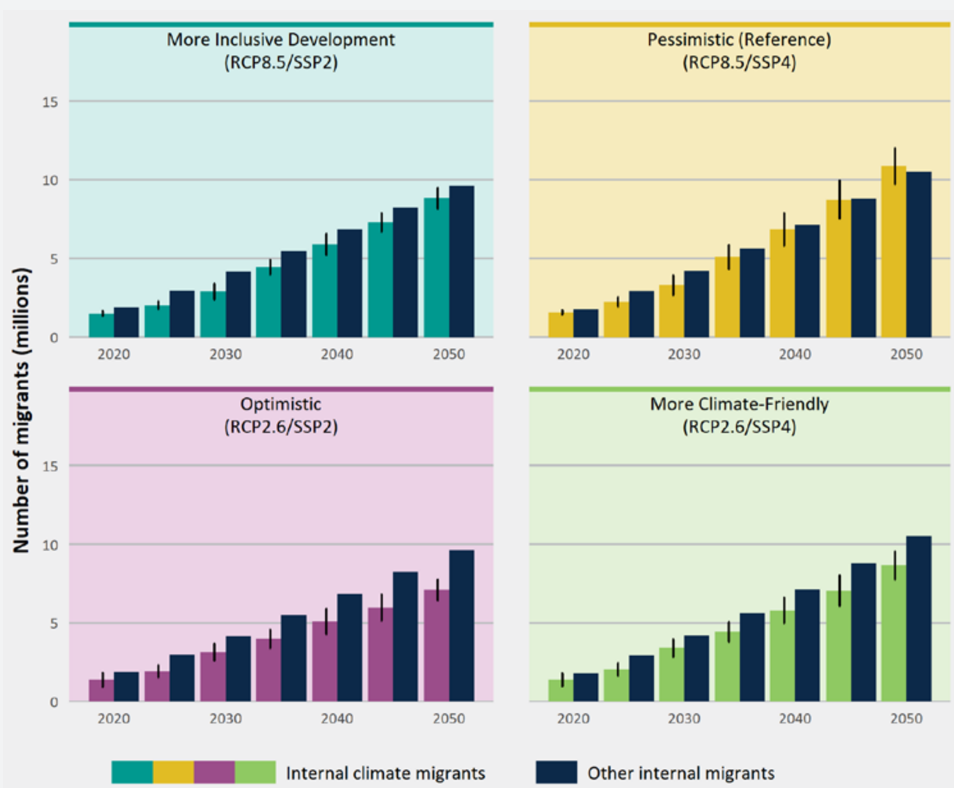
Note: The whiskers represent the lowest and the highest number of internal climate migrants in that scenario

3.3.2 Internal Climate Migrants Versus Other Internal Migrants

Other internal migrants include individuals who move internally due to changes in population growth, urbanization, income, and education (as set out in the SSP pathways). The projected number of other internal migrants was calculated by comparing projected population distribution under the SSP-only 2050 development scenarios (no-climate) to a counterfactual in which the population in each grid cell is scaled according to the 2010 population distribution. In other words, the counterfactual is a world in which the population changes, but people remain in place. The difference between these two scenarios is considered to be development or 'other' internal migrants.

Climate migration will not occur in isolation; other types of internal migration will occur simultaneously and will need to be managed in an integrated manner in a country with already high internal mobility. Internal climate migrants could outpace the share of other internal migrants under the pessimistic scenario before 2050 (Figure 3.9). The scale of climate migrants remains close to the numbers of other migrants for both the inclusive and climate friendly scenario. The small error bars for internal climate migrants reflect higher confidence around the models and greater certainty around these projections. These results suggest that Uganda is a highly climate-sensitive country in which climate factors are set to play an important role in driving future mobility.

Figure 3.9 Projected Rates of Internal Climate Migrants Compared to Other Migrants



Note: The whiskers on the climate migrant bars represent the 95th percentile confidence interval for the four model runs that comprise each scenario. There are no confidence intervals for other migrants, because only a single development trajectory is used in each scenario (SSP2 or SSP4).

These projections across the four scenarios suggest that climate migration is a present reality that calls for urgent attention today. The combination of high population growth and climate change impacts could make climate migration the dominant type of internal migration in the near future. From a policy perspective, it is important that the two types of internal migrants (climate migrants and other migrants) are not treated as equal. The climate migrants derived from this model reflect mobility driven by the adverse impacts of climate, whereas other internal migrants move for population growth, urbanization, income, and education. Nevertheless, the response strategies may benefit from more integrative approaches in addressing the underlying factors.

3.3.3 Climate In- and Out-Migration Hotspots

Climate migration hotspots reflect areas of high certainty (with agreement across the scenarios at the top 5th percentile) where spatial populations will shift into (climate in-migration) or out (climate out-migration) of a grid cell over time.

Climate out-migration will occur in areas where livelihood systems are increasingly compromised by climate impacts.

Climate in-migration will occur in areas with better livelihood opportunities. These reflect movements from less viable areas with lower water availability and crop productivity and from areas affected by rising sea level and storm surges to areas with better opportunities.

The emergence of internal climate migration hotspots, more contained in 2030 and 2040, could expand rapidly both in extent and intensity by 2050 (Figure 3.10 and 3.11 and Box 3.1). According to the ISIMIP results, as early as 2030, the south-eastern locality of Mbale and its surroundings are predicted to be a high-certainty in-migration hotspot, primarily driven by increases in water availability and crop production. Mbale is already facing increases in informal human settlements and inadequate human resources (Table 2.2). Mount Elgon, a key water tower with one of the highest populations and poverty rates in the country, is projected to become a high-certainty climate in-migration hotspot by 2050, and early action for management, conservation, and development interventions are an imperative. By 2050, the capital Kampala could also become a high-certainty in-migration hotspot. Given that Kampala is an already high dense locality, effective management efforts will be indispensable. The south-western locality of Ntungamo, on the border with Tanzania, could be another in-migration hotspot, mainly due to increases in water availability and crop production.

Box 3.1 Understanding Climate In- and Climate Out-Migration Hotspots

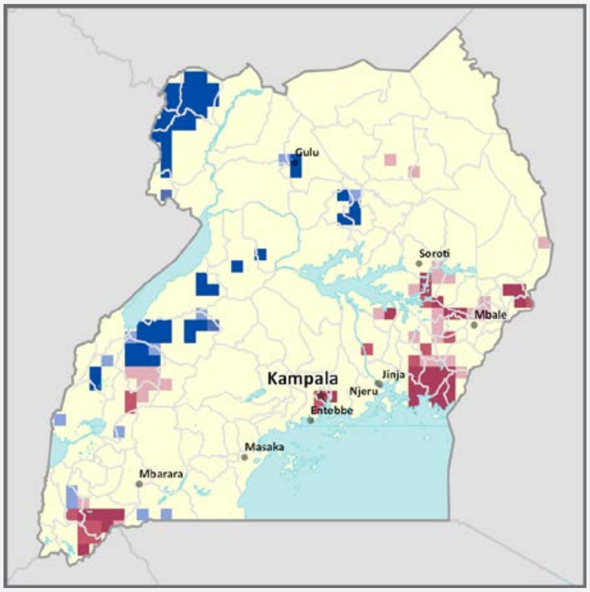
To map climate change-induced migration, population distributions are projected with and without climate impacts. The difference between the two is interpreted as changes in population due to migration. Hotspots represent the top 5th percentile of the distribution of total climate migrants per 15 km grid cell. Where two out of four scenarios overlap, it is considered a low certainty hotspot; where three out of four scenarios overlap, this is considered a moderate certainty hotspot; and where four out of four scenarios overlap, this is considered a high certainty hotspot. To be consistent across the time series, we apply the 2050 the 5th percentile population difference thresholds for 2030 and 2040. This gives a sense of the progression of hotspots over time.

More highly populated areas are more likely to have high in- or out-migration since thinly settled areas typically do not see a lot of difference in absolute numbers of population between the climate and no climate impacts model runs. Even though an area may represent an out-migration hotspot (in blue, figures 3.10 and 3.11), that does not mean that population will decline in these areas. The correct way to interpret these areas is that population growth will be dampened owing to climate impacts, particularly on water availability, but also on the agricultural (crop and livestock) sector.

By 2050, three major high-certainty out-migration hotspots are projected to emerge, mainly in the north-west and central-west around Lake Albert (Figure 3.10 and 3.11). As early as 2030, the north-western locality of Koboko—near border with DRC—could become a high-certainty out-migration hotspot, and continue to expand through 2050. According to the ISIMIP models, this out-migration will be driven primarily by decreases in water availability and crop production. As in Koboko, the out-migration around Lake Albert will escalate rapidly between 2040 and 2050, driven by reductions in crop production. In addition, Gulu and Lira, two small urban centers in central Uganda, are projected to become out-migration hotspots by 2050—also in response to impacts on crop production.

Overall, climate in- and out-migration hotspots in Uganda are mainly driven by positive and negative changes in water availability and crop production (Figure 3.1 and 3.2 and table 2.2). They are also driven in response to the full factor associated with flooding patterns. Table 3.2 provides a summary of the high intensity climate-in and climate-out migration hotspots and a status of their current environment and urban development context. This will be critical in shaping policy and forward-looking approaches for early action to avert the adverse consequences of climate-induced migration. The spatial and temporal nature of the emergence of climate hotspots provides critical information that can inform focused but differentiated territorial strategies for early planning and action for inclusive and climate resilient development action.

Figure 3.10 Projected Hotspots of Climate In-Migration and Out-Migration for 2050



IN-MIGRATION

- High certainty in high levels of climate in-migration
- Moderate certainty in high levels of climate in-migration
- Low certainty in high levels of climate in-migration

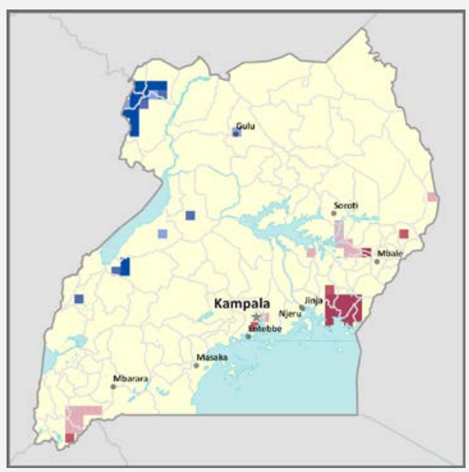
OUT-MIGRATION

- High certainty in high levels of climate out-migration
- Moderate certainty in high levels of climate out-migration
- Low certainty in high levels of climate out-migration

Figure 3.11 Projected Hotspots of Climate In-Migration and Out-Migration for 2030 and 2040

a. 2030

b. 2040



IN-MIGRATION

- High certainty in high levels of climate in-migration
- Moderate certainty in high levels of climate in-migration
- Low certainty in high levels of climate in-migration

OUT-MIGRATION

- High certainty in high levels of climate out-migration
- Moderate certainty in high levels of climate out-migration
- Low certainty in high levels of climate out-migration

Table 3.2 Projected High-Intensity Climate In- and Out-Migration Hotspots by 2050

Region	Hotspot Locality	Climate Predictions	Environmental Resource Degradation and Challenges Aggravated by Climate Change	Decade Emergence as High Intensity Hotspot*	Urban Development Context
			IN-MIGRATION		
Eastern	Mbale	Increases in water availability and crop production	Given its location on the foot of Mount Elgon, Mbale is vulnerable to landslides, earthquakes, floods, and droughts, which often put the locality at risk given its poor waste disposal, sanitation, water sources, and deforestation (UN-Habitat 2011). Rainfall is projected to increase during the wet season, which might increase erosion, flooding in valleys, and siltation of streams and rivers (Mbogga 2012). From December to February, precipitation is projected to decrease, which might increase water stress and scarcity for domestic use during that period (Mbogga 2012).	2030	Mbale is a large economic hub and urban center that was declared a city in July 2020 (Mbabazi and Atukunda 2020). Major economic activities are the trade, services, transportation, telecommunication, and food processing industries, restaurants, and hotel services. Mbale has a high urban population density, primarily driven by high-in migration from rural areas. The rapid population growth, combined with fragile land tenure systems, human resources, and infrastructures, resulted in an increase in informal human settlements and slums. There is also a shortage of land and lack of basic services due to poor drainage systems, lack of solid waste management facilities, and poor sanitation (UN-Habitat 2011).
Western	Ntungamo	Increases in water availability and crop production	Some parts of the Ntungamo district are in Uganda's cattle corridor, and this often experiences prolonged droughts that affect most the population given their reliance on crops and livestock (Tumushabe et al. 2013). The district also has a high incidence of crop diseases and pests, which are projected to worsen with further extreme weather events (Uganda Department of Relief, Disaster Preparedness and Refugees 2016). Most of the population rely on wood and biomass as their primary source of energy, which is highly vulnerable to climate changes and deforestation (Tumushabe et al. 2013). The district also has poor infrastructures and roads, and extreme weather events often result in their destruction or deterioration (Tumushabe et al. 2013).	2050	The Ntungamo Municipality is the capital of the Ntungamo district, in which subsistence agriculture is the major economic activity (Uganda Department of Relief, Disaster Preparedness and Refugees 2016). Sorghum, millet, peas, sweet potatoes, beans, cabbage, and onion are the most harvested crops in the district (Uganda Department of Relief, Disaster Preparedness and Refugees 2016). Ntungamo's rich wetlands facilitate and support the district's reliance on agriculture through the provision of natural resources for their agriculture-related livelihoods (Tumwebaze 2018).

