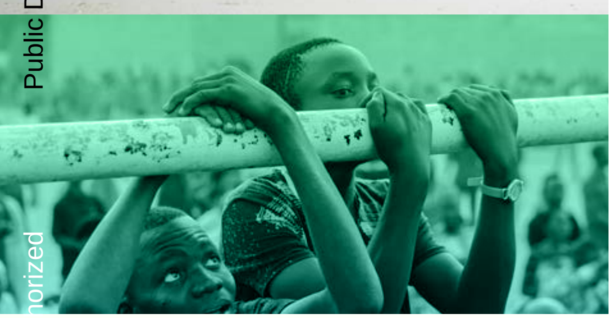

GROUNDSWELL AFRICA

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

Kanta Kumari Rigaud,
Alex de Sherbinin, Bryan Jones,
Anmol Arora, and Susana Adamo

WORLD BANK GROUP

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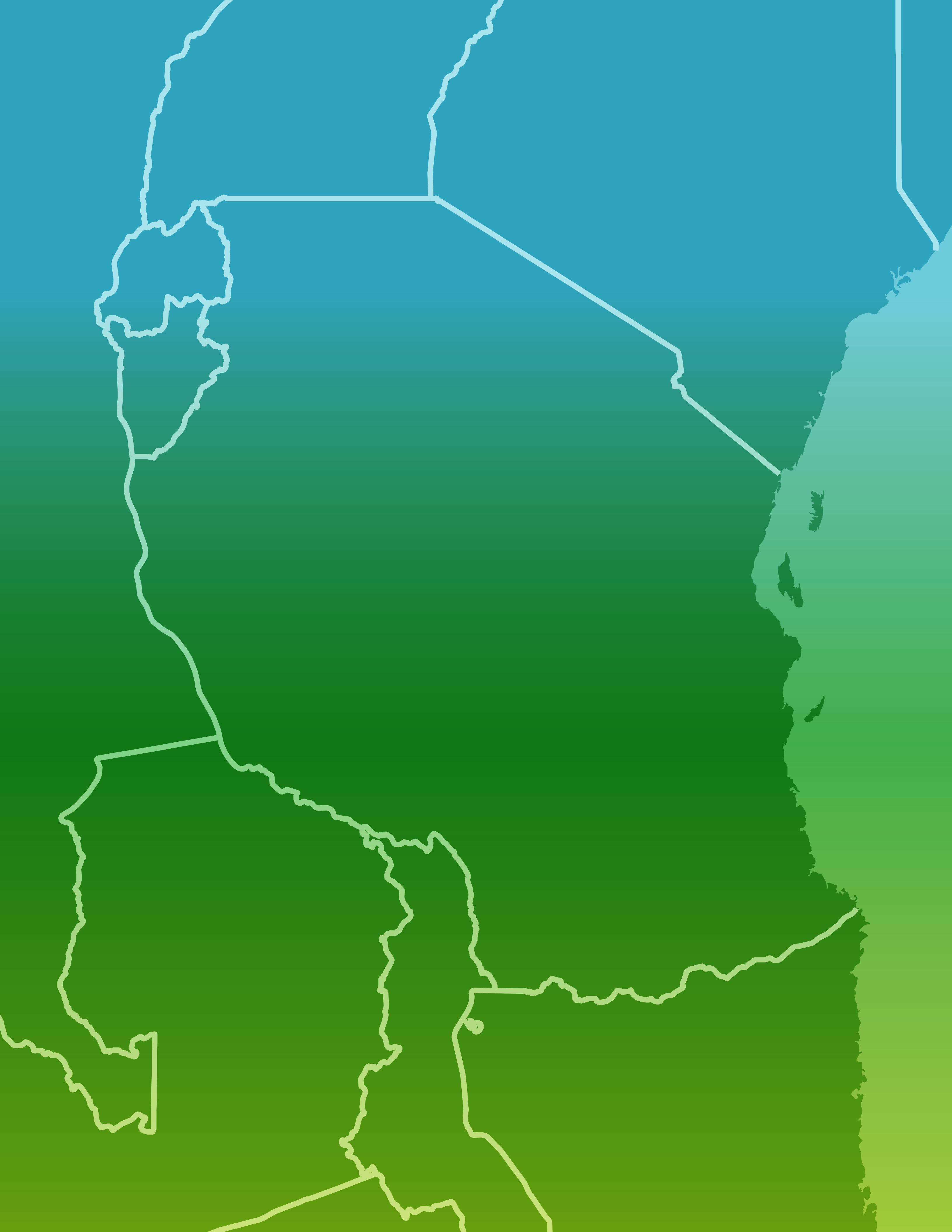

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Glossary

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 a number of 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).

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 as a result 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 into account climate impacts 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 into account climate impacts 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 analyze 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/or 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 as a result 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: Migratory movement in which an element of coercion exists, including threats to life and livelihood, whether arising from natural or man-made causes (for example, movements of refugees and internally displaced persons as well as people displaced by natural or environmental disasters, chemical or nuclear disasters, famine, or development projects). 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 not moving away from a place of risk due to choice.

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): Internal migration is 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 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/ administrative border.

Migration cycle: The three stages of migration process which can be leveraged for adaptation i.e., adapt in place, enable mobility and 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).

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 largely for reasons other than climate impacts.

Peri-urban: It denotes 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).

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 as a result of 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 as a result of 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—such as 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: The strategies that can reduce the root cause of vulnerability to climate induced migration.

Urban transition: The 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 (see Appendix A of Rigaud et al. 2021a).

Abbreviations

ACLED	Armed Conflict Location and Event Data Project
AU	African Union
BAU	Business as Usual
CCDR	Country Climate Development Report
CIESIN	Center for International Earth Science Information Network
CMIP5	Coupled Model Intercomparison Project Phase 5
CPF	Country Partnership Framework
DRDIP	Development Response to Displacement Impacts Project in the Horn of Africa
EAC	East African Community
ENSO	El-Nino Southern Oscillation
FAO	Food and Agriculture Organization
FYDP	Five-Year Development Plan
GDP	Gross Domestic Product
GHGs	Greenhouse Gases
GIS	Geographic Information System
GPWv4	Gridded Population of the World Version 4
GRID	Green, Resilient and Inclusive Development
ICT	Information and Communication Technology
IDMC	Internal Displacement Monitoring Centre
IDP	Iinternally Displaced Person
IFAD	International Fund for Agricultural Development
IGAD	Intergovernmental Authority on Development
IOM	International Organization for Migration
IPCC	Intergovernmental Panel on Climate Change
ISIMIP	Inter-Sectoral Impact Model Intercomparison Project
ITCZ	Inter-Tropical Convergence Zone
LECZ	Low Elevation Coastal Zone
LIC	Low Income Country
LMIC	Low- and Middle-income Country
LVB	Lake Victoria Basin
LVBC	Lake Victoria Basin Commission
MACS	Migration and Climate-informed Solutions
MIC	Middle-income Country
NAPA	National Adaptation Programs of Action
NBS	National Bureau of Statistics
NCAR-CIDR	National Center for Atmospheric Research-CUNY Institute for Demographic Research
NDC	Nationally Determined Contribution
NETIP	Northeastern Transport Improvement Project
NGO	Non-Governmental Organization
NPP	Net Primary Productivity
NSGRP	National Strategy for Growth and Reduction of Poverty
OCHA	United Nations Office for the Coordination of Humanitarian Affairs
ODI	Overseas Development Institute
RAPs	Resettlement Action Plans
RCPs	Representative Concentration Pathways
RPF	Resettlement Policy Framework
SCD	Systematic Country Diagnostic
SDGs	Sustainable Development Goals
SLR	Sea Level Rise
SSPs	Shared Socioeconomic Pathways
SST	Sea Surface Temperature
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
WDI	World Bank Development Indicators
WIM	Warsaw International Mechanism

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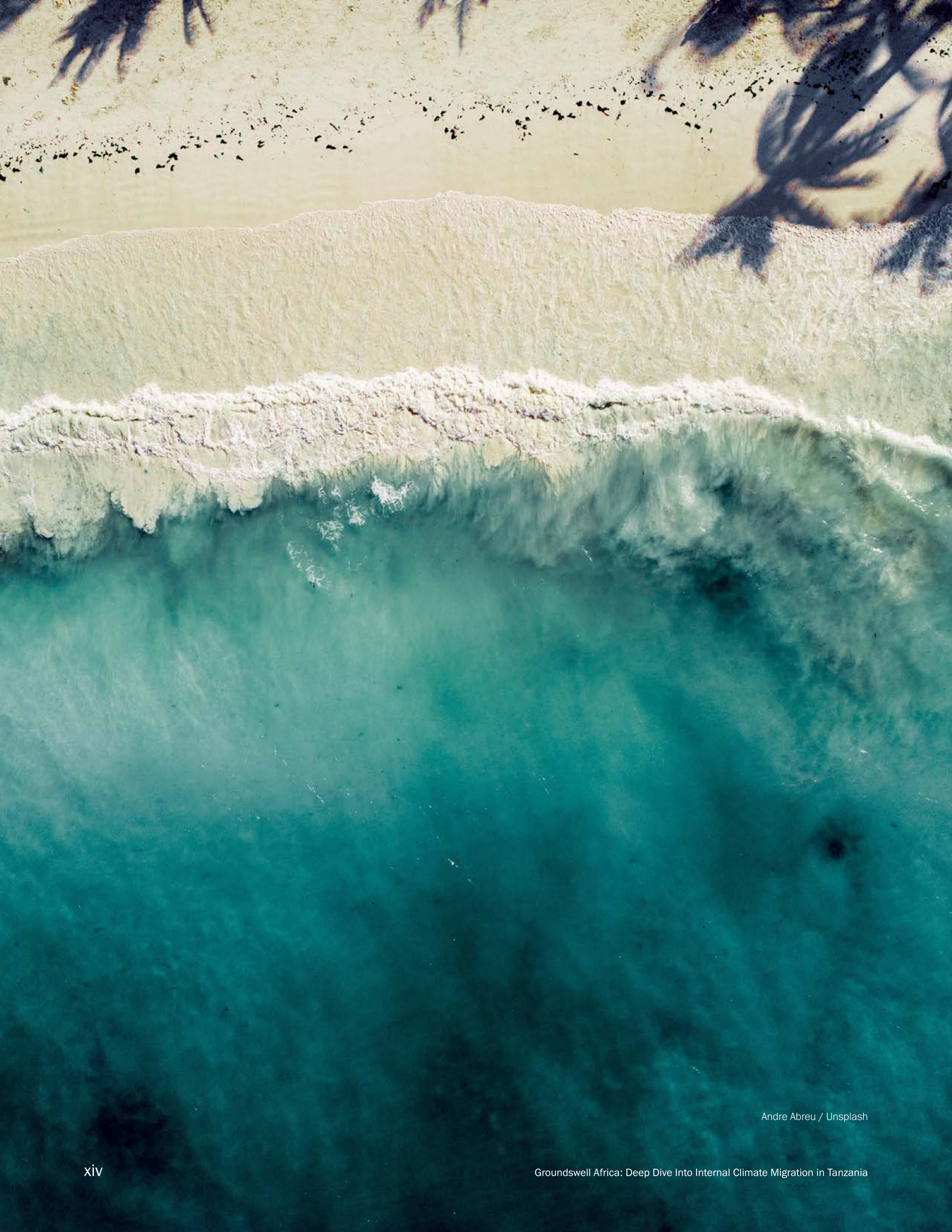

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Foreword

Between its natural wealth and impressive wildlife and its diverse cultures and rapidly growing cities, Tanzania is a country of vitality and dynamism. At the same time, the country is facing challenges from climate change that will put its people, policymakers, and ecosystems to a test, including recurring droughts, sea level rise, changes in water availability, and most notably, flooding.

Migration has long been a strategy of Tanzanians to deal with adverse climatic conditions, but as this deep dive illustrates, climate change will put further pressure on people to leave their homes and look for new opportunities elsewhere in the country.

Tanzania will see the emergence of "hotspots," where climate migration will be particularly intense, as early as 2030. This will have major implications, especially for the poorest households who are engaged in climate-sensitive sectors and for infrastructure and social support systems that will be pushed to accommodate more demand. For example, as water stress and rising sea-levels push people to search for new opportunities, cities like Dar es Salaam and Arusha could see growth dampened as early as 2030 while urban areas close to Lake Victoria, like Mwanza, Magu, and Geita, may experience an influx of climate migrants due to their more favorable conditions, including better water availability and crop production.

Drawing on the latest data on climate change and socio-economic trends, this deep dive on Tanzania shows that the country could see as many as 16.6 million internal climate migrants by 2050. Immediate and forceful action to limit greenhouse gas emissions as a global community and pursue inclusive resilient development at the national level could reduce the scale of climate migration, on average, by about 27 percent.

The good news is Tanzania has already taken important steps to integrate climate change in its legislation and plans, and the government has begun considering ways to support people who become displaced because of climate change. The National Adaptation Programme of Action refers to the displacement of coastal communities as a key area of vulnerability, laying out adaptation strategies. As party to the Kampala Convention, the government has also taken responsibility for assisting and protecting people who are displaced by climate change.

Tanzania now has an opportunity to reinforce its leadership on climate change by ensuring that climate migration is not just managed as a crisis, but also utilized as an opportunity to spur climate-resilient growth and development. For example, securing its major coastal cities while also reducing its carbon footprint through investments in sustainable infrastructure would help protect people and contribute to the global effort to cut greenhouse gas emissions.

Tanzania's diversity and dynamism are sources of strength, but they also call for urgent, scaled-up action to avert, reduce, and manage climate- induced migration. Undeniably, innovative action that takes the long view will go a far in helping secure the foundations of a peaceful, stable, and secure Tanzania.

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

Mara K. Warwick,
Tanzania Country Director
Eastern and Southern Africa, World Bank

Hendri Lombard / World Bank

Executive Summary

MESSAGE 1:
Tanzania is a highly mobile country where the potency for climate change to trigger internal climate migration will yield the highest numbers of climate migrants in the Lake Victoria Basin countries.

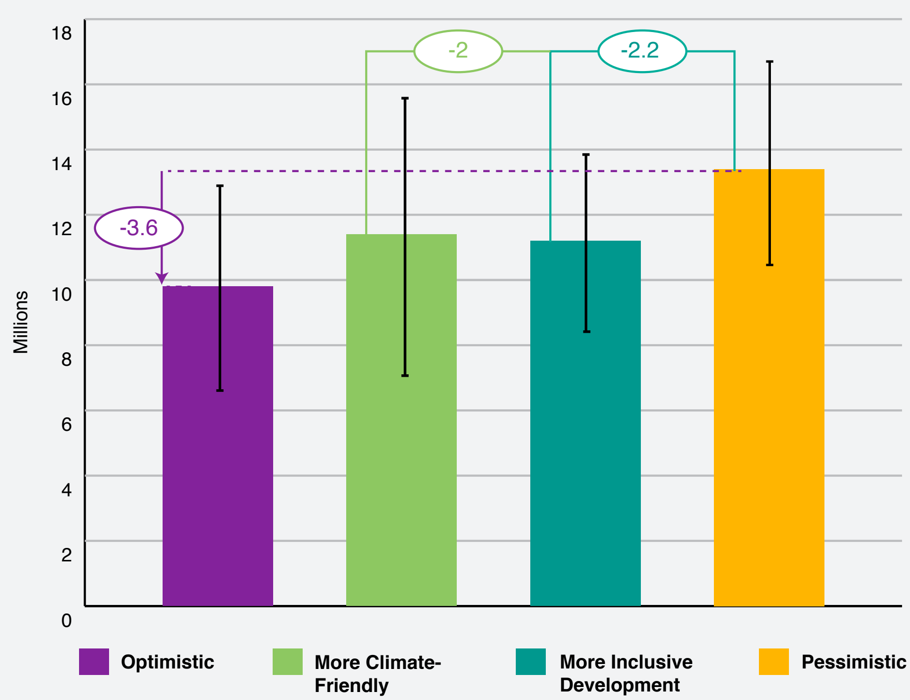
The World Bank's flagship report, Groundswell: Preparing for Internal Climate Migration (Rigaud et al. 2018), and the sequel (Clement et al. 2021), finds that that Sub-Saharan Africa is likely to witness high levels of climate-induced mobility. An expanded and deeper analysis through Groundswell Africa, 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 could see as many 38.5 million people moving 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 close up to 11 percent of the total population of the Basin 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.

Tanzania has a long history of mobility, and migration patterns have historically been dynamic. Internal migration, more broadly, has both positive and negative outcomes for Tanzania's economic and social well-being. Migration has been linked to poverty reduction and improved welfare not only for the migrants but also their households through cash remittances and in-kind transfers. It remains a widely practiced strategy to cope with and adapt to shocks and stresses, and to avail economic opportunities. However, low-income households are less likely to migrate in the face of financial constraints and limited assets.

Climate change is affecting the food and livelihood security of smallholder farmers, livestock keepers, and landless populations, and migration continues to be one of the many risk management strategies utilized in times of environmental stress. In Tanzania, the majority of migrants either move to rural areas with favorable weather conditions (northwest and southeast) to pursue agriculture and livestock rearing or to urban centers (Dar es Salaam and Zanzibar Town), where they perform nonagricultural activities such as retail, construction, and other services. Climate change has the potency to influence these patterns and intensities of migration and spatial population shift in the coming decades.

Internal climate migration in Tanzania could reach up to 16.6 million by 2050, the highest among the Lake Victoria Basin countries. This figure could represent up to 14 percent of the projected population, under the pessimistic scenario which combines high emissions with unequal development. 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 (Box ES.1). Alternative scenarios—more inclusive and climate-friendly—can reduce the scale of climate migration. The greatest gains in modulating the scale of climate migrations are realized under the optimistic scenario, which combines low emissions with moderate development pathways (figure ES.1). While the absolute number of internal climate migrants is the highest in Tanzania, other countries in the Basin can also reach high percentages of population on the move as a consequence of climate change. For example, internal climate migrants in Uganda and Kenya are projected to reach up to 10.72 and 8.29 percent of the population by 2050. No country is immune, but the scale of climate migration depends on the demographic, economic, and climate trends in each country. Early action targeting resilient development aspects–related to the management of climate related stresses and cutting down of emissions at the global level are critical to keep the scale of climate migrants lower.

Figure ES.1 Estimated Total Internal Climate Migrants in Tanzania by 2050



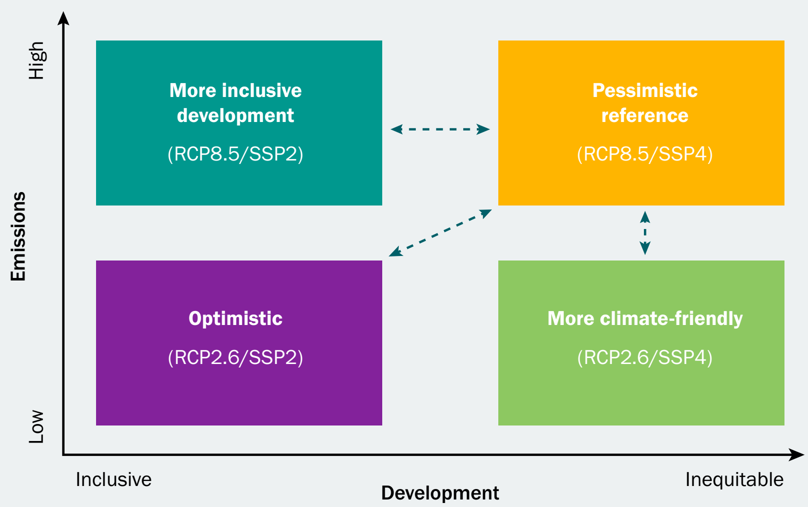
Note: The whiskers represent the lowest and the highest number of internal climate migrants in that scenario.

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). The expanded model includes the optimistic scenario, and additional climate (net primary productivity, flood risk) and nonclimate factors as variables.

The modeling results presented here are based on four plausible scenarios—reflecting different combinations of future climate change impacts and development pathways—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 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).

MESSAGE 2:

Internal climate migration will ramp up by 2050. It underscores how early action combining concrete climate and development action is an imperative to avert, reduce and manage the scale of the issue.

For Tanzania, all the modelling scenarios display an upward trend in climate migration by 2050. Between 2025-2050, the number of internal climate migrants could see an up to 3.0-fold rise (under the pessimistic scenario). Greatest gains are made when pursuing the optimistic scenario, with reductions of 3.6 million. The United Nations Intergovernmental Panel on Climate Change (IPCC)'s Sixth Assessment Report (IPCC 2021) highlights the progressive trend of the climate crisis and the urgency for action. The latest science on warming and impacts could challenge the prospects of reducing the scale of climate migration under the optimistic scenario.

Climate-induced migration could emerge as a dominant type of internal migration in Tanzania as early as 2030. By comparing population projections with and without climate factors, the assessment shows that the number of climate migrants could overtake the number of people who migrate because of development reasons. The gap between climate migrants and other migrants widens by 2050, across all the scenarios modelled, demonstrating that climate-induced migration is not a distant possibility, but a policy challenge that requires action today. These projections show that Tanzania is climate-sensitive and that climate factors will drive future mobility.

The sheer scale of plausible climate migration calls for urgent, concerted, and far-sighted planning and action to ensure that climate-driven movement does not turn into a crisis and undermines hard-won development gains. Strong, inclusive, resilient development must address pre-existing vulnerabilities and current development challenges as a key part of its action to avert adverse consequences of internal climate migration. Addressing long-standing environmental issues—including degradation of natural capital—is an imperative in Tanzania, where lives, livelihoods, and the economy are integrally linked with climate-sensitive sectors. Unattended, climate impacts will continue to deepen existing vulnerabilities and to reduce already low capacities, leading to 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 Tanzania will emerge as early as 2030 and continue to increase in strength and spread geographically (figure ES.2). These plausible hotspots reflect areas where population movements are considered high certainty across the scenarios modelled. These shifts happen in response to a changing viability of ecosystems and landscapes to support livelihoods due to changing water availability, crop and NPP, and habitability of coastal systems given sea level rise compounded by storm surges. The primary climate in-migration hotspots are in the north, particularly around Lake Victoria, in cities such as Mwanza, Magu, and Geita. Smaller pockets of climate in-migration are scattered in the west of the country, in Mpanda and Sumbawanga. Many climate in-migration hotspots coincide with areas of high poverty. Focusing on these hotspots and considering the spatial dimension of the challenge will be pivotal to build resilience and readiness across timescales.

The climate out-migration hotspots are concentrated in the east and south and include Dar es Salaam, Arusha, Korogwe, Dodoma, and Morogoro (figure ES.2). Large cities like Dar es Salaam and Arusha currently witness high levels of in-migration and are important engines of growth. Far-sighted planning will be essential to ensure that development gains are not lost. Climate out-migration, driven by water stress and sea-level rise in many of these areas, does not necessarily imply that the population will decline in these areas, rather that because of climate impacts, there will be a dampening of population growth.

Water stress and crop and NPP losses, analyzed at higher levels of granularity, reaffirm the influence of climate factors on internal climate migration in Tanzania over the next decades as set out in the original Groundswell study. Generally, 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. Climate impacts will continue to amplify beyond 2050, with models indicating a drying trend across Tanzania of varied intensity. Several models also show a strong decline in crop productivity in western Tanzania, while net primary productivity mostly increases in the country. The long coastline will witness sea-level rise compounded by storm surges, putting people and assets in coastal zones increasingly at risk.

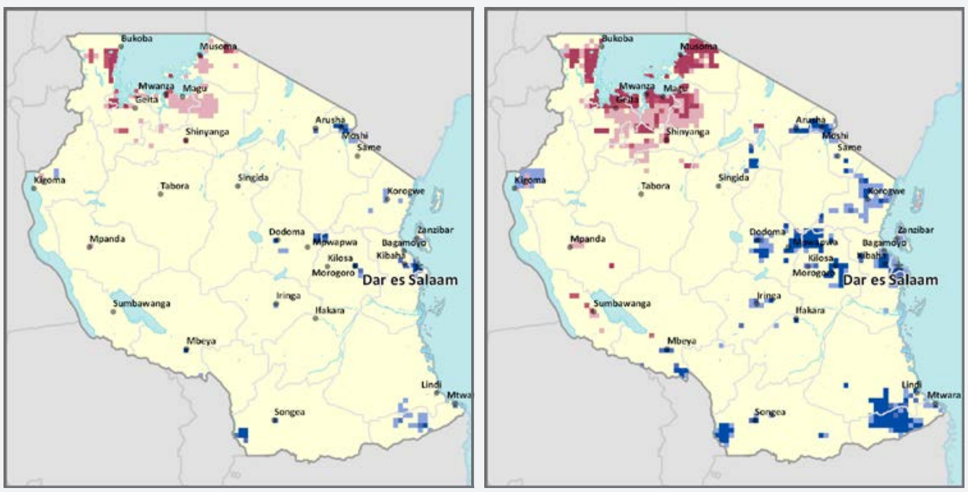
Further, the addition of non-climate factors, like median age, sex, and conflict, in the Lake Victoria Basin study as applied to the individual countries provides a more complete representation of how climate-induced migration trends will manifest. Age and sex composition are not strong influencers of spatial population shifts in the region, and conflict-related fatalities are negatively correlated with population change showing stronger effect in urban areas.

The hotspots 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 address the adverse consequences of climate-induced migration. They 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.

The hotspots provide Tanzania with an opportunity to create the right skills and jobs that can contribute to broader economic and demographic transitions. The doubling of the country's population from 56.31 million in 2018 to a high of 119.0 million in 2050 (under the unequal development pathway), and the high percentage of youth calls for a focus on creating skills and jobs with consideration to climate-sensitivity, as appropriate. Currently, more than 60 percent of the population is engaged in low productive agriculture, which will be further challenged by climate change. Informed by spatial analytics and monitoring systems, landscape approaches nested within territorial planning can support urban transitions and also structural transformations, especially in the agricultural and coastal landscapes. Foresighted and transformative action can add value to such transitions through end-to-end agriculture development or by providing alternative jobs and livelihood opportunities for climate migrants and the growing population, thus helping strengthen the resilience of the Tanzanian economy. These shifts are imperative for Tanzania to guard against a roll-back of development gains, while at the same time forging ahead to secure its development goals.

Figure ES.2 Projected Hotspots of Climate In- and Out-Migration, Tanzania by 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.

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

Concerted action at the global level to reduce 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 Agreement goals. The latest IPCC report (2021) finds that the global average temperature increase will exceed 1.5°C during the 21st century unless there is a deep reduction in GHG emissions in coming decades. Without immediate, rapid, and large-scale reductions in GHG emissions, limiting warming to 2°C may be beyond reach. Beyond these threshold temperatures, climate-related risks for natural and human systems are higher, with disproportionate impacts on the poorest and most vulnerable (IPCC 2021; UNEP 2020). Without aggressive global emission reductions that meet the Paris targets, which are in line with the climate friendly scenario modelled in this study, the opportunity to reduce the scale of internal climate migrants in Tanzania by up to 60 percent (down to a low of 6.5 million) will be hard to achieve. As this window of opportunity to meet the Paris target continues to close, the far-reaching consequences of climate change on internal climate migration and beyond makes action more urgent than ever. The call for solutions on internal climate migration cannot be subscribed to the very communities that may have to move in response to increasing intensity and frequency of climate impacts.

