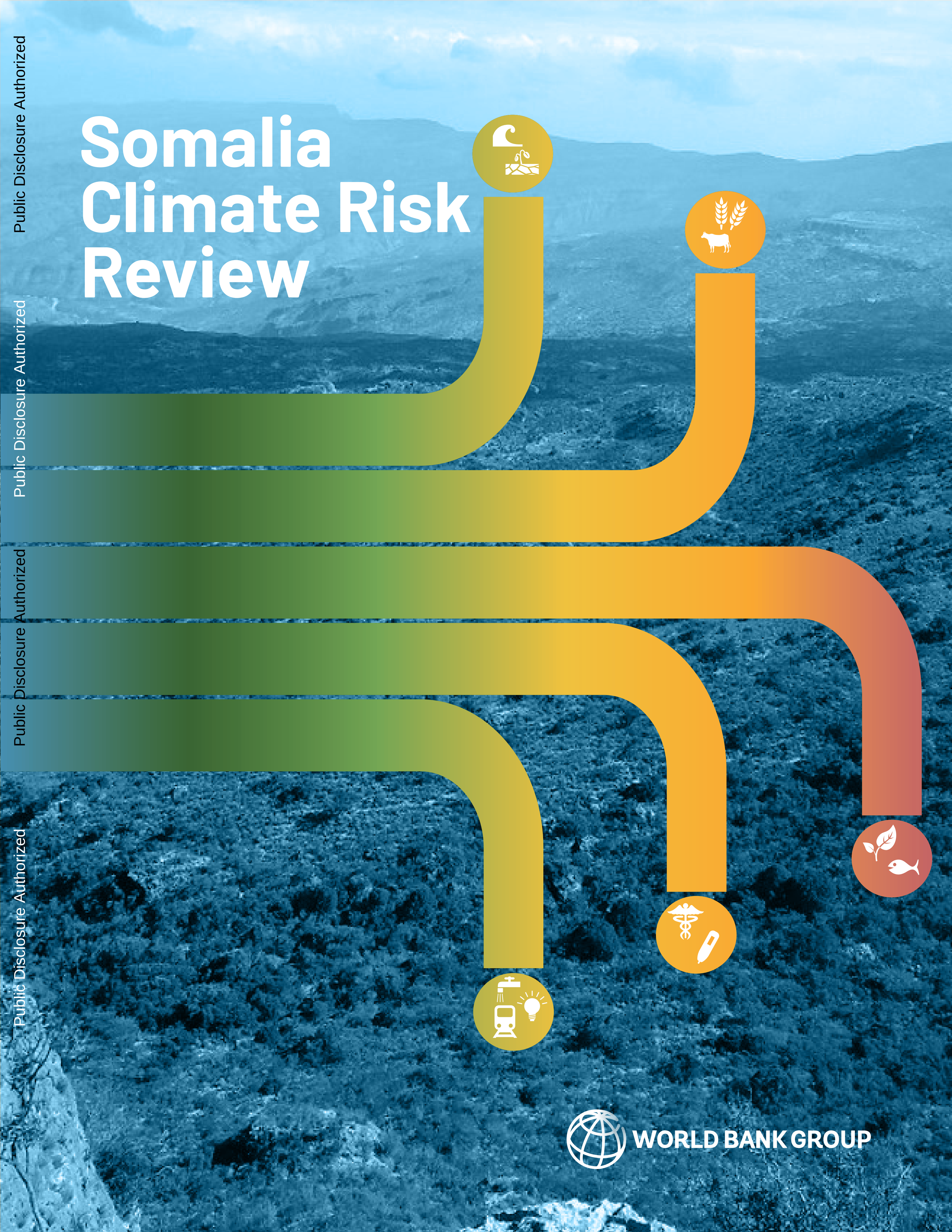
Somalia Climate Risk Review



WORLD BANK GROUP

Somalia Climate Risk Review

WORLD BANK GROUP

1818 H Street NW
Washington, DC 20433
Telephone: 202-473-1000
Internet: www.worldbank.org

Photos: Abdirahman Zeila Dubow / World Bank

Contents

BOXES, FIGURES, MAPS, AND TABLES

Boxes

Figures

Maps

Tables

Abbreviations

AMISOM	African Union Mission in Somalia
cm	centimeter
EEZ	Exclusive Economic Zone
ESP	energy service provider
FAO	Food and Agriculture Organization of the United Nations
GBV	gender-based violence
GDP	gross domestic product
ha	hectare
ICU	Islamic Courts Union
IDP	internally displaced person
km	kilometer
m	meter
masl	meters above sea level
mm	millimeter
NDC	Nationally Determined Contribution
RCP	Representative Concentration Pathway
RVF	Rift Valley fever
t/ha	metric ton/hectare
TFG	Transitional Federal Government
UHI	urban heat island
UN	United Nations
W	watt
WASH	water, sanitation, and hygiene
WHO	World Health Organization

Executive Summary

Climate shapes Somalia's past, present, and future

Somalia's natural and human geography is shaped by its harsh climate. Lying at the eastern extremity of the Sahel, Somalia has an arid to semi-arid climate. Average annual rainfall is under 200 millimeters in much of the country, although it is significantly more in the northern highlands and the south. Mean daily maximum temperatures exceed 30°C in most areas, although they fall much lower in the northern highlands and are tempered by cool offshore currents along the eastern seaboard. Most of Somalia's land area is covered in desert and semi-desert ecosystems, with sparse or seasonal grassland vegetation. Over 50 percent of the country supports only extensive, nomadic pastoralism; with just 13 percent suitable for cultivation, including seasonal agropastoralism and a much smaller irrigated agropastoralism zone located along the two main river valleys (Shabelle and Juba). These limited agricultural areas, and nearby or coastal cities, support the vast majority of the population.

Somalia is in the midst of a prolonged and complex climate disaster, which shows little sign of abating. It has recently endured its longest drought in four decades, now punctuated with renewed flooding. Since 2020, Somalia has experienced five consecutive failed rainy seasons, adversely affecting 46 percent of the population, displacing over a million people, and causing an estimated 46,000 deaths in 2022 alone. Droughts have become more