Region	Hotspot Locality	Climate Predictions	Environmental Resource Degradation and Challenges Aggravated by Climate Change	Decade Emergence as High Intensity Hotspot*	Urban Development Context
			IN-MIGRATION		
Central	Kampala	Increases in water availability and crop production	High population density in Kampala has accelerated degradation and ecosystem loss, primarily due to poor waste and water practices and piped sewerage networks (World Bank 2015b). Kampala generates more than 1,500 tons of solid waste per day, but it only has the capacity to dispose 50 percent of it (Uganda NPA 2020). The unsafe disposal of municipal and solid waste is one of the causes of water pollution (Uganda NPA 2020). Given the city's location on low rolling hills linked by wide valleys of wetlands, increased rainfall due to climate change has caused storm runoffs, causing flooding and pollution spread (World Bank 2015b).	2050	Kampala is the largest city in Uganda with an estimated 3.9 million people in 2020, and is the third- fastest-growing city in the world after Zinder (Niger) and Bujumbura (Burundi) (Hoff 2020). The consistent population growth for decades has posed challenges to provide adequate housing, sanitary, and public services (World Bank 2015b). This has resulted in more than 40 percent of the Kampala population living in unplanned and highly dense informal settlements (World Bank 2015b)
Eastern	Mount Elgon	Increases in water availability and crop production	The high reliance on Mount Elgon's resources, combined with unsustainable land management practices, has resulted in land fragmentation and deforestation. Mount Elgon is also prone to flooding, landslides, and soil erosion (Mafabi 2017).	2050	Extinct volcano on the border between Kenya and Uganda with high vegetation and biodiversity. Mount Elgon is a major water tower that supplies water to multiple rivers—including the Nile—and regulates water quantity, quantity, and flow evenness. It has high population densities of 1,000 people per square kilometer, and the population growth increases every year. Mount Elgon has high poverty levels (Mafabi 2017).
			OUT-MIGRATION		
Northern	Koboko	Decreases in crop production	Given the limited availability of fertile land due to the rapid population growth and climate change, croplands have expended into forest areas, which has disrupted the provision of ecosystem services such as water and firewood (Speziale and Genaletti 2014). Koboko does not have a piped water system and adequate surface and ground water resources, and the available water is often contaminated due to high population (UN-Habitat 2020). Other environmental challenges are deforestation, poor waste management, overgrazing, and poor land management (Speziale and Genaletti 2014; UN-Habitat 2020).[24]	2030	Koboko town is the capital of the Koboko district situated at the corner of northwestern Uganda. Koboko's main economic activities are crops (vegetables, cassava, and groundnuts), fisheries, and poultry. It is one of the poorest districts in Northern Uganda with one of the highest rates of rural poverty and fertility. Around 90 percent of its population relies on agriculture for nutrition, making Koboko highly vulnerable to climate changes. Koboko hosts large numbers of refugees from neighboring countries, particularly DRC and South Sudan. (Speziale and Genaletti 2014; UN-Habitat 2020).[25]

24 See https://koboko.go.ug/lg/population-culture
25 See https://koboko.go.ug/lg/population-culture

Region	Hotspot Locality	Climate Predictions	Environmental Resource Degradation and Challenges Aggravated by Climate Change	Decade Emergence as High Intensity Hotspot*	Urban Development Context
			OUT-MIGRATION		
Eastern	Near Lake Albert	Decreases in crop production	Lake Albert's catch per unit effort (CPUE) significantly decreased in 2017 and 2018 due to overfishing, primarily driven by high population growth, lack of alternative livelihood opportunities, and high poverty rates. The number of fishers in Lake Albert has almost doubled in the span of ten years, with 14,364 fishers in 2007 and 27,944 in 2018. Other factors impacting the lake's resources and management are the increase of illegal fishing, poor management practices and regulations, higher demand for fish, access to markets, and open access to fish resources (NEMA 2021).	2040	Lake Albert is the seventh-largest lake in the African continent, and it is shared between DRC and Uganda. Between 2017 and 2018, it became the first contributor to Uganda's (43 percent) after Lake Victoria (40 percent), and it has at least 55 different fish species (NEMA 2021). Fishing and fish mongering is the main economic activity near the lake. In the past 50 years, the population in the shores of the lake has increased due to in-migration from other parts of Uganda and neighboring countries—primarily DRC—seeking opportunities in the fishery sector (D'Udine et al. 2015; NEMA 2021).
Northern	Lira and Gulu	Decreases in crop production	The average annual temperature in Gulu has increased since the 1980s and has accelerated the presence of pests and crop diseases (Africa Climate Change Resilience Alliance 2014). Extreme weather events have also intensified, with heavy rains often closing roads and schools (Africa Climate Change Resilience Alliance 2014). In Lira, agricultural production has decreased due to declining soil fertility and high population growth (Uganda Disaster of Relief, Disaster Preparedness and Refugees 2016). This has forced people's settlement in wetlands, which has undermined the availability of surface and underground water, often resulting in flooding, destruction of roads, crops, reduced fish stock, and biodiversity and habitat loss (Uganda Disaster of Relief, Disaster Preparedness and Refugees 2016).	2050	Gulu and Lira are two small rapidly growing urban centers in northern Uganda that were declared cities in July 2020 and July 2022 respectively (Mbabazi and Atukunda 2020). Agriculture is the main economic activity of both cities (Slotkin 2017; UBOS 2017). It has one of the poorest poverty rates in the country, with around 60 and 71 percent of its population living below the poverty line (Africa Climate Change Resilience Alliance 2014).

*Decade in which this locality becomes a high-intensity hotspot

3.4 BEYOND THE HOTSPOTS–THE LARGER SPATIAL CONTEXT

By 2050, the population change per square kilometer caused by internal climate migration in Uganda could be positive in the middle, southeast and southwest, and negative in the western side. Figure 3.12 displays the absolute projected population change per square kilometer by 2050 due to internal climate migration—the difference between the climate and no climate impacts scenarios. It reinforces the hotspots results of Figure 3.10 while also reflecting the population shifts across the territory of Uganda. Areas of negative differences do not necessarily mean that the population will decline in these areas, but that owing to climate impacts, their growth may be slower than it otherwise would have been.

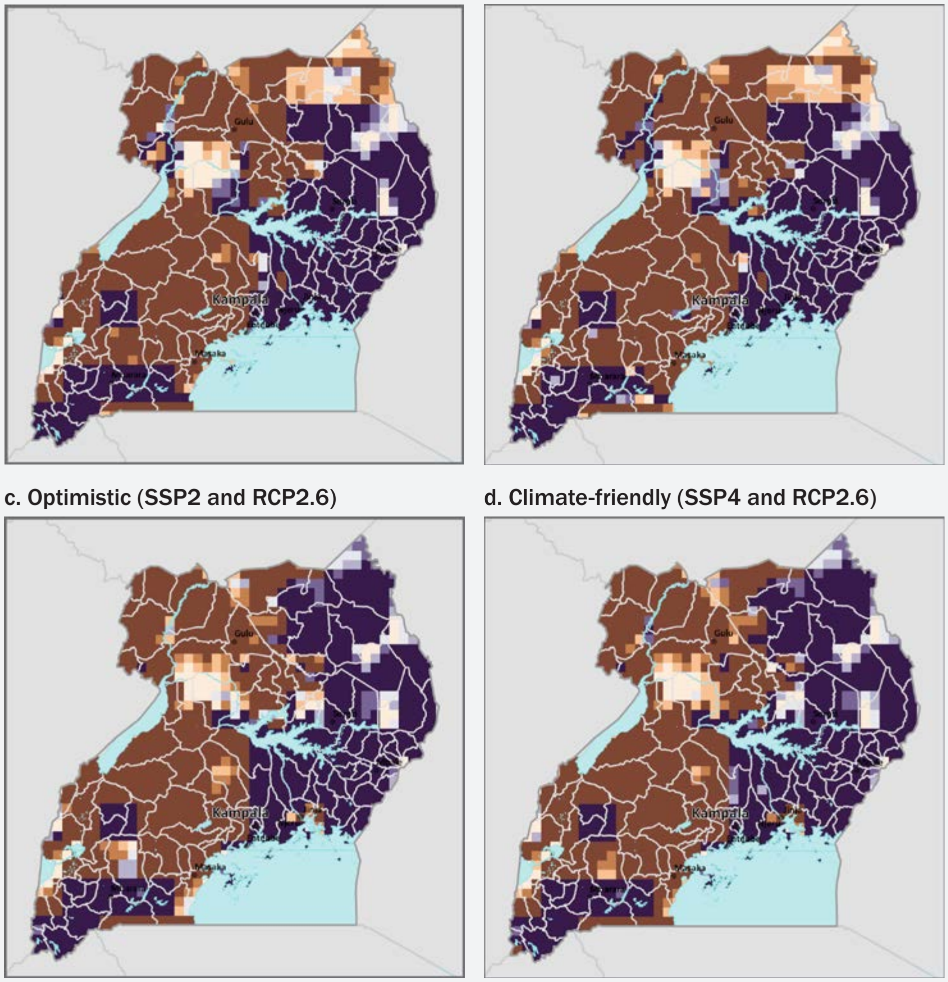
The pattern is consistent across the scenarios. There is an agreement across the four scenarios of a negative population change in the western part of Uganda caused by climate out-migration. In contrast, mid- and south-eastern Uganda is projected to see positive population changes due to climate in-migration. These results correspond with the migration hotspots by 2050 (Figure 3.10), which projects in-migration areas in eastern Uganda and out-migration in north- and central-western areas. Climate-in migration hotspots could emerge in the sub-regions of Karamoja, Teso, Bukedi, Busoga, and Elgon, which have high poverty with 40 and 60 percent of their population living below the poverty line (Figure 3.2). Early opportunities to understand the underlying factors and devising strategies could reduce the scale of this adverse migration through adapt in place measures, or anticipatory planning to facilitate transitions that may be needed.

Spatial projections, as percentages and absolute numbers, show why farsighted and anticipatory approaches are needed to avert, minimize, and address the adverse consequences of climate-induced migration. Figure 3.13 displays the information in Figure 3.11 (the difference between climate impact and no climate impact scenarios), as percentage of the population under the no climate impacts (SSP-only) scenario in each grid cell. This highlights changes in less densely settled areas, which explains why Kampala is depicted as having very high levels of climate migration in Figure 3.12 but relatively small percent changes in population owing to climate migration in Figure 3.13. Figure 3.13 shows some (small) differences among the scenarios. In particular, the areas with large negative percent change (over 10 percent) are larger in the pessimistic and inclusive development scenarios, covering almost entirely the central region up to Lake Victoria. Instead, areas with large positive percent change appear larger in the optimistic and more climate-friendly scenarios, covering an extensive area in the northeast.

Figure 3.12 Projected Population Change due to Climate Migration in 2050

a. Inclusive development (SSP2 and RCP8.5) b. Pessimistic (reference) (SSP4 and RCP8.5)

c. Optimistic (SSP2 and RCP2.6) d. Climate-friendly (SSP4 and RCP2.6)

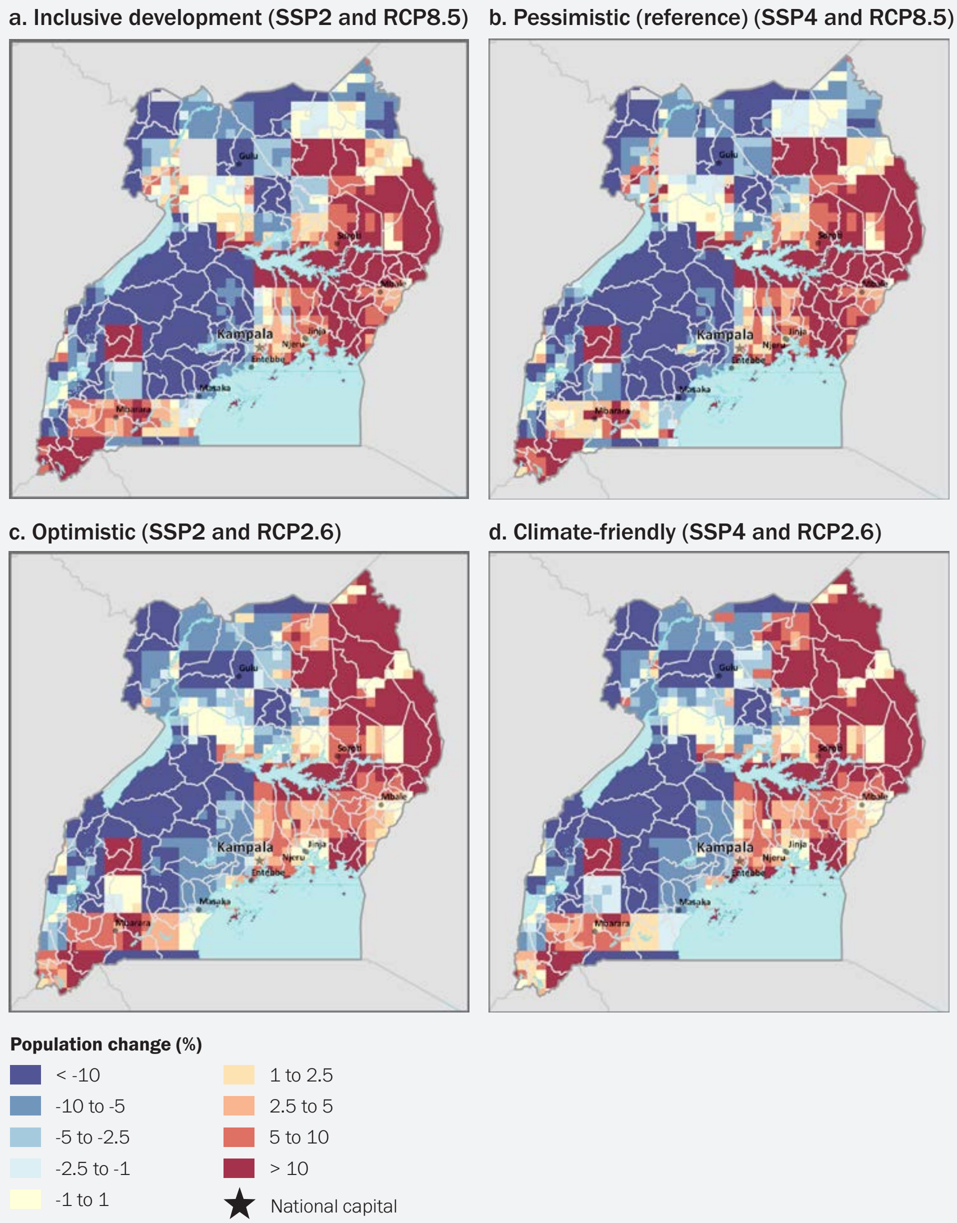


Population change (count)

- < -1,000
- -1,000 to -500
- -500 to -100
- -100 to 0
- 0 to 100
- 100 to 500
- > 1,000
- ★ National capital

Note: Estimated changes shown per square kilometer.

Figure 3.13 Projected Share of Difference in Population due to Climate Migration in 2050, according to the no climate scenario



Note: Estimated changes shown per square kilometer.

3.4.1 Internal Climate Migration by Livelihood Zones

Livelihood zones used here are based on an aggregation of anthropogenic biomes produced by Ellis et al. (2013 and 2010). These livelihood zones are static, meaning they are not projected into the future based on likely climate influences on ecosystems (for example Williams et al. 2007). However, they do reflect the historical climate period from 1970-2010. The distribution of zones in the future could obviously be altered by climate impacts on the water and agriculture sectors and natural ecosystems. Furthermore, livelihood zones are land-based, and therefore do not consider the livelihoods of those dependent on marine fisheries along the lake.

Climate Migration by Livelihood Zones

The distribution of livelihood zones in Uganda shows extensive rainfed croplands (Figure 3.14). The models project an overall climate out-migration from rainfed croplands and rice growing areas, and climate in-migration in dense settlements and semi-natural and pasturelands. Areas of semi-natural wildlands appear in the west, by Lake Albert, and in the east on the border with Kenya, while pastoral and rangelands can be observed in the north. Spots of dense settlements are visible in the more urbanized southeast area, where some of the largest cities are located (Kampala, Mbale) and on the southeast border, where also some refugee camps are found (Coggio 2018). Small spots of irrigated croplands are visible close to Gulu (north central), the northwest border with DRC and in the southeast.