Strong inclusive, resilient development may well be the first line of defence in the face of stalling action on GHG emissions, but will not suffice by itself. Climate change impacts are amplifying pre-existing vulnerabilities of lives, livelihoods, and economies for the poorest and in the poorest communities due to their reliance on climate-sensitive sectors. Environmental and land degradation, vulnerability of coastal systems and degradation of pastoral livelihoods are particularly at risk. Major GHG emitting countries must find direct and indirect ways to complement countries' efforts on climate-induced migration, particularly through development assistance, including through leveraging and engaging the private sector.

MESSAGE 5:

Inclusive, resilient, and green development can be nurtured into a positive force through a focus on domains of actions buttressed by core policy directions.

Internal climate migration cannot be divorced from development and, as the human face of climate change, it must be addressed in a holistic, 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 climate-induced migration across time and space, facilitate social and economic transformation, and reduce vulnerabilities. Applying this anticipatory approach will ensure that Tanzania's economy is braced not just for the challenges but also the opportunities of 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 in Tanzania where internal climate migration will play out calls for focused attention and solidarity, which can be guided by five action domains to avert migration driven by adverse impacts of climate change. These include:

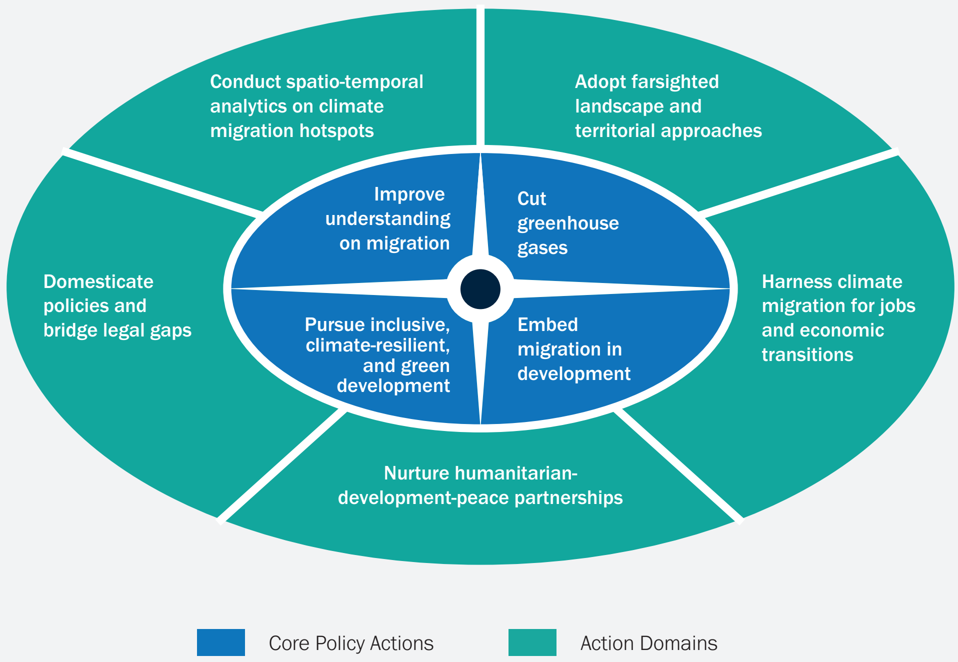
- Conduct spatio-temporal analytics to understand the emergence of climate migration hotspots.
- Adopt farsighted landscape and territorial approaches.
- Harness climate migration for jobs and economic transitions.
- Nurture humanitarian-development-peace partnerships.
- Domesticate policies and bridge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

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

Box ES.2 The 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.

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



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).

The right set of climate and development policy, underpinned by the MACS framework and in alignment with country's development vision and plans, 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 Tanzania, such as job diversification, land management, landscape programming, climate change resilience, and natural resource and environmental risk management. These platforms present untapped opportunities to leverage and further embed climate migration and policies aligned with the MACS framework. The adapation priority sectors in Tanzania's updated Nationally Determined Contributions (NDCs)—agriculture, livestock, coastal and marine environment, fisheries, water resoures, forestry, health, tourism, human settlement and energy—will be critical to counter the adverse consequences of climate induced migration. The World Bank's upcoming Country Climate Development Report (CCDR), a new diagnostic tool which looks closely at the interplay of climate and development and its economy wide implications, could also provide opportunities in the future to understand and address climate induced migration as a crucial part of delivering on poverty eradication and boosting shared prosperity.

The development community is not starting from zero. 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 finds 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 also provide for enabling interventions (early warning systems and social safety nets) and address underlying causes of mobility by investing in environmental restoration. There is a need to step up these measures with great vigor and urgency—acting in partnership and engagement of those directly affected.

MESSAGE 6:
Tanzania must act boldly, and with urgency, on internal climate migration—delaying action will raise the stakes considerably.

The call for action on internal climate migration is clear and compelling. The potential scale of the issue, the trends and the emergence of hotspots of climate migration as early as 2030 should have major implications on conceiving effective responses.

Investing in iterative scenario modelling, grounded in new data and development progress, will be crucial to support decision making. Such investments should try to facilitate long-term planning and increase adaptive capacity to build climate resilience. This will not only require action at the international and national level, but also locally.[1] One example is the community consultatios held as part of the Tanzania Urban Resilience Programme. These gatherings helped people develop basic spatial awareness at local levels with respect to flood hazards and typical community flood response (World Bank 2018c).

Landscape and territorial approaches can enable early planning and action across spatial and time scales in climate in- and out-migration hotspots. Climate change can degrade land, water and natural resource base thereby creating conditions for migration and displacement. 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; and it needs to address both slow- and rapid-onset climate factors and their interlinkages will be important. Understanding and mapping climate impacts, community livelihoods (and adverse consequences) and emerging hotspots will be key. Conflicts between pastoralists, farmers, and conservationist over natural resource management exists already and may increase further due to the impacts of climate change. The landscape approach supports site-specific planning for climate-induced migration thorough an expanded and integrated view of land with a focus on local priorities and natural resource uses. For instance, the Resilient Natural Resource Management for Tourism and Growth project bolsters the management of natural resources and tourism assets while creating access to alternative livelihoods for communities living near priority areas of southern Tanzania, and should continue to manage unfolding climate impacts proactively.

Considering climate-induced migration as a long-term strategy can lead to jobs and economic structural transformation in Tanzania. Lower agricultural productivity due to climate change will compel Tanzania to absorb labor and a large youth bulge into non-agricultural and less climate-sensitive sectors, potentially particularly in climate in-migration hotspots. Policies need to facilitate a shift into value-added agriculture or productive and climate-resilient labor markets. Climate-smart urban transitions could harness the youth bulge through nurturing and building skills, talent, and workforce into energy-efficient, green, and resilient urban infrastructure and services.

Cooperation and stepped-up action by development, humanitarian, security, and disaster risk management communities across the mobility continuum could greatly assist Tanzania achieve more 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, this approach can reduce humanitarian need, risk, and vulnerability through well-aligned short-, medium- and longer-term contributions

1. The findings of this report can serve as a useful guidance tool to hold on ground dialogue with stakeholder groups and develop concrete policy response that caters to the particularities of local context.

by humanitarian and development actors. World Bank financing instruments and other technical support modalities provide support to climate migrants, and there is potential for further support focusing on development opportunities and policies for the safe movement of people and provide viable options for in situ adaptation.

A well-defined, equitable, and implemented legal architecture brings clarity, protects affected individuals and communities, and reconciles international funding and local decision-making. It ensures that migration acts as a force of good for all strata of society. Guaranteeing that existing legal frameworks are in line with the Kampala Convention, 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 Tanzania 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. Climate-friendly, inclusive development can significantly reduce the scale of 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 and recognizing that these structural transformations will need to take place in a context of climate change and internal climate migration. Foresighted and transformative action, across the migration cycle, will go a long way to ease people out of vulnerability and help secure the foundations of a peaceful, stable, and secure Tanzania.

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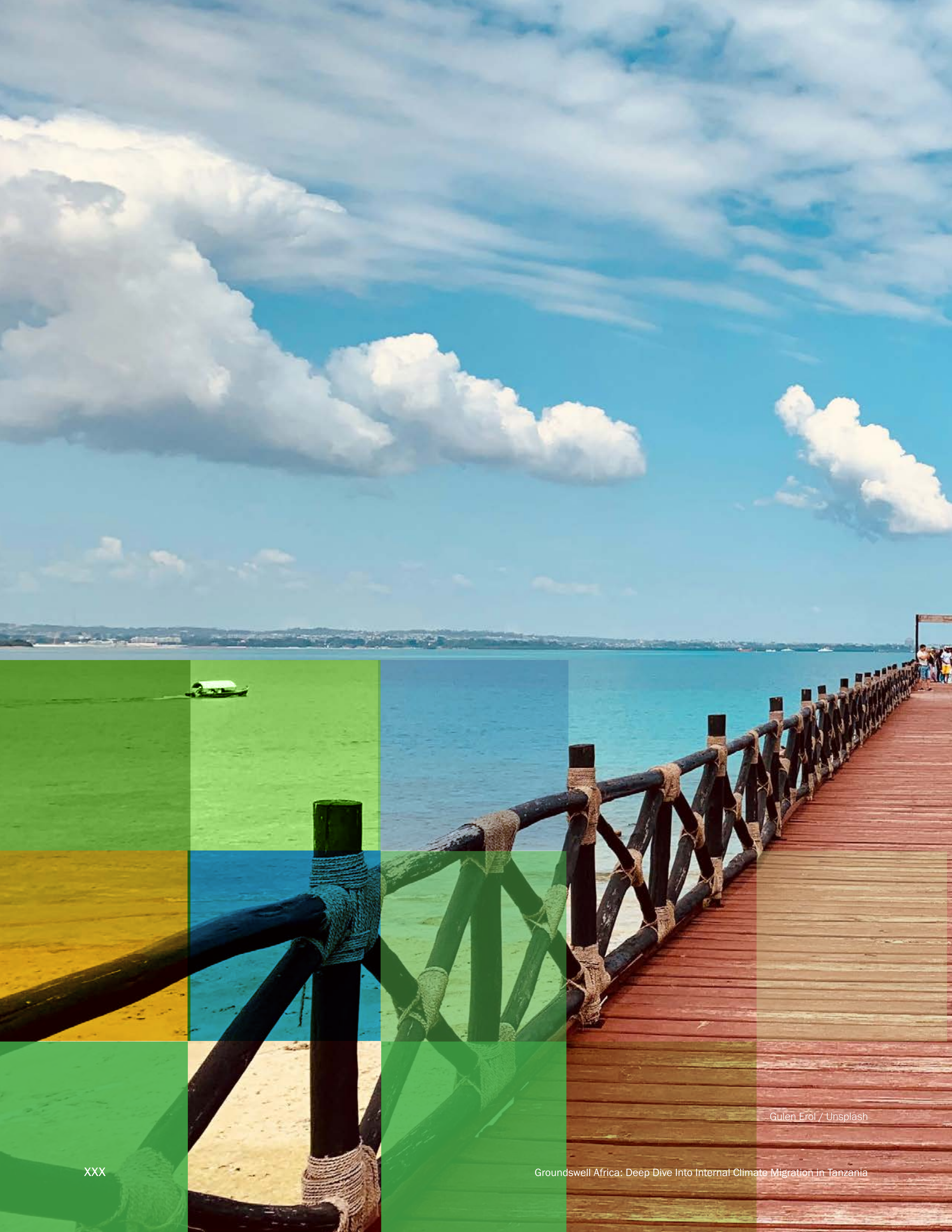

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Chapter 1

Introduction

Climate change is 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 notes that without concrete climate and development action, the number of internal climate migrants in Sub-Saharan Africa could reach 86 million by 2050. In East Africa, rapid population growth has contributed not only to land fragmentation, which has spurred rural to urban migration, but also to rapid urbanization through natural population increase and movements from the highlands to lowlands. The region has a history of internal displacement and refugee flow because of conflict (Fischer and Vollmer 2009). Rigaud et al. (2018) shows that the Lake Victoria Basin (LVB) countries (Burundi, Kenya, Rwanda, Tanzania, and Uganda) form a hotspot of climate in- and 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 fled their homes due to disasters (IDMC 2021). Tanzania has witnessed an increasing number of displacements in response to recent natural hazards and disasters. In 2020, there were 57,000 displaced by floods and storms. Pastoralists in North Tanzania reported cattle deaths, disease outbreaks, and possibility of conflicts influenced by climatic factors (Kimaro, Mor, and Toribio 2018). Livestock routes have been blocked and pastural quality has deteriorated in the arid regions of Tanzania (Irish Aid 2015). If unaddressed, climate change, alongside poverty, vulnerability, and conflict, could put more people at risk in the region. Other stressors are high population growth and increasing urbanization rates, predicted to increase dramatically in the coming decades. The growing number of people on the move is straining current systems and will have long-term impacts on host countries. Influxes of migrants could undermine and reverse much of the development progress achieved in the past two decades.

Climate migration is critically important in the face of escalating climate impacts. Maasai pastoralists in Tanzania are forced to travel greater distances in search of water and pasture because of more frequent and severe droughts (UN OCHA et al. 2010). To drive informed policy and planning, 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. 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 climate migrants. 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. Drivers of displacement are a complex overlap of social, political, economic, and environmental factors, particularly slow-onset hazards such as drought, desertification, coastal erosion, and land degradation.

1.1 SCOPE, OBJECTIVE, AND METHODOLOGY

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

The region 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 owing to heightened storms and sea level rise. When coupled with the high dependence on the agriculture and fisheries sectors, the economy and livelihoods are highly vulnerable to climate variability and change. This suggests that these impacts may spur over the coming decades even higher rates of migration: both ones that are an adaptation to climate change and bring more stable livelihoods and higher incomes, and distress migration and displacement from intolerable situations that leave migrants impoverished and with few 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[2] is to convey the potency of climate-induced migration within Tanzania to inform policy makers about the urgency for near- and far-sighted planning, policy, and action as an integral part of the development responses. This report uses a quantitative and qualitative understanding of plausible future climate migration scenarios, and proposes core policy direction and domains for action to better anticipate and prepare. The government needs overarching policies that embed climate risks and opportunities, as well as climate migration, into national and local development planning. Inaction would mean missing a vital opportunity to reconfigure where, when, and how climate-resilient investments are made in support of robust economies.

Methodology

This report draws from Groundswell Africa: Internal Climate Migration in the Lake Victoria Basin Countries (Riguad et al. 2021a). It adopts a quantitative approach to understand climate-induced migration, and uses peer reviewed literature and other assessments to understand climate migration trends at the national and local levels in Burundi, Kenya, Rwanda, Tanzania, and Uganda. The results build on the Groundswell model described in Rigaud et al. (2018), and use empirical modeling and qualitative assessments of climate migration trends at the national and local levels to lay out future climate scenarios. Key elements of the groundswell methodology (box ES.1) are the following:

- It uses a population gravity model that isolates the portion of future changes in population distribution that can be attributed to slow-onset climate factors.
- It develops plausible scenarios to characterize the scale and spread of climate migration using emission pathways (RCPs) and development pathways (SSPs). Under RCP2.6, greenhouse gas (GHG) emissions begin to decline by 2020 and radiative forcing peaks by midcentury, before declining to

2. This report draws from the Riguad et al. 2021. "Groundswell Africa: Internal Climate Migration in the Lake Victoria Basin Countries," but undertakes a deeper dive on the analysis.

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 model uses 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 rise compounded by storm surge data to capture slow-onset climate factors. Sources of uncertainty and the possibilities of expanding the scope are laid out.
- Results are contextualized against current and historic mobility patterns in peer-reviewed literature, and a multistakeholder consultation in February 2021 to further inform patterns of migration and the proposed response framework.

The expanded methodology used for this study includes the following enhancements:

(i) Four scenarios

The Groundswell methodology uses three scenarios based on combinations of SSPs and RCPs: pessimistic (reference), more inclusive, and climate-friendly. The enhanced model adds a fourth, 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.

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 (IPCC 2014). This aligns with the Paris Agreement goals, in which countries reduce greenhouse gas emissions to zero within the next 15 to 20 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.

(ii) Slow and Rapid Onsets

First-time actual climate impact models for agriculture and water resources are used to understand how these would affect future population distributions, as well as sea level rise compounded by storm surge. The expanded model includes another slow-onset impact (ecosystem impacts) and rapid-onset events (such as flood risk projections), in addition to data related to conflict areas.

(iii) Coefficients

The enhanced model includes model coefficients that show the influence of the variable on the observed 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 net primary productivity are not included in the calibration for urban populations because these are not hypothesized to have an impact in those areas (their populations are not directly dependent on cropping or animal husbandry).

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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.[3] Note that sea level rise (as applied to coastal Kenya and Tanzania) is not considered a driver of migration, but rather is a spatial mask in the modeling work, to move populations out of inundated areas.

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
Net primary productivity[a]	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: n.a. = not applicable.

a. Net primary productivity, which is intended to reflect impacts on pastoral populations, is included in the model only where 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, introduced in the enhanced model, affect climate migration projections through their relationship with population change (as derived through the spatial autoregressive calibration), and through their interaction with the climate drivers). With the Basin countries, alignment between these factors means they amplify the impact of climate. In contrast, in the West Africa region, demographic variables mitigated or dampened climate migration (Rigaud et. al. 2021b).

Sea Level Rise

The analysis for sea level rise is based on projections to 2050 based for the RCP2.6 and 8.5 scenarios, augmented with an increment to account for storm surge. The modeling results reflect loss of habitable land for each coastal grid cell linearly interpolated for five-year time steps. Storm surges amplify loss of habitability in the near term through erosion of coastal landforms from wave action. According to Dasgupta et al. (2007, 6), "Even a small increase in sea level can significantly magnify the impact of storm surges, which occur regularly and with devastating consequences in some coastal areas."

3. 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.

Table 1.3 Projected Rise in Sea Level under Low and High Representative Concentration Pathways

Meters above current mean sea level

	RCP2.6			RCP8.5		
Year	Lower	Middle	Upper	Lower	Mid	Upper
2030	0.092	0.127	0.161	0.098	0.132	0.166
2050	0.157	0.218	0.281	0.188	0.254	0.322
Storm surge increment	0.89–0.9			1.68–1.85		

Sources: Church et al. 2013.; Center for International Earth Science Information Network (CIESIN)/Columbia University 2013 (storm surge).

Note: The 1- and 2-meter sea level rises are based on NASA Shuttle Radar Topography Mission data, as modified by the Center for International Earth Science Information Network for the Low Elevation Coastal Zone (LECZ) version 2 data set (CIESIN 2013); and the increment for storm surge was 0.85–0.9 meters, for a total of 1 meter; under RCP8.5, the increment was 1.68–1.85 meters, for a total of 2 meters.

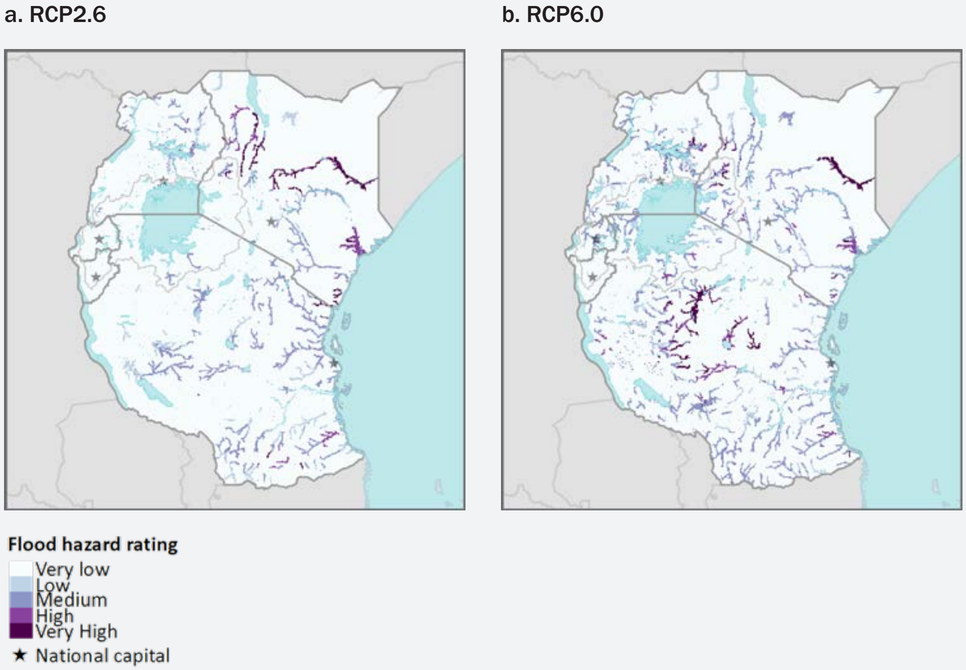
The analysis considers sea level rise projections from the IPCC Fifth Assessment Report, (2013) augmented by an increment for storm surges. Table 1.3 displays the lower-, middle-, and upper-bound sea level rise by 2030 and 2050, as reported by the IPCC (Church et al. 2013), but does not include storm surge. A comprehensive assessment of the likely levels of storm surge for all the coastal areas covered by this report was beyond the scope of this project. Nor were we able to find data on coastal erosion that cover enough of the coastline consistently.

Two scenarios representative of changes in sea level by 2050, associated with RCP2.6 and RCP8.5, were adapted by adding an increment to account for storm surge to the estimates in table 1.3. Under RCP2.6, the increment for storm surge was 0.85–0.9 meters, for a total of 1 meter; under RCP8.5, the increment was 1.68–1.85 meters, for a total of 2 meters. These assumptions are applied to all coastlines; they represent the loss of habitable land as a result of sea level rise plus storm surge in each coastal grid cell. Both the 1- and 2-meter sea level rises are based on NASA Shuttle Radar Topography Mission data, as modified by the Center for International Earth Science Information Network for the Low Elevation Coastal Zone (LECZ) version 2 data set (Center for International Earth Science Information Network (CIESIN)/Columbia University 2013). Processing coastal elevation over large areas is time consuming, so the global LECZ data expedited this work. That said, there is strong scientific grounding for the addition of the increments (Dasgupta et al. 2007; Hallegatte et al. 2011).

In the model, the proportion of each grid cell at or below sea level is calculated for 2010 and under the projection to 2050 (for both the 1-meter and 2-meter sea level rise), and the amount is linearly interpolated for each five-year time step in between. The model implements sea level rise by progressively removing land from occupation, thereby reducing the population that will be accommodated in a coastal grid cell over time.

The flood risk analysis is based on projected flood depth simulated by a global flood model CaMa-Flood (Yamazaki et al. 2011) version 3.4.4. It primarily represents riparian (along rivers), not coastal flooding, although it does capture rivers emptying into the ocean. Potential coastal flooding is better captured by the sea level rise mask (table 1.3). The input required by this global flood model is daily runoff simulated by multiple global hydrological models participating in the ISIMIP2b (Frieler et al. 2017) project. These hydrological models are forced by four bias-corrected climate models that include standard outputs (temperature, precipitation, radiation, etc.) from the Coupled Model Intercomparison Project Phase 5 (CMIP5) (PCMDI 2013; Taylor, Stouffer, and Meehl 2011). Map 1.1, panels a and b, depicts the flood risk data for East Africa under RCPs 2.6 and 6.0. 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.

Map 1.1 Flood hazard rating in Tanzania for 2040



Source: Rigaud et al. 2021a

(iv) Time and Resolution

Scenarios were run in decadal increments from 2010 to 2050, 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. Climate migration analysis is carried out at 1-kilometer resolution in the near coastal zone and 14-kilometer resolution elsewhere.

1.2 OUTLINE OF REPORT

This country report is divided into five chapters. This chapter underscores the potency of climate-induced migration and displacement in Sub-Saharan Africa and lays out the scope, objectives and methodology, consistent with *Groundswell Africa: Internal Climate Migration in the Lake Victoria Basin Countries* (Rigaud et. al 2021a) which this study is part of. Chapter 2 sets out the development, demographic, migration, and climate context for Tanzania, including an overview of historic migration patterns and a brief snapshot of environment-related migration and displacement. Chapter 3 introduces the historical and current climate patterns, and a snapshot of climate change impacts on key economic sectors (agriculture, livestock, water resources, health, fisheries, and forestry). It presents climate migration futures based on the results of an expansion of the groundswell model. Chapter 4 discusses core policy directions and key domains of action that can be leveraged to foster climate and development action that encompasses farsighted approaches to avert, minimize, and manage internal climate migration and displacement for sustainable growth and resilient and inclusive outcomes. Chapter 5 presents the strategic response framework: Tanzania, Five-Year Development Plans (FYDPs), Country Partnerships Framework (CPF), and Systematic Country Diagnostic (SCD).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Chapter 2

Country Context

2.1 POPULATION AND DEVELOPMENT CONTEXT

The World Bank upgraded Tanzania to a low- and middle-income country (LMIC) status in July 2020 (Battaile 2020). As a result, Tanzania became the first East African country to enter the LMIC group by crossing the 2019 gross national income (GNI) threshold of US$1,036 for LMIC status (Serajuddin and Hamadeh 2020; World Bank 2021). The country's gross domestic product (GDP) has also shown consistent growth, increasing from US$13.4 billion in 2000 to US$58 billion in 2018 (in current U.S. dollars) (table 2.1). Over the same period, the average annual growth of the GDP measured 6.4 percent (which is among the world's 10 fastest-growing economies), and the GDP per capita increased from US$411 in 2000 to US$1,061 in 2018 (AFDB 2020b; WBI 2020).

Table 2.1 Development Indicators, Tanzania

Population	
Population (thousands) (2018)	56,318.3
Annual population growth (%) (2018)	3
Population in 2050 under SSP2 (thousands)	102,253.9
Population in 2050 under SSP4 (thousands)	119,048.2
Urban share of population (%) (2018)	33.8
Employment in agriculture (% of total employment) (2019)	65.3
GDP	
GDP (current US$, billions) (2018)	58
Annual GDP growth (%) (2018)	5.4
GDP per capita (current US$) (2018)	1,061
Value added of agriculture (% GDP) (2017)	28.7
Poverty	
Poverty headcount ratio at US$1.90 a day (2011 PPP) (% of population) (2017)	49.1
Climate and disaster risk indexes	
ND GAIN Index	
Rank (2018)	148
Score (2017)	38

Sources: World Bank World Development Indicators database 2021[4]. ND-GAIN Country Index 2018[5]

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.

4. See the World Bank Development Indicators (WDI) database, https://data.worldbank.org/country/TZ
5. See the ND-GAIN database, https://gain.nd.edu/our-work/country-index/rankings/

The service sector was the highest contributor to the country's GDP (38 percent) in 2017, followed by agriculture, forestry, and fishing, which cumulatively totalled 29 percent of the GDP.[6] Other sectors of note are livestock, tourism, mining, services, and industry (including construction and manufacturing) (AfDB 2020b). The agriculture sector provided employment to a disproportionate number of the workforce in 2020 (65 percent) followed by services (28.3 percent) and industry (6.8 percent) (World Bank 2020). In terms of gender variability, 63 percent of the workforce are male agricultural workers and 67 percent, female. The high dependence on agriculture-related employment makes the workforce highly vulnerable to the impacts of climate change (AfDB 2020a,184).