intense and frequent in recent decades as annual rainfall has decreased. Thus far in 2023, precipitation has been higher, which may relieve current drought conditions, but is also bringing severe flooding to vulnerable areas such as the city of Beledweyne. Almost all significant natural disasters in Somalia are climate related. Major floods and droughts are extremely frequent, cause losses of hundreds of millions—or even billions—of dollars to millions of people, and are the largest cause of Somalia's ever-increasing internal displacement crisis.

Climate impacts are inextricably linked to Somalia's social and political vulnerabilities. While climate change may not directly drive conflict in Somalia, it complicates and exacerbates related stresses and vulnerability. The prevalence of vulnerable populations in the country is in part a function of the harshness of its climate. Vulnerability and social divisions are mutually reinforced by weak and unrepresentative institutions and by conflict. Direct and indirect climate impacts disproportionately affect girls and women, who are more likely to forgo education, engage in risky coping mechanisms, and be exposed to gender-based violence as a result. Youth are also put at risk by climate-related displacement, and the resulting hopelessness and marginalization among young men can in turn help fuel conflict.

Climate impacts on natural resources may also fuel the pernicious cycle of conflict, weakened institutions, and resource degradation and competition. Where land tenure is weak and resource access is contested between separate groups dependent on different livelihood systems, climate variability and change are very likely to disrupt the balance between them and to exacerbate conflict. The history of conflict in Somalia is indeed related to contestation of climate-limited resources and marginalization of disadvantaged clans. Widespread land appropriations under the Barre regime were often facilitated by climate-related agricultural policies and contributed to Somalia's descent into civil war. Commercialization of the livestock trade also led to a reconfiguration of the pastoral economy, with a huge growth in livestock increasing the pressure on grazing lands and water resources, even as the number of herders was reduced. Armed groups have been able to draw on both exploitation of natural resources and a large pool of young men, economically disenfranchised in part by the precariousness of rural livelihoods.