Dense settlements and semi-natural wildlands consistently show positive values, while all categories of cropland show negative values. The scenarios generally agree that there would be net climate out-migration from rainfed croplands and rice growing areas, and net climate in-migration in dense settlements and semi-natural wildlands and pasturelands. It is important to note here that the climate-induced migration shifts from one livelihood zone to another do not convey a shift in livelihoods—just population shifts responding to climate factors. Table 3.3 provides the net in- and out-migration of livelihood zones.

Figure 3.14 Uganda's Livelihood Zones

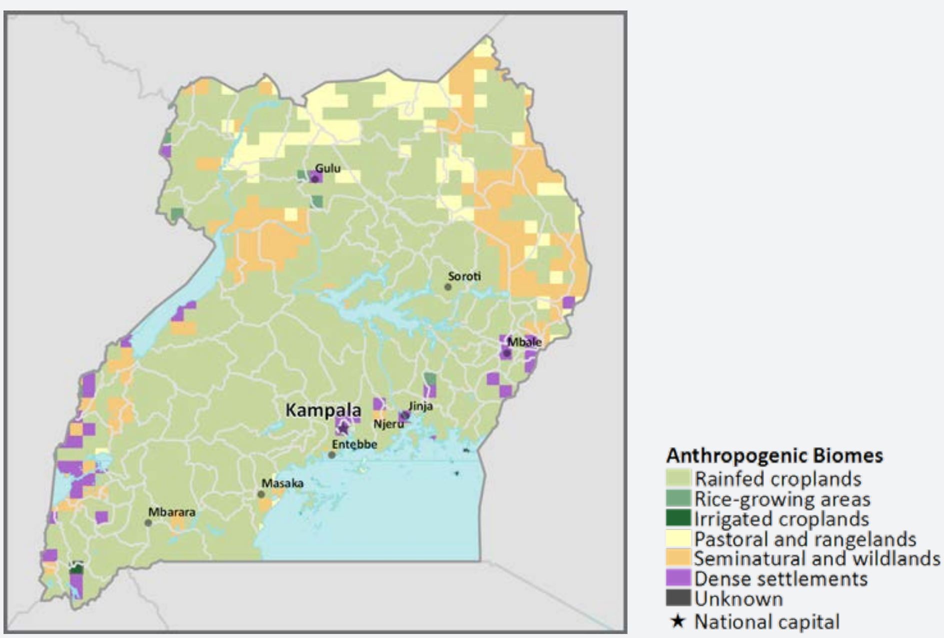


Table 3.3 Projected Net Migration by Scenario and Livelihood Zone and Decade

Year and livelihood zone	Scenario			
	More Climate-Friendly (RCP2.6/SSP4)	More Inclusive Development (RCP8.5/SSP2)	Optimistic (RCP2.6/SSP2)	Pessimistic (Reference) (RCP8.5/SSP4)
2030				
Dense settlements	20,784	6,190	12,035	23,422
Irrigated croplands	1,007	-2,221	1,464	-2,717
Pastoral and rangelands	50,742	-12,367	53,344	-16,097
Rainfed croplands	-125,520	2,136	-124,026	-3,531
Rice-growing areas	-32,813	-35,293	-26,949	-42,800
Seminatural and wildlands	76,181	30,905	75,388	29,660
Undefined	9,619	10,650	8,745	12,062
2040				
Dense settlements	10,985	69,460	6,172	70,484
Irrigated croplands	3,703	12,083	4,605	9,936
Pastoral and rangelands	73,421	-16,606	74,736	-27,082
Rainfed croplands	-172,274	-87,668	-172,480	-60,426
Rice-growing areas	-65,523	-41,994	-51,564	-58,014
Seminatural and wildlands	136,387	46,663	127,009	42,947
Undefined	13,301	18,063	11,522	22,155
2050				
Dense settlements	27,579	122,316	13,577	115,584
Irrigated croplands	7,942	28,371	9,870	23,932
Pastoral and rangelands	20,651	-76,723	12,486	-94,879
Rainfed croplands	-106,786	-101,771	-78,357	-50,323
Rice-growing areas	-101,583	-73,375	-74,353	-105,325
Seminatural and wildlands	135,005	76,372	102,688	78,071
Undefined	17,192	24,810	14,089	32,940

3.4.2 Internal Climate Migration by Province

By 2050, the eastern region in Uganda is projected to see increases in population due to climate change, while the western region would see a decrease. Results show that the eastern region displays the largest numbers and a consistent positive trend across the scenarios. In contrast, the western region is projected to have negative migration rates, particularly for the pessimistic and more inclusive development scenarios.

The western and central regions could see climate out-migration, but confidence intervals for these regions are very large. Again, projected increases in water availability are the primary reasons for positive net in-migration in the eastern portions of Uganda. The lack of subnational data on median age means that this does not play a role in modeling results in Uganda.

Figure 3.15 and Table 3.4 display net climate migration for 2050, by subnational first level administrative area (equivalent to province or region depending on the country).

Figure 3.15 Projected Net Climate Migration by Province and by Scenario for all of

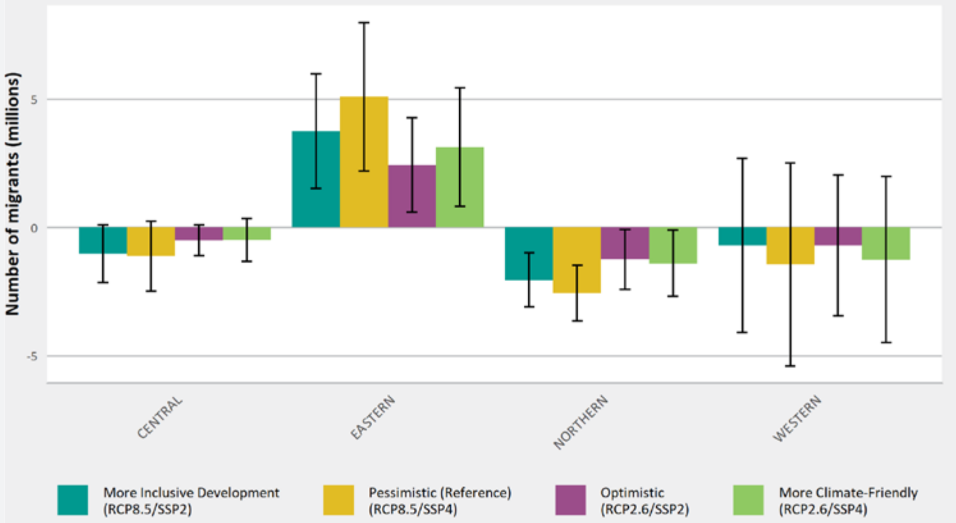


Table 3.4 Projected Net Climate Migration by Scenario and by Province, 2050

Region	More Climate-Friendly (RCP2.6/SSP4)	More Inclusive Development (RCP8.5/SSP2)	Optimistic (RCP2.6/SSP2)	Pessimistic (Reference) (RCP8.5/SSP4)
Central	-483,167	-1,015,155	-500,526	-1,113,108
Eastern	3,126,880	3,754,569	2,438,379	5,102,585
Northern	-1,395,243	-2,045,475	-1,244,930	-2,548,271
Western	-1,248,470	-693,940	-692,923	-1,441,206

Some districts could see climate in-migration while others see climate out-migration. Table 3.5 shows the number of climate migrants by scenario at the district level. For the pessimistic scenario, four of the five districts projected to have the largest positive net migration are in the eastern region, and the fifth is in the western region by the south border. Among the five districts projected to have the largest negative net migration, four are located on the west of the country, two in the western region by Lake Albert, two in the northern region's northwest corner, and one in the central region.

Table 3.5 Projected Net Migration by Scenario and by District of Uganda, 2050

Districts	More Climate-Friendly (RCP2.6/SSP4)	More Inclusive Development (RCP8.5/SSP2)	Optimistic (RCP2.6/SSP2)	Pessimistic (Reference) (RCP8.5/SSP4)
Abim	113,868	59,293	99,309	67,334
Adjumani	-94,520	-89,779	-85,817	-103,253
Agago	240,182	120,161	195,393	137,047
Alebtong	-13,654	-20,833	-22,918	-25,091
Amolatar	29,345	26,394	13,201	52,912
Amudat	121,087	114,308	97,648	129,497
Amuria	108,078	93,965	84,071	126,641
Amuru	-214,540	-244,497	-192,451	-279,989
Apac	-22,322	-27,069	-26,728	-9,594
Arua	-508,801	-515,724	-422,193	-658,069
Budaka	33,297	55,091	26,867	68,825
Bududa	2,388	9,670	2,495	14,640
Bugiri	482,323	471,182	372,583	667,392
Buhweju	-34,386	-37,095	-25,211	-51,409
Buikwe	53,133	68,912	34,800	104,334
Bukedea	62,620	109,489	49,268	137,813
Bukomansimbi	-49,186	-68,577	-37,997	-88,876
Bukwo	59,456	85,332	58,864	81,724
Bulambuli	31,549	52,835	24,697	66,328
Buliisa	-36,220	-22,469	-32,394	-20,768
Bundibugyo	-55,698	-45,612	-43,409	-64,016
Bushenyi	27,090	23,276	34,129	5,262
Busia	160,559	185,981	130,199	254,434
Butaleja	74,003	146,661	62,091	206,890
Butambala	-23,704	-28,328	-18,379	-35,575
Buvuma	20,918	27,722	12,833	39,190
Buyende	153,569	163,836	113,215	225,255
Dokolo	1,991	1,424	-3,316	12,917
Gomba	-59,673	-83,412	-45,145	-106,889
Gulu	-194,480	-202,572	-157,372	-265,231
Hoima	-352,938	-316,328	-291,079	-388,955
Ibanda	-69,021	-81,955	-50,989	-107,522
Iganga	160,806	205,459	130,140	286,546
Isingiro	-118,563	-14,564	-70,924	-48,209
Jinja	10,697	44,796	8,708	55,788
Kaabong	146,243	-39,187	125,834	-36,328
Kabale	189,490	279,721	201,910	233,191
Kabarole	-167,812	-152,445	-133,655	-195,026
Kaberamaido	23,736	29,071	14,106	48,312
Kalangala	21,089	9,719	16,064	10,796

Districts	More Climate-Friendly (RCP2.6/SSP4)	More Inclusive Development (RCP8.5/SSP2)	Optimistic (RCP2.6/SSP2)	Pessimistic (Reference) (RCP8.5/SSP4)
Kaliro	41,257	85,942	37,641	119,954
Kalungu	-32,836	-43,621	-25,080	-56,809
Kampala	78,359	22,194	30,310	48,822
Kamuli	95,277	94,217	73,329	113,013
Kamwenge	-12,021	60,193	12,746	32,019
Kanungu	-15,223	371	-5,494	-15,323
Kapchorwa	16,698	28,692	13,534	34,356
Kasese	-132,673	-105,524	-101,890	-144,143
Katakwi	69,490	104,870	51,351	152,961
Kayunga	133,045	95,772	86,987	154,370
Kibaale	-657,874	-591,423	-543,099	-711,714
Kiboga	-69,554	-71,625	-55,487	-87,322
Kibuku	31,122	58,509	26,707	81,828
Kiruhura	21,528	46,441	46,295	32,027
Kiryandongo	-35,391	-23,919	-31,675	-25,585
Kisoro	21,943	104,942	33,560	81,506
Kitgum	66,566	-35,593	35,431	-44,497
Koboko	-176,229	-197,333	-147,639	-246,602
Kole	-128,229	-120,112	-107,516	-144,314
Kotido	159,970	34,513	132,798	39,235
Kumi	109,377	120,568	83,952	165,352
Kween	83,423	122,943	84,503	114,788
Kyankwanzi	-111,770	-118,254	-92,670	-136,825
Kyegegwa	-27,892	4,339	-5,643	-32,599
Kyenjojo	-121,432	-13,286	-68,874	-82,655
Lamwo	-55,538	-98,573	-58,158	-104,709
Lira	-145,304	-137,714	-116,176	-184,480
Luuka	32,305	54,425	28,855	66,309
Luwero	10,275	-17,252	14,411	-21,217
Lwengo	-38,404	-59,949	-22,119	-92,076
Lyantonde	-33,549	-47,047	-25,553	-60,247
Manafwa	10,778	33,490	9,368	49,344
Maracha	-194,194	-200,939	-158,611	-258,287
Masaka	-23,917	-28,098	-13,341	-48,360
Masindi	-175,957	-173,535	-138,735	-223,805
Mayuge	289,458	307,434	228,407	415,107
Mbale	13,689	39,319	11,482	56,560
Mbarara	69,298	50,722	83,932	47,115
Mitooma	14,786	-2,351	20,745	-20,648
Mityana	-67,778	-74,908	-54,897	-79,380
Moroto	92,091	99,753	79,650	109,052

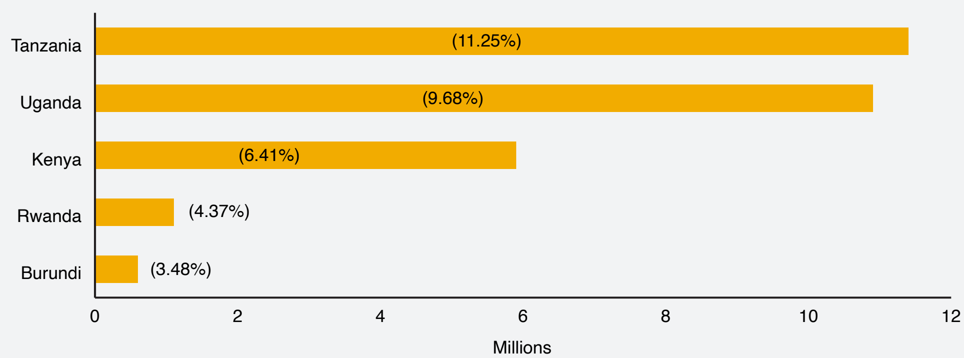
Districts	More Climate-Friendly (RCP2.6/SSP4)	More Inclusive Development (RCP8.5/SSP2)	Optimistic (RCP2.6/SSP2)	Pessimistic (Reference) (RCP8.5/SSP4)
Moyo	-57,053	-49,700	-49,188	-61,013
Mpigi	-37,343	-68,308	-29,788	-91,476
Mubende	-280,053	-312,466	-221,165	-386,372
Mukono	208,387	88,908	126,616	182,749
Nakapiripirit	95,437	96,307	82,042	110,394
Nakaseke	-76,020	-93,484	-58,335	-113,198
Nakasongola	-36,073	-24,315	-32,761	-26,800
Namayingo	180,537	187,582	142,970	265,024
Namutumba	55,090	83,352	42,981	118,572
Napak	105,637	114,976	96,943	114,058
Nebbi	-40,603	20,165	-43,623	35,599
Ngora	139,702	97,667	90,490	150,134
Ntoroko	-18,798	-10,588	-17,382	-7,947
Ntungamo	434,775	339,612	407,882	325,496
Nwoya	-57,390	-54,403	-54,069	-56,441
Otuke	7,395	-8,876	-1,296	-12,785
Oyam	-138,642	-108,513	-118,121	-123,390
Pader	11,655	-14,953	5,289	-20,233
Pallisa	211,169	210,284	153,986	290,795
Rakai	-49,401	-5,898	-28,421	-14,732
Rubirizi	-25,300	-25,898	-20,362	-31,988
Rukungiri	-23,596	-29,875	-16,474	-40,030
Serere	223,365	192,487	158,457	273,822
Sheema	53,415	43,308	63,166	14,518
Sironko	37,790	61,379	27,909	82,829
Soroti	62,709	66,912	47,223	92,678
Ssembabule	-98,045	-122,828	-78,381	-148,966
Tororo	60,565	151,130	47,934	218,571
Wakiso	78,932	-60,012	16,974	-58,250
Yumbe	-427,113	-488,784	-361,753	-590,019
Zombo	-118,101	-77,617	-81,524	-131,992

3.5 UGANDA AND THE LAKE VICTORIA BASIN

The Lake Victoria Basin is highly mobile, and it is therefore important to contextualize Uganda's modeling results against movements in the regional context. Since the 2007 freedom of movement protocols established under the East African Community (EAC), citizens of the five Basin countries (Burundi, Kenya, Rwanda, Tanzania, and Uganda) can live and work throughout the region. Given the free movement and connectivity among the Basin countries, considering the potency of climate-induced migration in the region is equally relevant to inform planning, policy, and actions.