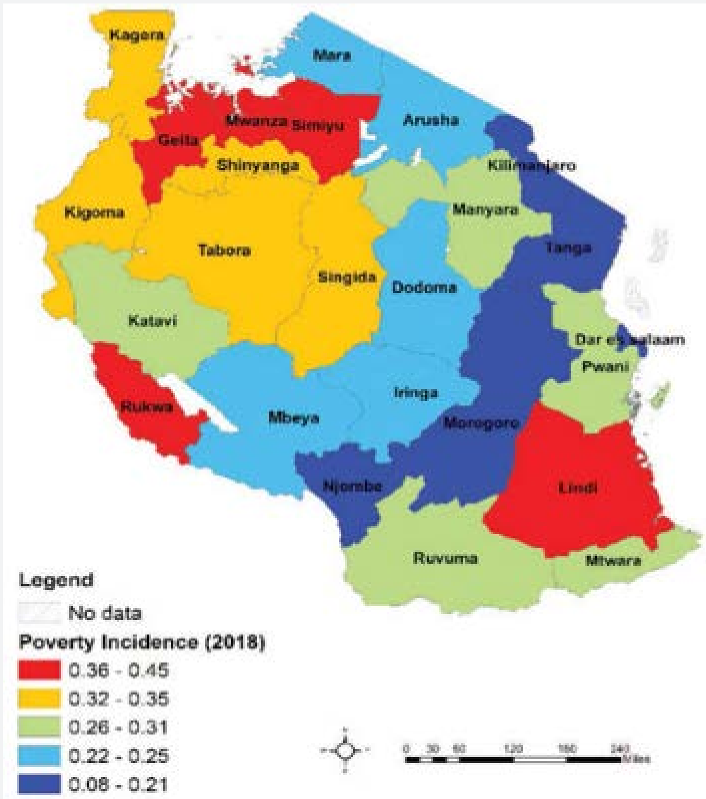
Poverty, youth unemployment, and inequality persist despite economic growth (AfDB 2020a). Tanzania ranks 163 out of 189 in the Human Development Index (HDI), presenting scope for improvement in health, gender and education markers, among others (UNDP 2020).[7] Its natural resource depletion, expressed as a percentage of GNI, stands at 2.1 percent (ibid). The national poverty rate in Tanzania fell from 34.4 percent to 26.4 percent between 2007 to 2018, however, the country's development efforts are undermined by population growth, unemployment, poor health, HIV/AIDS, low investment, a reliance on primary production, shortage of skills, and difficult governance issues (Hepworth 2010; World Bank 2019c). In 2018, almost half the country's population, or approximately 26 million people, lived below US$1.90 per day (World Bank 2019c). There is also real danger of a large number of people living just above the poverty line slipping below it. In addition, the absolute number of poor people has remained constant partly due to the population growth (AfDB 2020a). Many Tanzanians, especially the young, uneducated, and poor women, do not have access to formal accounts, savings, and credit system (World Bank 2019c).

6. Data are from World Bank Data—Agriculture, forestry, and fishing, value added (% of GDP)—Tanzania database, World Bank, Washington, DC, https://data.worldbank.org/indicator/NV.AGR.TOTL.ZS?locations=TZ.
7. Data are from UNDP Human Development Reports: Tanzania, UNDP, New York, http://hdr.undp.org/en/countries/profiles/TZA.

Raissa Lara Lutolf Fasel /Unsplash

Poverty is higher in rural areas, and there are large disparities across different regions (map 2.1). The Lake Victoria Basin's (LVB's) Geita, Mwanza, and Smiyu regions have seen some of the highest incidences of poverty (World Bank 2019c) (map 2.1). This regional concentration of poverty is due to primacy of rural and subsistence activities, limited access to markets, and poor road infrastructure (World Bank 2019c). Urban areas have been able to reduce poverty faster because of better trade opportunities and job availability, and a shift toward services and industry (World Bank 2019c).

Map 2.1 Share of Poverty Incidence (%) by Region, Tanzania, 2018



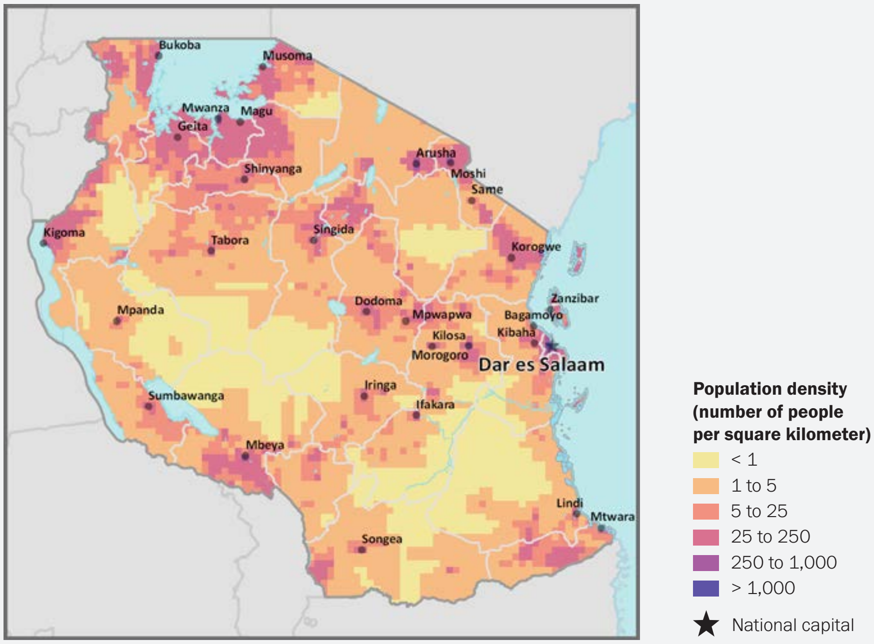
Source: World Bank 2019c.

Tanzania's total population was 56.3 million in 2018 (UNDESA 2018), with an annual growth rate of 3 percent. The population is projected to reach 129.4 million by 2050 (UN medium variant). The population growth is expected to decline over time, with a projected growth rate of 1.09 percent by 2100 (UN medium variant). Fertility is high, but it's expected to continue its downward trend, going from the current 4.92 children per woman to 2.39 children per woman from 2095 to 2100, while the life expectancy is projected to increase from 64.84 years from 2015 to 2020 to 79.5 years from 2095 to 2100 (UNDESA 2019).

At the median age of 18 years, Tanzania's population is comparatively younger to both eastern Africa (18.1 years) and Africa as a whole (19.7). Tanzania is projected to see a sizeable increase in the working age population for several decades which presents an opportunity to reap the benefits of demographic dividend. As fertility and mortality decline, the median age is expected to reach 31.9 years by 2100. The process of urbanization can also be a catalyst for economic growth and overall socioeconomic transformation with UN projections indicating that about 53percent of the population of Tanzania will live in urban areas by 2050 (UNPD, 2014). The sex ratio (males per 100 females) was 99.9 in 2020, lower than the global ratio of 101.7, equal to the African ratio of 99.9, and higher than the eastern African ratio of 97.7 (UNDESA 2019).

The population of Tanzania is unevenly distributed across the country (map 2.2). Higher densities are in the coastal areas close to large urban centers, the Lake Victoria Basin, and the northeast, southeast, and southwest borders (NBS 2013b). The less densely populated areas correspond to protected areas and game reserves (although densities are high in the Serengeti and in Mount Kilimanjaro), and to pasturelands and wildlands in arid and semiarid areas and lowlands in the central west and south of the country.

Map 2.2 Population Density, Tanzania, 2010 (Reference)



Tanzania is a largely rural country, with 34.5 percent of its population living in urban areas in 2019.[8] However, the average annual urban population growth, estimated at 5.2 percent for 2015–20, points to a rapid urbanizing trend.[9] By 2050, this rate of urban growth would place 55.4 percent of Tanzanians in urban areas, skewing population distribution away from rural areas. Tanzania's largest city, Dar es Salaam, has 6.7 million people, and the number is expected to reach 13.4 million by 2035.

Rapid urban growth in both area and population has resulted in increasing environmental deterioration in Dar es Salaam and the surrounding regions (Hojas-Gascon et al. 2016). Mining-related migration and economic activities have fueled the growth of small and medium cities in the Basin (Bryceson 2012), including Mwanza. The second largest city, Mwanza, is home to 1.1 million people. Mwanza is projected to double its population by 2035 (UNDESA 2018). Located in the heart of Lake Victoria gold fields, Mwanza has received substantial migration flows owing to mining activities (Jønsson and Bryceson 2017).

8. Data are from World Bank Data—Urban population (% of total population)—Tanzania database, World Bank, Washington, DC, https://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS?locations=TZ.
9. Data are from World Bank Data—Urban population (% of total population)—Tanzania database, World Bank, Washington, DC, https://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS?locations=TZ

2.2 MIGRATION PATTERN

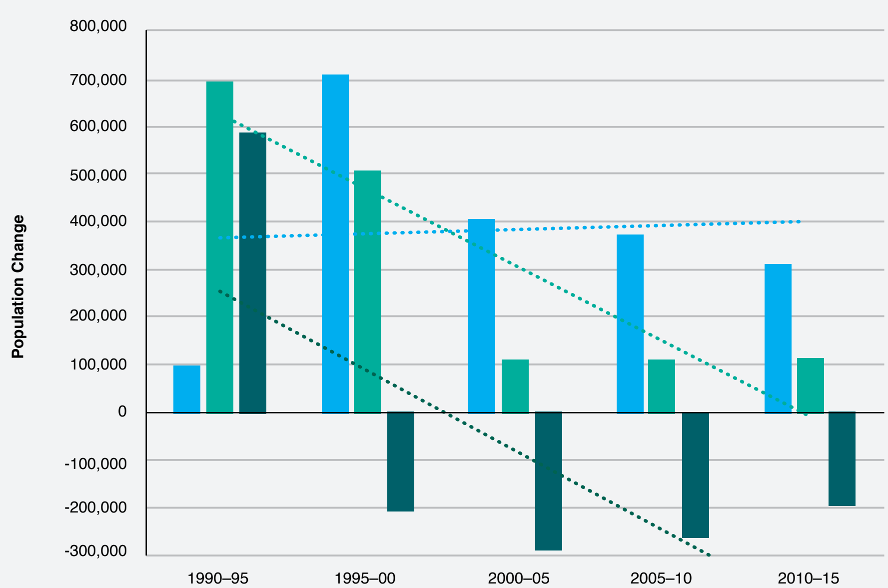
2.2.1 Cross-Border and Regional Migration

Tanzania's location on Africa's east coast, relative political stability, and shared border with eight countries has made it suitable for migration flows as a country of origin, transit, and destination (IOM 2020a). Tanzania experienced linear net migration change from a positive balance in early 1990s to a negative balance in 2010–15, as immigration declined at a much faster rate than emigration (figure 2.1) (Abel and Cohen 2019; World Bank 2020c). Proximity, labor movement, and ethnic relationships contribute to immigration from neighboring countries including Burundi, the Democratic Republic of Congo, Kenya, Malawi, Mozambique, Rwanda, Uganda, and Zambia (NBS 2015).

Emigration is concentrated among neighboring countries in East Africa and partner states of the Southern Africa Development Community (NBS 2015). The growing economic diversification of Kenya and Rwanda into sectors such as finance, technology, and information technology is an important pull factor for high-skilled labor from Tanzania (IOM 2020b). The growing demand for low-skilled labor in traditional sectors such as mining adds to emigration numbers. The East African Common Market Protocol facilitates free movement of labor in this region (IOM 2020b), and international remittances represented 0.7 percent of Tanzania's GDP in 2019, or US$435 million.[10] There are cross-border pastoral communities with historical links and routes predating colonial experiences (EAC 2017). Labor migration from other East African Community (EAC) countries under the EAC-Common Market Protocol is mostly in the highly skilled sector (Samuel Hall 2017). Gender gaps in migration, irregular migrants, and of less-qualified workers remain poorly understood (Samuel Hall 2017).

In the 1990s, Tanzania was a host refugee country, particularly for refugees from the Democratic Republic of Congo, Burundi, and Rwanda, although numbers have decreased drastically in the last decades (Bidandi and Meissner 2018; IOM 2020b). By mid-2019, Tanzania was home to 509,166 international migrants, of which 352,700 were refugees and asylum seekers.[11] Most refugees and asylum seekers live in three refugee camps in northwestern Tanzania: Nyarugusu, Nduta, and Mtendeli (UNHCR 2019).

Figure 2.1 International Migration Trends, Tanzania, 1990–2015



Source: Abel and Cohen 2019.

10. Data are from World Bank Data—Personal remittances, received (% of GDP)—Tanzania database, World Bank, Washington, DC, https://data.worldbank.org/indicator/BX.TRF.PWKR.DT.GD.ZS?locations=TZ.
11. Data are from UNDESA—International migrant stock 2019: Country Profiles database, UNDESA, New York, https://www.un.org/en/development/desa/population/migration/data/estimates2/countryprofiles.asp.

2.2.2 Internal Migration and Displacement

Tanzania has a long history of internal migration, both long and short distances (NBS 2015). In the colonial and precolonial period, migration was undertaken primarily by single men to mining and plantation towns in search of livelihood (Agwanda and Amani 2014). The scale of internal migration has risen considerably, with half of the country's population practicing this strategy over the past two decades (World Bank 2015b). This migration takes the form of rural-urban, urban-urban, urban-rural, and rural-rural flows. Short-distance migration is concentrated among neighboring rural regions with cultural proximities (NBS 2015; Wilkinson et al. 2016b). Long-distance flows are toward gold mines in the Mwanza and Shingaya regions, and pastoralists traveling to the Usangi Plains and other areas in the Mbeya region in search of land for settlement and livestock grazing (Agwanda and Amani 2014).

Urban centers, such as Dar es Salaam, Mwanza and Arusha, attract many migrants because of economic opportunities, availability of land for settlement, and rich natural resources (NBS 2015; UNDP 2017). The rural-urban per capita income differential is significant implying people migrate to urban centres with anticipation of making better earning in urban areas (Aikaeli, and Mtui, and Tarp 2021). Internal migration accounts for almost half of the increase in urban population between 1978 and 2012 (UNDP 2017). Conversely, the lack of employment opportunities, population pressure, harsh environmental conditions, and land for settlement are driving people away from areas in the southern corridor, including Lindi, Mtwara, and Ruvuma, and regions in semi-arid areas, such as Dodoma and Singida (NBS 2015). The study by Mulungu, and Helena (2020) indicates poverty as the major factor for out-migration to both urban areas and within Ileje district district.

The migrants primarily consist of young adults aged between 25 to 34 years (29 percent) and adults aged between 35 and 64 years (61 percent) (Msigwa and Mbongo 2013). Higher education level is positively correlated with the likelihood of migration (World Bank 2015b). More females than males practice internal migration, pointing to feminization of migration (NBS 2015). Men are predominantly migrating for work reasons and better housing services. The pursuit of education and job opportunities drive both educated and uneducated women to urban centers (NBS 2015), in addition to marriage and family reasons.

The migrants (especially those moving long distance) have experienced larger declines in poverty than those staying in the communities of origin, particularly if also moving out of agricultural activities (Beegle et al. 2011; World Bank 2015b). They have experienced 21.2 percent growth in their consumption pattern compared to that of nonmigrants (World Bank 2015b). This results in improved welfare not only for the migrant but also the household through cash remittance and in-kind transfers (World Bank 2015b). Twelve months prior to the National Population Survey (2013a), approximately 23 percent of Tanzanian households reported receipt of remittance. The amount for more than 50 percent of these households varies between US$0 to US$100 per household (NBS 2013a). The remittance is used for household consumption, followed by spending on education and health (World Bank 2015b).

Internal migration has both positive and negative outcomes on Tanzania's economic and social well-being. It is a widely practiced strategy to cope with and adapt to shocks and avail economic opportunities (Warner and Afifi 2014). Notwithstanding, there are considerable challenges related to city congestion, insufficient urban infrastructure, unemployment, and displacement of poverty from rural to urban areas (Wilkinson et al. 2016b; World Bank 2015b). The ability to exercise migration is not universal: members of farm households in the middle of the income distribution are much likely to migrate, while low-income households face financial constraints (Hirvonen 2016; Kubik and Maurel 2016).

2.2.3 Environment-Related Migration and Displacement

Climate change is affecting the food and livelihood security of smallholder farmers, livestock keepers, and landless, which drive them toward risk management strategies (Nelson and Stathers 2009; Rowhani et al. 2011; Wilkinson et al. 2016b). Migration is used in times of environmental stress (Kubik and Maurel 2016; Nelson and Stathers 2009; Ocello et al. 2015; Warner et al. 2012). The 1995–97 drought and the 1997–98 El Niño rains forced pastoralists to trek three times the distance to water sources, from an average (across zones) of 5.9 kilometers before drought to 15.8 kilometers during drought. The distances to grazing sites also increased, from an average (across zones) of 5.5 kilometers before drought to 20.4 kilometers during drought (DCG 2002). A recent study on agricultural households in Tanzania posits that a 1 percent decrease in agricultural income increases the probability of migration by 13 percent in the following year (Kubik and Maurel 2016). Environmental stressors can also inhibit the ability to leverage migration i.e., leave individuals trapped highlighting the complexity of mobility-immobility dynamics (Blocher and Kileli 2020).

Most migrants either move to rural areas with favorable weather conditions (northwest and southeast) to pursue agriculture and livestock rearing or to urban centers (Dar es Salaam and Zanzibar Town) where they perform nonagricultural activities such as retail and other services (Kubik 2017; Wilkinson et al. 2016b). This is true for the most vulnerable households with no recourse to livelihood diversification strategies, off-farm activities, and education. Environmental factors, therefore, interact and exacerbate more proximate factors to shape migration decisions and poverty outcomes. Research points toward adverse environmental conditions acting as a barrier to migration for certain social groups with liquidity constraints (Hirvonen 2016; Ocello et al. 2015).

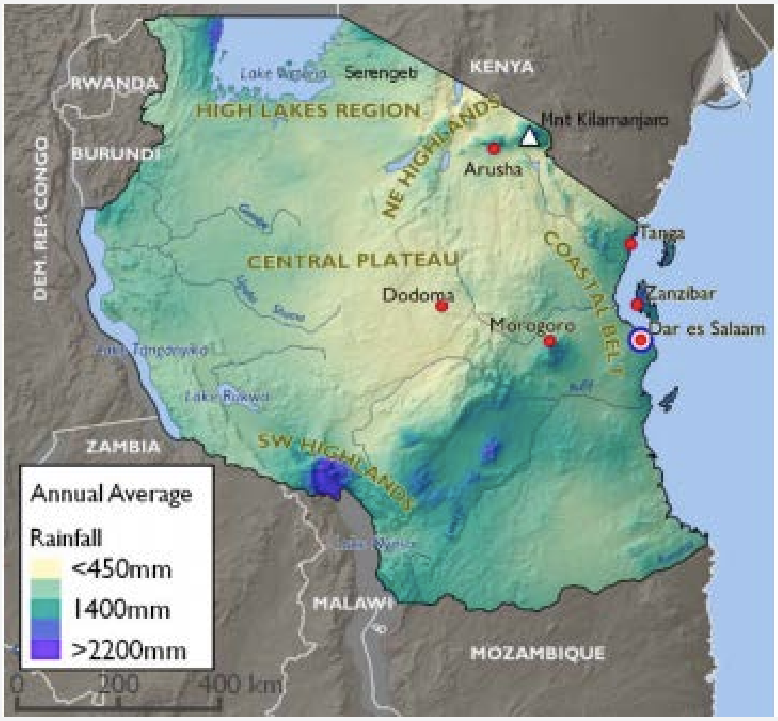
Displacement in the past decade has been primarily caused by floods, storms, and earthquake (IDMC 2020). The extreme rainfall in January 2008 led to floods that displaced hundreds of people; flooded mining pits in Mererani caused more than 70 deaths (Gov of Tanzania 2012). In April 2020, floods in North Tanzania displaced 10,540 people (IFRC 2020). Disasters were responsible for 11,000 new displacements in 2019, 29,000 in 2018, and 36,000 in 2006 (IDMC 2019; IFRC 2020). Internal displacement due to conflict is not common in the country as it enjoys relative political stability (World Bank 2015b).

2.3 CLIMATE CONTEXT AND IMPACTS

2.3.1 Current and Future Climate

Tanzania, one of the largest countries in East Africa, has diverse landscapes, climatic zones, and natural resources (World Bank 2015a). It has a tropical climate with an average annual precipitation of 1,042 millimeters, and the temperature ranges between 17°C to 27°C (USAID 2018). The intranational variation is most significant between the country's four climatic zones: (i) hot and humid coastal belt (including the Zanzibar archipelago); (ii) hot and arid central plateau; (iii) cooler semi-temperate high lakes region in the north and west (home to the lakes and valleys of the East African Rift System; and (iv) highlands of the northeast (Kilimanjaro) and southwest (map 2.3).

Map 2.3 Climatic and Rainfall Zones, Tanzania



Source: USAID 2018.

The humid coastal belt typically sees the highest temperatures, around 27°C to 30°C, and rainfall between 750 millimeters and 1,250 millimeters per year, while Zanzibar records rainfall between 1,400 millimeters and 2,000 millimeters per year (USAID 2018). The central plateau is the country's most hot and arid zone with less than 500 millimeters of rainfall per year. The high lakes region to the north and west will typically see cooler semi-temperate weather and average annual rainfall between 750 millimeters and 1,250 millimeters. The northeastern highlands are the coldest, and the southern highlands and Lake Tanganyika basin in the west see over 2,000 millimeters of rain per year.

The country's total area of 945,000 kilometers includes a central plateau, highlands in the north and south, and a coastline approximately 800 kilometers long (Agrawala et al. 2003). The northeastern, northwestern, and the northern parts of the coastal belt have bimodal rains, or two distinct rainfall seasons comprised of the long rains (Masika) between March and May and short rains (Vuli) between October and December (USAID 2018; Wambura, Tumbo, and Sangalungembe 2014). In the southern, central, western, and southeastern parts, rainfall is mainly unimodal, starting from mid-November and running until mid-April.

Tanzania is exposed to sudden and slow-onset climate events such as recurring droughts, floods, sea level rise, and changes in water availability (Gov of Tanzania 2012; Wilkinson et al. 2016b; World Bank 2015a). The Notre Dame Global Adaptation Initiative (ND-GAIN) Index ranks Tanzania as the 32nd most vulnerable and 42nd least ready to adapt to climate change, of the countries it covered for 2018.[12] Since the 1960s, the average annual temperature has increased by 1°C, rainfall decreased at an average rate of 2.8 millimeters per month and 3.3 percent per decade, and glacial volume has significantly diminished (Mbilinyi, Saibul, and Kazi 2013; USAID 2018). The ice cover on Mount Kilimanjaro has seen an 85 percent reduction

12. Data are from ND-GAIN (Notre Dame Global Adaptation Initiative)—Country Rankings database, Univeristy of Notre Dame, Notre Dame, Indiana, https://gain.nd.edu/our-work/country-index/rankings.

from 1912 to 2009 (Thompson et al. 2009). There are drying trends in northeastern and much of southern part of the country (FCFA 2017). According to the National Climate Change Strategy (Gov of Tanzania 2012), 70 percent of all natural disasters in Tanzania are hydrometeorological, and are linked to droughts and floods. The country has experienced six major droughts over the past 30 years (USAID 2012; World Bank 2015a). The droughts of 2003, 2005, and 2009 crippled agriculture and led to massive deaths of livestock and wildlife (Gov of Tanzania 2012). Further, the growing season has shifted because of unpredictable onset and cessation and considerable shortening of the rainy season (World Bank 2015a).

Tanzania is projected to experience change in precipitation, temperature, and sea level rise owing to climate change. By 2050, the average temperature is projected to increase between 1.4°C and 2.3°C (USAID 2018). The duration of heat waves could rise by seven to 22 days and dry spells by up to seven days (USAID 2018). High temperatures could pose a threat to public health, and deaths related to climate change could rise to about 13.4 percent (WHO 2015). Studies suggest that sea level could rise up to 42 centimeters, posing a critical challenge to the coastal settlements by 2050 (Gov of Tanzania 2007; USAID 2018). Flooding threatens to make many current settlements uninhabitable and could put at risk 0.3 million to 1.6 million people per year by 2030 (Watkiss et al. 2011). Drought projections vary: some models project an intensification, particularly in the south, while others indicate reductions in severity (Watkiss et al. 2011). Precipitation patterns vary widely, especially between the bimodal rainfall pattern in the north and the unimodal rainfall areas in central and southern Tanzania. Many models show increased precipitation over the whole country with considerable regional and seasonal variations (Agrawala et al. 2003; Watkiss et al. 2011). Rainfall is projected to decrease by about 0 percent to 20 percent in the inner parts of the region and the country, with dry season(s) becoming longer and having less rainfall. In contrast, rainfall is predicted to increase by 30 percent to 50 percent in the coastal areas (Gov of Tanzania 2012; Paavola 2003).

2.3.2 Climate Impact on Key Sectors

Agriculture

The agriculture, forestry, and fishing sector, cumulatively, is the mainstay of Tanzania's economy, accounting for 29 percent of the country's GDP in 2017.[13] Almost 80 percent of the agricultural production comes from rainfed, low-input smallholder farms, which are dependent on environmental factors (Ojoyi 2017; Rioux et al. 2017; USAID 2018). The current annual loss of agricultural productivity from weather-related risks (mainly droughts) is estimated at US$200 million (Arce and Caballero 2015). Migration is a widely used risk management strategy in response to low agricultural yields brought about by environmental stress (Kubik and Maurel 2016; Warner et al. 2012). Warner et al. (2012) finds the prevalence of migration to rural areas with favorable weather conditions, where migrants undertook farming and livestock-keeping activities or laborer jobs. The National Climate Change Strategy (Gov of Tanzania 2012) states that highly productive areas of Tanzania, such as the southern and northern highlands, will be affected by declining rainfall, frequent droughts, and significant increases in spatial and temporal variability of rainfall. The projected climate change impacts include shifts in agro-ecological zones, leaching of nutrients, washing away of topsoil, and water logging (Gov of Tanzania 2007; Arce and Caballero 2015).

Crops

Climate change will cause a decline in the yields of the main food crops—maize, cassava, rice, sweet and Irish potatoes, bananas, sorghum, and sugar cane (FAO 2019). Maize is grown by half of all the farmers (FAO 2019; USAID 2018), occupies one-third of the crop production area (4 million hectares) and caters to one-third of the nation's daily calorific intake (Hepworth 2010; USAID 2018). Shinyanga, Mbeya, Iringa, Rukwa, Tanga, and Manyara are the largest maize producing regions in the country (Arce and Caballero 2015). Rainfall shortages and drought pose critical risks for maize and rice production (Arce and Caballero 2015). The previous three years of drop in maize yields (2003, 2009, and 2011) coincide with droughts (Arce and Caballero 2015). According to Tanzania's National Adaptation Plan of

13. Data are from World Bank Data— Agriculture, forestry, and fishing, value added—Tanzania database, World Bank, Washington, DC, https://data.worldbank.org/indicator/NV.AGR.TOTL.ZS?locations=TZ

Action (Gov of Tanzania 2007), maize may see a 33 percent decrease in the yield due to increased heat stress, drying, erosion, and flood damage. The projections of other important food crops, such as bean, sorghum, and rice, show similar trends, with declines in yields ranging from 5 percent to 9 percent by 2050 (USAID 2018).

Some cash crops (cotton and coffee) could see increases in productivity as a result of rising temperature (Gov of Tanzania 2007). Cotton provides foreign exchange earnings (US$88 million in 2011/12) and employment to 1 million Tanzanians (Arce and Caballero 2015). The main environmental-related risks to cotton include rainfall variability, insect pests, and disease (Arce and Caballero 2015). According to NAPA (Gov of Tanzania 2007), cotton is projected to improve by 18 percent in bimodal rainfall areas and 16 percent in unimodal rainfall areas. Coffee, which is primarily grown in southern and western zones, follows similar yield increase patterns and distribution of growth (Arce and Caballero 2015).