Climate change is intensifying a wide variety of risks, including but going well beyond the cycle of acute drought and flooding. By the end of the century, average temperature in Somalia is likely to exceed that experienced by any nation now or across all of human history. Rainfall trends are uncertain: a moderate increase in rainfall is the most likely outcome over the course of the century, but Somalia could either become significantly more arid (close to a pure desert country like Qatar) or significantly wetter (becoming a generally semi-arid country like Kenya). If realized, such changes would have profound effects on both natural and agricultural ecosystems.

Climate risks will multiply with climate change and socioeconomic change

Somalia faces a wide range of climate risks, including acute climate disasters and chronic challenges like heat stress. Most are high-frequency or chronic risks, affect the poor disproportionately, and are likely to increase with climate change (table ES.1). Most are strongly linked to poverty, given the high reliance of the poor on rural livelihoods and outdoor labor, and their limited ability to avoid the impacts of extreme events. While climate change is expected to directly increase the severity of most risks, this increase may not be dramatic in many cases over the coming decades, , and there is significant uncertainty due to the very wide range of potential rainfall outcomes. Over the medium term, increasing exposure due to population and asset growth will probably be a more important driver of risk than climate change. Some risks, however, are likely to see very dramatic climate-driven increases, particularly those associated with heat stress.

Currently, Somalia's most critical risks are major climate disasters—drought and inland flooding. These have particularly severe impacts on rural populations, driving much of the internal displacement crisis affecting Somalia. They have wide-ranging social and economic consequences on production and exports, food security, social vulnerability and cohesion, and ultimately help entrench Somalia's governance and conflict crises. Managing these risks is imperative to stabilizing the country and facilitating its development. The potential for rural production systems to contribute significantly to future growth will depend on adaptation and climate-proofing of rural livelihoods. Flooding has wider economic impacts because of its effects on urban populations, infrastructure networks, and the delivery of key services.

A second set of risks are currently significant and have the potential to increase. Chronic climate stress on crops and livestock will increasingly affect rural production and may drive some livelihood systems to routine failure, unless a significant increase in rainfall is realized. Locust outbreaks are also likely to increase in frequency. Stress on other natural resource–based systems will intensify, with fisheries particularly affected by rising sea temperatures. Chronic health impacts will be exacerbated by climate change. Gastrointestinal disease will significantly increase. The overall effects of changing climate conditions on vector-borne disease and crop and livestock pests and diseases are much harder to predict, given the specific and complex ecologies involved; it is almost certain, however, that some pests and pathogens will be greatly boosted by climate change. Addressing increasing stresses on rural livelihoods will be critical to the ability of the agriculture, livestock, and fisheries sectors to ameliorate rural poverty, improve food security, improve the balance of trade, and contribute to overall economic growth. Human health impacts have a set of implications for human capital that affect productivity and growth more broadly, particularly in relation to efforts to industrialize the economy or develop higher-value service sectors.

Another set of risks are not currently very prominent but have the potential to significantly disrupt future development. Designing resilience to these risks into future development plans and investments is critical. Heat stress is expected to increase dramatically with

Table ES.1 Summary table of Somalia's climate risks with magnitude and trend measures

Sector	Risk	Frequency	Economic cost	Mortality	Poverty linkage	Climate trend
Climate disasters	Drought	3	5	5	5	4
	Fluvial and pluvial floods	3	4	2	5	4
	Coastal flooding	2	3	2	5	4
Agriculture and livestock	Locusts	1	4		5	4
	Crop stress	5	3?		5	3
	Agricultural pests & disease	2	3		5	3
	Heat stress on livestock	5	4?		5	5
	Fodder availability	5	4?		5	4
	Livestock pests and disease	5	4		5	3
Natural resources	Terrestrial ecosystems	5	2?		5	4
	Fisheries	5	2		4	4
Health	Heat stress	5	3	3	5	5
	Vector-borne disease	5	3	5	4	3
	Gastrointestinal disease	5	3?	3	4	5
Infrastructure and services	Degradation of infrastructure	5	3?		3	4
	Disruption of energy supply	5	1		3	3
	Disruption of water supply	5	3?		4	4