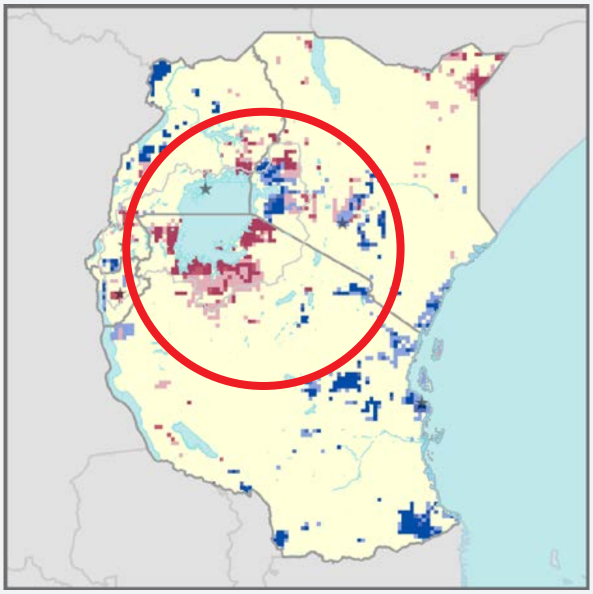
Uganda is projected to have one of the highest numbers of internal climate migrants in Lake Victoria Basin by 2050, along with Tanzania, with results reflecting good agreement and high certainty across the models (Figure 3.16). The stark differences are significantly driven by the high population increases in Uganda and Tanzania, which are projected to see a doubling of its population by 2050. With more than 10 million migrants in Uganda reflecting more than 10 percent under the pessimistic scenario, combined with the high certainty of the models, this highlights the need for urgent attention and concrete climate and development action.

Figure 3.16 Projected Mean Number of Internal Climate Migrants under the Pessimistic Scenario and as a Share of the Total Population in 2050 in LVB countries



Uganda and Tanzania are projected to see climate in-migration towards the Lake Victoria (Figure 3.17). Kenya could see out-migration in the area immediately surrounding the lake, but in-migration in the area around Eldoret, just to the north of the lake but still within the Lake Victoria Basin. Given these countries' high reliance on fisheries and natural resources of the lake, proactive and collaborative management of its resources across the three countries is essential. The in-migration hotspots around the lake across the three countries, especially in Tanzania and Uganda, coincide with areas of high poverty incidence. Coupled with increasing population density, these already vulnerable areas have poor infrastructure and basic social services and demand inclusive and participatory climate resilient development and planning. This is particularly important in the case of Uganda where climate migrants and development migrants could both be high, with the former outpacing the former.

Figure 3.17 Hotspots of Internal Climate In- and Out-Migration in the Lake Victoria Basin by 2050



IN-MIGRATION

- High certainty in high levels of climate in-migration
- Moderate certainty in high levels of climate in-migration
- Low certainty in high levels of climate in-migration

OUT-MIGRATION

- High certainty in high levels of climate out-migration
- Moderate certainty in high levels of climate out-migration
- Low certainty in high levels of climate out-migration

Source: Rigaud et al. 2021a

Note: The map is based on compilation of individual country results (top and bottom five percent highest differences between the climate and no climate impact scenarios by country).

3.6 STAKEHOLDER CONSULTATION

3.6.1 Virtual Consultation Session

On 23 February 2021, the World Bank convened a virtual *"Consultation on Internal Climate Migration with a focus on the Lake Victoria Basin Countries"* as part of a study on mainstreaming climate migration into development planning and policy (World Bank, unpublished). The focus was on the Basin countries (Burundi, Kenya, Rwanda, Tanzania, and Uganda), and the participants represented stakeholder groups including civil society, government institutions, academia, regional and international organizations, nongovernmental organizations (NGOs), and donors. The consultation—particularly through the breakout groups sessions—provided feedback on patterns of mobility, the modeling results, and suggestions on policy responses.

3.6.2 Participant Responses

The Modeling Exercise

The results of the modeling exercise mostly aligned with participants' experiences based on current patterns and trends, and research in the region and specific countries. Participants agreed that climate change is increasingly an important driver in migration and displacement in the Basin countries. Water availability, crop production, and sea level rise was widely accepted as one of the driving factors of mobility in the region along with the ability of land to support livelihood. The group also agreed with the scenarios and the climate in- and out-migration hotspots identified by the model and expected that there will be future climate migration hotspots to come (World Bank, unpublished).

Pastoral Routes—Climate Migration and Conflict-Driven Displacement

Participants suggested that changes in pastoral routes were due to climate change as well as historical conflict-driven displacement in the region. Participants highlighted that pastoralism was particularly vulnerable to climate change given its dependence on its natural resource base. They cited land degradation and water availability as important drivers of migration. As climate change puts pressure on pastoralist's natural resource base, conflict-related displacement increases. Already existing tensions and conflicts increase as pastoral routes change and conflict builds over access to farmlands (World Bank, unpublished).

Disasters

Participants also raised concern about higher seasonal migration and longer periods of displacement caused by disasters. These were identified as a prime reason for displacement in Burundi, Rwanda, and Kenya (World Bank, unpublished).

3.6.3 Participant Recommendations

Participants stressed the importance of preparedness and resilience. They raised the importance of taking into consideration rapid population growth and poverty when understanding and planning for in- and out-migration hotspots. They further highlighted the need to understand the pressure on land and water resources and the degree to which these can be addressed in policy (World Bank, unpublished).

Other policy directions that participants discussed were recalibration of spatial planning, partnership and solidarity across government levels, agencies, and sectors, and more accurate data collection to inform policymaking. These key areas of feedback have informed this report (World Bank, unpublished).

Peter Kapuscinski / World Bank

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Chapter 4

Strategic Framework Response To Mainstream Climate Migration Into Development Planning

4.1 CONTEXT

Climate-induced migration is no longer part of the distant future, but a debilitating and undignified everyday reality of vulnerable individuals and communities (Wodon et al. 2014).[26] According to this study, the number of internal climate migrants in Uganda could reach a high of close to 12 million by 2050. This would represent 10.7 percent of the population. The population could double in this period and, and as early as 2030, there could be an emergence of climate in- and out-migration hotspots driven by climate factors. Lower emission scenarios (the optimistic and climate friendly) could reduce the scale of climate-induced migration by 3.8 million people in Uganda, especially through a focus on inclusive and resilient development.

International frameworks and national policy responses have increasingly recognized climate-induced migration as an underlying cause and threat to sustainable development, but current responses to address the issue continue to lag (de Jong 2019; Thomas and Benjamin 2018; Wilkinson et al. 2016a). Greenhouse gas emissions continue to increase, and compliance with the Paris Agreement is at risk (UNEP 2020; Watson et al. 2019). Inequitable and uneven growth and development has left behind an increasing number of individuals, communities, and regions, with climate impacts amplifying the challenge (FAO et al 2020; IDA 2020; UN 2020; World Bank 2020e). In the absence of transformative and at-scale action on climate and development, climate-vulnerable countries, such as Uganda, are projected to be dealing with increasing number of internal climate migrants by 2050 (Rigaud et al. 2018).

26 See: https://www.brookings.edu/research/the-climate-crisis-migration-and-refugees/

Climate-induced migration is both a symptom and a signal of underlying failures and crises and must be addressed more pointedly if countries are to achieve their Sustainable Development Goals (SDGs) (IDMC 2012; ODI 2018). Intensifying climate impacts, the escalation in the scale of climate-induced migration, and the emergence and spread of climate migration hotspots as early as 2030 will affect Uganda. These trends will likely accelerate beyond 2050 with worsening climate change. The deepening nature of this crisis—alongside the entrapment of the most impoverished—means that inaction is not an option. Current policies and strategies must understand and address the climate-migration-development nexus in a more focused manner.

Box 4.1 Climate Migration in International Frameworks

International law on human mobility in the context of climate change continues to evolve.

The 2018 COP24 Decision of the United Nations Framework Convention on Climate Change (UNFCCC) calls for approaches to avert, minimize, and address displacement related to the adverse impacts of climate change as outlined in the Warsaw International Mechanism report (UNFCCC 2018).

The Global Compact for Safe, Orderly, and Regular Migration (GCM) adopted in 2018 recognizes the need to strengthen joint analysis and sharing information to better map, understand, predict, and address migration movements, including those that may result from rapid- and slow-onset natural disasters and the adverse effects of climate change, as well as develop adaptation and resilience strategies that consider the potential implications on migration.

The Sendai Framework highlights the significance of incorporating considerations relating to disaster-induced displacement to improve disaster preparedness (para 33h) and disaster risk governance (para 28(d); See also paras 27 and 30).

International Organization for Migration's (IOM's) continued focus on migration and environmental change and that of the **Platform on Disaster Displacement** as a state-led initiative working toward better protection for people displaced across borders in the context of disasters and climate change have continued to guide the international processes. Domesticating these at the national level can be challenging as there is often no single instrument or branch governing the issue.

The urgency for transformative and farsighted planning and action on climate migration cannot be postponed. Uganda has already witnessed an increase of around 1.3°C in its average annual temperature between 1960 and 2012, and an overall reduction in annual and seasonal rainfall (USAID 2012; World Bank 2020a). The frequency and severity of extreme weather events, such as droughts, flooding, and landslides have increased, and slow onset climate change acting through impacts on crop productivity and water stress will amplify in the coming decades (World Bank 2020a).

The scale of climate migration in Uganda ramping up between 2025 and 2050 to reach a high of close to 12 million under the high end of the pessimistic scenario suggests the need for early action. Compared to other countries in the Lake Victoria Basin, the results for Uganda show the strongest certainty across the models, further underscoring the need for urgent attention and action. Additionally, with extreme events on the rise, new displacements due to environmental disasters in the scale of 40,000 as in 2020 (IDMC 2021) could become the new norm under business-as-usual ex-post responses to either internal climate migration or displacements will not suffice. It is imperative to have a step change—transformation at scale—to counter distress-driven climate migration, as part of broader development action. These internal displacements will occur against a backdrop of the highest number of refugees on the country – of 1.5 million (as of 2021). Learning lessons, managing the issue proactively, and averting adverse consequences driven by resource constraint and environmental degradation, amplified by climate change, is a critical part of the solution.

Migration can be an important adaptation strategy and a pathway out of poverty (Adger et al. 2003; Barnett and O'Neill 2012; Ellis 2003). Under certain circumstances, voluntary migration can be a desirable form of adaptation, not a reflection of failure to adapt (Black et al. 2011; McLeman and Smit 2006). Strengthening adaptive capacities and increasing readiness in the face of climate change can create an enabling environment for the positive effects of migration to manifest (Arora et al. 2019; Rigaud et. al. 2018; Warner et al. 2009).

Uganda has taken important steps in integrating climate change, climate internal displacement, and refugees in its legislation and plans. The latest 2020/21 - 2024/25 National Development Plan (NDP) recognizes that climate change is a major contributing factor leading to forced displacement, hunger, and disruption of most development goals (Uganda MWE 2015c). The 2015 National Climate Change Policy specifically mentions that the effects of climate change on agriculture, forestry, and fisheries can cause people to migrate to urban areas, often leading to the formation of slums (Uganda MWE 2015c). Uganda was one of the first countries in the world to implement a Comprehensive Refugee Response Framework (CRRF), an approach that links the humanitarian response to forced displacement with long-term development. In January 2020, Uganda adopted the Water and Environment Sector Refugee Response Plan (WESRRP), which regulates long-term water supply and sanitation for refugee settlements and host communities. Uganda also has the 2004 National IDP policy, which covers IDPs displaced due to natural disasters (Santner 2013). Uganda's refugee policy is considered one of the most progressive and generous refugee laws and policy regimes in the world. At the regional level, Uganda has ratified the Kampala Convention.

There is a real opportunity to harness internal climate migration as a factor of growth, jobs, and economic transition within countries, which to date has remained untapped (Scheffran, Marmer, and Sow 2012; Rigaud et al. 2018). A unified approach to addressing climate migration must deliver on the core development needs—food, water, environment—and prioritize delivering on Uganda's SDGs and the World Bank's poverty goals. Climate migration will play out against a backdrop of other mega-trends of population growth, urbanization, and biodiversity loss as well as technological innovation, digital revolution, and broader economic transitions to low carbon pathways.

Uganda's population is projected to almost triple by 2050, reaching between 93.3 million (in SSP2) and 112.3 million (in SSP4). Uganda also has a large youth bulge, with a median age of 16.7 years in 2020 (UNDESA 2019). While the climate migration scenarios presented in this report are only projections, they do provide opportunities. During the pivotal 2020s decade, through proactive global, national, and local action, it is possible to reduce the scale of internal climate migration, and to harness opportunities for growth and jobs as part of the transition to resilient and low carbon economies.

Uganda has an opportunity to continue showing leadership with respect to climate-induced migration in the next decade—not as a crisis, but as an opportunity to grow. The next section proposes a contextualized strategic response framework for mainstreaming climate migration into development policy and planning in Uganda.

4.2 MACS FRAMEWORK

Climate migration is a reality and a cross-cutting issue that needs to be addressed through policy informed actions that are farsighted in their approach and execution. Unless concerted climate and development action is taken now, the scale of climate migration could ramp up by 2050, and hotspots of climate in- and out-migration could spread and intensify. These trends will likely accelerate beyond 2050 with worsening climate change.