Livestock

Livestock production is practiced by 60 percent of the rural households in Tanzania and accounts for 25 percent of agricultural contribution to the GDP (USAID 2018); it is increasingly challenged by shifting rainfall patterns. This sector is heavily dependent on seasonal rainfall for pasture and water (CIAT and World Bank 2017). The drought of 2009 led to the deaths of 4,00,000 cattle (Arce and Caballero 2015). Climate change is shrinking rangelands used by livestock producers; almost 60 percent of the rangelands are infested by tsetse fly, rendering them unsuitable for livestock pasture and human settlement (Arce and Caballero 2015; Gov of Tanzania 2007, 2019b). As a result, livestock keepers are shifting their herds toward southern Tanzania in search for pastures (Gov of Tanzania 2007). There have been conflicts between pastoralist and farmers in the Morogoro region, Kilosa District, Mamba ward, Mara region, and Kilimanjaro District because pastoralist have been forced out of their traditional grazing areas in search of water and pasture (Gov of Tanzania 2003; Kibona 2008).

The shift in foliage species composition, lignification, and low crude protein content of plants could affect the milk and meat production capacity of livestock and lead to high incidence of pet and livestock disease (Arce and Caballero 2015; CIAT and World Bank 2017. Drought could lead to decreases in quantity and quality of forage (CIAT and World Bank 2017). Disruptions include changes in plant species and forage composition, general increase in dry matter yields, water scarcity, favorable condition for pests and disease, and livestock deaths due to drought and heat waves (Munishi 2009). Overall, climate change is projected to further hinder the survival and productive capacity of livestock, particularly cattle (Ministry of Livestock and Fisheries 2019).

Water Resources

Climate change is expected to exacerbate current stresses on water resources, affecting water security, socioeconomic activities, and hydropower potential. Climate change stressors on Tanzania's nine river basins and three large freshwater lakes (FAO 2016; Gov of Tanzania 2014) will impinge on critical ecosystem services, agriculture, energy, tourism, and the mining sector (Watkiss et al. 2011). Hydropower accounts for 55 percent of Tanzania's energy demands. The drought in 2003 had devastating impacts on energy security, and the resultant incremental thermal generation cost US$67 million from January 2004 to February 2005 (World Bank 2006). Climatic changes in Lake Manyara National Park and hydrological conditions threaten migration patterns, breeding of 380 bird species, and other wildlife. The GDP losses due to moderate climate change and high climate change scenarios could amount to 0.7 percent and 1.7 percent due to decreased rainfall in the central region of Tanzania, where 95 percent of the country's hydropower installations is expected to be located by 2030 (ECA 2009). The increased runoff for the Pangani and Rufiji basins is projected to exacerbate the risk of flooding and sedimentation, while decreased runoff for the Wami/Ruvu Basin can result in increased water stress in Dar es Salaam, Morogoro, Kibaha, and Dodoma (USAID 2018).

Health

Climate change will adversely impact the health of Tanzanians in diverse ways, including stress on the most basic life-sustaining elements (adequate food, clean air, safe water, adequate shelter, and healthy environment); and transmission of vector-, food-, and water-borne diseases to extreme events (Gov of Tanzania 2007; Hulme et al. 2001; Wu et al. 2016). Malaria and cholera are two major climate sensitive diseases that pose significant challenges. Rainfall increase has been linked with the outbreak of cholera in Tanzania (Gov of Tanzania 2003, 2007; Yanda, Kangalawe, and Sigalla 2006). The study by Trærup, Ortiz, and Markandya (2011) demonstrates that initial risk of cholera increased by 15 percent to 19 percent for every 1°C temperature increase. Malaria is one of the most concerning vector-borne diseases in Tanzania (Agrawala et al. 2003; Gov of Tanzania 2003). It's the leading cause for morbidity and accounts for 16.7 percent of all deaths (Gov of Tanzania 2003). Low coastal belts and the shores of Lake Victoria have the highest transmission for malaria. However, malaria occurs even in high altitude areas such as Kilimanjaro and Arusha (the northeastern zone) and Iringa (the southern highlands). Most densely populated settlements (Mbeya, Njombe, Iringa, and Arusha) are in the cooler regions, which inhibit malaria transmission. The projected temperatures rise and prolonged rainy seasons might open new areas to seasonal or year-round transmission.

Fisheries

Climate change is causing degradation of coral reefs, fish nursery grounds, and breeding and feeding areas in Tanzania (Gov of Tanzania 2014). The fisheries sector is an important source of livelihood and food security in coastal areas and adjacent to the major lakes of Victoria, Tanganyika, and Malawi (Irish Aid 2016). The sector contributes 2.3 percent to the country's GDP, and employs more than 177,527 people directly and as many as 4,000,000 people indirectly (Gov of Tanzania 2015). Fish and mollusks are the main source of protein for people residing in coastal areas (Gov of Tanzania 2013). Since 1913, the surface waters of Lake Tanganyika have increased from 0.9°C to 1.3°C, resulting in a decrease in primary productivity by 20 percent and threatening the sustainability of Lake Tanganyika's fishing industry as catches of sardine species have declined by 30 percent to 50 percent (Cohen et al. 2016). Climate change impacts on lake ecosystem have been linked to a 0.03 percent decrease in the contributions from the fish sector caused by decrease in fish catches between 2007 to 2012 (Irish Aid 2016). The projected sea level rise and increased temperature will affect this sector through change in habitat, potential destruction of breeding grounds and mangroves, and coral bleaching (FAO 2018; Gov of Tanzania 2003).

Forestry

Climate change is displacing and changing forest species composition (Hemp 2005), and future variability could lead to shifts toward drier ecosystems, grasslands, and woodlands (Gov of Tanzania 2003). Forests and woodland occupy 48.1 million hectares of land, or 55 percent of the total country area (FAO 2015). The forests are rich in biodiversity, and their contribution to the GDP is estimated to be 4 percent in 2017 (Gov of Tanzania 2017a). Climate change is causing shifts in vegetation and deterioration of ice cover on Mount Kilimanjaro. It could further lead to glacier retreat and complete disappearance of the ice cap (Kilungu et al. 2019). Under climate change, most forests are projected to shift toward drier regimes: from subtropical dry forest, subtropical wet forest, and subtropical thorn woodland to tropical very dry forest, tropical dry forest, and small areas of tropical moist forest, respectively (Gov of Tanzania 2003). The rising temperature and reduced rainfall during the dry season are projected to result in losses of suitable lowland forest habitat above 10 percent by 2085 (John et al. 2020). The projected losses are particularly pronounced in the southeast of the country in the regions of Ruvuma, Mtwara, and Lindi (John et al. 2020). Climate change is projected to affect growth, tree health, wider biodiversity, and even system stability, with potentially irreversible losses (Watkiss et al. 2011).

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Chapter 3

Modeling Results: Future Climate Migration Patterns and Trends

3.1 CLIMATE IMPACT PROJECTIONS

Figures 3.1–3.3 present the average projected changes in water availability, crop production, and net primary productivity (NPP) for the 2010–2050 time period, respectively. Appendix A has projections from 2050-2100. These projections represent the inputs for the estimation of future population shifts induced by climate change as a proxy of climate migration. For further information on the methodology see Appendix A of Rigaud et al. 2021a.

Water availability is a key climate factor that will influence migration in Tanzania 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 net primary productivity (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. NPP is used to gap-fill areas with no crop production in rural areas. These projections represent the inputs for the estimation of future population shifts induced by climate change, as a proxy for climate migration.

The climate models project contrasting results for water availability between 2010 and 2050 in Tanzania (figure 3.1, panels a and b). The IPSL-CM5A-LR model projects increase in water availability across most of the country, with the northeast region projecting the highest increase. The HADGEM2-ES model, however, projects drying in the east and northeast (against very low baselines) and an increase in the water availability in the west and north, with some variations.

The climate models project contrasting results for crop production between 2010 and 2050 (figure 3.2, panels a–b). The IPSL-CM5A-LR model coupled with LP-JmL crop (RCP2.6) projects marginal decline in crop productivity in the north and west. Meanwhile, the HADGEM2-ES model coupled with LP-JmL crop (RCP2.6) project marginal increase in crop productivity. The same models in RCP8.5 project a decline in crop productivity in the north and west. The notable increase in water availability in the northwest is offset marginally by declines in crop production in some of the models. Overall, crop production shows declines in western Tanzania across a number of models and a marginal increase in others.

The climate models project increase in NPP across different scenarios, although the intensity of the increase in production and spatially distribution varies considerably (figure 3.3, panels a–b). Small gaps in crop production areas in central Tanzania are filled by NPP, which show increases in these areas.

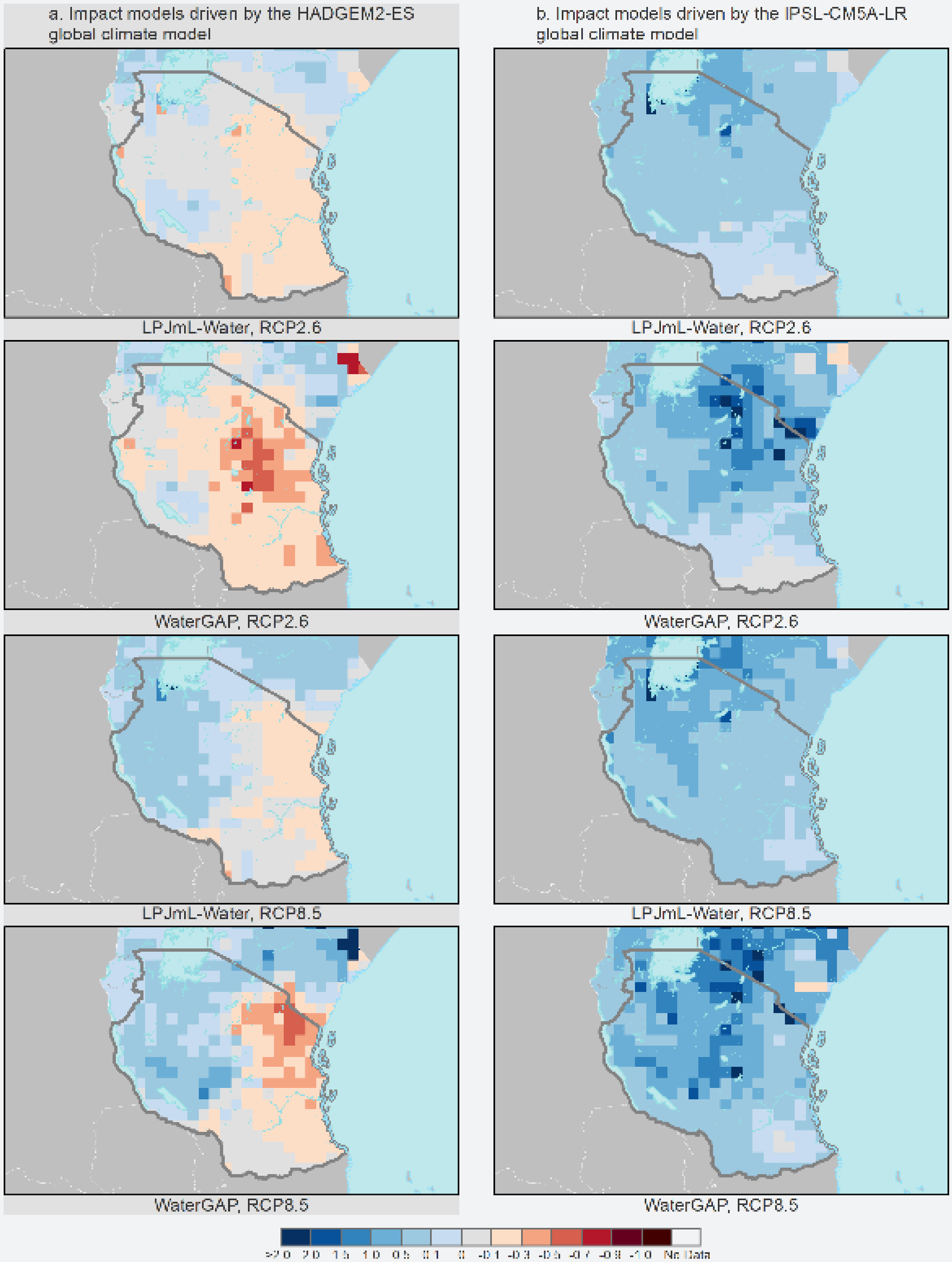
The climate projections along the coastal portions of Tanzania (and Kenya) are challenged by factors related to the inability of the climate models from the Coupled Model Intercomparison Project version 5 (CMIP5) archive to accurately capture the effect of sea surface temperature gradients in the Indian Ocean. Thus, uncertainty is relatively high.

Box 3.1 Uncertainties in Climate Projections in the Lake Victoria Basin

Lake Victoria Basin (LVB) countries have two rainy seasons that lie between the northern hemisphere summer and winter monsoons. Coastal East Africa is semi-arid due to the cool waters offshore (Yang et al. 2015a). Climate models tend to, in general, underestimate east-west sea surface temperature (SST) gradients and to weaken them further under greenhouse gas forcing (Yang et al. 2015b). Hence, they predict coastal East Africa to get wetter. However, coastal East Africa has gotten drier over the past century (Williams and Funk 2011). This may partially be due to natural variability; however, it may also be that the Intergovernmental Panel on Climate Change (IPCC) climate models in the CMIP5 version 5 archive do not well represent the role of ocean dynamics in influencing tropical SSTs. This inability means the models do not correctly represent the seasonal cycle of precipitation in coastal East Africa (Yang et al. 2015b). Furthermore, there are some indications that the east-west SST gradients could actually increase, which would tend to result in drier conditions, not wetter (R. Seager, personal communication).

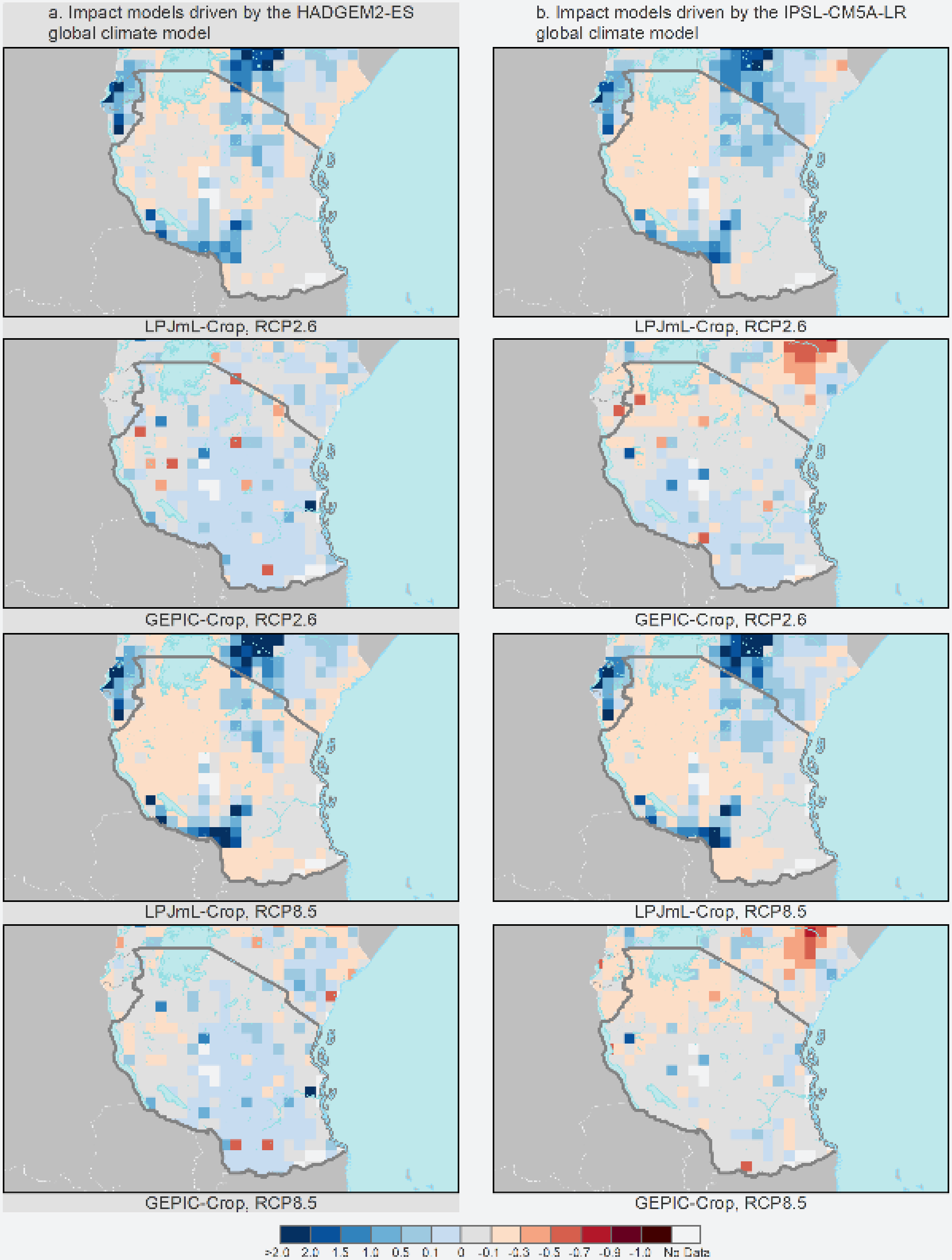
Climate impacts on the water and agriculture sectors, ecosystem impacts, future flood risk, and storm surges (and increasingly sea level rise) have and will influence future population distributions. Each factor influences the attractiveness of a locale by interacting with the local environment and, in turn, population distributions. Generally, areas that see positive deviations in water and productivity see more in-migration, as reflected through spatial population distribution shifts.

Figure 3.1 ISIMIP Average Index Values during 2010–50 against 1970–2010 Baseline for Water Availability, Tanzania



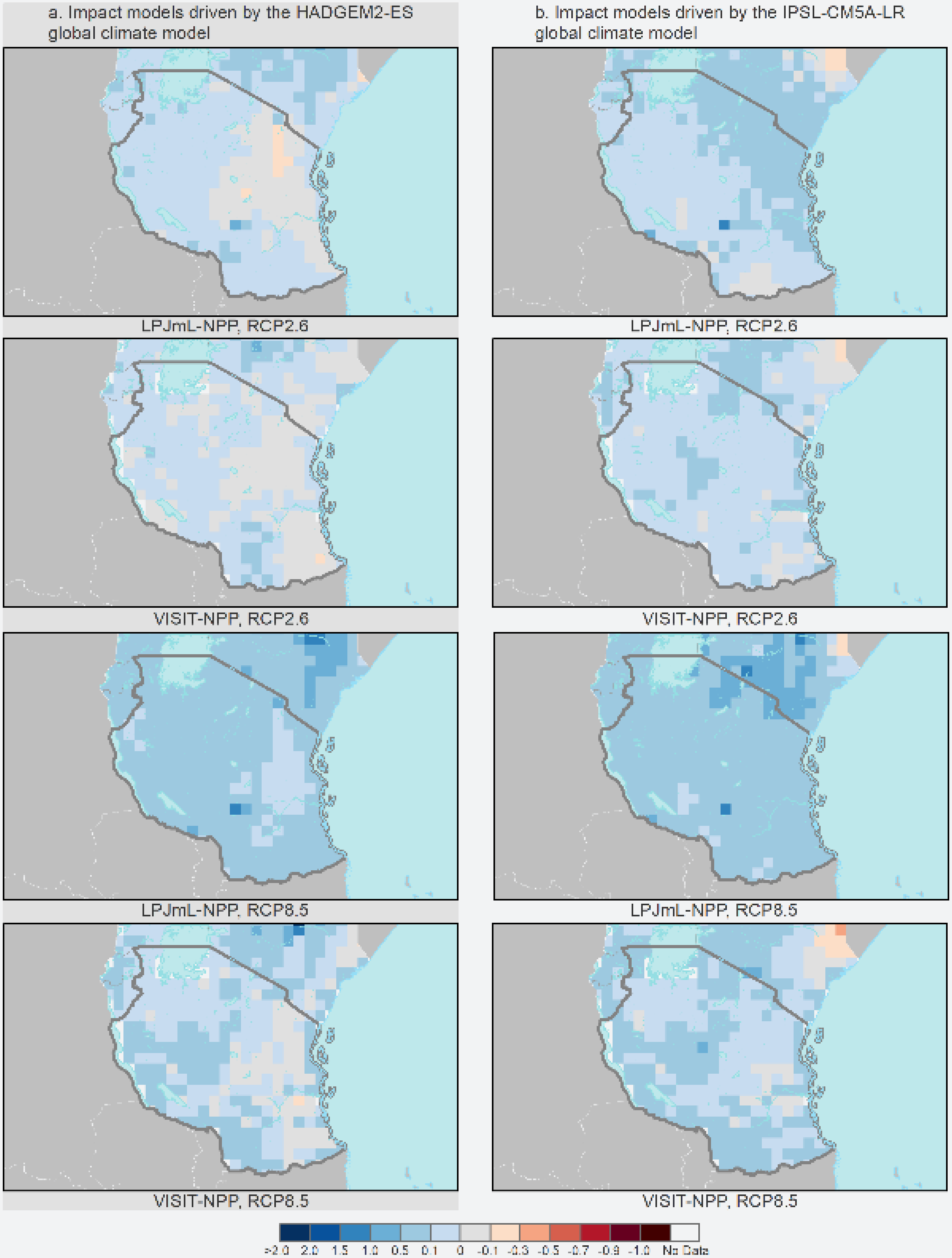
Note: From LPJmL/water and WaterGap, forced with the HadGEM2-ES climate model (panel a) and IPSL-CM5A (panel b) under RCP2.6 and RCP8.5. Blue areas indicate wetting relative to the historical baseline, and grey to tan to red areas indicate drying.

Figure 3.2 ISIMIP Average Index Values from 2010–50 against 1970–2010 Baseline for Crop Production, Tanzania



Note: Blue areas indicate increased crop production relative to the historical baseline, and grey to tan to red areas indicate decreased crop production. White areas have no crop production and are gap-filled with NPP. NPP = net primary productivity.

Figure 3.3 ISIMIP Average Index Values during 2010–50 against 1970–2010 Baseline for Net Primary Production, Tanzania



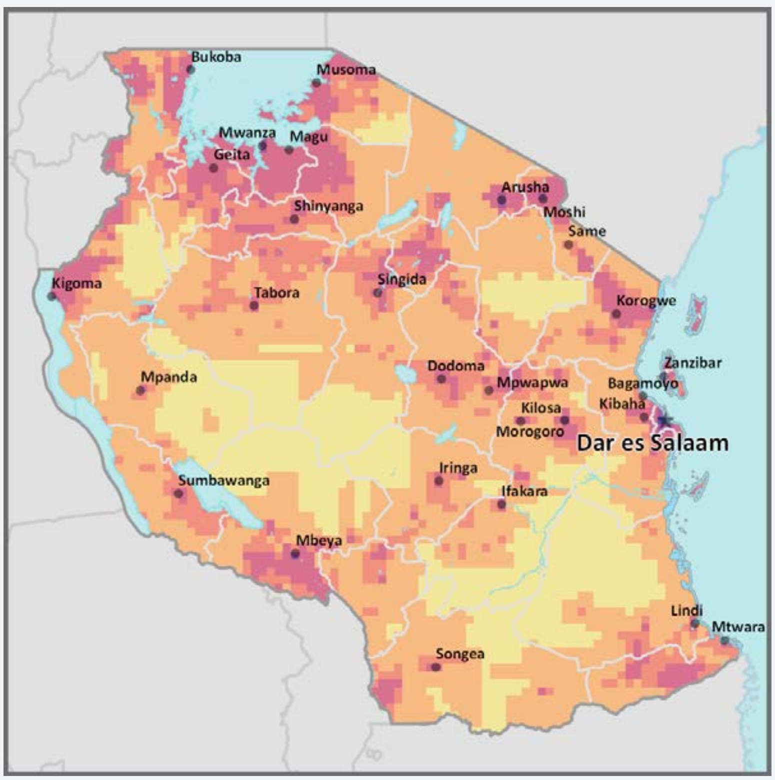
Note: Blue areas indicate increased NPP relative to the historical baseline, and grey to tan to red areas indicate decreased NPP. NPP is used only to gap-fill in small areas without crop production in central Tanzania. NPP = net primary productivity.

3.2 POPULATION CHANGE PROJECTIONS

3.2.1 Population Projections and Population Densities

Tanzania will see a doubling of its population from 2010 to 2050 and an intensification of its population densities over large areas. The population will almost double from 56.3 million in 2018 to 102.3 million under SSP2 by 2050 (table 2.1). Map 3.1 displays Tanzania's population density per square kilometer in 2010 (baseline). Map 3.2 (panels a–d) displays the projected population to 2050 across the four scenarios. Areas of high population density intensify and expand, particularly around the Lake Victoria region, to the southeast (Mwanza and Magu) and southwest (Geita) and pushing southward (Shinyanga and Tabora), and close to more urbanized and coastal areas. Dar es Salaam and Kibaha (east), Mtwara and Lindi (southeast), Songea, Mbeya, and Sumbawanga (southwest), Mwanza and Bukoba (northwest), and Musoma and Arusha (northeast) are projected to witness density increase upward of 1,000 persons per square kilometer. The two big tracts of low-density areas in the south and central west are projected to shrink under all four scenarios by 2050. The pessimistic scenario projects the highest degree of change, and the optimistic scenario the lowest of the four scenarios.