KEY:

	Frequency	Economic cost	Mortality	Poverty linkage	Climate trend
1	Rare	<$1 million	< 10	Very weak	Strong decrease
2	Occasional	$1–$10 million	10–100	Weak	Weak decrease
3	Frequent	$10–$100 million	100–1,000	Neutral or unclear	No clear trend
4	Routine	$100 million–$1 billion	1,000–10,000)	Strong	Weak increase
5	Chronic	>$1 billion	> 10,000	Very strong	Strong increase

Note: Impact is figured per event, or per year for routine or chronic events, for economic cost and mortality. **Frequency** ranges from rare (multidecadal), to occasional (once or twice a decade); to frequent (at least 50% of years); to routine (generally every year); to chronic (constant impact, not discrete acute events). **Economic cost** is figured in $ and includes damage and losses; those that are particularly uncertain are denoted with a "?" **Mortality** is indicated if applicable. **Poverty linkage** is whether impact disproportionately affects the poor, with a very weak link meaning the poor are much less affected than others, weak less affected, neutral affected similarly to others, strong affected more, and very strong meaning the poor are much more affected than others. **Climate trend** reflects strength of expected change in climate stressors influencing risk, as well as the strength of their influence on the risk (as most risks will be complex processes involving many drivers).

increasing temperature and precipitation; this could significantly reduce labor productivity not only in agriculture and rural production systems, but also in construction and other forms of low-paid urban labor where workers have little access to cooling. Disruption of infrastructure and key services will also be a major drag on the development of trade and urban economies if not tackled in the planning and design of public and private infrastructure. Urban water supply could become a major challenge in the future, although much of the change will be driven by the increase in population and demand rather than climate. Over the longer term, coastal flooding could pose a significant constraint to trade and urban development if not addressed in the design of port infrastructure and vulnerable coastal cities.

Climate adaptation priorities involve managing existing acute climate impacts, disrupting their links to wider social fragility, and climate-proofing future development

Addressing acute and recurrent climate disasters from drought and flooding primarily requires policy action and investment in the following areas.

- **Disaster risk management.** This includes action and investment in strengthening the preparedness and emergency response architecture, and hydromet and climate information systems; integrating disaster risk management into strategic and spatial planning for key sectors; adaptive social safety nets; and a national disaster risk financing strategy.
- **Resilient rural livelihoods and natural resources.** This includes investment in scaling up soil and water conservation/agroforestry/rangeland management; sustainable rural energy provision; and protection and management of key natural habitats, including establishment and management of terrestrial and coastal protected areas and active restoration of critical habitats. As government builds its regulatory and service delivery capacity, this investment should be complemented by policy action on climate-smart agricultural diversification and value chains; policy frameworks (e.g., land and resource access and tenure, harvesting regulations) and support to local and community institutions for natural resource management and sustainable resource-based livelihoods, particularly for rangeland and fisheries management; digital and physical market access infrastructure to help expand private investment; and mainstreaming forest and biodiversity concerns in policy development and investment planning within key sectors.
- **Water infrastructure.** Investment in water infrastructure will support both disaster risk management and resilient rural livelihoods; this includes investment in storage and irrigation infrastructure; flood and drought-resilient water supply and sanitation infrastructure; and flood defenses for critical locations. These water infrastructure investments should be supported within a wider framework of integrated water resource management planning systems and institutions to balance competing water demands, particularly under the growing pressures of climate change.

Climate adaptation in Somalia must be rooted in efforts to disrupt the linkages between climate, social fragility, and conflict. The first step is to do no harm—that is, to ensure that interventions to address one dimension of the problem do not exacerbate another—by employing *social risk management tools informed by the social and political context*. Peacebuilding and mediation need to be informed by climate and security risks, including through appropriate social and climate screening. Ensuring that women, youth, disadvantaged clans, and other vulnerable groups have full and equitable representation in the adaptation planning process is key to avoiding adverse social impacts of climate investments. Wherever possible, win-win solutions should be identified to address both the climate and social dimensions of risk in tandem, so climate adaption efforts are pro-peace and peacebuilding initiatives support climate adaptation. Key win-win areas are the implementation of *sustainable livelihoods and natural resource management programs* that strengthen local institutions and social structures helping to build social and climate resilience, and *tackling the drivers and consequences of Somalia's internal displacement crisis*. Addressing the vulnerability of internally displaced persons and expanding youth employment will also disrupt the linkage between social crises and conflict.