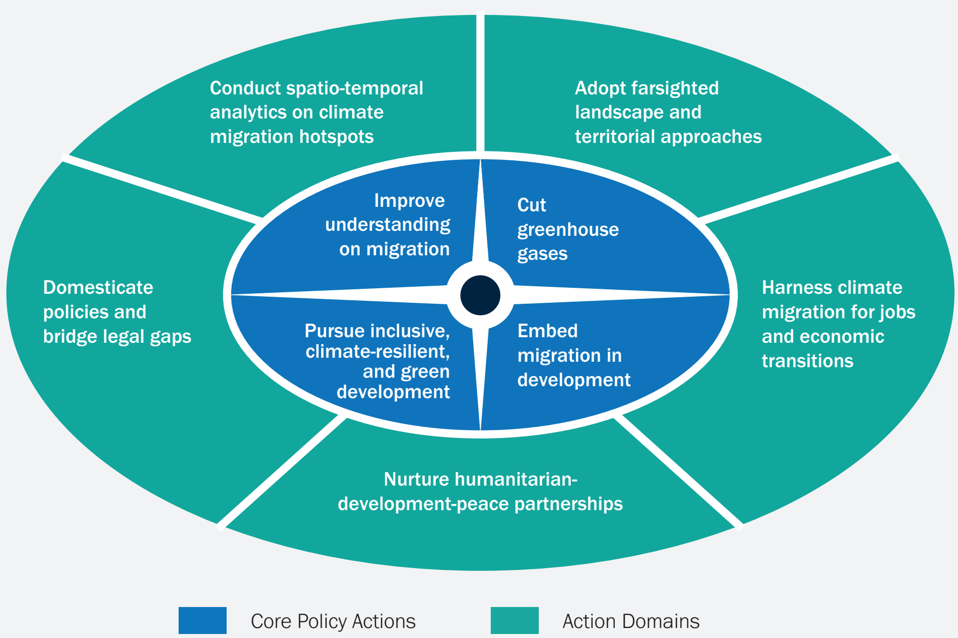
The World Bank's *Groundswell* report underscored the need for bold and transformational action to address climate-induced migration through four lines of policy action (Rigaud et al. 2018a)

- Cut GHGs now.
- Pursue iinclusive, climate-resilient, and green development.
- Embed climate migration in development planning.
- Invest in an improved understanding on migration.

These policy directions must be buttressed with a core set of action domains to ensure durable and sustainable development outcomes with respect to distress-driven climate migration.

The Migration and Climate-Informed Solutions (MACS) framework (figure 4.1) allows us to make connections across time and space that have hitherto been missing and cope with future uncertainties and disruptions. It seeks to ensure that vulnerable communities are prepared to confront current and future climate risks, and that the economy of the country is braced not just for the challenges, but also the opportunities of climate migration.

Figure 4.1 Migration and Climate-Informed Solutions (MACS) Framework



a. MACS was derived as part of the two Groundswell Africa regional reports: *Groundswell Africa: A Deeper Dive into Internal Climate Migration in the Lake Victoria Basin Countries* (Rigaud et al. 2021a) and *Groundswell Africa: Internal Climate Migration in West African Countries* (Rigaud et al. 2021b).

MACS stems from the growing interest within the World Bank and the wider community to better understand the implications of climate induced migration and mainstream this phenomenon into development plans, programmes and policies. The Groundswell report (Rigaud et. al. 2018) introduced slow-onset climate impacts (water stress, crop failure, sea level rise) into a model of future population distribution—and established four core policy actions central to MACS framework: (i) cut greenhouse gases now; (ii) pursue inclusive and climate-resilient development policies; (iii) embed climate migration in development planning; and (iv) invest in an improved understanding.

The MACS framework is the outcome of the World Bank's efforts through the Groundswell reports (Rigaud et al. 2018; Clement et al. 2021) and subsequent deeper dives via Groundswell Africa (Rigaud et al. 2021a and 2021b) to better understand the implications of climate-induced migration and mainstream this phenomenon into development plans, programs, and policies. It stems from the result of the abovementioned modeling exercise, contextualized against current and historical mobility patterns, peer reviewed literature, and multi-stakeholder consultations. A portfolio review of the design features of 165 World Bank projects operating at the climate-migration-development nexus further informs this framework (Rigaud et al. 2021c).

MACS is flexible and adaptive, based on the premise that climate migration is linked to broader development challenges across spatial scales. It can guide policymakers and practitioners by offering critical information and insights related to development and policy implications of climate-induced internal migration. This reflects the call for anticipatory approaches over larger time and spatial scales to avert and minimize the adverse consequences of climate-induced migration and harness opportunities brought forth by migration.

4.2.1 Core Policy Directions

Action across the four major policy areas of the MACS framework (Figure 4.1) could help reduce the number of people forced to move in distress due to climate change.

1. Cut greenhouse gases now to reduce climate pressure on people's livelihoods and the associated scale of climate migration

Rapid reductions in global GHG emissions can reduce the scale of climate migration and movements under distress. Lower global emissions reduce climate pressure on ecosystems and livelihoods and broaden the opportunities for people to stay in place or move under better circumstances. Under the optimistic scenario, there could be 3.8 million less internal climate migrants in Uganda—with numbers reduced from an average of 10.9 million climate migrants in the pessimistic scenario to an average of 7.1 million in the optimistic scenario by 2050 (Figure 3.8 and Table 3.1). While these numbers are not set in stone, there is confidence in the positive impact of reducing greenhouse emissions in mitigating climate migration in Uganda given the high certainty among the models.

Increased ambition in the next round of Nationally Determined Contributions (NDCs) submissions must have emboldened and comprehensive mitigation policies (especially of the largest emitters globally). They must also include carbon pricing, urban and land use planning, and innovations in performance standards. Uganda's positive commitment to reducing greenhouse gas emissions in the energy supply, forestry, and wetland sectors by 22 percent in 2030 is welcomed (Uganda MWE 2019). Mitigation policies must be inclusive and pro-poor guarding against potential blowback of mitigation measures.

2. Pursue inclusive and climate-resilient development policies together with targeted investments to manage the reality of climate migration

Climate migration demands anticipatory development policies that respond to the scale of the issue over the medium to long term. This is particularly important for low and lower-middle-income countries (LIC, LMIC), such as Uganda, where the numbers of climate migrants by 2050 could be as high as 10.72 percent (pessimistic scenario) of the total population. Climate-induced migration could take place against a more than a doubling population by 2050. Uganda is one of the youngest countries in the world, and almost three-quarters of young people are still employed in agriculture, which sustains more than 70 percent of the total Ugandan population (World Bank 2020b). Given the predictions that crop production could decrease up to 30 percent in certain areas of Uganda (central and western), there is a strong need to diversify its economy and pursue climate-smart and inclusive growth to secure development gains. These shifts can result in more value-added agriculture or fisheries through structural transformation.

Migrants in Uganda move for different reasons, and this requires different policy responses and plans. Internal climate migrants, as derived from in this model, reflect mobility driven by the adverse impacts of climate as opposed to other internal migrants moving for reasons of economic opportunity. Understanding the different needs of these two types of mobility patterns is essential for effective planning and policymaking. Good management of demographic transitions and investment in human capital can also reduce climate vulnerability. Targeted interventions—such as facilitating informed migration decisions, making social protection portable and scalable, and tapping the potential of financial and social remittances—must be deployed in the short and medium term to support positive and sustainable outcomes. This should also include the transition of young workers from agriculture-related jobs into higher productivity industry and service jobs, including in plans for new urban centers (Merotto 2019).

3. Embed climate migration into development planning

Uganda can anticipate and integrate climate migration into national development plans and all facets of policy. Policy focus on the full migration life cycle, *adapt in place*, *enable mobility,* and *after migration,* will ensure the presence of the adequate ecosystem to avert, minimize, and address climate-induced migration in response to current and future climate risks and impacts.

Adapt in place would allow communities in areas predicted to be highly impacted by climate change to stay in place (assuming local adaptation options are viable and sensible). The locality of Koboko in the north, communities near Lake Albert, and the small urban centers of Lira and Gulu of Uganda are projected to see climate-out migration by 2050. These localities are highly dependent on agriculture, which makes them especially vulnerable to climate change. Components of successful local adaptation in these localities could include: (1) investing in natural resource management and resilience; (2) climate-smart infrastructure, (3) diversifying income-generating activities, (4) building responsive financial protection systems for vulnerable groups, including women; and (5) complementing provision of basic services and social safety nets. Given the slow pace of lowering emissions globally, transformative and at-scale inclusive development has become even more important to counter distress-driven climate migration.

Box 4.2 In Practice: Adapt in Place in Uganda

Uganda Investing in Forests and Protected Areas for Climate-Smart Development Project (P170466)
This project focuses on improving the sustainable management of forests and protected areas and increase benefits to forest-dependent communities in the Albertine Region and the refugee-hosting areas in Northern Uganda.

Uganda Irrigation for Climate Resilience Project (ICDP, P163836)
This project supports the shift towards more resilient agriculture through the development of sustainable irrigation services. Access to irrigation allows farmers to cope with climate changes, increase agricultural productivity, and diversify towards higher value crops. The project addresses Uganda's climate change vulnerabilities by: (1) promoting adoption of irrigation by smallholder farmers, in synergy with other agriculture inputs and technologies; (2) increasing water storage capacity; and (3) promoting sustainable catchment management. This change will be market-driven, with irrigation becoming the anchor for stronger producer organizations and development of value chains.

Climate Smart Agriculture and Agribusiness Development Project (P173296)
This project will increase the agricultural productivity and incomes for smallholder farmers and improve their adaptive capacity and resilience to climate change across different agro-ecological zones of targeted project areas.

Uganda Intergovernmental Fiscal Transfers (P160250)
This project aims at improving the adequacy, equity and effectiveness of financing and the oversight, management, and delivery of local government services in education, health, water and environment, and micro irrigation, including refugees and their host communities. One goal of the project is to integrate climate adaptation and mitigation measures across the infrastructure investments in micro irrigation, water and environment, health, and education.

Sources: World Bank 2019b, 2020f, 2020g, 2020h, and 2021b

Enable mobility helps people move away from unavoidable climate risks when the limits of local adaptation and viability of ecosystems are reached. Facilitating safe, orderly, and dignified migration (or, as a last resort, planned relocation) toward these areas of lower risk and higher opportunity could reduce vulnerabilities. This should be done by providing skills training, information, and legal support.

The north-western locality of Koboko, near the border with DRC, is projected to see climate-out migration as early as 2030 driven by decreases in crop production and water availability (Figure 2.1, Figure 2.2 and Figure 3.10). This locality and its surroundings host large numbers of refugees who might be at risk of secondary displacement due to climate change (Figure 2.5). Adapt in place options should be explored and supported, while at the same time where necessary, governments should facilitate and support mobility (enable mobility). This should be done through appropriate and durable solutions that consider potential out-migration in a transparent and inclusive manner, with bottom-up engagement of communities.

After migration is the process of ensuring that people in both sending and receiving areas are well connected, socially cohesive and adequately prepared for the medium and longer-term. According to the ISIMIP results, Kampala, Mbale, and their urban surroundings are projected to be high-certainty in-migration hotspots (Figure 3.10), primarily driven by increases in water availability and crop production. Kampala is already a high-density locality, and Mbale currently faces increases in informal human settlements along with inadequate human resources.

Local and national policymakers could develop and implement effective development and preparedness plans in Mbale and Kampala for the immediate and longer-term population growth due to climate-migration. As growth poles, these two cities can support large and active domestic markets and focus areas for tertiary manufacturing. At the same time, they can strengthen rural to urban linkages by providing access to markets. In addition, there is an opportunity include more plans viable livelihood opportunities, skills training, critical infrastructure and services, registration systems for migrants (to access services and labor markets), and the inclusion of migrants in planning and decision making.

4. Invest now to improve understanding of internal climate migration

More investment is needed to better contextualize and understand climate migration. This is especially important at both regional to local levels, where climate impacts may deviate from the broader trends identified in a global-scale analysis. There are inherent uncertainties in the way climate impacts will play out in each locality, and this will affect the magnitude and pattern of climate change-induced movements.

Studies, as conducted for this report, are instrumental in providing insights on the scale of the issue. Over time, as more data become available on climate change and its likely impacts on water availability, crop productivity, and sea level rises, the scenarios and models would need to be updated. Increasing the modelling resolution and improving data inputs to produce more spatially detailed projections are among the possible future applications of the approach used in this report.

Building country-level capacity to collect and monitor relevant data can increase understanding of the interactions among climate impacts, ecosystems, livelihoods, and mobility. This would help countries tailor policy, planning, and investment decisions. Building this capacity needs to include a range of activities and approaches such as the following:

- Climate-related and migration questions in national census and existing survey, which is a cost-effective way to advance understanding.
- Evidence-based research, complemented by country-level modelling. In support of this, new data sources—including from satellite imagery and mobile phones—combined with advances in climate information can be beneficial to improving the quality of information about internal migration or averting displacements.
- Protection of the privacy of personal data and human rights.

An example of how having timely and robust data can contribute to decision making includes the 2016 drought in Karamoja. During the 2016 El Niño, early detection of drought using satellite data on vegetation in Karamoja triggered a US$4 million pay-out through a Disaster Risk Financing scheme. This provided scaled-up a labor-intensive public works program to 30,000 households—averting (1) a food crisis, and (2) possible displacements (World Bank 2019e).

4.2.2 Domains of Action to Drive Planning and Action at Scale

The four core policy directions are implemented through five domains of action. These actions can bolster the delivery of the core policy direction to reduce, avert, and minimize distress-driven internal climate migration as presented and summarized in Table 4.1.

Table 4.1 Domains of Action to Drive Planning and Action: Rationale Examples, Uganda

ACTION	DOMAIN OF ACTION	RATIONALE	EXAMPLE
1.	**Conduct spatio-temporal analytics to understand the emergence of climate migration hotspots**	Climate-induced migration leads to the emergence of climate in- and out-migration hotspots and poses distinct spatio-temporal challenges. Coinvesting in iterative scenario modelling, grounded in new data and development progress, will be crucial for decision support based on countries' own progress against which climate-induced migration will unfold. Such investments will be best placed to facilitate long-term planning and investments in adaptive capacity to secure climate resilience.	The south-eastern locality of Mbale and its surroundings, Mount Elgon, the capital Kampala, and the south-western locality of Ntungamo, on the border with Tanzania, are projected to be climate in-migration hotspots due to increases in water availability and crop production. These areas are already facing severe environmental challenges due to climate change, including landslides, flooding, droughts, and land degradation. They are also facing development challenges, including high poverty rates, informal human settlements, and weak services and infrastructures.
2.	**Adopt landscape and territorial approaches for far-sighted planning to avert, minimize and address climate-induced migration**	Addressing underlying causes of distress-driven migration—slow and rapid onset climate factors—through enhanced land management, natural resource management, livelihoods, and ecosystem integrity must be a priority. Placement within larger territorial approaches to enable planning across spatial and time scales through a focus on the full migration cycle (adapt in place, enable mobility, and after migration) is an imperative for readiness and sustainable and durable outcomes.	Areas in the north-west and central-west around Lake Albert and Albertine Rift are projected to be out-migration hotspots as early as 2030 owing to decreases in water availability and crop production. These areas are already facing high levels of deforestation and degradation, and host a fast-growing population dependent on agriculture, including refugees.
3.	**Address and harness climate-induced migration as an opportunity for jobs and economic transitions**	Effective management of climate-induced migration can drive growth, jobs, and transition. Driving economic transition to help countries leapfrog into climate resilience at scale—by harnessing climate migration to nurture jobs, skills, and economic growth through well-conceived economic, demographic, and urban transitions—is pivotal.	Uganda's plan to declare 15 new cities by July 2023, coupled with the rapid demographic growth, provides the scope to plan at territorial levels while harnessing plausible climate migration futures. Early planning and an integrative approach can harness economic transition and job opportunities for climate-induced migration and youth populations while contributing to growth and poverty reduction.