Map 3.1 Population Density per Square Kilometer, Tanzania, 2010 (Baseline)

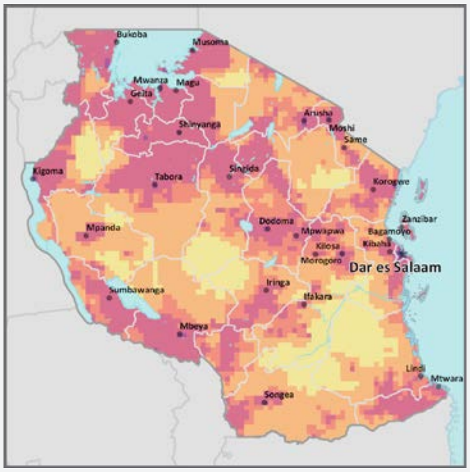


Population density
(number of people per square kilometer)

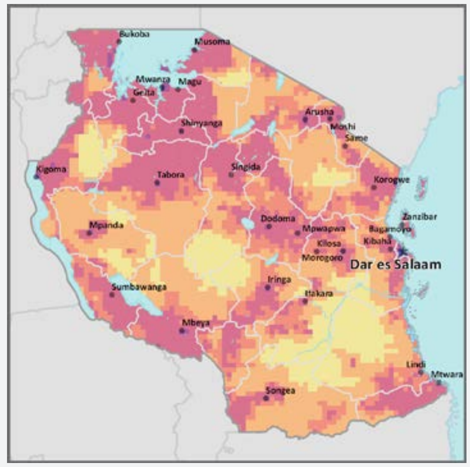
- < 1
- 1 to 5
- 5 to 25
- 25 to 250
- 250 to 1,000
- > 1,000
- ★ National capital

Map 3.2 Projected Population Density per Square Kilometer under Four Scenarios, Tanzania, to 2010-2050

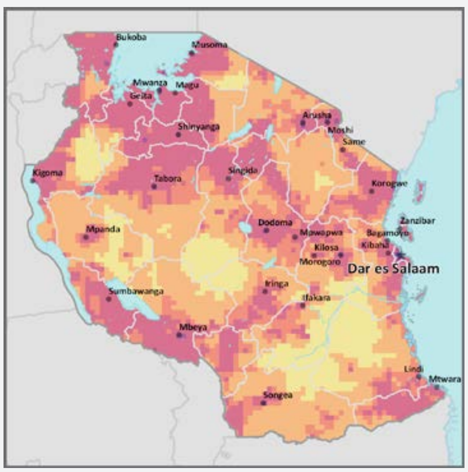
a. Inclusive development scenario (SSP2 and RCP8.5)



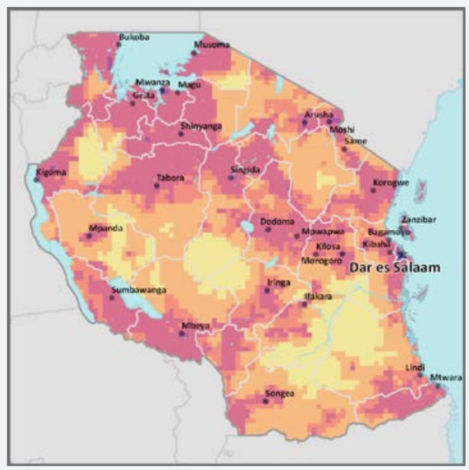
b. Pessimistic / reference scenario (SSP4 and RCP8.5)



c. Optimistic scenario (SSP2 and RCP2.6)



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



Population density
(number of people per square kilometer)

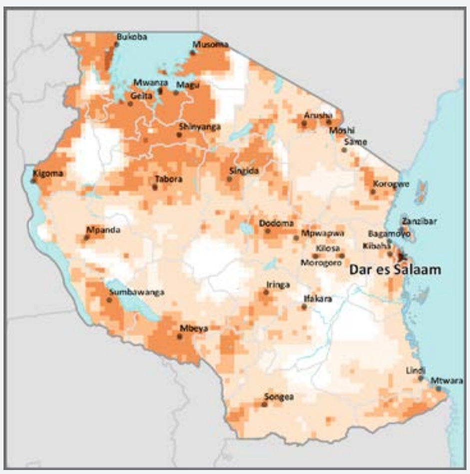
- < 1
- 1 to 5
- 5 to 25
- 25 to 250
- 250 to 1,000
- > 1,000
- ★ National capital

3.2.2 Change in Population Densities

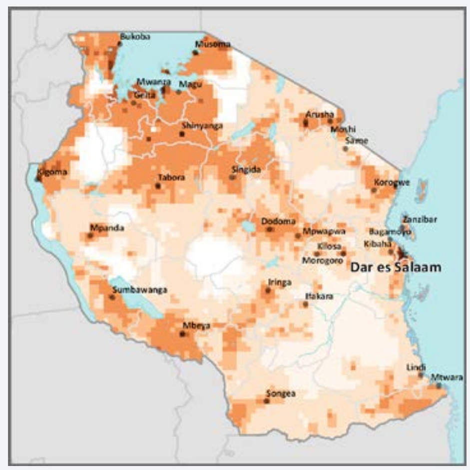
The projected change in population density of Tanzania per square kilometer is expected to increase significantly in large tracts of the country by 2050. Map 3.3 (panels a–d) projects change in the total population density per square kilometer between 2010 and 2050 under the four scenarios. Across the models, the projected changes in population density follow similar trajectory: the pessimistic scenario projects the highest increase, and the optimistic scenario projects the lowest. The biggest cluster of projected increase in population density is in the northwest. The pessimistic scenario projects change in density upward of 500 people per square kilometer, with some areas, such as Mwanza, projecting an increase in density upward of 1,000 people per square kilometer. Areas around Dar es Salaam reflect lower density increase under the pessimistic scenario, and the central and south region project increases of fewer than 50 per square kilometer. In comparison, the optimistic scenario projects lower density of change in population in the northwest between 100 to 500 people per square kilometer, and in some areas between 50 to 100 people per square kilometer. Areas such as Kigoma, Musoma, and Mbeya all project lower density of increase in the optimistic scenario, highlighting the importance of inclusive development and low emission pathways.

Map 3.3 Projected Change in Population Density under Four Scenarios, Tanzania, 2010–50

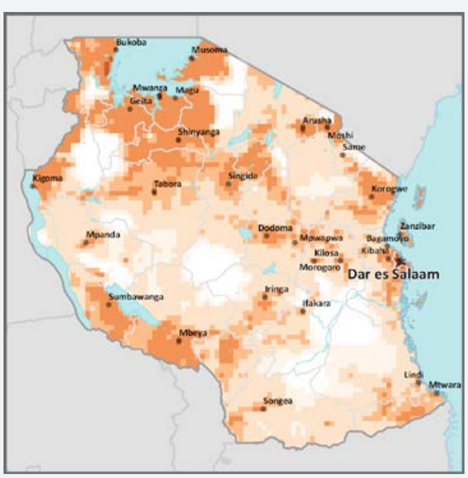
a. Inclusive development scenario (SSP2 and RCP8.5)



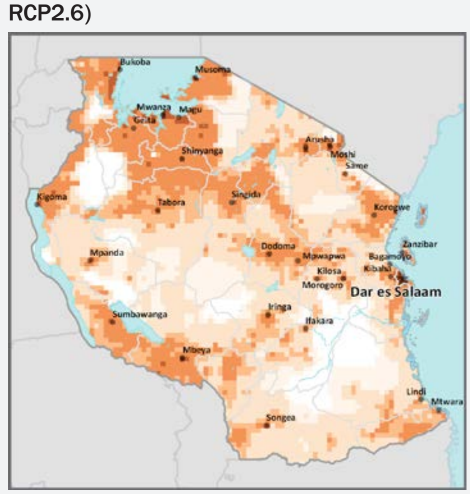
b. Pessimistic / reference scenario (SSP4 and RCP8.5)



c. Optimistic scenario (SSP2 and RCP2.6)



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



3.2.3 Internal Climate Population Projections

The model estimates the number of climate migrants and their future locations by comparing future population distributions under climate impacts with future population distributions under scenarios with no climate impacts.[14] Population distributions have been and will be influenced by climate impacts on the water and agriculture sectors, ecosystem impacts, future flood risk, and, increasingly, sea level rise, all of which influence the attractiveness of a locale by interacting with the local environment. Generally, areas that see positive deviations in water and productivity see more in-migration. Differences in population levels between scenarios that include climate impacts (emission pathways, or RCPs) and development trajectories (SSPs). Those that include only development trajectories are interpreted as being driven by the fast demographic variable: migration.[15]

3.3 INTERNAL CLIMATE MIGRATION

3.3.1 Scale and Trajectory of Internal Climate Migration

The number of internal climate migrants are projected to follow an upward trend across all four scenarios between 2025 and 2050. Figure 3.4 (panels a–d) presents the projected number and percentage of internal climate migrants by scenario and decade from 2020 to 2050, and table 3.1 displays the average, low, and high values of internal climate migrants by 2050. The white areas around the central trend line show greater agreement for the pessimistic and more inclusive scenarios.

Tanzania could have up to 16.6 million internal climate migrants at the high end of the pessimistic scenario by 2050. The average number of internal climate migrants is also the highest in the pessimistic scenario (13.4 million), representing 11.25 percent of the total population by 2050, and lowest in the optimistic scenario (9.8 million), representing 9.57 percent of the total population. The more climate-friendly and more inclusive development scenarios fall in between, with 11.4 million (9.6 percent) and 11.2 million (10.94 percent), respectively. The steady increase in internal climate migrants from 2020 onward underscores the need for early action. These results likely reflect the combined influence of changes in water availability, the strongest driver according to the model results, along with crop yield and NPP. The IPSL-CM5A-LR model projects a high increase in water across large tracts of the country. The model driven by HADGEM2-ES projects a decrease in the northeast. The crop yield model projects a decline in the north and west, offsetting marginally the increase in water availability (figures 3.1 and 3.2 and table 2.1 (on coefficients) and population growth trends).

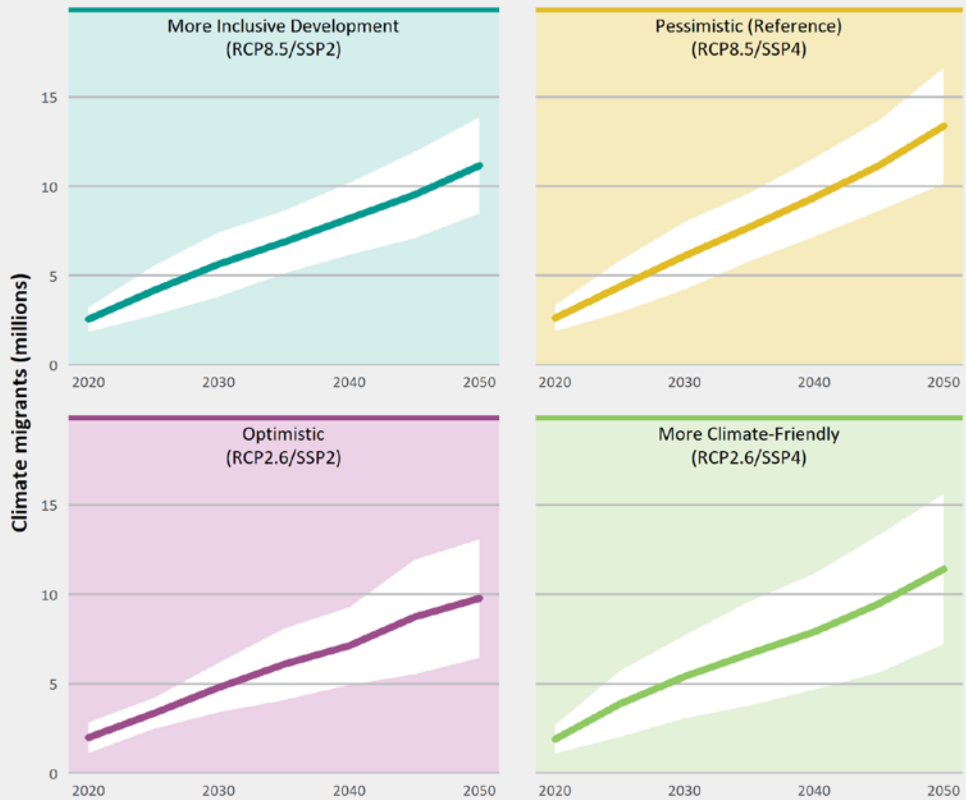
Both inclusive development and low emissions are critical for modulating scale of climate migration, with greatest gains through early action (figure 3.5). Under the pessimistic scenario, the number of internal climate migrants could increase 3.0-fold between 2025 and 2050. The more inclusive development scenario is projected to reduce average internal climate migration by 2.2 million by 2050 in comparison to the pessimistic scenario; the climate-friendly scenario reduces average internal climate migration by 2.0 million. Greatest gains are made when pursuing the optimistic scenario (low emissions and inclusive development), with reductions of 3.6 million. Even so, the lock-in to climate migration is worth noting (9.8 million, or 9.56 percent). The uncertainties in the model support concrete early action to avert some of these impacts. This suggests a need for Tanzania to rapidly pursue highly resilient policies

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

15. To produce these numbers, the population distribution of an SSP-only (no climate impacts) scenario is subtracted from its respective climate impact scenario—that is, a population distribution projected using only SSP4 is subtracted from the pessimistic and climate-friendly scenarios, and a distribution projected using only SSP2 is subtracted from the inclusive development and optimistic scenarios. Demographic variables of births and deaths are already captured within the natural population growth patterns as part of the baseline.

and shifts toward less climate sensitive sectors at scale. These scenarios provide a roadmap to chart out urgent and concerted action characterized by inclusive development and climate-friendly policies to reduce the adverse consequences of climate migration. However, without collective global action to meet the Paris target, some of these gains may become difficult to realize.

Figure 3.4 Projected Total Climate Migrants and Share of Total Population, Tanzania, 2020–50



Climate migrants as a percentage of the total population

Year	2020	2030	2040	2050
%	4.4	7.75	9.31	10.94

2020	2030	2040	2050
4.43	7.88	9.6	11.25

Year	2020	2030	2040	2050
%	3.44	6.59	8.1	9.57

2020	2030	2040	2050
3.21	6.94	8.09	9.6

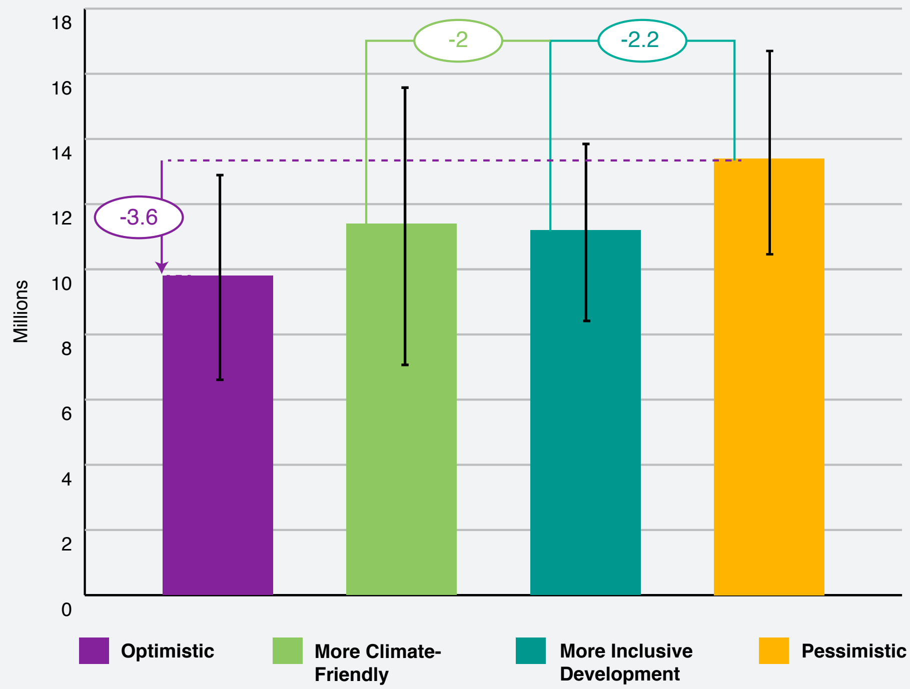
Note: The white areas around the central trend line represent the confidence intervals, which reflect the degree of agreement among the four model runs used to provide each estimate for each scenario. Narrower confidence intervals indicate greater agreement among the model runs in each scenario.

Table 3.1 Projected Total Climate Migrants, Tanzania, 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 (millions)	13.4		11.2		11.4		9.8	
Minimum (left) and Maximum (right) (millions)	10.2	16.6	8.5	13.9	7.2	15.6	6.5	13.1
Internal climate migrants as % of pop.	11.25		10.94		9.6		9.57	
Minimum (left) and Maximum (right) (%)	8.53	13.97	8.3	13.58	6.08	13.13	6.32	12.81

Unsplash

Figure 3.5 Projected Reductions in the mean number of internal climate migrants, Tanzania, 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.

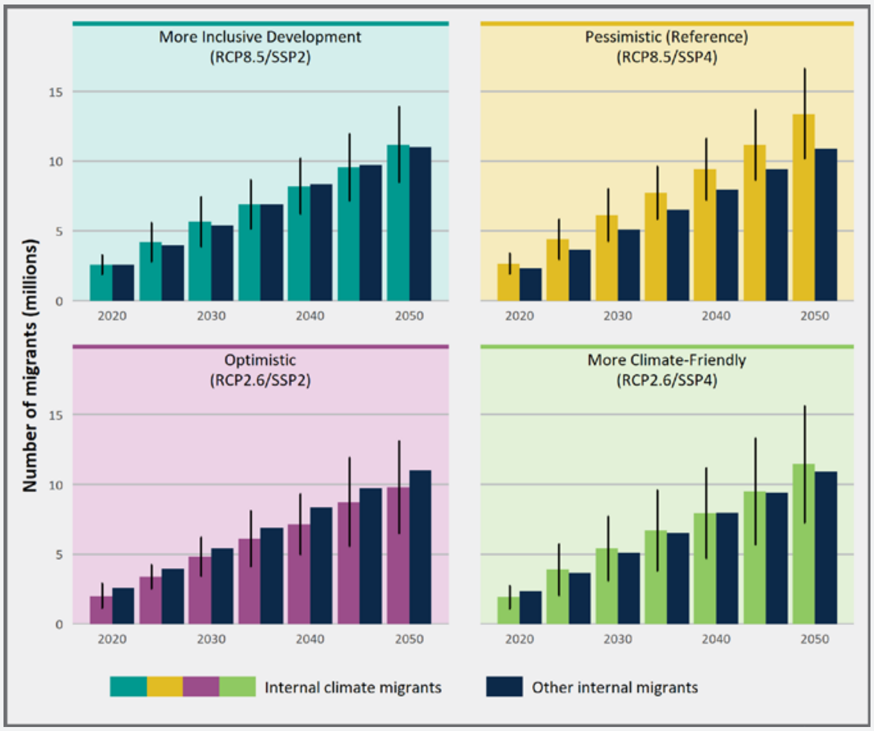
3.3.2 Internal Climate Migrants Compared to Other Internal Migrants

Other internal migrants include those 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 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 the counterfactual, the population changes, but people remain in place. The difference between these two scenarios is development or "other" internal migrants.

Internal climate migrants are projected to overtake the share of other internal migrants as early as 2030 in three of the four scenarios. Figure 3.6 (panels a–d) shows the number of climate migrants in comparison with other internal migrants (those who migrate because of development reasons). While the error bars on the climate migrants show some uncertainty, the total number of internal climate migrants at the high end could surpass other internal migrants across all scenarios. Looking at 2050, the model projects an increase in this gap in the pessimistic scenario (ratio = 1.23) and to a lesser degree in the more climate-friendly (ratio = 1.05) and more inclusive development scenarios (ratio = 1.02). The ratio of climate to other migrants is 0.9 in the optimistic scenario. From a policy perspective, the two types of migrants should not be treated as equivalent. The climate migrants, as derived from this model, reflect mobility driven by the adverse impacts of climate as opposed to other internal migrants moving for economic opportunity.

These projections, across the scenarios, suggest that climate migration is not a challenge in the distant future, but a present reality that calls for urgent attention. Recent studies show evidence of migration because of temperature changes and rainfall variability (Afifi et al. 2014; Hirvonen 2016; Kubik and Maurel 2016). These projections further imply that the combination of high population growth and high climate change impacts could make climate migration the dominant type of internal migration in the near future.

Figure 3.6 Projected Rates of Climate Migrants Compared to Other Migrants, Tanzania, 2020–50



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).

3.3.3 Climate In-Migration and Out-Migration Hotspots

The emergence of hotspots of climate migration as early as 2030 could continue to increase in certainty and spread by 2050 (box 3.2). Map 3.4 presents projected hotspots of climate in- and out-migration by 2050. Map 3.5, panels a–b, shows projected hotspots of climate in- and out-migration by 2030 and 2040. Climate in-migration hotspots emerge in many parts of the north, particularly around Lake Victoria, with high certainty in high levels of migration in cities such as Mwanza, Magu, and Geita by 2050. Most of the ISIMIP model results indicate increasing water availability in this region and offer a possible explanation for its attractiveness to climate migrants, although this is offset partially by decrease in crop yield, according to some models (figure 3.1, panels a–b). These climate in-migration cities are characterized by the highest poverty levels nationwide and will require policy foresight to ensure they can adapt to climate change and cope with the influx of migrants. Smaller pockets of climate in-migration are scattered in the west in Mpanda and Sumbawanga. Table 3.2 summarizes the high intensity climate in- and climate out-migration hotspots, and a status of their current development context. The data will be critical in shaping policy and forward-looking approaches for early action to avert the adverse consequences of climate-induced migration. The current state and usage of environmental resources, which are imperative to livelihood and well-being, are also presented. These issues become important as part of the broader considerations of adapt in place.

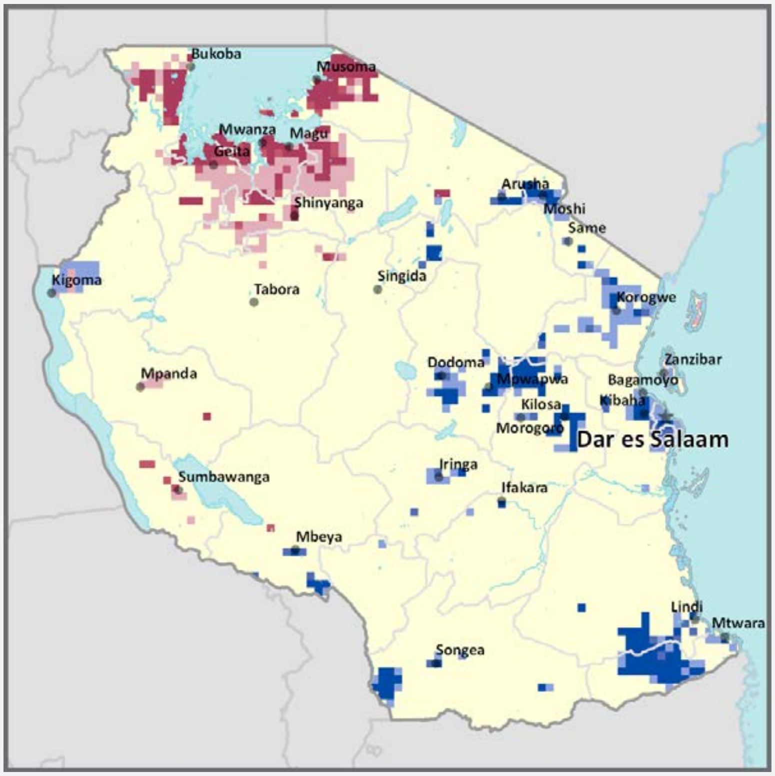
Climate out-migration hotspots are concentrated in the east and south and include such cities as Dar es Salaam, Arusha, Korogwe, Dodoma, and Morogoro. The HADGEM2-ES models show decline in water availability in these regions, while many crop production models project small increase in crop yields. In coastal areas, sea level rise will increasingly have an impact on population distribution. In these coastal regions, the level of certainty and spread of out-migration increases steadily from low, moderate, to high between 2030 to 2050. These out-migration projections run contrary to the current internal migration pattern wherein the abovementioned cities are attracting migrants in large numbers by virtue of economic opportunities, availability of land for settlement, and rich natural resource base (NBS 2015). Thus, climate out-migration is projected to take place from relatively rich regions with lower incidence of poverty (figure 2.1). Climate out-migration dampens overall population growth in these coastal urban cities rather than causing the population to decrease, due to the overall high population growth (maps 3.2 and 3.3). One hotspot in Kigoma, near the border with Burundi, indicates the mix of low intensity climate in- and out-migration across decades.

Box 3.2 Understanding Climate In- and Out-Migration Hotspots

To map climate change–induced migration, population distributions are projected with and without climate impacts; the difference between the two are interpreted as changes in population due to migration. Hotspots represent the top 5th and bottom 5th percentile of the distribution of total climate migrants per 15-kilometer grid cell. When two out of four scenarios overlap, it is considered a low certainty hotspot; when three out of four scenarios overlap, this is considered a moderate certainty hotspot; and when four out of four scenarios overlap, this is considered a high certainty hotspot. To be consistent across the time series, we apply the 2050 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, maps 3.4 and 3.5, panels a–b), that does not mean that population will decline in these areas. 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 on water availability, but also on the agricultural (crop and livestock) sector.

Map 3.4 Projected Hotspots of Climate In- and Out-Migration, Tanzania, 2050



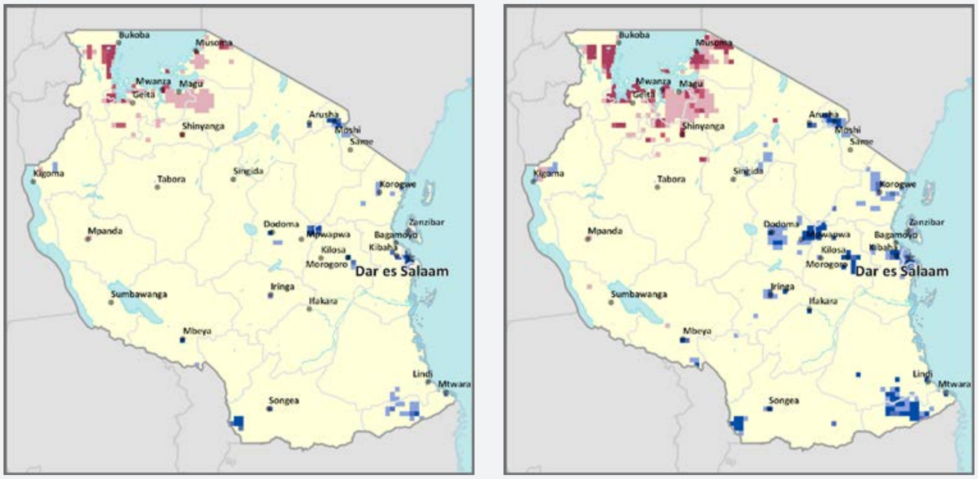
IN-MIGRATION

- 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

Map 3.5 Projected Hotspots of Climate In- and Out-Migration, Tanzania, 2030 and 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

Sofiya Kirik / Unsplash

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

Region	Hotspot locality	Climate context	Environmental resource degradation/ challenges aggravated by climate change	Decade emergence as high intensity hotspot	Urban development context	Climate drivers
			In-migration			
Mwanza	Mwanza	Highly vulnerable region to extreme weather events such as landslides, floods, and storms	Mwanza relies heavily on the functions of the lake for livelihood (water supply, sanitation, fish industry, micro-climate), which is seeing degradation by climatic and nonclimatic factors. Solid and liquid waste are discharged into the lake without adequate treatment.[a] Climate change impacts include decrease in water quantity and quality affecting domestic, commercial, and agricultural use and fisheries.[b]	2030	Mwanza is a leading business destination in North Tanzania with a population of 2.77 million.[c] The economic activities include tourism, mining, fisheries, small- and medium-scale industries.[d]	Increase in water availability Decrease in crop yield Increase in net primary productivity Higher and more extensive flood hazard
			In-migration			
Geita	Geita town	Highly vulnerable region to increased rainfall and temperature and extreme climate events.[e]	Gold mining causes significant environmental destruction, mercury pollution, land degradation, and deforestation, which adversely affects long-term health and development goals. Almost 1,050 km of Geita District is covered by the lake, which plays a key role in marine diversity and fishing and requires better management.[f]	2040	Geita town is the capital of Geita region with an estimated population of 807,619.[g] There are substantial mining activities taking place along with growth of small-scale industries, agriculture, livestock rearing, fisheries, and tourism.	Water availability projections show increase across the ISIMIP water simulation models; mixed results in crop yields, and increases in NPP
			Out-migration			
Dar es Salaam	Dar es Salaam	Highly vulnerable region to sea level rise, coastal erosion, and tidal waves.	Solid and liquid waste, air pollution, and soil erosion pose significant problems. The Ruvu Basin, which supplies water to Dar es Salaam, is projected to have up to 10% decline in its runoff.[h] Important livelihood activities (salt making, tourism, and fishing) are likely to further be affected by climate change and natural resource degradation.[i]	2040	Dar es Salaam is the largest city in Tanzania and an important economic center with a population of 6.7 million people. Primary economic activities are mining, urban agriculture, fishing, and recreation and tourism.[j]	Water availability projections show mixed results across the ISIMIP water simulation models; moderate increase in crop yields; increase in NPP.