To climate-proof development, diversifying away from rural livelihoods is necessary but not sufficient. Somalia is already undergoing rapid urbanization, driven in part by climate impacts on rural livelihoods. To avoid replacing rural vulnerabilities with urban, and for this transition to facilitate an economic shift toward trade and small-scale manufacturing, climate analysis should be mainstreamed into development planning. In particular, key investments and policy action are required related to the following.

- **Resilient infrastructure and livable cities.** This includes resilient construction standards and establishment of national building codes covering public infrastructure (ports, roads, water and energy supply), and private construction and services; and climate-smart public investment management. Resilient urban development needs to go beyond reactive construction standards to encompass climate-smart urban development to reduce disaster risks; ensure sustainable energy, transport, and water services; and include green spaces and reduce urban heat island effects.
- **Public health and human capital.** This includes health and safety regulations for public buildings and work spaces, particularly to manage risks of heat stress and floods; postdisaster emergency health provision (mobile clinics, screening and prevention programs, etc.); disease vector monitoring and control programs; and public awareness campaigns on heat stress, water supply and sanitation, vector-borne disease, and post-disaster health and safety.

Purpose and structure of this report

This Climate Risk Review aims to systematically summarize existing knowledge on Somalia's climate risks in an accessible and standardized form. It has developed a set of semiquantitative metrics to summarize and compare risks. It contains four chapters:

- **Chapter 1: Climate Overview** outlines Somalia's climate context and how it shapes natural and human geography and rural production systems, as well as briefly summarizes current climate policies.
- **Chapter 2: Climate Change, Conflict, and Social Risks** examines the interaction between climate, armed conflict, and social risks, both to better understand the wider context of vulnerability and to identify particularly harmful interactions.
- **Chapter 3: Risk Summaries** inventories the major biophysical climate risks across five areas: climate disasters, agriculture and livestock, natural resources, health, and infrastructure and services. For each risk, it collates current information and indicates how ongoing climate change will likely affect the intensity of that risk in future.
- **Chapter 4: Prioritizing Adaptation Action** recaps the overall findings across different risks and links these to the broader development agenda within Somalia. It identifies broad priorities and approaches for climate action in relation to policies and institutions, physical investments, and knowledge. This information is complemented by a more systematic review of adaptation options across different sectors in the report's appendix.

The report is intended as a reference resource and basis for informing further analytical work. The investments and actions it highlights will need to be supported by new and detailed analytical work to identify the most efficient interventions and the institutional steps needed to support them. In particular, new knowledge work should include: (1) analyzing optimal types and scales of water infrastructure investments, (2) integrating hazard mapping with spatial infrastructure and urban planning to identify robust strategies for development of key services, and (3) assessing the feasibility of various risk finance approaches and tools. The World Bank is planning further analytical work on climate impacts and adaptation options in major sectors, including rural livelihoods, resilient infrastructure, and climate-smart urban development, as well as a climate change institutional assessment (CCIA) to help identify appropriate climate governance actions and tools across government at the federal and state levels. This work will inform the preparation of a country climate and development report (CCDR) for Somalia, a new core World Bank Group diagnostic that combines key sector analysis and climate-informed macroeconomic modeling to identify key investments and reforms, and to inform national development and climate change policies.