ACTION	DOMAIN OF ACTION	RATIONALE	EXAMPLE
4.	**Nurturing development-humanitarian-peace partnerships for end-to-end action at the national and local levels**	Climate-induced migration can exacerbate the current social fault lines leading and contributing to or exacerbating conflict and potentially derailing humanitarian and development agendas of poverty reduction. For an end-to-end approach that provides for human dignity in mobility, we need to work collectively and in partnership–building on mandates and responsibilities–with country governments and local actors.	Erratic rainfall and prolonged dry spells have increased the likelihood of violence through pressures on natural resources, particularly land and water. Local and cross border clashes have been observed around Lake Victoria over the exploitation of fisheries. The increase of fishing in this area coincides with the in-migration of displaced populations from the northern Ugandan conflict, in part as a response to the other climate-related drivers. The link between climate-induced migration and conflict requires the integration of humanitarian-development-peace efforts.
5.	**Bridge the gap in legal mandates and frameworks on climate-induced migration to support well-conceived responses**	Legal architecture brings clarity, protects affected individuals and communities, and reconciles international funding and local decision-making. There is an opportunity to build on the legal architecture to address climate-induced mobility to drive operations and response at scale.	The porous nature of the borders, the degradation and scarcity of natural resources, and pressure on livelihoods coupled by demographic growth and climate in-migration may lead to complex challenges (and potentially conflicts) that require sound legal mandates and frameworks.

1. Conduct spatio-temporal analytics to understand the emergence of climate migration hotspots

Climate-induced migration is not uniform within Uganda, and its impacts vary across space and time. As a result, it poses distinct spatial challenges that necessitates spatially aware long-term planning to avert, minimize, and reduce the negative impacts of climate migration. Expanded and more granular modelling and analysis undertaken in this study, including a focus on water stress, crop productivity, net primary productivity, floods, and conflict would benefit from local data, tailored assessments, and on-site interviews.

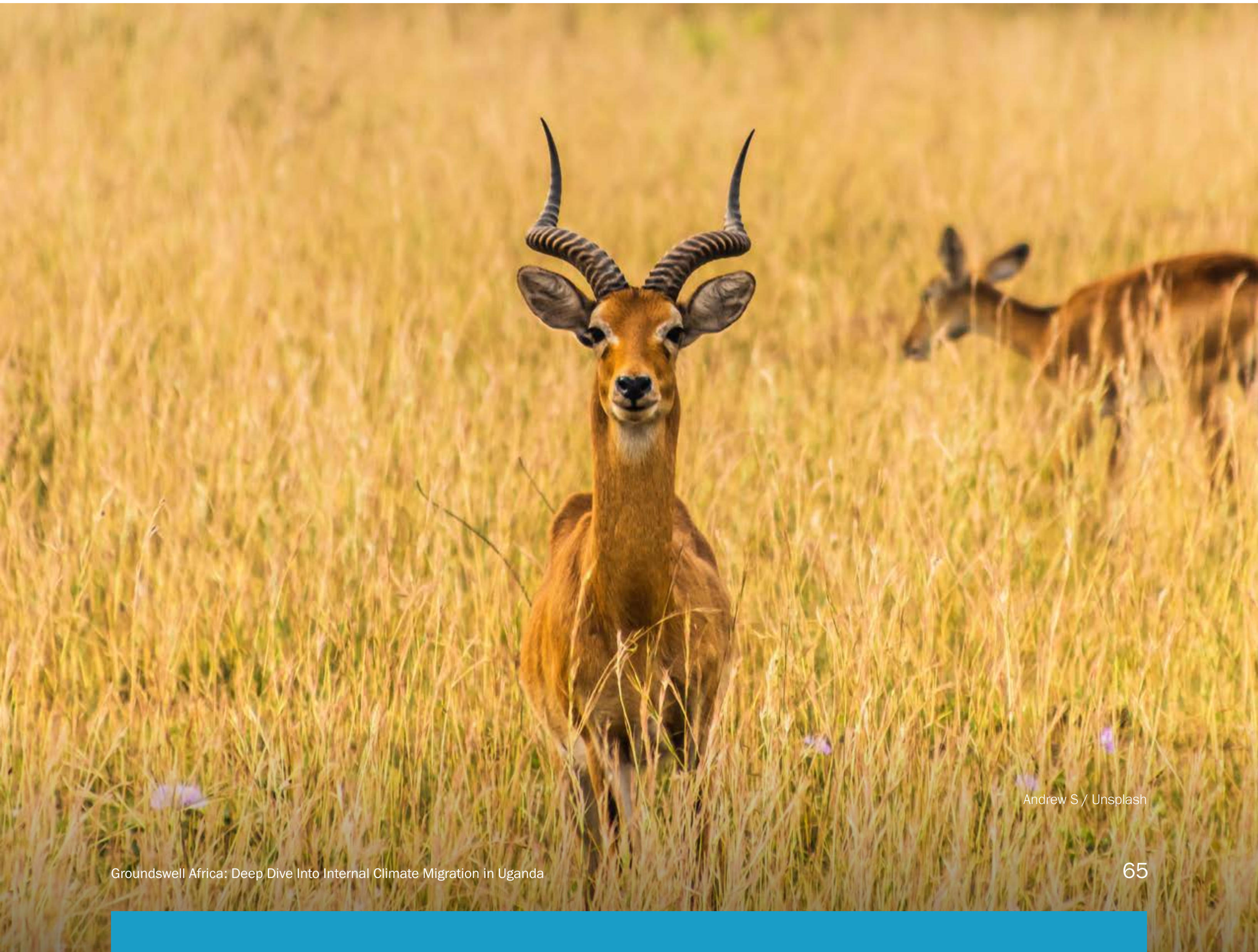
While the scale of conflict-induced internal displacement is less in Northern Uganda, it continues to be an important driver of displacement in Uganda. These factors have important policy implications and require greater analysis. It is imperative to develop climate migration hotspot maps for the country, identify spatial climate and social risks and impacts to secure resilience.

Early action, aided by state-of-the-art models on the current and future trends of mobility, is crucial for policymakers to drive proactive and informed action in this regard. Investing in evidence-based research at national level and mobilization of new data sources—including from satellite imagery and mobile phones—can help better contextualize and understand climate migration (particularly at local scale) where climate impacts may deviate from the broader regional or global trends.

The results from this study demonstrate that climate migrants could move from less viable areas with lower water availability and crop productivity, and extreme weather events, such as droughts, flooding, and storms. Some of these localities are Koboko in the north-west, around Lake Albert, and Lira and Fulu at the center of the country. Uganda is projected to see a population shift from the west to the east owing to climate migration (Figure 3.12). This pattern and the emergence of hotspots of climate-migration will have major implications on conceiving effective responses. The suite of policy actions to embed resilience in hotspots should include investments and economic opportunities in green industry, environmental safeguards, institutional strengthening and coordination, health, sanitation, and energy infrastructure (IUCN 2018; LVBC 2018).

2. Enable and embrace landscape and territorial approaches for far-sighted planning to avert, minimize, and address climate-induced migration

Climate change impacts and other socio-economic trends could change the desirability of land and natural resources, vary their uses, and shift the comparative advantage of locations across the landscape (Childress, Siegel, and Törhönen 2014). According to the *Next Generation Africa Climate Business Plan* (World Bank 2020e), slow-onset climate factors will adversely affect water and land resources and food systems. Ultimately, these changes have implications on migration patterns and necessitates deeper engagement with land uses and their interactions with broader forces. Protecting the underlying ecological foundation becomes crucial to achieve a resilient rural economy (World Bank 2020e). Areas in the north-west and central-west around Lake Albert and Albertine Rift are projected to be out-migration hotspots owing to decreases in water availability and crop production (Figure 4.2) These areas are already facing high levels of deforestation and degradation (Figure 4.3). Given that they host a rapidly growing population, rich biodiversity, and large numbers of refugees, far-sighted planning to avert and minimalize the effects of climate change is essential.



Andrew S / Unsplash

Figure 4.2 Climate In- and Out-Migration Hotspots in 2050

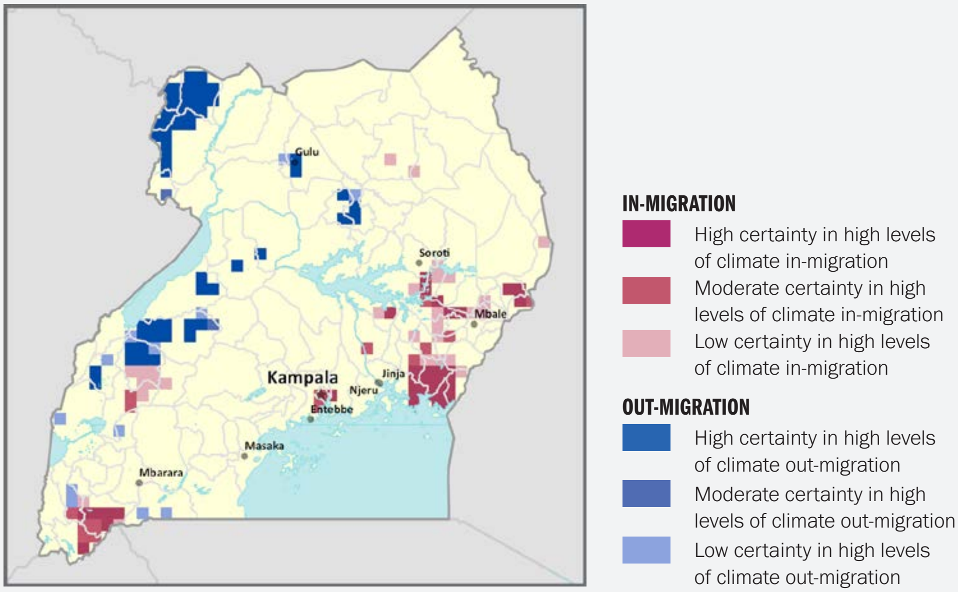
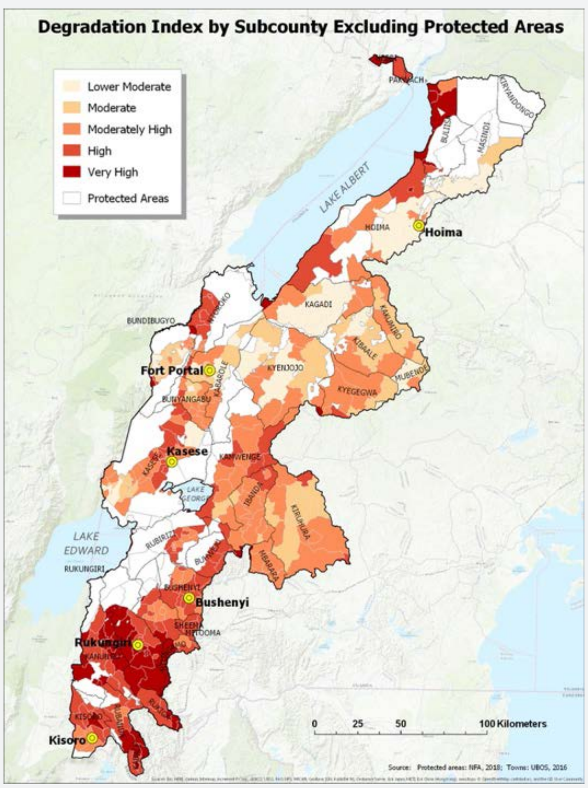


Figure 4.3 Degradation Index by Subcounty Excluding Protracted Areas in the Albertine Landscape, Western Uganda



]Source: UNIQUE 2019

The placement of a landscape approach within larger territorial approaches enables planning across spatial and time scales through a focus on the full migration life cycle (before, during, and after). It considers the underlying causes of distress-driven migration—and addresses both slow onset and rapid onset and their inter-linkages. It also offers a pathway to site-specific planning for climate-induced migration with an expanded and integrated view of land that can support local priorities and natural resource uses. Unlike sector-oriented planning, it allows deeper understanding of human-natural ecosystems and how they impact migration through land management, natural resource management, livelihoods, and ecosystem integrity.

Climate in-migration hotspots around the periphery of Lake Victoria might see increasing resource competition and stress on the lake ecosystem. Local and cross-border clashes have already been observed around the lake over the exploitation of fisheries (Glaser et al. 2019). The increase of fishing in this area coincides with the in-migration of displaced populations from the northern Ugandan conflict, in part a response to the other climate-related drivers (Glaser et al. 2019; Rigaud et al. 2018). Mount Elgon, a key water tower with one of the highest populations and poverty rates in the country, is also projected to become a high-certainty in-migration hotspot by 2050, and early action for management, conservation, and development interventions are important.

Local, national, and regional level planning is essential to avert conflicts and crises which will be amplified by the population increase. Site-based and locally driven practices to undertake forest management, conserve wildlife, develop water management plans and integrated community programs, and land-use plans will allow us to avert, minimize and address climate-induced migration. In addition, the Lake Victoria Basin is of particular importance as a critical natural resource for fishing, water, transport and other services, and its contribution to the economy of the Uganda and the region. Its emergence as a climate in-migration hotspot suggests the urgent need for both national and regional approaches to its conservation and management.

Demographic growth coupled with urbanization and the proposition to plan for up to 15 cities in Uganda provides the scope to plan at territorial levels while harnessing plausible climate migration futures (Mbabazi and Atukunda 2020) (Box 4.3). Early planning and an integrative approach can harness economic transition and job opportunities for climate-induce migration and youth populations while contributing to growth and poverty reduction.

Box 4.3 Uganda's Plan to Create 15 Cities

In 2019, Uganda's Cabinet declared 15 new cities due to the rapid urbanization growth rate across the country (Table 4.2). One criterion for becoming a city is having a population of at least 300,000 residents with a minimum and a maximum population density of 6,000 and 20,000 persons per square kilometer. This declaration of new cities aligns with the Uganda 2040 agenda, which calls for the creation of new strategic cities as a driver of development.

Table 4.2 Timeline for the Creation of Cities

Commencement date	Cities that will be created
July 2020	Jinja, Mbarara, Fort, Portal, Masaka, Mbale, Arua, Gulu
July 2021	Hoima, Lira, Soroti
July 2022	Entebbe
July 2023	Moroto, Nakasongola, Kabale, Wakiso

Two newly declared cities (Gulu and Lira in blue) are projected to be climate-out migration hotspots by 2050. It is important that these cities' urban strategy and planning include job diversification and resilience measures to climate changes, given that crop productivity and water availability will be a main push factor in Gulu and Lira by 2050.