Region	Hotspot locality	Climate context	Environmental resource degradation/ challenges aggravated by climate change	Decade emergence as high intensity hotspot	Urban development context	Climate drivers
			Out-migration			
Arusha	Arusha	Highly vulnerable to droughts, water insecurity, health hazard.[k]	Livestock productivity, distribution, and survival have declined because o present climate change variability, decrease in the quality of rangelands, and prevalence of vector-borne diseases.[l]	2030	Arusha is the third-largest city in Tanzania, located in the foothills of the volcanic plain of Mount Meru. It has a population of 416,442[m] and informal settlements scattered across the city. It has numerous small and large businesses, banking, retail, and commercial enterprises.	Water availability projections show mixed results across the ISIMIP water simulation models; moderate increase in crop yields; increase in NPP.

Note: NPP = net primary productivity.

a. Ministry of Water 2012.
b. Adaptation Fund 2019.
c. Ministry of Water 2012; National Census Report 2012.
d. Gov of Tanzania 2017.
e. Luhunga and Songoro 2020.
f. Mwakaje 2012.
g. Gov of Tanzania 2019a.
h. Gov of Tanzania 2003.
i. Mwandosya, Nyenzi, and Luhanga 1998; Paavola 2003.
j. Kibona 2008.
k. Agrawala et al. 2003.
l. Ojija et al. 2017.
m. Gov of Tanzania 2013

Beyond the Hotspots—The Larger Spatial Context

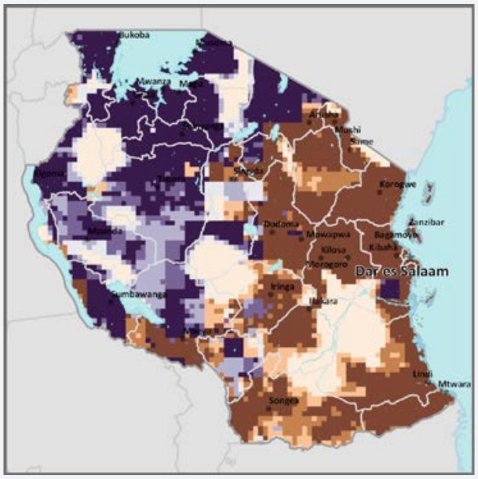
The population change per square kilometer owing to climate migration will be positive in north and west and negative in the south and east, across the four scenarios, by 2050. Map 3.6 (panels a–d) displays the projected population change per square kilometer owing to climate migration by 2050—the difference between the climate and no climate impacts scenarios. The results reinforce those of maps 3.4 and 3.5 (panels a–b) while reflecting population shifts across Tanzania. Across the four scenarios, there is an increase in the population in the north and west, and a decrease in the east and south, reflecting increases in population densities (map 3.3, panels a–b). The projected movement away from coastal belt in the coming decades could be explained by sea level rise impacts compounded by storm surges on the coast, and increased water availability inland.

The highest degree of changes are in the pessimistic scenario and the lowest in the optimistic scenario (map 3.6, panels a–d). The optimistic and more climate-friendly scenarios project a section in the west with a decrease in population density between the positive change zones. The areas of negative population change per square kilometer do not imply a decline in the total population. Instead, they imply that the growth of population change will be reduced by the departure of climate migrants. The three distinct white patches in the southeast, center, and northwest project minimal change in population, and fewer or more than 100 represent reserve areas. The modeling uses geospatial processing to exclude protected areas or places where the terrain is too rugged to inhabit from consideration. The effect is that the algorithm is not applied in these areas.

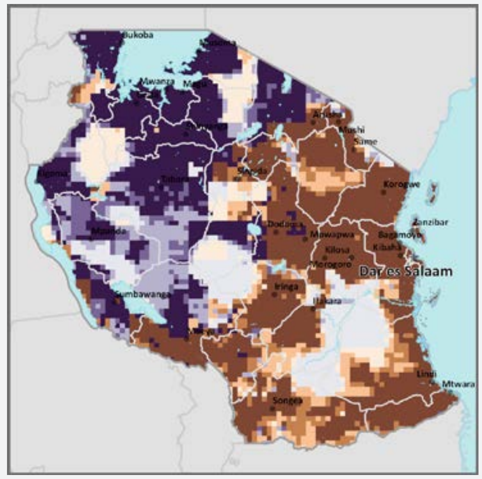

K15 Photos / Unsplash

Map 3.6 Projected Population Change due to Climate Migration, Tanzania, 2050

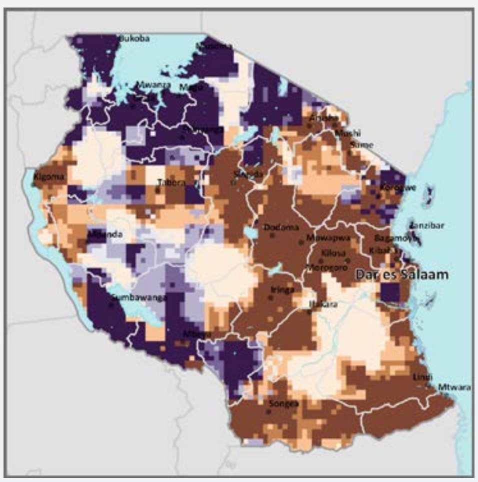
inclusive development scenario (SSP2 and RCP8.5)



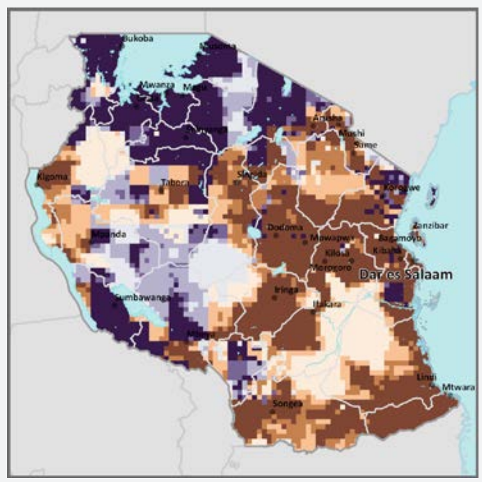
pessimistic / reference scenario (SSP4 and RCP8.5)



optimistic scenario (SSP2 and RCP2.6)



Climate Friendly scenario (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.

Map 3.7 (panels a-d) displays climate migrants as a percentage of the population under the no climate impacts (SSP-only) scenario in each grid. The patterns are similar to those in map 3.6, panels a–d. So far, in this section, we have examined the following:

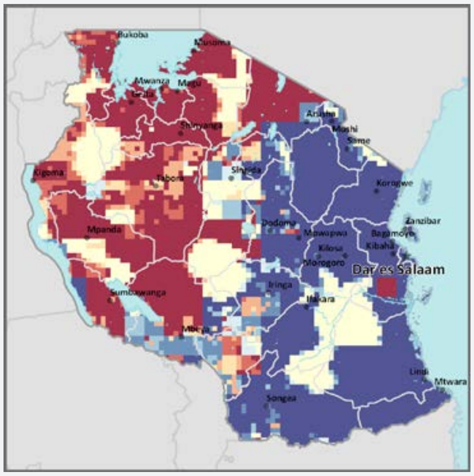
- Future climate change impacts (water availability, crop yields, and NPP)
- Baseline and future projections of the change in the total population and its density due to climate change
- Scale and trajectory of climate-induced migration
- Compared climate and other migrants

- Mapped climate in- and out-migration hotspots
- Mapped population change per square kilometer in 2050 due to climate migration

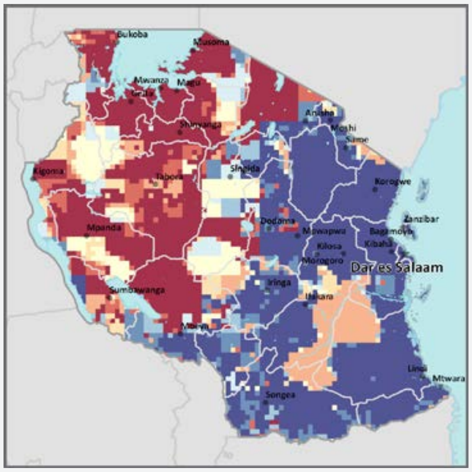
These spatial projections, as percentages and absolute numbers, underscore the need for far-sighted and anticipatory approaches if localities are to avert, minimize, and address the adverse consequences of climate-induced migration.

Map 3.7 Projected Share of Difference in Population due to Climate Migration, in Share of Population Based on No Climate Scenario, Tanzania, 2050

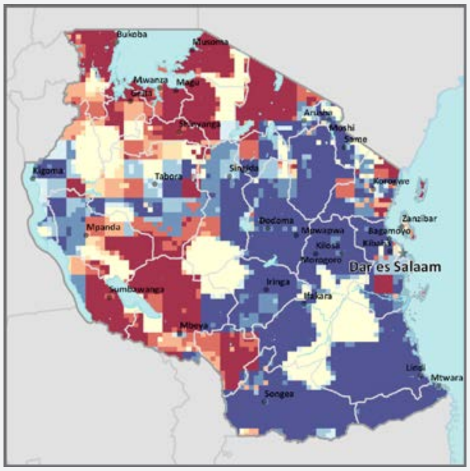
inclusive development scenario (SSP2 and RCP8.5)



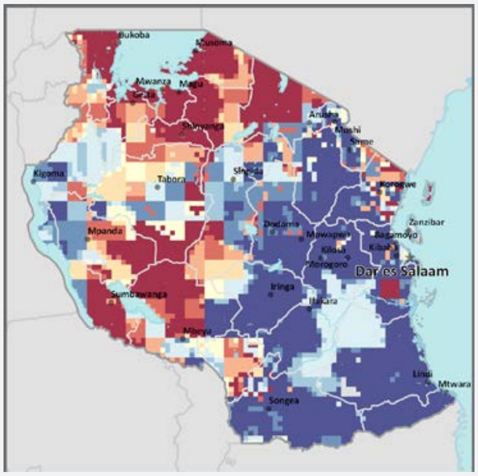
pessimistic / reference scenario (SSP4 and RCP8.5)



optimistic scenario (SSP2 and RCP2.6)



Climate Friendly scenario (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.

3.3.4 Climate Migration Projections by Livelihood Zones and Provinces

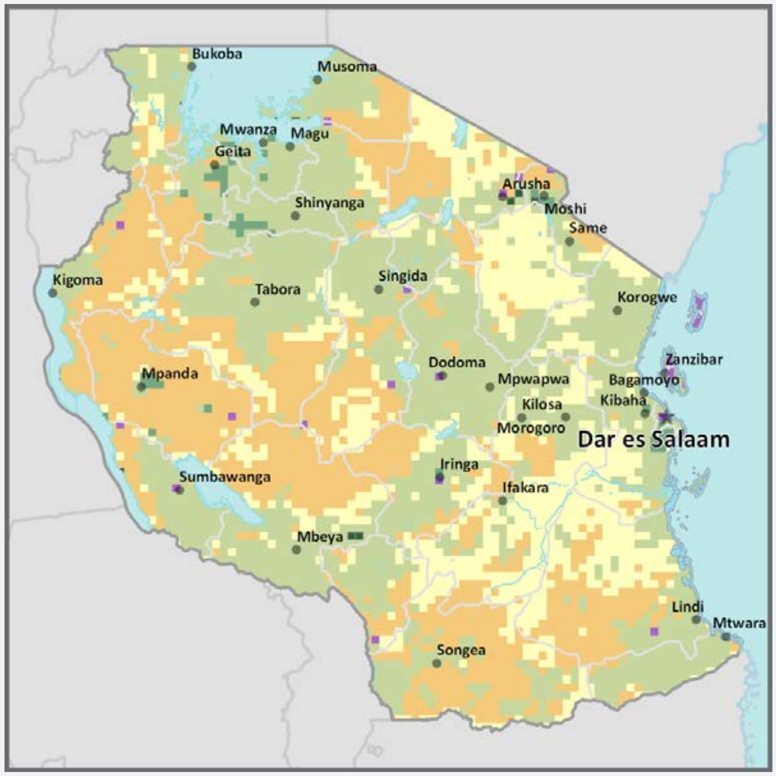
Livelihood Zones

Map 3.8 shows the distribution of livelihoods zones in Tanzania based on an aggregation of anthropogenic biomes produced by Ellis et al. (2010 and 2013). Rainfed cropland covers large tracts of the country from the center of the country, Lake Victoria to the Indian Ocean coast, along the coast up to the border with Mozambique, and the west along the coast of Lake Rukwa. Pastoral and rangelands, as well as seminatural and wildlands, are found to the east and west of the rainfed croplands and in the central southern area. Small patches of rice-growing areas are visible around Lake Victoria, and close to Arusha (northeast) and Mpanda (west). Finally, dense settlements follow the distribution of urban areas.

Table 3.3 displays net migration by livelihood zone under the four scenarios and from 2030 to 2050. Rainfed croplands consistently project positive net migration starting from 2030 to 2050. The scale of net migration to rainfed cropland by 2030 ranges from 190,000 (more inclusive development scenario) to 317,000 (more climate-friendly scenario). This projection is consistent with the density maps that show in-migration in these areas (map 3.9). Irrigated croplands, dense settlements, and pastoral and rangelands display negative balances, while rice growing croplands and seminatural and wildlands have mixed results across scenarios and decades.

The out-migration from dense settlements could be as high as –288,000 (pessimistic scenario) by 2030. However, the projections reduce to –83,000 (climate-friendly scenario) and –24,000 (optimistic scenario), highlighting the stark difference low carbon emissions and inclusive development can affect. The out-migration projections from dense settlements are consistent with the decrease in water availability in the coastal urban region under the HADGEM2-ES models and sea level rise (figure 3.1, panels a–b) (table 1.2). The climate-induced migration shifts from one livelihood zone to another do not convey a shift in livelihoods, simply of population shifts responding to climate factors.

Map 3.8 Livelihood Zones, Tanzania



Note: Livelihood zones are static, meaning they are not projected into the future based on likely climate influences on ecosystems (see Williams et al. [2007]), but 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 take consider livelihoods dependent on marine fisheries along the coast.

Table 3.3 Projected Net Migration by Scenario and Livelihood Zone, Tanzania, 2030, 2040, 2050

Year and livelihood zone	More climate-friendly (RCP2.6/SSP4)	More inclusive development (RCP8.5/SSP2)	Optimistic (RCP2.6/SSP2)	Pessimistic (reference) (RCP8.5/SSP4)
2030				
Dense settlements	–82,866	–168,476	–23,926	–287,612
Irrigated croplands	–10,178	–19,960	–7,963	–21,621
Pastoral and rangelands	–124,020	–267,686	–38,120	–254,847
Rainfed croplands	316,720	190,142	246,656	306,754
Rice-growing areas	–17,187	140,262	–3,875	136,661
Seminatural and wildlands	–85,822	120,751	–175,920	115,027
Undefined	3,353	4,967	3,147	5,639
2040				
Dense settlements	–4,266	–285,849	46,595	–537,008
Irrigated croplands	–15,012	–25,153	–12,691	–27,770
Pastoral and rangelands	–209,597	–338,920	–126,087	–328,457
Rainfed croplands	330,762	341,404	267,429	598,676
Rice-growing areas	41,263	95,304	64,510	83,062

Year and livelihood zone	More climate-friendly (RCP2.6/SSP4)	More inclusive development (RCP8.5/SSP2)	Optimistic (RCP2.6/SSP2)	Pessimistic (reference) (RCP8.5/SSP4)
2040				
Seminatural and wildlands	−148,745	208,347	−245,720	205,109
Undefined	5,596	4,867	5,965	6,387
2050				
Dense settlements	−15,410	−435,455	58,519	−894,577
Irrigated croplands	−21,737	−45,583	−23,980	−51,311
Pastoral and rangelands	−211,037	−476,215	−166,085	−456,164
Rainfed croplands	458,250	422,470	323,841	846,990
Rice-growing areas	−1,141	139,726	31,003	151,292
Seminatural and wildlands	−215,879	388,788	−230,365	396,990
Undefined	6,954	6,269	7,067	6,780

Climate Migration by Province

Figure 3.7 and table 3.4 display net migration for 2050, by region. The regions in the Lake Victoria Basin (Kagera, Geita, Mwanza, Mara, Simiyu, and Shinyanga) display positive net migration across scenarios, showing how the increase of water availability has a significantly greater impact on climate migration than the projected declines in crop production. Two regions immediately south of the basin (Tabora and Singida), the western regions of Rukwa and Katavi, and Arusha region in the north also show positive net migration. The southern regions of Mtwara, Lindi, Ruvuma, Iringa, and Morogoro, the central Dodoma and Manyara regions, as well as the eastern regions of Tanga, Pwai, and Dar es Salaam display negative balances (that is, will see a dampening effect). The top three regions of projected negative net migration in 2050 are Morogoro (−1.4 million), Tanga (−1.36 million), and Dar es Salaam (−1.29 million) in the pessimistic scenario. Conversely, the regions with the highest projected positive net migration in the pessimistic scenario are Kagera (1.87 million), Geita (1.54 million), and Mwanza (1.61 million), all situated around Lake Victoria.

Figure 3.7 Projected Net Climate Migration by Province and by Scenario, Tanzania, 2050

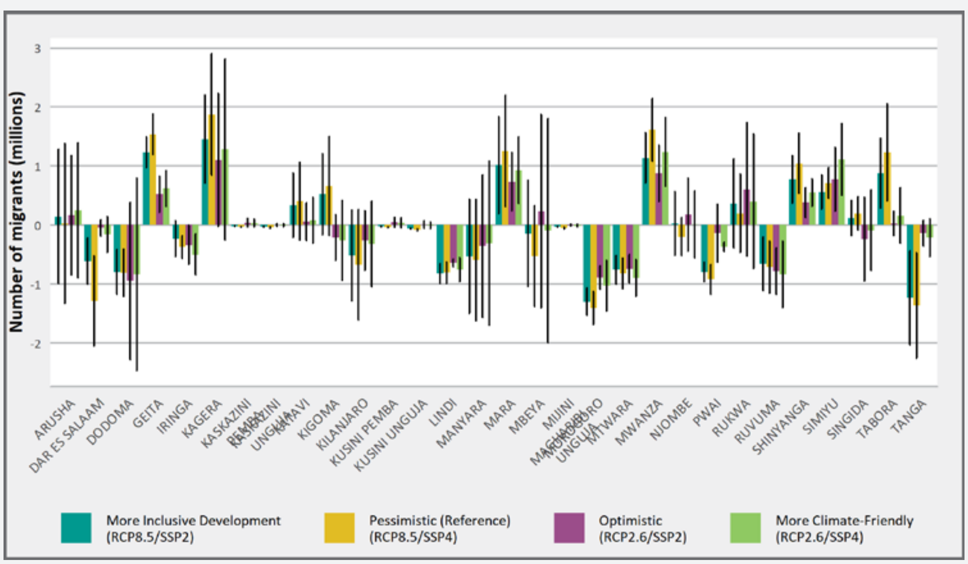


Table 3.4 Projected Net Migration by Scenario and by Region, Tanzania, 2050

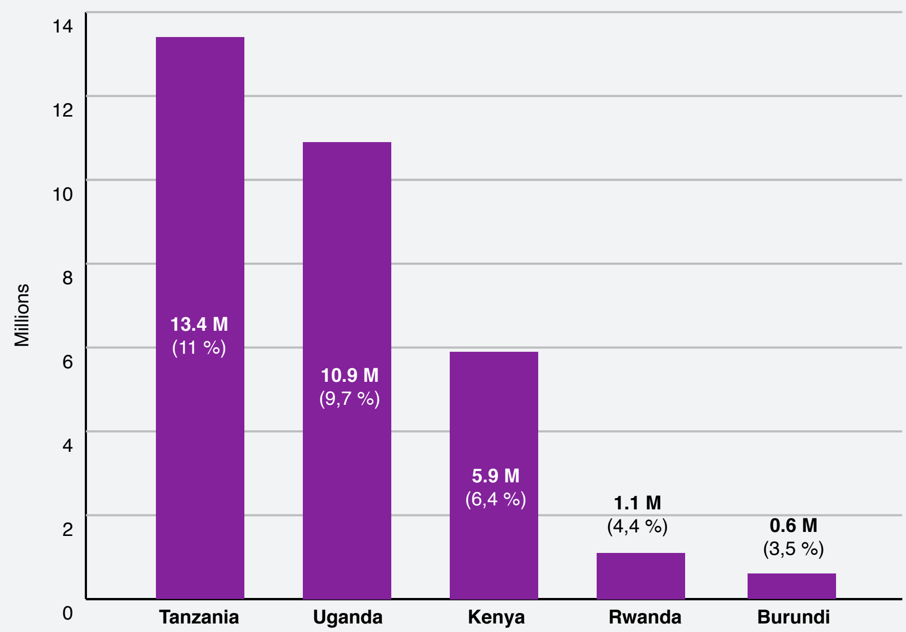
Region	More climate-friendly (RCP2.6/SSP4)	More inclusive development (RCP8.5/SSP2)	Optimistic (RCP2.6/SSP2)	Pessimistic (reference) (RCP8.5/SSP4)
Arusha	248,410	144,044	164,954	21,439
Dar es Salaam	−157,968	−612,617	−48,047	−1,286,469
Dodoma	−835,621	−795,618	−948,503	−811,954
Geita	620,165	1,230,977	521,593	1,535,659
Iringa	−500,194	−231,808	−336,666	−374,132
Kagera	1,278,739	1,454,627	1,103,772	1,874,061
Kaskazini Pemba	34,646	−20,004	42,050	−29,739
Kaskazini Unguja	−4,474	−27,799	2,979	−40,811
Katavi	77,615	333,269	55,108	402,755
Kigoma	−260,762	522,389	−212,960	661,027
Kilimanjaro	−320,645	−515,171	−260,675	−675,094
Kusini Pemba	39,196	−23,493	45,618	−35,443
Kusini Unguja	−8,051	−59,618	10,987	−83,425
Lindi	−757,713	−824,383	−642,039	−808,416
Manyara	−308,039	−532,962	−356,646	−595,260
Mara	928,483	1,016,147	732,667	1,254,418
Mbeya	−95,008	−142,074	235,874	−526,257
Mijini Magharibi Unguja	−10,109	−29,369	−4,200	−52,801
Morogoro	−1,029,359	−1,298,110	−887,768	−1,404,341
Mtwara	−896,817	−759,313	−743,899	−820,746
Mwanza	1,238,578	1,136,179	877,949	1,612,146
Njombe	9,873	25,372	176,339	−199,098
Pwai	−371,897	−797,685	−139,347	−918,304
Rukwa	400,875	367,705	602,907	197,749
Ruvuma	−836,199	−655,415	−784,534	−715,235
Shinyanga	549,385	774,772	378,260	1,043,306
Simiyu	1,109,258	560,766	773,943	709,660
Singida	−88,813	115,956	−241,972	195,358
Tabora	159,969	878,511	23,134	1,230,114
Tanga	−213,524	−1,235,278	−140,881	−1,360,164

3.4 TANZANIA AND THE LAKE VICTORIA BASIN

East Africa is a highly mobile region, so Tanzania's modeling results must be contextualized against regional movements. Since the 2007 freedom of movement protocols established under the East African Community (EAC 2002), citizens of the five Basin countries (Burundi, Kenya, Rwanda, Tanzania, and Uganda) can live and work in throughout the region. Given the free movement and connectivity among the LVB countries, considering the potency of climate-induced migration in the region is equally relevant to inform planning, policy, and actions.

Tanzania is projected to have the highest numbers of climate migrants in the Lake Victoria Basin by 2050 followed by Uganda (figure 3.8). Compared to that of Uganda, where the climate impacts models reflect good agreement and high certainty across the scenarios, those in Tanzania reflect better agreement under the pessimistic and inclusive scenarios. The high population increases in Tanzania and Uganda, which are projected to see a doubling of its population by 2050, are responsible in part for this stark difference with other countries. With a projected mean of 13.4 million internal climate migrants reflecting more than 11 percent by 2050, the urgency for inclusive and resilient action cannot be postponed.

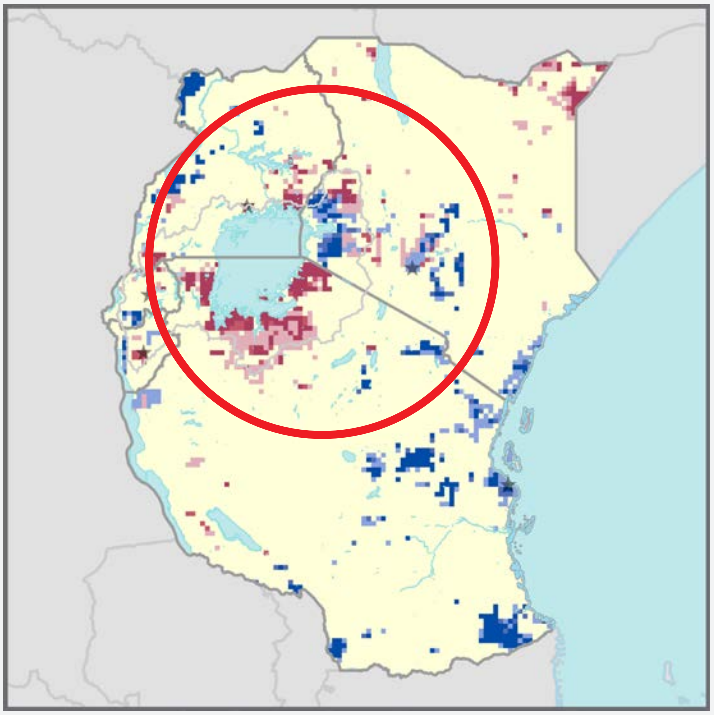
Figure 3.8 Projected Mean Number of Internal Climate Migrants under Pessimistic Scenario and as Share of Total Population, Tanzania, 2050



Tanzania is projected to see climate in-migration toward Lake Victoria and out-migration from the south and east (map 3.9). Unlike Tanzania, Kenya will 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 Tanzania, where there will be high numbers of climate migrants and development migrants, with the former outpacing the former.

Toby Wong / Unsplash

Map 3.9 Projected Hotspots of Internal Climate In- and Out-Migration, Lake Victoria Basin countries, 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: Based on compilation of individual country results and top and bottom 5 percent highest differences between the climate and no climate impact scenarios by country.

Source: Rigaud et al. 2021a

3.5 CONSULTATION FINDINGS AND BROADER COUNTRY LINKAGES

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 on February 23, 2021. 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, modeling results, and suggestions on policy response (World Bank, unpublished).

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 was widely accepted as one of the driving factors of mobility in the region along with the ability of land to support livelihood.

Considering the historical and current migration patterns, participants alluded to the change in pastoral routes and directions. Pastoralists in Tanzania are moving internally in different directions and coming across farmlands, which is causing conflict. Participants raised concern about higher seasonal migration and longer periods of displacement, especially on account of disasters. Disasters were identified as a prime reason of displacement in Burundi, Rwanda, and Kenya. The group found the scenarios and climate in- and out-migration hotspots (determined in the model) to be plausible and stressed the importance of preparedness and resilience. They expect that there will be future climate migration hotspots. In fact, many are already emerging. The need to understand the pressure on land and water resources and the degree to which these can be addressed in policy was highlighted.