In contrast, the new city of Mbale (in red) is projected to be a climate-in migration hotspot as early as 2030. Mbale is an urban center with a high population growth due to attractive job opportunities. There is an opportunity for the city to plan for immediate and long-term population growth due to climate-migration, especially in terms of infrastructures, services, and job opportunities.

Source: Mbabazi and Atukunda 2020

3. Address and harness climate-induced migration as an opportunity for jobs and economic transitions

Migration affects the well-being of the migrant, the household, and the sending and receiving community (World Bank 2019a). Incremental, low regret measures alone will not be sufficient to counter the magnitude of climate impacts (Kates, Travis, and Wilbanks 2012). Sequences of flexible incremental adaptation should be explored alongside more transformational adaptation, to secure resilience over longer timescales (Pal et al. 2019).

However, sound management of demographic transitions and investment in human capital can reduce adverse impacts of climate migration. Lower agricultural productivity due to climate change will compel Uganda to absorb labor and a large youth bulge into non-agricultural and less climate-sensitive sectors. Climate-induced migration will take Ugandans to different anthropogenic biomes possibly requiring them to adapt their livelihood practices. To tap the demographic dividend, demographic transitions need to be accompanied by policies to absorb larger working age populations into productive and climate-resilient labor markets—and to ensure that they have good access to health care, employment, and education (PRB 2012). These interventions should be contextualized for the demographic, economic, and social characteristics of each locality. For example, some of the projected climate out-migration hotspots in the west-central areas coincide with Uganda's oil fields and oil industry. Anticipatory planning and interventions in these areas will need to take into consideration the livelihoods and economic activity in these hotspots.

Climate-smart urban transitions also provide win-win opportunities to invest in the next generation of skills to foster green and resilient jobs, and secure cities as engines of growth. Anticipatory planning through a focus on climate in-migration to secondary cities or peri-urban areas near Mbale and Kampala could lay their foundation as growth poles in place of sprawling slums steeped in poverty. Combining these opportunities with climate-smart urban transitions (as above) that also nurture and build skills, talent, and workforce to harness the youth bulge through a focus on energy efficient, green, and resilient urban infrastructure and services would present win-win opportunities. Remittance services facilitation, access to livelihood and education, skills training, registration service, accessible transport systems, social protection, mitigating conflict, cash for work programs, and land tenure offer ways to make migration work for all (FAO 2019a).

4. Nurturing development-humanitarian-peace partnerships for end-to-end action at the national and local levels

National and local stakeholders can help reduce migration in the triple nexus of humanitarian-development-peace efforts. While this report does not focus on cross-border migration, the modeling identifies numerous migration hotspots in areas close to national borders. Climate change can be an inhibitor or a driver of cross-border migration, depending on factors that propel individuals to decide to move. Extended dry spells and droughts have forced the Karamoja pastoralists to migrate longer and farther away, and in some instances, they return to their origin areas in smaller numbers, while in other cases they do not return at all (Lwasa, Buyinza, and Nabassa 2017). More severe and frequent climate changes could push the Karamoja pastoralists to cross-border migration.

There is an opportunity to deploy holistic strategies to deal with the facets and actors of mobility in the face of climate change. Cooperation and stepped-up action by development, humanitarian, security, and disaster communities across the mobility continuum could greatly assist Uganda in pursuing more holistic and durable solutions to climate-induced migration and displacement (World Bank 2019) in support of peace, stability, and security in the region. Unplanned migration and absence of policies and strategies to integrate different communities can exacerbate existing social tensions and fault lines into a downward spiral leading to conflicts (Thoha 2020).

Treating migration as a nexus of the humanitarian-development-peace framework implies overcoming structural barriers and internal divisions around sources of funding, coordination mechanisms, and project timelines (OCHA 2017). This approach can benefit from the comparative advantage of different actors to strengthen local capacity (OCHA 2017). It is geared to reduce humanitarian need, risk, and vulnerability through short-, medium- and longer-term contributions from humanitarian and development actors (OCHA 2017). The linkages need to happen simultaneously to secure peace, address humanitarian objectives to save lives and alleviate human suffering and achieve the development priority to alleviate poverty (Lewis 2001). Examples to increase the impact of climate-humanitarian-development-peace actions include: (1) establishing local platforms for solving cross-border natural resources management conflicts; (2) mobilizing community leaders and strengthening traditional institution for implementation; and (3) instituting multilateral or globally focused partnerships.

5. Bridge the gap in legal mandates and frameworks on climate-induced migration to support well-conceived responses

There is an absence of comprehensive and coherent legal architecture to address climate-induced mobility (Leighton 2010; Kuusipalo 2020). Adequate protections under international law are generally not afforded to those moving primarily due to environmental factors (Kuusipalo 2020). As the impacts of climate change intensify, there will be more migrants and displaced people uncovered by law. The Groundswell report (Rigaud et al. 2018) suggests that the Lake Victoria Basin could become more attractive under climate change owing to its higher elevation and more stable and plentiful rainfall, compared to other regions of Uganda, Kenya, and Tanzania that are semi-arid. Water availability—a major driver of migration in the model—is projected to remain stable or increase in the basin. The porous nature of the borders in the Basin, the scarcity of natural resources, and the pressure on livelihoods can lead to complex challenges that require sound legal mandates and frameworks (LVBC 2018; Mwiturubani and van Wyk 2010).

A well-defined and implemented legal architecture brings clarity, protects affected individuals and communities, and reconciles international funding and local decision-making (Mayer 2011). It can pave the way for migrants to demand and seek assistance, ensure meaningful consultation about relocation, secure tenure at the new location, and restore or improve their livelihoods. In addition, disadvantaged and vulnerable individuals and communities can receive special attention (Kuusipalo 2020). For instance, as an unintended outcome of the Msimbazi Opportunity, demolitions in the Lower Victoria Basin heightened social tension around resettlement. A resettlement action plan (RAP) is being created for affected households and businesses to get information and support. Team members are expected to have the skills or have access to surveyors, sociologists, agronomists, appraisers, lawyers, or other specialists. The RAPs are to be prepared by a consultant or consortium that could include a company and a local NGO, and the work should be overseen by a steering committee that includes the lower levels of government and community members.

Policymakers must guarantee that existing legal frameworks are in line with the Kampala Convention and international frameworks. This will bolster the legal architecture to address climate-induced migration. Key components of any legal framework should include and promote a cross cutting view of housing, land and property issues, access to schools, work, and health care policies; monitoring and evaluation of the extent to which governments' actions are aligned with their legal obligations, legal clinics, and the collection of accurate information.

4.2.3 Taking Anticipatory Action to Tackle Climate-Induced Migration

Inclusive and climate resilient development is at the front and center of the response mechanism to climate-induced migration. More inclusive and climate-friendly pathways can reduce the scale and spread of climate-induced migration and climate in- and out-migration hotspots. By taking anticipatory action, based on state-of-the-art evidence and projections, Uganda can not only avoid the worst impacts of this issue, but harness climate-induced migration as a factor for growth and jobs as part of the transition to resilient and low carbon economies. Compared to other countries in the Lake Victoria Basin, the results for Uganda show the strongest certainty across the models, further underscoring the need for immediate, concerted, and targeted action. Key strategies and frameworks provide a platform to engage on the issue of mainstreaming climate migration. This section sets out how the MACS framework can be applied to the Uganda context to advance an anticipatory approach to tackle climate-induced migration.

1. Move “from a peasant to a modern and prosperous Uganda”

The third National Development Plan (NDP) (NDPIII 2021-2025) aims at increasing household incomes and improving the quality of life of Ugandans (Uganda NPA 2020). The Government of Uganda plans to achieve this goal through a resource-led sustainable industrialization that will (1) bring value addition in key growing economic sectors (agriculture, tourism, and minerals), and (2) prompt structural change and eventual transition of low-paid agriculture jobs to relatively better paid industrial employment (Uganda NPA 2020). According to the NDP, these factors should “stimulate increased incomes and demand for agricultural output, quality education, and health services, and hence improvement in the quality of life of Ugandans” (Uganda NPA 2020). The overall NDP strategy aligns with the Uganda Vision 2040 of transforming the Ugandan society “from a peasant to a modern and prosperous” one (Uganda NPA 2020).

2. Create opportunities for jobs and smart economic transitions

Climate migration can be an impetus for the structural transformation that the Ugandan NDP is calling for. The MACS framework encourages Ugandan policymakers and the private sector to see climate migration as an opportunity for jobs and smart economic transitions. Strengthening policies and institutions for technical and vocational training could harness the youth bulge through nurturing and building skills, talent, and workforce into energy-efficient, green, and resilient urban infrastructure and services. This aligns with World Bank’s priority in Uganda of creating climate-resilient jobs and promoting digital transformation and access to electricity, as exemplified by the Digital Acceleration Program (P171305, FY21) and Electricity Access Scale up (P166685). It also aligns with the MACS framework’s goal of harnessing climate migration to nurture jobs and skills as part of sustainable and resilient economic, demographic, and urban transitions.

3. Mainstream climate migration into NDPIII

Acting on climate migration aligns with Uganda’s NDP, which recognizes climate change as a driver of forced displacement and calls for “integrating migration and refugee planning and all other cross cutting issues in national, sectoral and local government plans” (Uganda NPA 2020). The objectives and development strategies outlined in the NDPIII present untapped opportunities to leverage and further embed climate migration. The NDP has four key objectives: (1) Enhance value addition in key growth opportunities; (2) Strengthen the private sector to create jobs; (3) Consolidate and increase the stock and quality of productive infrastructure; and (4) Enhance the productivity and social wellbeing of the population (Uganda NPA 2020).

To achieve these objectives, the NDP identified key development strategies. These include: (1) promoting agro-industrialization; (2) increasing local content participation; (3) institutionalizing infrastructure maintenance; (4) developing intermodal transport infrastructure to enhance interoperability; (5) increasing access to stable, reliable and affordable energy; (6) leveraging urbanization as a driver for socio-economic transformation; (7) improving access and quality of social services; (8) promoting Science, Technology, Engineering and Innovation as well as ICT; and (9) increasing access to social protection (Uganda NPA 2020). The MACS framework calls for and considers embedding climate migration into development strategies, such as the ones above, as win-win opportunities for Uganda. The virtual consultation also saw participants touch on some of these points.

4. Approach climate migration from a multi-Sectoral perspective

The World Bank goals in Uganda go hand in hand with mainstreaming climate migration. The SCD and Country Partnership Framework (CPF) recognize that Uganda is highly vulnerable to climate changes, including rising temperatures, floods, storms, droughts, and heat waves. They also consider climate-related shocks and the long-term degradation of natural resources as a key constraint in Uganda's economy and development goals, particularly affecting poor households that are dependent on agriculture.

This study finds that there is a relation between these climate-related factors and internal mobility, and if it is not managed, it could undermine the World Bank's goal of fostering physical and social reliance. Climate migration could reach as high as 10.7 percent of the population by 2050 (12 million) (Table 3.1). Climate-induced migration could outpace the other internal "development" migrants in Uganda before 2050 in the pessimistic scenario, suggesting the adverse impacts that climate can act as push and pull factors (Figure 3.9). The emergence of climate in- and out-migration hotspots as early as 2030 and the current state of natural resource challenges could impinge on future development outcomes. Implementing multi-sectoral responses as outlined in the MACS framework will ensure short- and medium-term positive and sustainable environment, development, and social outcomes in Uganda.

5. Use the World Bank's new diagnostic platform

The study reveals the emergency of climate in- and out-migration hotspots that converge with areas of high poverty incidence and higher economic growth, respectively. The MACS framework's focus on spatio-temporal analytics in climate migration hotspots will provide important nuances on the pattern and scale of internal climate migration in Uganda, and its linkages to development and other sectors. Integrating these in strategic frameworks will ensure that climate migration is approached from a multi-sectoral perspective. The World Bank's new diagnostic—Country Climate and Development Report (CCDR)—is an important platform to embed and mainstream climate migration to identify opportunities that boost adaptation and mitigation to climate change while eradicating poverty and boosting shared prosperity.

6. Take a landscape approach to understand causes of distress-driven migration

Adopting a proactive stance on climate-induced migration through a landscape approach and sustainable natural resource management as outlined in the MACS framework will contribute to improving the living conditions of people in climate-vulnerable urban areas. The study projects that areas in the north-west and central-west around Lake Albert and Albertine Rift could be out-migration hotspots owing to decreases in water availability and crop production. These areas are already facing high levels of deforestation and degradation, on top of hosting a rapidly growing population and large numbers of refugees. Taking a landscape approach and considering the underlying causes of distress-driven migration—both slow-onset and rapid-onset and their inter-linkages—offers a pathway to site-specific planning for climate-induced migration with an expanded and integrated view of land that can support local priorities and natural resources. This is in line with the CPF's goal to support resilient landscape program, including integrated water and forest resources management.

7. Adopt socially inclusive approaches to drive climate-smart urban transitions

Anticipatory planning through a focus on climate-in migration to secondary cities or peri-urban areas can also lay their foundation as growth poles in place of sprawling slums steeped in poverty. Projected in-climate migration hotspots, such as Mbale and Kampala, are already facing development challenges related to the rapid population increase. Mount Elgon, a key water tower with one of the highest populations and poverty rates in the country, is projected to become a high-certainty in-migration hotspot by 2050. Applying the MACS framework's call for harnessing climate migration as an opportunity for economic and job transformation in these localities would ensure that they benefit from socially inclusive approaches that go beyond livelihood strategies to drive climate-smart urban transitions that combine with sustainable use and management of natural resources. Nurturing and building equity, skills, talent, and a workforce to harness the youth bulge through a focus on energy-efficient, green, and resilient urban infrastructure and services would present win-win opportunities. This is critical to meet the CPF, SDC, and NDP's goals of improving the living standards in urban areas—specifically focusing on access to water, sanitation, and electricity.

8. Incorporate the full migration cycle into planning and design of migration policy measures

Policies that consider the full migration cycle can benefit from and provide impetus for institutional transformation. The NDP, CPF, and SDC underscore the weakness of public service delivery, especially in education, health, water supply, and sanitation. Assisting climate migrants to adapt in place, or to move to a different location voluntarily and safely can put additional pressure on public institutions and service delivery systems. The MACS framework provides actionable steps to adopt migration policy measures that can build the overall efficiency and equity in public institutions and service delivery systems, such as remittance services, registration services, accessible transport systems, social protection, cash for work programs, and land tenure. Ensuring that climate migrants—especially women, poor, and marginalized communities—are included in the design of solution and services is pivotal for ensuring durable, dignified, and context-based solutions.