World Bank's Systematic Country Diagnostic (SCD) and Country Partnership Framework (CPF) resonate with these policy directions. The SCD identifies three pathways to achieve the national development goals by which the country can accelerate equitable and sustainable growth and reduce poverty. These are (i) structural transformation to leverage Tanzania's natural assets and capture latent comparative advantage to create more jobs; (ii) spatial transformation to build on Tanzania's geographic advantages and maximize benefits from spatial integration and agglomeration; and (iii) upgrading public institutions and organizations, underpinned by expanding human capital, gender equity, and macroeconomic stability. For instance, the study identifies Dar es Salaam, Arusha, Korogwe, Dodoma, and Morogoro as climate out-migration hotspots. Climate in-migration hotspots are in the north, particularly around Lake Victoria, in cities such as Mwanza, Magu, and Geita. Securing these hotspots from climate risks and capitalizing on migration would prove critical to achieve spatial integration and transformation. The SCD identifies nine priorities and two foundations: (i) human capital and gender equity and (ii) macroeconomic stability (World Bank 2017).

The CPF covering FY18–FY22 has three areas of strategic focus that guide the path to sustainable and equitable growth (World Bank 2018a). These are Focus Area 1—enhance productivity and accelerate equitable and sustainable growth; Focus Area 2—boost human capital and social inclusion; and Focus Area 3—modernize and improve efficiency of public institutions (figure 4.3). Some of the current Bank projects that illustrate actions on these issues are:

The Boosting Inclusive Growth for Zanzibar: Integrated Development Project (P165128) (US$150 million) offers support programs to improve the livelihoods of local residents in three types of areas in Zanzibar: (i) urban core; (ii) fast-growing urban areas; and (iii) established and emerging towns/villages. It speaks to the livelihood challenge highlighted in the consultation and includes physical investments that will be undertaken, such as for improving drainage and retention ponds, solar-powered street lighting, renovating and greening of public spaces, improvement of streets, and bringing adaptation and mitigation benefits (World Bank 2020a).

The Tanzania Water Security for Growth project (P168238) (US$ 350 million) aims to (i) strengthen bulk water security of prioritized urban areas and (ii) bring critical water-source areas under sustainable watershed management. The project, similar to the consultation, emphasizes water security and will invest in climate-resilient storage such as reservoirs or groundwater and resilient landscapes and watershed management upstream of growth poles to increase water availability and improve water quality. As part of this project, reliability of household water supply will be fostered, lessening water-related time burden, and affording more time for education and economic activities. Rural households, especially the smallholder female farmers, will benefit from improved micro-watershed management and climate-resilient livelihood adaptation within the basins (World Bank 2019d).

The Tanzania Cities Transforming Infrastructure and Competitiveness Project (P171189) proposes to improve basic infrastructure and services in Tanzanian urban local government authorities. The physical activities include construction of select roads, drainage, bus stands, markets, and landfills in selected urban areas. This would lead to better liveability and resilience of strategically important cities in the country. It will entail improvements in service provision, in solid waste management, sanitation, and drainage. Through technical assistance, the project will also enhance support to urban disaster risk management, and climate change adaptation (World Bank 2019b).

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Chapter 4

Strategic Response Framework

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 (Podesta 2019; Wodon et al. 2014). According to this study, the number of internal climate migrants in Tanzania could reach close to 16.6 million by 2050, representing 13.97 percent of the population. The population will double in this period, and driven by climate factors, will see an emergence of climate in- and out-migration hotspots—as early as 2030. The optimistic scenario—coupling lower emissions with inclusive development—could reduce the scale of climate-induced migration by 3.6 million people in Tanzania.

International frameworks and national policy responses increasingly recognize climate-induced migration as an underlying cause and threat to sustainable development, but current responses to address the issue are lagging (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 have left behind an increasing number of individuals, communities, and regions (IDA 2020), with climate impacts amplifying the challenge (FAO et al. 2020; UN 2020; World Bank 2020b). In the absence of transformative and at-scale action on climate and development, climate-vulnerable countries, such as Tanzania, are projected to be dealing with increasing numbers of internal climate migrants by 2050 (Rigaud et al. 2018).

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 all of Tanzania. 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.

The 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 (WIM) report (UNFCCC 2018). The Global Compact for Safe, Orderly, and Regular Migration adopted in 2018 recognizes the need to strengthen joint analysis and sharing of 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 potential implications on migration (IOM 2018). The Sendai Framework highlights the significance of incorporating considerations relating to disaster-induced displacement to improve disaster preparedness[16] and disaster risk governance.[17] The 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 guide international processes.

Tanzania has taken important steps in integrating climate change, climate internal displacement, and refugees in its legislation and plans. Tanzania's National Adaptation Programmes of Action (NAPA) mentions migration of people and livestock as a source of vulnerability and lays out adaptation strategies (Gov of Tanzania 2007). The country is a signatory to the Kampala Convention under which the onus of assistance and protection of internally displaced persons (IDPs) rests on the government, including those displaced by climate.[18] International and national policies relevant to refugees include the Convention on Refugees and the OAU Convention Governing the Specific Aspects of the Refugee Problem in Africa; the International Covenant on Civil and Political Rights; the International Covenant on Economic, Social and Cultural Rights; the African Charter on Human and Peoples' Rights; the Convention on the Rights of the Child of 1989; the National Land Policy, 1997; the National Human Settlements Development Policy, 2000; the Agricultural and Livestock Policy, 1997; the National Environmental Policy; the National Forestry Policy; the National Wildlife Policy, 1998; the National Education Policy; the Employment Policy, 1997 (under review); and the National Fisheries Policy, 1997 (Chimanda and Morris 2020).

Migration as an adaptation strategy can be a pathway out of poverty (Adger et al. 2003; Barnett and O'Neill 2012; Elllis 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). However, migration must be addressed holistically and embedded in development policies and planning through inclusive and participatory approaches (Arora 2020). Strengthening adaptive capacities and increasing readiness in the face of climate change (Arora et al. 2019; Rigaud et. al. 2018; Warner et al. 2009) can create an enabling environment for the positive effects of migration to manifest. Tanzania's NAPA includes relocation of vulnerable communities, infrastructure, and services as an adaptation strategy in hazard-prone areas.

The urgency for transformative and far-sighted planning and action on climate migration cannot be postponed—with 2030 a critical year. The increasing number of extreme events and displacements in Tanzania raises an alarm bell (Gov of Tanzania 2012). Climate impacts will continue to deepen existing vulnerabilities and lower capacities, leading to poverty and fragility (Gov of Tanzania 2012). Already, the number of additional internal displacements attributed to disasters stands at 57,000 (IDMC 2020). Ex post responses to crises 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.

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16. *Sendai Framework*, at para 33(h).
17. *Sendai Framework*, at para 28(d). See also paras 27 and 30.
18. Data are from the AU Convention for the Protection and Assistance of Internally Displaced Persons in Africa (Kampala Convention) database, AU, Addis Ababa, Ethiopia, https://au.int/en/treaties/african-union-convention-protection-and-assistance-internally-displaced-persons-africa.

There is a real opportunity to harness climate migration as a factor of growth, jobs, and economic transition within countries, which to date has remained untapped (Scheffran, Marmer, and Sow 2012; World Bank 2018b). A unified approach to addressing climate migration must deliver on the core development needs—food, water, environment—and priorities to deliver on Tanzania's SDGs and the 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. Tanzania's population is projected to almost double by 2050, reaching between 102.3 million (in SSP2) and 119.0 million (in SSP4). The plausible climate migration scenarios presented in this report provide an opportunity—through proactive global, national, and local action—to not just reduce the scale of climate migration but also to harness opportunities for growth and jobs as part of the transition to resilient and low carbon economies in the pivotal 2020s. Compared to other countries in the Lake Victoria Basin, the results for Tanzania project the largest plausible scale of climate migration; with the number of climate migrants outpacing other internal migrants under all but optimistic scenarios. This underscores the need for urgent attention and far-sighted planning. This chapter proposes a strategic response framework for mainstreaming climate migration into development policy and planning in Tanzania.

4.2 THE MACS FRAMEWORK

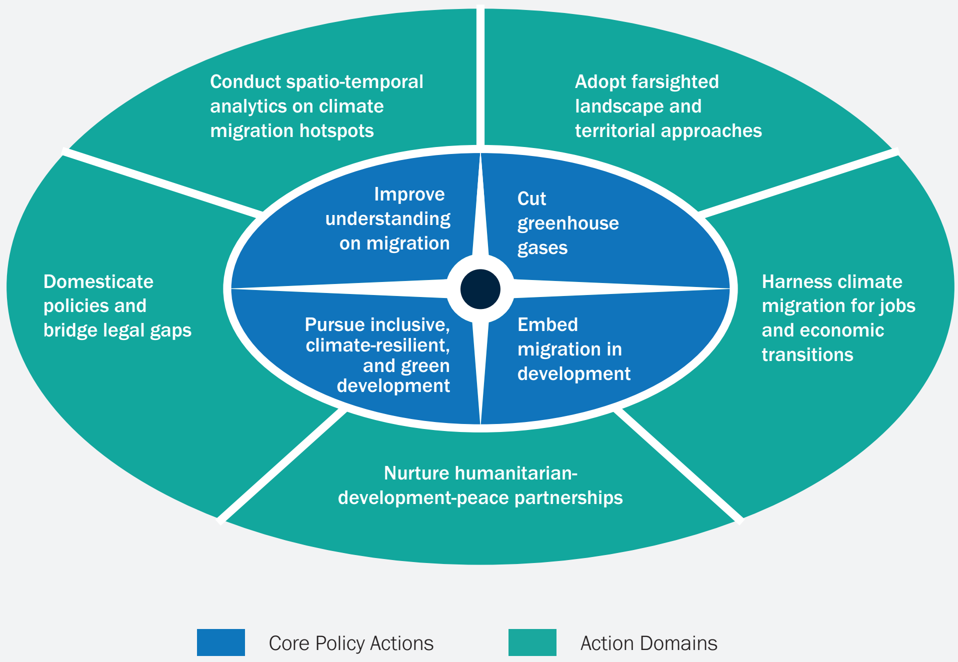
Climate migration is a reality, and as a cross-cutting issue it must be addressed through policy-informed actions that are far-sighted in their approach and execution. Unless concerted climate and development action is taken now, the scale of climate migration will ramp up by 2050, and hotspots of climate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

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

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

Figure 4.1 Migration and Climate-Informed Solutions (MACS)[a]



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).

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 economy of the country is braced not just for the challenges but also the opportunities of climate migration.

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 (Figure 4.1).

The findings from the Groundswell Africa paved the way for domains of action to bolster the delivery of core policy directions set within MACS to reduce, avert, and minimize distress-driven internal climate migration. It followed an expanded modelling of climate induced migration in the Lake Victoria Basin Countries (Rigaud et. al. 2021a) and the West Africa countries (Rigaud et. al. 2021b) and identified five domains of action (i) conduct spatio-temporal analytics to understand the emergence of climate migration hotspots; (ii) enable/embrace landscape and territorial approaches; (iii) address and harness climate induced migration as an opportunity; (iv) nurture development-humanitarian-peace partnerships; and (v) bridge the gap in legal mandates and frameworks (Figure 4.1). The results contextualised and localised the Groundswell findings on the basis of literature review of the current and historic mobility patterns and stakeholder consultations. This analysis was further supplemented by the examination from the design features of 165 World Bank projects operating at the climate-migration-development nexus with commitments amounting to US$197.5 billion between 2006-2019 (Rigaud et. a. 2021c).

The MACS framework underscores the need for anticipatory approaches. While the core policies offer high-level forward looking strategic directions, the domains of action are grounded in reality, linked to sectoral interventions, and speak to different group of actors in an inclusive way and along the entire development-climate-humanitarian spectrum.

MACS is designed to be flexible, based on the premise that climate migration is linked to broader development challenges across spatial scales. Paramount to this premise is the need for country leadership and bottom-up engagement to set out policy and embed action in concrete investment projects backed with the right operational instrument. MACS is not restricted to any single country or region nor is there one formula or pre-determined sequence of actions to operationalize it. It provides a holistic yet flexible set of domains of action that can be applied and sequenced, at different stage of planning, in response to the local, country or regional context and migration patterns. It was developed with vital contributions from World Bank staff and a group of internal and external peer reviewers. Stakeholders inputs from civil society, government institutions, and academia, as well as regional and international organizations and donors were also integrated during the course of consultations.

The MACS framework speaks to both policymakers and practitioners as it offers critical information and insights with regards to trends, timelines and development and policy implications of climate-induced internal migration. It is intended to inform the preparation of strategic and sectoral development plans and is targeted to national and local level planners, who are in the frontline of future climate migration trends. From the World Bank's perspective, MACS offers inputs to the core diagnostic tools—including the new the Country Climate and Development Report (CCDR)—that inform country engagement and helps to pinpoint areas that may become hotspots of climate in- or out-migration in both rural and urban areas, and across vital landscapes, and key coastal and livelihood zones. In addition, the framework is geared to inform international actors along the humanitarian-development-security continuum. Donors and development partners can use MACS to leverage concrete instruments to finance investments and design new projects, which tackle climate migration as a cross-sectoral issue and address challenges faced by climate-driven migrants and host communities, in particular, in fragile environments.

4.2.1 Overarching 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 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. In Tanzania, there could be 3.6 million less internal climate migrants, with numbers reduced from an average of 13.4 million in the pessimistic scenario to an average of 9.8 million in the optimistic one by 2050 (figure 4.2 and table 3.1). Stringent global climate action would be needed to adhere to the Paris Agreement and limit future temperature increases to less than 2°C by the end of this century, close to the more climate-friendly scenario in this report. According to UNEP (2020), the world is moving toward a temperature rise in excess of 3°C this century, and could increasingly foreclose some of the options for reducing climate-induced migration. Increased ambition in the next round of Nationally Determined Contributions (NDCs), especially for the high emission countries, must have emboldened and comprehensive mitigation policies and include carbon pricing, urban and land use planning, and innovations in performance standards. Mitigation policies must be inclusive and pro-poor, guarding against potential blowback of mitigation measures. Tanzania, a relatively low emitter, contributed 0.01 percent (13.3 million tonnes) to the cumulative global emissions in 2019 and has a commitment to reduce its emissions 10 percent to 20 percent by 2030 relative to the business as usual (BAU) scenario (Gov of Tanzania 2018).[19]

19. Data are from Knoema World Data Atlas—CO2 Emissions database, https://knoema.com/atlas/ranks/CO2-emissions?baseRegion=TZ

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 over the medium to long term. This is particularly important for low and lower-middle-income (LIC, LMIC) countries such as Tanzania, in which the numbers of climate migrants by 2050 could be as high as 13.97 percent (pessimistic scenario) of the total population. The urgency for inclusive climate development and transformative action at scale is even more important in the face of locked-in warming patterns and the slow pace of global emission reduction. For example, with almost one-third of the Tanzania's gross domestic product (GDP) in 2017 coming from the agriculture, forestry, and fishing sector (World Bank 2020<letter>); and 80 percent of the agriculture rainfed and smallholder, the sector remains highly climate vulnerable (Ojoyi 2017; Rioux et al. 2017; USAID 2018). Annual losses of agricultural productivity from weather-related risks (mainly droughts) are estimated at US$200 million (Arce and Caballero 2015) and highly productive areas in the southern and northern highlands are increasingly affected by declining rainfall, frequent droughts, and significant increases in spatial and temporal variability of rainfall (NCCS 2012). The livestock keepers have already changed their movement patterns, shifting their herd toward southern Tanzania in search for pastures (Gov of Tanzania 2007). In this context, the focus on building resilience and adopting adaptive strategies must include far-sighted planning not only for agriculture but also alongside economic transitions toward less climate-sensitive jobs and livelihood opportunities. Far-sighted management of demographic and urban transitions and investment in human capital can also reduce climate vulnerability to rapid and slow-onset events. Targeted interventions, including promoting better adapt in place options, 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 while considering the range of mobility patterns and displacement.

3. Embed climate migration in development planning for all phases of migration and across time scales

Countries must integrate climate migration for all phases and patterns of migration across time scales into national development plans and policy. Most regions have poorly prepared strategies, policies, plans, and laws to deal with people moving from areas of increasing climate risk into areas that may be heavily populated. 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 helps communities to stay in place where local adaptation options are viable and sensible. There are land and water degradation in climate in- and out-migration hotspots in Tanzania linked to climatic and nonclimatic factors. Studies show that climate migration hotspots such as Dar es Salaam face difficulty in meeting their water security, and these challenges will escalate with increasing demand and climate change (Gov of Tanzania 2003; Nobert and Skinner 2016). These impacts need to be addressed for the people now facing the brunt and for near-term migrants.

Components of successful local adaptation include investing in climate-smart infrastructure, diversifying income-generating activities, and building responsive financial protection systems for vulnerable groups, including women. For example, the Msimbazi Opportunity Plan (World Bank 2019f) in Dar es Salaam builds resilience across the migration cycle. It contributes to adapt in place by converting most of the floodplain into city parks and building elevated terraces to guide the water and create higher edges to protect against recurrent flooding that has plagued the Msimbazi basin.

Enable mobility facilitates movement of people away from unavoidable climate risks when the limits of local adaptation and viability of ecosystems are reached. Governments should facilitate safe, orderly, and dignified migration (or, as a last resort, planned relocation) toward areas of lower risk and higher opportunity by providing skills training, information, and legal support. In Tanzania, models project that sea level rise compounded by storm surge will see climate out-migration increase in the east and south. Another climate migration hotspot, Arusha, is estimated to see lowering of groundwater levels to 50–

75 meters by 2050 as a result of urbanization and future climate change. Enable mobility offers a risk management strategy that reduces the vulnerability especially of the poor populations in informal areas with limited access to basic services such as water supply, sanitation, and electricity (Olarinoye et al. 2020). Through mobility, the Msimbazi Opportunity Plan aims to reduce the people, properties, and vital infrastructure exposed to the flood hazard.

In after migration, sending and receiving areas and their people are well-connected and adequately prepared for the medium and longer term. Policy makers should develop and implement migration preparedness plans for the immediate and longer-term population growth from migration. Secondary cities are growth poles that can support large, active domestic markets and focus areas for tertiary manufacturing, while strengthening rural to urban linkages by providing access to markets. Plans should include 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. Finally, those individuals and businesses in unsafe areas will be resettled and provided compensation in the Msimbazi Opportunity Plan. The resettlement will include livelihood restoration programs, based on good international practices (World Bank 2019e).

4. Invest now to improve understanding of internal climate migration

More investment is needed to better contextualize and understand climate migration, particularly at scales ranging from regional to local, in which 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 a given locale, which will affect the magnitude and pattern of climate change–induced movements. Studies, as conducted for this report, provide insights on the scale of the issue. As more data become available on climate change and its likely impacts on water availability, crop productivity, and sea level rise, scenarios and models need to be updated. Increasing the modeling 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, technological change, and mobility, and help countries tailor policy, planning, and investment decisions. Including climate-related and migration questions in national census and existing surveys is a cost-effective way to advance understanding. Decision-making techniques under deep uncertainty need to be further developed and applied for policy making and development planning. Evidence-based research, complemented by country-level modeling, is vital. In support of this, new data sources (including from satellite imagery and mobile phones)—and advances in climate information—can improve the quality of information about internal migration. In all of these efforts, the privacy of personal data needs to be protected, and human rights observed. Tanzania has growing experience and expertise related to the use of technology and data that can be mobilized for such analytics. For instance, Tanzania's Urban Resilience Programme uses satellites, drones, and community data collection methods to map the urban environment (World Bank 2018c). The mapping campaigns have trained more than 350 Tanzanian students and engaged 35,000 households in the collection of community knowledge in rapidly growing neighborhoods. This exercise has garnered data on houses at risk and transport and drainage networks, flood perceptions in the Msimbazi Valley, solid waste dumps, and community priorities for protection.

4.2.2 Domains of Action to Drive Planning and Action at Scale

The Five domains of action can bolster the delivery of the core policy direction to reduce, avert, and minimize distress-driven internal climate migration as presented below and summarized in table 4.1.

Table 4.1 Domains of Action to Drive Planning and Action: Rationale and Illustrations, Tanzania

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.	Areas of high poverty around the Lake Victoria Basin could emerge as hotspots for climate in-migration by 2030.
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.	Coastal urban centers such as Dar es Salaam are projected to see climate out-migration as early as 2030 and potentially experience a negative net migration balance of 1.3 million by 2050.

ACTION	DOMAIN OF ACTION	RATIONALE	EXAMPLE
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.	Climate migration can become the dominant type of internal migration. Climate-smart urban transitions that 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. Anticipatory planning and focus on climate in-migration in secondary cities or peri-urban areas could lay their foundation as growth poles in place of sprawling slums steeped in poverty.
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.	There have been conflicts between pastoralists and farmers in the Morogoro region, Kilosa District, Mamba ward, Mara region, and Kilimanjaro district because pastoralists have been forced out of their traditional grazing areas in search of water and pasture. The sheer scale and complexity of challenges of climate-induced migration could require 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.	Tanzania occupies 44 percent of the 180,950 square kilometers of the Lake Victoria Basin. The porous nature of the borders, the degradation and scarcity of natural resources, and pressure on livelihoods couple by demographic growth and climate in-migration may lead to complex challenges (and potentially conflicts) that require sound legal mandates and frameworks.

a. Mayer 2011.

b. Leighton 2010

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

Climate-induced migration is not uniform within Tanzania: its impacts vary across space and time. As a result, it poses distinct spatial challenges that necessitate spatially aware long-term planning that can avert, minimize, and reduce the negative impacts of climate migration. While climate migrants will ramp up across the scenarios studied in this report, in Tanzania, for example, they could outpace other migrants as early as 2030 (under the pessimistic scenario) compared to in Burundi and Uganda, where this result will not occur until 2040 and 2050, respectively. The possible emergence of climate migrants as the dominant category in 2030 calls for urgent policy action in Tanzania. Furthermore, the mean scale of the climate migration across scenarios in Tanzania ranges from 9.57 percent to 11.25 percent, reflecting local characteristics of demography, geography, and socioeconomic conditions. Expanded and more granular modeling and analysis undertaken in this study, including a focus on water stress, crop productivity, net primary productivity, and sea level rise compounded by storm surge, floods, and conflict, would benefit from local data, tailored assessments, and on-site interviews. For example, the study shows that median age and sex (gender) demographic variables, which have their own relationship with population change, amplify climate migration in the rural areas of Lake Victoria Basin countries and dampen of climate migration in urban areas. These findings have important policy implications and require greater scrutiny and analysis. To secure resilience, it's imperative to develop climate migration hotspot maps for the country, identify spatial climate risks and impacts, and investigate the state of natural resources and plan for their conservation.

Early action, aided by state-of-the-art models on the current and future trends of mobility, is crucial for policy makers to drive proactive and informed action. Investing in evidence-based research at the national level and mobilizing new data sources—including from satellite imagery and mobile phones—can help policy makers better contextualize and understand climate migration (particularly at local scales) when climate impacts may deviate from the broader regional or global trends. The results from this study demonstrate that climate migrants will move from less viable areas with lower water availability and crop productivity and from areas affected by rising sea level and storm surges. These trends and the emergence of hotspots of climate migration will have major implications on conceiving effective responses. In Tanzania, climate in-migration will be concentrated in the north, particularly around the Lake Victoria Basin, which has high incidence of poverty, whereas the climate out-migration hotspots will be concentrated in the east and south. This implies the need for greater development efforts, investments, and focus to adequately prepare the Basin for the influx of climate migrants. 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 and sanitary services and energy infrastructure (IUCN 2018; LVBC 2018). For example, community meetings as part of the Tanzania Urban Resilience Programme helped people develop basic spatial awareness at local levels with respect to flood hazards and typical community flood response (World Bank 2018c).

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

Climate change impacts and other socioeconomic 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 2020b), slow-onset climate factors will adversely affect water and land resources and food systems. Ultimately, these changes affect migration patterns and necessitate 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 2020b). Coastal zones, key river basins (Rufiji, Wami/Ruvu, and Pangani), and drylands will be disproportionately affected by climate change and exhibit unique risks (World Bank 2015a). Climate out-migration could occur as early as 2030 and Dar es Salaam could potentially experience negative net migration balance of 1.3 million people (pessimistic scenario) by 2050. Meanwhile, the regions in the Lake Victoria Basin (Kagera, Geita, Mwanza, Mara, Simiyu, and Shinyanga), consisting primarily of rainfed croplands, display positive net migration across scenarios.

Analysis of climate change impacts on landscape, terrestrial, and marine ecosystems and natural habitats combined with community-focused planning is a step forward. For instance, the Resilient Natural Resource Management for Tourism and Growth project bolsters the management of natural resources and tourism assets while creating access to alternative livelihoods for communities living near priority areas of southern Tanzania should continue to manage plausible climate impacts proactively.

The placement of landscape approach within larger territorial and regional approaches enables planning across spatial and time scales through the full migration life cycle (before, during, and after). It considers the underlying causes of distress-driven migrations and addresses both slow- and rapid-onset climate impacts and their interlinkages. Site-specific planning for climate-induced migration can occur with an expanded and integrated view of land that supports local priorities and natural resource uses. Unlike sector-oriented planning, a landscape approach allows deeper understanding of how human-natural ecosystems affect migration through land management, natural resource management, livelihoods, and ecosystem integrity. Lower agricultural productivity and changing precipitation patterns could lead to climate in-migration hotspots around the periphery of Lake Victoria, increasing resource competition and stress on the lake ecosystem. Local, national, and regional planning are essential to avert conflicts and crises amplified by population increase. Site-based and locally driven practices to undertake forest management, conserve wildlife, and develop water management plans, integrated community programs, and land use plans will enable us to avert, minimize, and address climate-induced migration (Gov of Tanzania 2012; World Bank 2015a). The Lake Victoria Basin is a critical natural resource for fishing, water, transport, and other services, and contributes to the regional economy. Its emergence as a climate in-migration hotspot suggests the urgent need for both national and regional approaches to its conservation and management.

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 et al. 2012). Sequences of flexible incremental adaptation should be explored with more transformational adaptation, to secure resilience over longer time scales (Kates et al. 2012; Pal et al. 2019). 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 Tanzania to absorb labor and a large youth bulge into nonagricultural and less climate-sensitive sectors. Climate-induced migration will take Tanzanians to different anthropogenic biomes, 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).

Good management of migration, driven by climate change over longer time scales, can produce positive momentum for such shifts (World Bank 2019a). Climate-smart urban transitions 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. For instance, the vibrant cities of Dar es Salaam and Tanga will be affected by sea level rise, compounded by storm surges. In such cases, early action to fortify coastal assets through green and grey infrastructure must be optimized through adapt in place options, while considering participatory planned relocation as part of longer-term solutions. Anticipatory planning through a focus on climate in-migration to secondary cities or peri-urban areas could help them become growth poles instead of sprawling slums steeped in poverty. Combining these opportunities with climate-smart urban transitions that 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 a win-win. 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 make migration work for all (FAO 2019).

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

National and local stakeholders can help place migration in the triple nexus of humanitarian-development-peace efforts. While this report does not focus on cross-border migration, 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. Countries must 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 countries in pursuing more holistic and durable solutions to climate-induced migration and displacement (World Bank 2019a) in support of peace, stability, and security in the region. In the past, humanitarian efforts were followed by development efforts with different objectives, counterparts, instruments, and logic (Guinote 2019). Tanzania, for example, has formulated comprehensive national policies along with operating funds for disaster risk reduction (DRR). DRR is included in the Poverty Reduction Strategy Paper (PRSP) (in Tanzania it is known as National Strategy for Growth and Reduction of Poverty [NSGRP]) (Bhavnani et al. 2008). Climate change is posing novel challenges and causing new dilemmas to undermine the humanitarian, development, and peace agenda. 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). In Tanzania, conflicts have occurred between pastoralists and farmers in the Morogoro region, Kilosa District, Mamba ward, Mara region, and Kilimanjaro District because pastoralists have been forced out of their traditional grazing areas in search of water and pasture (Gov of Tanzania 2003; Kibona 2008).