9. Address cross-border migration regionally

The MACS framework's call for local, national, and regional level planning to address migration can reduce potential conflicts. The NDP recognizes that the exploitation of and access to natural resources is one push factor for conflict-driven displacement in the region. Climate-in migration hotspots around the periphery of Lake Victoria and inland, such as Mount Elgon in Uganda close to border with Kenya, have seen increasing resource competition and stress on the lake ecosystem. In Uganda, local and cross-border clashes have already been observed around the lake over the exploitation of fisheries. The acceleration of climate change in neighboring countries and the region could intensity regional conflicts and drive forced displacement towards Uganda. Sharing information across neighboring countries, facilitating movement along migration corridors, supporting market linkages, conducting livestock disease surveillance, and vaccination campaigns for pastoralists' livestock are sound potential actions. Training local institutions about conflict resolution related to land rights and land access could also be transformative.

4.3 IN SUMMARY

In sum, the NDP, CPF, and SCD provide the opportunity to highlight that climate migration is not distributed evenly across countries, or across population groups. In many places, social groups in vulnerable situations—the poor and underprivileged, women, the elderly, children—are the most severely affected by climate change impacts (Reckien et al. 2017). For example, when only men migrate, women, children, people with disabilities, and the elderly left behind are at greater risk of food insecurity and personal safety. Land degradation and climatic variability can also force higher levels of gendered migration or longer-duration migration.

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Appendix A

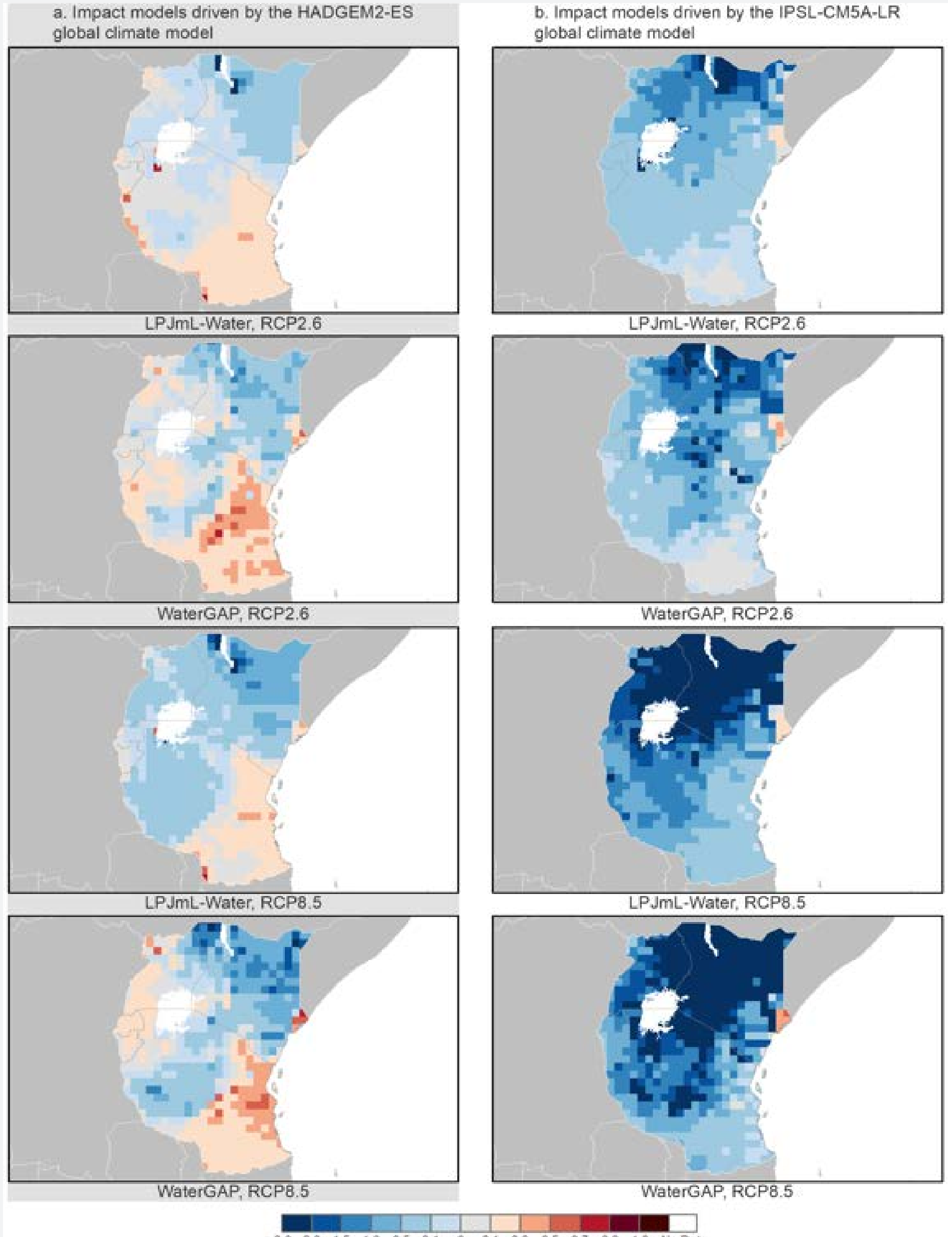
ISIMIP Projections to 2050-2100

This appendix presents the projections for the water, crop, and ecosystem models out to 2050-2100 for the Lake Victoria Basin (LVB) region.[27] Positive index values are capped at 2, which represents a tripling of the baseline value (whether it be water availability, crop production, or ecosystem productivity).

Figure A.1 shows that water availability will continue some of its earlier trajectory. The Hadley model (HADGEM2-ES) shows drying in the south of the LVB region and wetting in the north. The IPSL-CM5ALR model shows mostly a wetting pattern across the region, but with modest drying in southern Tanzania in under the LPJmL-water model. The water model runs are highly consistent across the two GCMs (figure A.2). A number of models show strong declines in crop productivity in northeastern Kenya and in western Tanzania and Uganda. The LPJmL Crop model shows a strong increase in water availability across all models runs in the southeastern corner of Kenya near Lake Victoria. NPP models out to the end of the century show mostly increases in net primary productivity except some modest areas of decline along the eastern coastal areas that vary in intensity and location by model (figure A.3).

27 The projections used an index in which the historical baseline value is subtracted from the projected value and then divided by the historical baseline value. For more details on this index the overall methodology, please refer to the World Bank's report *"Groundswell Africa: Internal Climate Migration in the Lake Victoria Basin Countries"* (Rigaud et al. 2021a).

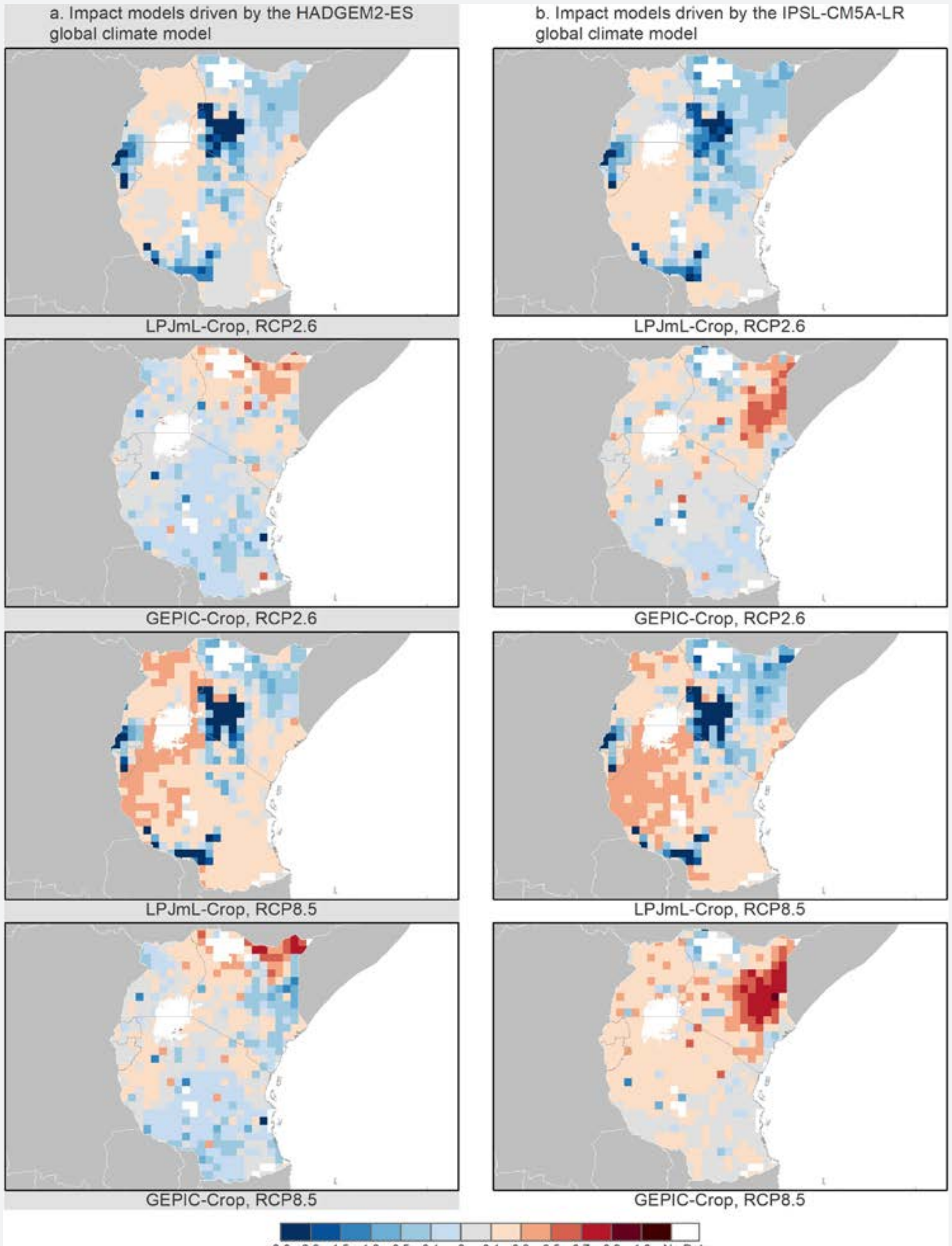
Figure A.1 ISIMIP average index values during 2050-2100 against 1970-2010 baseline for water availability



Source: Rigaud et al. 2021a

Note: LPJmL/water (left) and WaterGap (right), forced with the HadGEM2-ES climate model (top 4 maps) and IPSL-CM5A (bottom 4 maps) under RCP2.6 and RCP8.5. Blue areas indicate wetting relative to the historical baseline, and gray and tan areas indicate drying

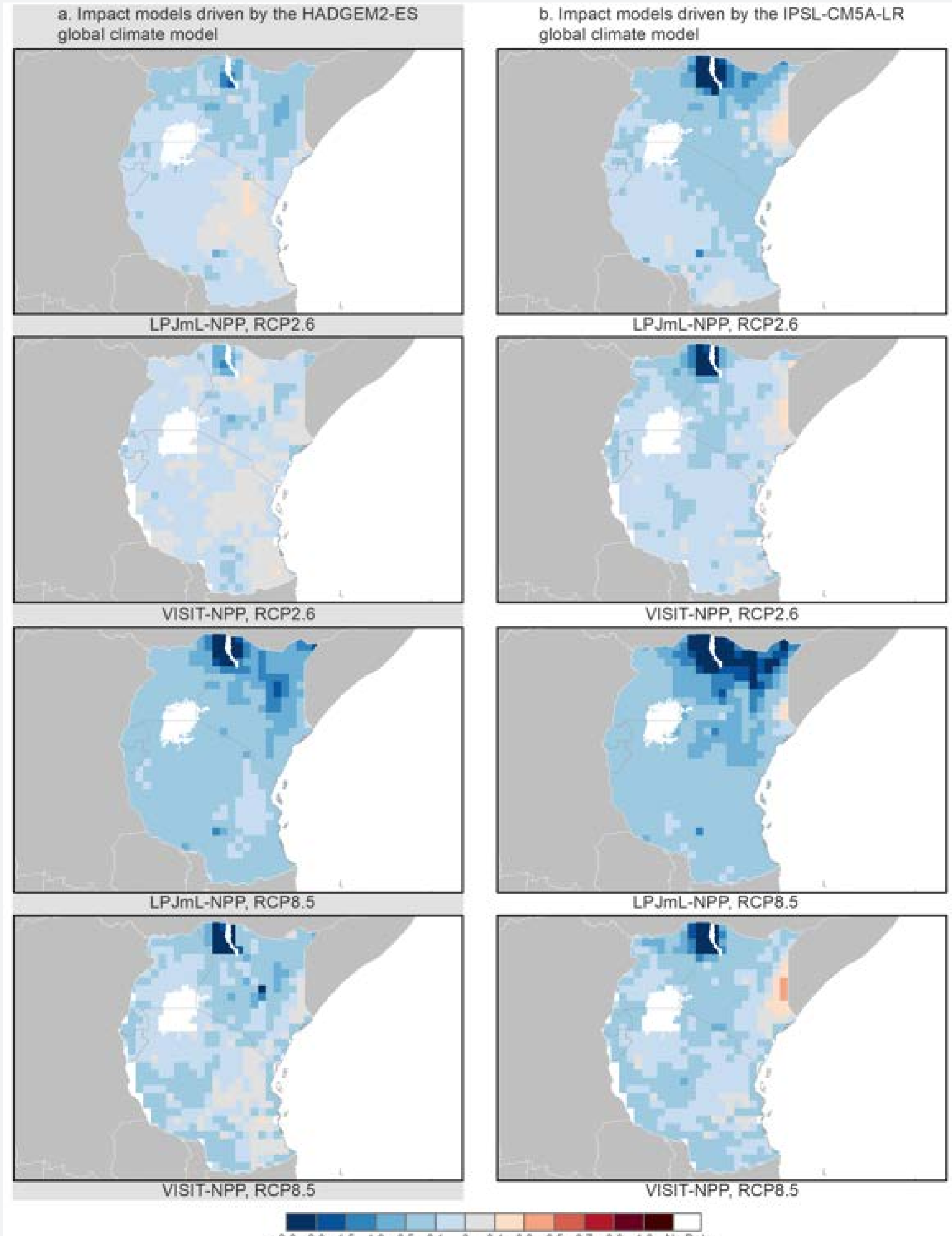
Figure A.2 ISIMIP average index values during 2050-2100 against 1970-2010 baseline for crop production



S ource: Rigaud et al. 2021a

Note: LPJmL/crop (left) and GEPIC (right), forced with the HadGEM2-ES climate model (top 4 maps) and IPSL-CM5A (bottom 4 maps) under RCP2.6 and RCP8.5. Blue areas indicate wetting relative to the historical baseline, and tan to red areas indicate drying. White areas do not grow the four major crops.

Figure A.3 ISIMIP average index values during 2050-2100 against 1970-2010 baseline for ecosystem net primary productivity (NPP)



Source: Rigaud et al. 2021a

Note: LPJmL (left) and VISIT (right), forced with the HadGEM2-ES climate model (top 4 maps) and IPSL-CM5A (bottom 4 maps) under RCP2.6 and RCP8.5. Blue areas indicate higher NPP relative to the historical baseline, and tan to red areas indicate lower NPP.

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