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). This approach is geared to reduce humanitarian need, risk, and vulnerability through well-aligned short-, medium- and longer-term contributions by humanitarian and development actors (OCHA 2017). The linkages need to happen simultaneously (Lewis 2001) to secure peace, address humanitarian objectives to save lives and alleviate human suffering, and achieve the development priority to alleviate poverty. Modalities to increase the impact of climate humanitarian development and peace actions include establishing local platforms for solving cross-border natural resources management conflicts; mobilizing community leaders and strengthening traditional institutions for implementation; and supporting bilateral, trilateral, United Nations– (UN-) facilitated, regional (including international development and Bank-facilitated); and 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). Adequate protections under international law are generally not afforded to those moving primarily due to environmental factors. As the impacts of climate change intensify, there will be more migrants and displaced people uncovered by law. The *Groundswell Africa: Internal Climate Migration in the Lake Victoria Basin Countries* (Rigaud et. al 2021a) report posits 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 regions of Uganda, Kenya, and Tanzania that are semi-arid. Tanzania occupies 44 percent of the 180,950 square kilometers of the Basin. 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 Lake Victoria Basin, scarcity of natural resources, and 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 receive special attention. For instance, as an unintended outcome of the Msimbazi Opportunity, demolitions in the Lower 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. Policy makers must ensure the existing legal frameworks are in line with the Kampala Convention and international frameworks. There should be a cross-cutting review of housing, land, and property issues, and policies that ensure access to schools, work, and health care. There should be monitoring and evaluation of the extent to which governments' actions are aligned with their legal obligations. The provision for legal clinics for basic legal information, advice and representation made available. Accurate information will bolster the legal architecture to address climate-induced migration (IDMC 2010).

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Chapter 5

Call to Action

Inclusive and climate-resilient development should be the center of the response mechanism to climate-induced migration. More inclusive and climate-friendly pathways reduce the scale of climate-induced migration and the scale and spread of climate in- and out-migration hotspots (figure 3.4 and table 3.1) By taking anticipatory action, based on state-of-the-art evidence and projections, we can avoid the worst impacts of this issue, particularly in Tanzania with its significant scale and spread of climate migrants projected in the near future. Tanzania's Development Vision 2025 (Gov of Tanzania 1999) sets out socioeconomic development efforts, and the Five-Year Development Plan II (FYDP) provides multiple entry points to mainstream climate-induced migration including as follows.

- To foster economic growth and industrialization
- To foster human development and social transformation
- To improve the environment for business and enterprise development
- To strengthen implementation effectiveness

Within each strategic priority lies untapped opportunities to leverage and embed migration. The interventions to foster economic growth and industrialization include (i) strengthen natural resource management, prevent environmental degradation, combat climate change; (ii) enable greater use of modern technologies, value chain development, skills development, and improved infrastructure for agriculture; (iii) promote micro, small, and medium enterprises and local content; and (iv) promote investments in creative industries. The interventions for fostering human development and social transformation include (i) education, capability, and skills development; (ii) interventions in water supply and sanitation; (iii) urban planning, housing, and human settlements development; (iv) food security and nutrition; and (v) social protection. The interventions for improving the environment for business and enterprise development include (i) macroeconomic stability; (ii) provision of adequate infrastructure and services; and (iii) ease of doing business. Finally, interventions for strengthening implementation effectiveness include (i) ensure effective institutional organization and coordination and (ii) re-activate the developmental role of the state in economic management and governance. Mainstreaming migration into these strategic priorities offers a win-win opportunity for the country.

Figure 5.1 Links between the FYDP II, the SCD, and the CPF Focus Areas, Tanzania, FY19–FY22

Government 5-Year Development Plan	Country Partnership Framework	Systematic Country Diagnostic
Industrialization Interventions • Manufacturing, Agriculture, Trade • Natural Resource Management, Environment and Climate Change, Tourism • Science Technology and Innovation **Enabling Environment Interventions** • Macroenconomic Stability, • Provision of Infrastructure and Services • Ease of Doing Business	**Focus Area 1: Enhance Productivity and Accelerate Equitable and Sustainable**	**Pathway 1: Structural Transformation** • Agriculture Commercialization and market-orientation • Diversification into high value and non-farm activities • Industry and Services: Exploration of existing and latent comparative advantages; Moving up the value chain and exoirts; Tradability of services • Natural resources: Better leveraging and managing resources **Pathway 2: Spatial Transformation** • Improved rural connectivity with urban areas; Sound urbanization to foster inductrial agglomeration; Role of secondary citites in spatial development.
Human Development Interventions • Education and Capability, Skills Development • Health • Water Supply and Sanitation • Uran Planning and Housing • Food Security and Nutrition • Social Protection • Good Governance	**Focus Area 2: Boost Human Capital and Social Inclusion**	**Pathway 3: Institutional Transformation** • Strangthening capacity of government institutions for better service delivery and public investments **Foundation-1: Human Capital and Gender** • Strangthening labour productivity • Closing rural-urban and gender gaps • Building strong institutions
Reforms to facilitate Effective Implementation • Eradicate Corruption and Promote Strong • Improve Business Environment • Flagship Projects • Land Administration	**Focus Area 3: Modernize and Improve the Efficiency of Public Institutions**	**Pathway 3: Institutional Transformation** • Strangthening capacity of government institutions for better service delivery and public investments • Transparency and accountability **Foundation 2: Macroeconomic Stability**

Source: World Bank 2018c. World Bank Country Partnership Framework for Tanzania FY18-FY22

Strategic frameworks in Tanzania largely perceive patterns of migration as a rural to urban movement. The Country Partnership Framework (CPF) reflects on migration for service delivery and resource deterioration challenge, which would require significant financial inputs. The CPF recognizes that half the population will be urban by 2050, up from a third currently, driven in a large part by population growth and rural-to-urban migration (World Bank 2018a). This will heighten the need for sustainable urban living conditions, including sanitation, waste disposal, and control of both indoor and outdoor air pollution and of industrial effluents. Urban migration is also seen as an opportunity for sustained growth and poverty reduction (World Bank 2017).

This study, through its focus on slow-onset climate factors, reveals important nuances on the pattern and scale of internal climate migration in Tanzania. The scale of climate migration could reach as high as 13.97 percent of the population by 2050 (16.6 million) (figure 3.4). Climate-induced migrants could outpace other "development" migrants in Tanzania as early as 2030—in the high emission scenario (pessimistic and inclusive scenarios), suggesting the adverse impacts of climate can act as push and pull factors (figure 3.4). The emergence of climate in- and out-migration hotspots and the current state of natural resource challenges could impinge on future development outcomes. This internal climate migration will be a response to shifts from less viable areas with lower water availability and crop productivity and from areas affected by rising sea level and storm surges. These patterns are not uni-directional—that is, from rural to urban—or from the poor localities to better off localities. 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. This divergence from traditional patterns of mobility calls for a closer attention to climate and socioeconomic considerations to ensure that we pursue inclusive and climate-informed development.

The plausible scale of internal climate migration and spread of climate migration hotspots require holistic responses aligned with the framework responses of the Five-Year Development Plan (5YDP), CPF, and Systematic Country Diagnostic (SCD) frameworks (figure 5.1). For example, the focus on "enhancing productivity and equitable and sustainable outcome" must be underpinned by structural and spatial transformation buttressed in sound natural resource management (around and of Lake Victoria). Embedding climate migration into territorial and spatial planning has the opportunity to foster growth and sustainable outcomes. A far-sighted focus on climate out-migration hotspots—in centers of economic growth such as Dar es Salaam—should include a set of diverse strategies including grey and green infrastructure and institutional transformations for better service delivery. This focus can embed resilience and preparedness in the face of sea level rise and storm surges.

By moving from a reactive to anticipatory approach, through a focus on climate in- migration hotspots to secondary cities or peri-urban areas could lay their foundation as growth poles in place of sprawling poverty. For example, climate in-migration hotspots projected around Mwanza and Geita, areas of high poverty, could benefit from socially inclusive approaches that go beyond livelihood strategies to drive climate-smart urban transitions that combine with sustainable use and management of nearby Basin 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. Migration, seen through this lens, can be leveraged to consolidate human capital gains which runs across the SCD, CPF, and FYDP.

Good management of migration, driven by climate change over longer time scales, can benefit from and provide impetus for institutional transformation. Both CPF and SCD documents underscore the gaps in the strength and quality of public institutions, especially in sectors such as education, health, water supply, and sanitation. The World Bank's new diagnostic—Country Climate Development Report (CCDR)—provides a further opportunity to understand and address climate induced migration as a crucial part of delivering on poverty eradication and boosting shared prosperity. The sheer scale of projected climate migrants, complexity of drivers, and movement patterns can put additional pressure on public institutions and service delivery systems, necessitating transformation. These goals can be fostered by mainstreaming climate-induced migration in development plans. Migration policy measures, such as supporting remittance services, registration services, accessible transport systems, social protection, cash for work programs, and land tenure, offer ways to make migration work for all while improving the overall efficiency and equity in public institutions and service delivery systems.

The call to manage natural resources for equitable growth through structural transformation and spatial transformation go hand in hand with climate-induced migration. The intervening logic, according to CPF, is the risk of resource degradation and jeopardizing provision of services caused by economic expansion, population growth, and competing demands. Structural transformation is considered important for the "movement of resources from lower- to higher-value-adding activities, and by raising productivity" (World Bank 2017). Spatial transformation can help to capitalize on Tanzania's advantageous geographic location and maximize benefits from spatial integration and agglomeration, empowering rural areas, supporting sound urbanization, and building new cities. Greater connection of people, industries, and markets can drive productivity growth in urban areas. For example, southern Tanzania, historically constrained by poor connectivity and access to markets, needs to be economically integrated and connected to the rest of the country. Sustainable resource management remains at the center of these goals. For instance, domain 2 on landscape and territorial approaches would benefit the Resilient Natural Resource Management for Tourism and Growth project by accounting for the underlying causes of distress-driven migration and offering a pathway to site-specific planning for climate-induced migration with an expanded and integrated view of land.

Box 5.1 World Bank Portfolio Review (2006-2019) on operational responses and experiences in addressing mobility as a primary and/or secondary objective

A portfolio review was carried out to examine and draw actionable insights from the design features of 165 World Bank projects operating at the climate-migration-development nexus with commitments amounting to US$197.5 billion between 2006-2019 (Rigaud et al. 2021c). The learnings from the portfolio proves instructive as we seek to address future challenges, complexities and uncertainties that arise particularly from slow and rapid onset climate impacts and influence mobility-immobility dynamics in the near and long-term. The learnings show that a more systematic and anticipatory approach in designing projects geared toward addressing climate migration is possible. Increasingly, newer projects in the portfolio not only address migrants' direct needs but also provide for enabling interventions (early warning systems and social safety nets) and address root causes of mobility by investing in environmental restoration. There is a need to step up on this with greater vigor and urgency—acting in partnership and engagement of those directly affected.

Climate migrants will move away from areas of water stress, low crop yield, and sea level rise into areas with more favorable climatic conditions. Modeling results suggest that the movement of Tanzanians will carry significant spatio-temporal variations, leading climate in- and out-migration hotspots. This movement might exacerbate spatial disconnects and disruptions in structural transformation and diversification into industries less reliant on natural resources. Because of the migrational shifts and impacts of climate change, policy makers must consider location-specific natural resource challenges, demands, and pressures. The integration of spatio-temporal dimensions with a focus on climate in- and out-migration hotspots will strengthen the spatial transformation objective of CPF and SCD pathway 1.

The landscape approach, espoused in the domains of action, can enable planning across spatial and time scales through a focus on the full migration life cycle (before, during, and after). It offers a pathway to site-specific planning with an expanded and integrated view of land that can support local priorities and natural resource uses, critical to meeting CPF1. Unlike sector-oriented planning, it allows deeper understanding of human-natural ecosystems and how they affect migration through land management, natural resource management, livelihoods, and ecosystem integrity. 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 enable us to avert, minimize, and address climate-induced migration (Gov of Tanzania 2012; World Bank 2015a). At the same time, the landscape approach supports the CPF goal to ensure that 9000 hectares of land is under sustainable landscape management practices by 2022.

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Appendix A

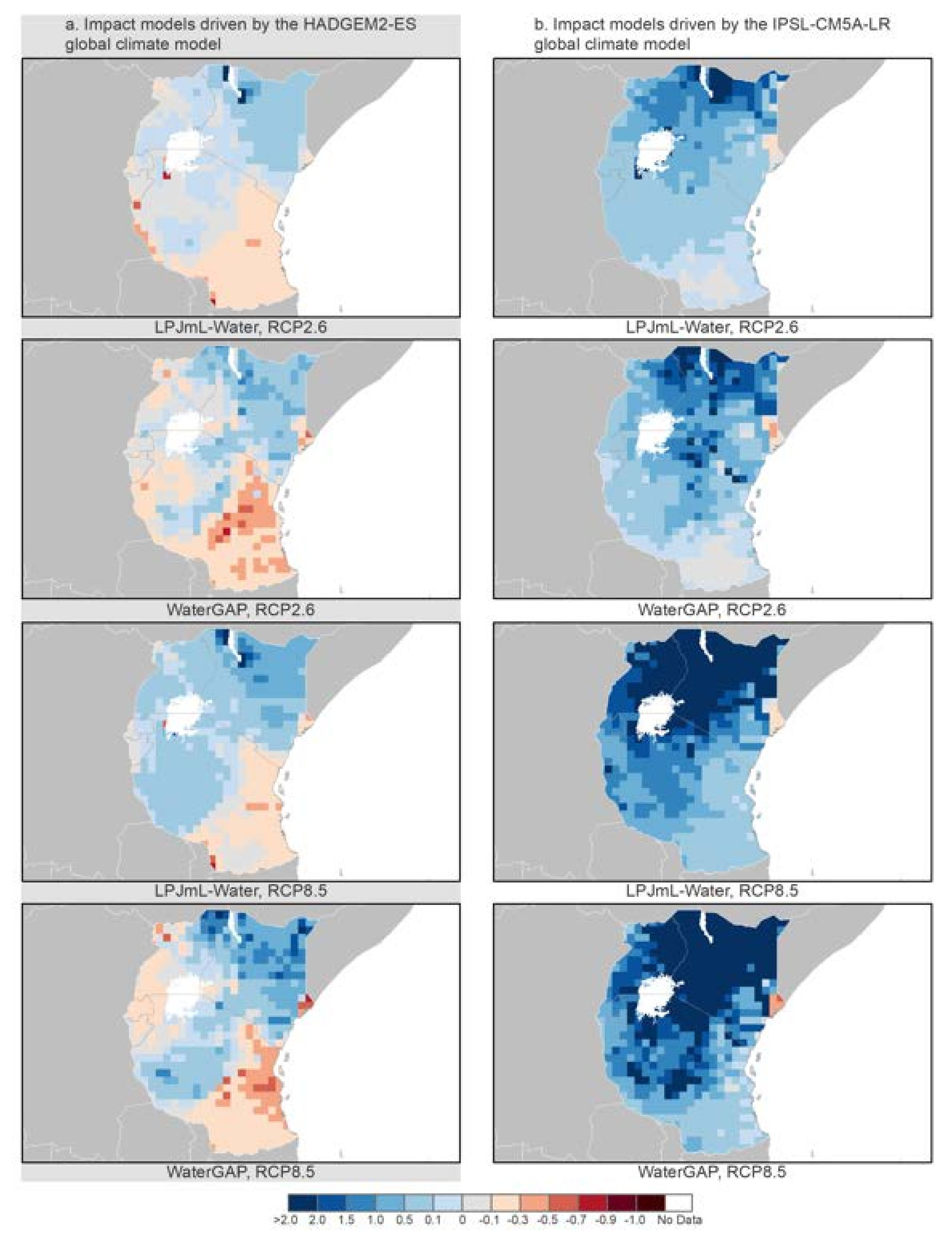
ISIMIP Projections to 2050-2100

This appendix presents the projections for the water, crop, and ecosystem models out to 2050-2100 for the Lake Victoria Basin (LVB) region.[20] 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 a drying in the south of the LVB region and a 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 model 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.

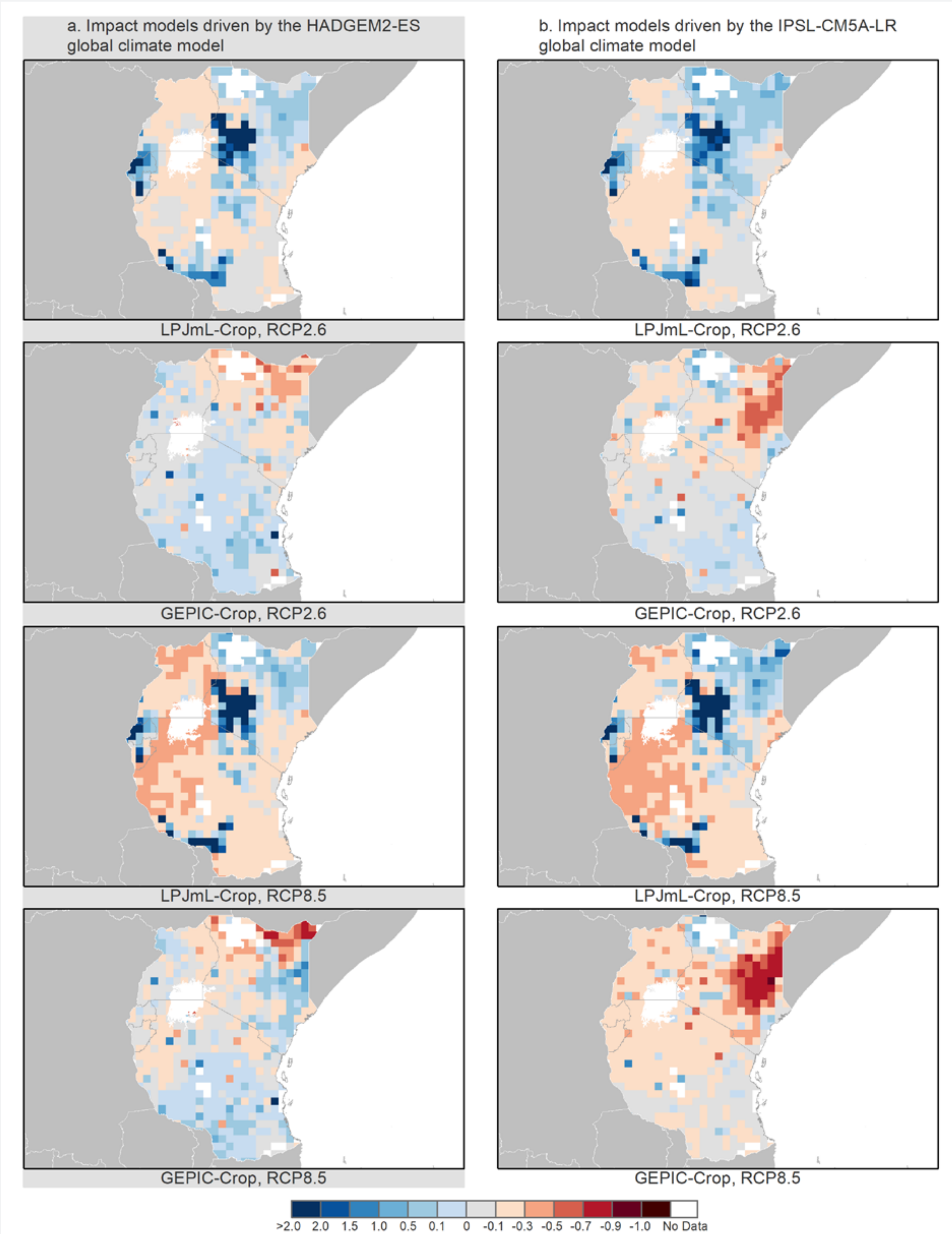
20. The projections used an index in which the historical baseline value is subtracted from the projected value and then divided by the historical baseline value. For more details on this index the overall methodology, please refer to the World Bank's report *"Groundswell Africa: Internal Climate Migration 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



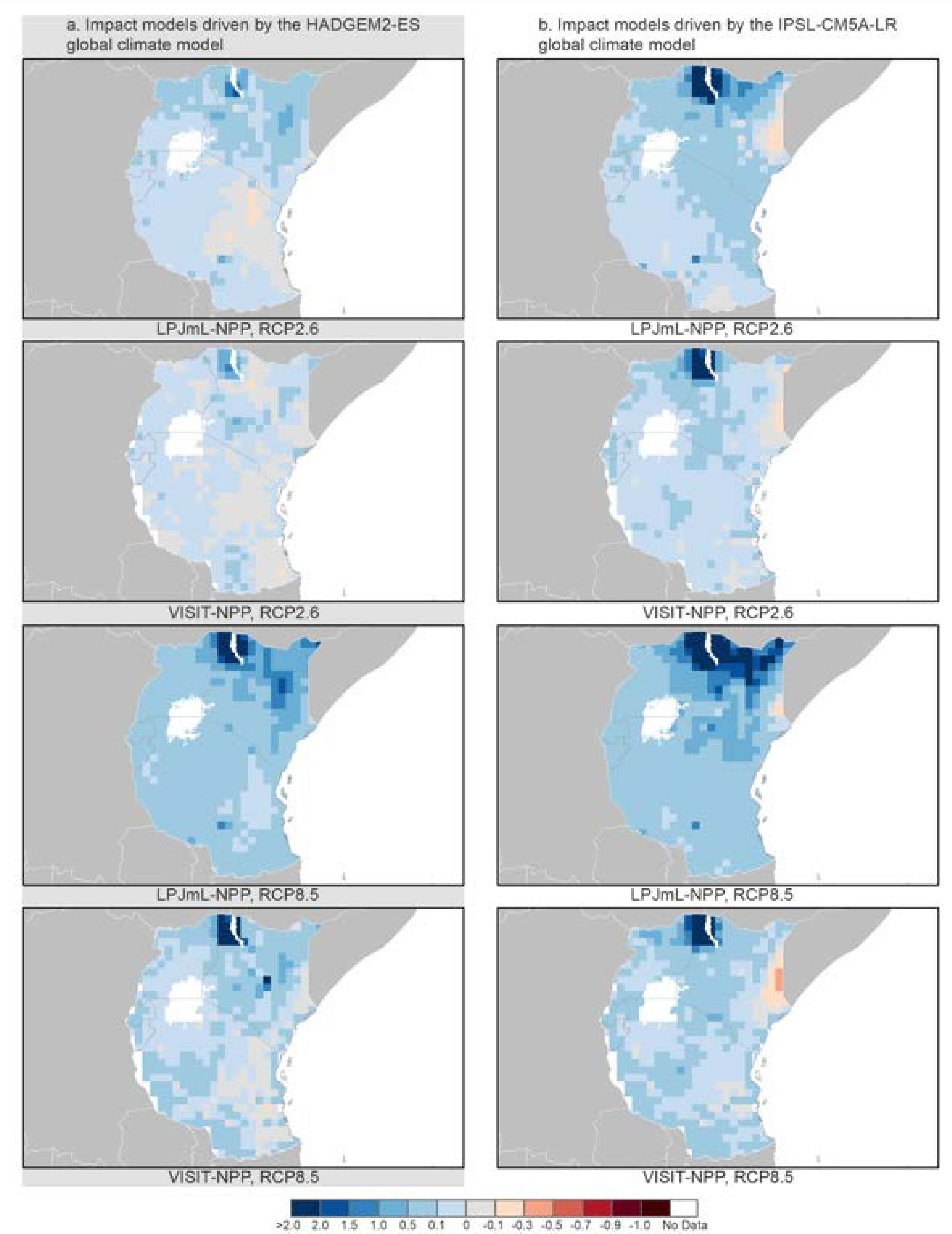
Source: Rigaud et al. 2021a.

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

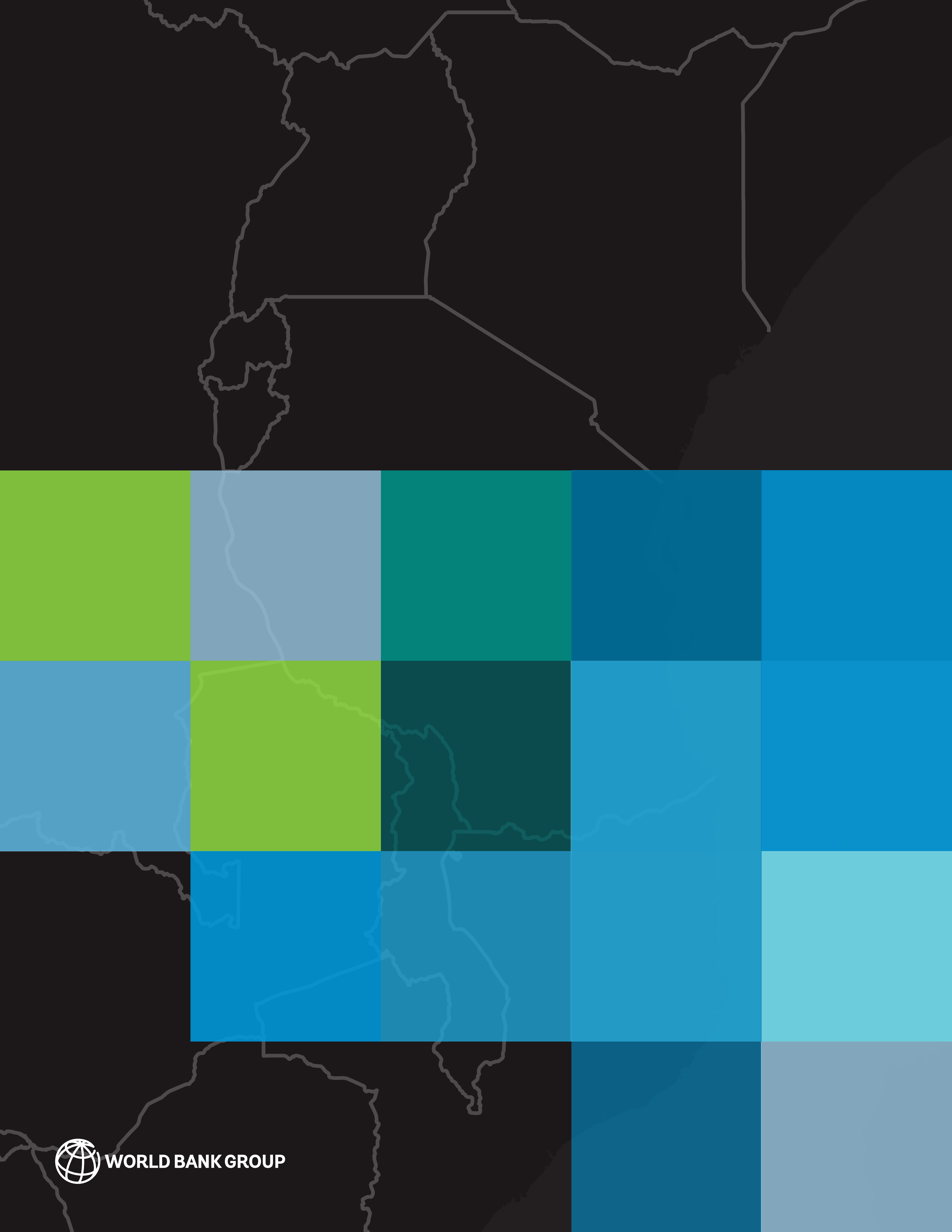


Source: Rigaud et al. 2021a

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



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