Warbixin Kooban

Saamaynta Isbeddelka Cimilada ku hayo Soomaaliya: Xilli hore, Hadda iyo Gadaalahabo

Soomaaliya, dabeecadeeda asalka ah, dal iyo deegaanbo, waxaa qaabeysa cimilo qallafsan. Asay ku taal cirif shishaadka bari ee saaxil, Soomaaliya waa dal dhulkiisa meeshaan jidhi oomane (arid) ahayn tahay sool oomane-u-eke ah (semi-arid). Waa dal intiisa badan, kolki laga reebo, koraadka waaqooyi iyo deexooyinka koonfur, roobka ka da'a sanadki ka hooseeya 200 milimiitar. Intiisa badan dalka, isku celcelis heerkulka ugu sarreeya wuxuu dharaar walba kor u dhaafaa 30°C, in kasta oo koraadka waaqooyi iyo deexooyinka ku teedsan xeebaha badweynta, heerkulka aalaa, intaas (30°C) aad uga hooseeya. Barriga Soomaaliya, intiisa badan, waa barri ka ahaysan hab-aagyada hannaska (saxaraha) tooska ah ama kan geedgaableydda oommane-u-ekaha (ee marna abaarsata marna aaranta). In ka badan boqolkiiba 50, dalka wuxuu un kaafin karaa habnololeedka xoola-dhaqashada ee raacatada guurguurta; meesha uu boqolkiiba 13 keli ku habboon yahay dalag beerasho, taas oo ay ka mid yihiin: beerasho iyo xooladhaqasho laysku dhexwado iyo hab beer-biyo-siiska macmalka ah (irrigation) oo laga fuliya agaggaarka dooxooyinka waaweyn ee labada webi (Shabeelle iyo Jubba). Dhul buuhoodkaa (beerashada ku fiican) xaddidan iyo magaalooyinka badda saaran, ayey, intooda badan, dadweynaha ku nool yihiin.

Soomaaliya waxa ay ku sugan tahay dhibaato cimileed dabo-dheeraatay oo aan u muuqan, mid mar dhow waabsami doonta (dhammaani doonta). Iyada oo dhowaan ka soo baxday abaarti ugu darneyd iyo cunta-yarowggi ugu dheeraa, afartanki sano ee la soo dhaafay, ayaa hadda, kaddar oo dibi dhal weeye e, abaarihi daadad u soo daba mareen. Tan iyo 2020, Soomaaliya waxaa isu soo dabo maray shan abaar oo xiriir ah oo aan dhibic roob ah la arag. Taas oo si ba'an u saammaysay 46% dadweynaha, kun-kun oo qofna barakicisay. Sanadki 2022 keli, waxaa, cunta-yarow (famine) dartii u dhimmatay tiro lagu qiyaaso 46 kun oo qof. Abaaraha ayaa noqday kuwo aad u ba'an dalkana barriinsaday kudhannadi (decades) la soo dhaafay kaddib markay roobabki sanadleha ahaa yaraadeen. Haddase, waa sanadka 2023 e, roobabku waa soo yare kordheen, taas oo la filaya inay lurki abaaraha wax ka xalliso, iyadoo isla markaas, la oddorosaya, inay dhibaatooyin fatahaad iyo daadad meela dagan gaarisiin doonaan, sida kuwa magaalada Beledweyne ka dhacay. Aalaa, dhibaatooyinka daran ee dabiiciga ah ee Soomaaliya ka dhaca, waa kuwo uu sababo isbeddelka cimilada. Abaaro iyo abaarsad joogta ah oo qajeel daba yaallaan daadad iyo fatahaadyo dad iyo duunyabo aynaba, khasaaro boqolaal milyan ama xitaa balaayiin doollar gaarayana keena, sababna u ah kor u kaca barakaca joogtada noqday ee gudaha dalka ka jira.

Cimilada ayaa si aan kala hakad lahayn ugu lug leh baylaha, dhib-u-dagnaanta iyo tabaalaha ay bulshada Soomaaliyeed la ildaran tahay iyo jahawareerka ajeeyey siyaasadda dalkooda. Iyadoo laga yaabin qaallowgga (isbeddelka) cimilada, in si toos ah, colaado Soomaaliya gudaheeda uga kiciyo, hayeesha e, wuxuu sii adkeyna hayaa duruufta, siina kordhina hayaa walwalka iyo waxtabashada ka dhalata basanbaaska ka beermo isbeddelka cimilada. Baahsanaanta baylaha iyo tiro badnaanta maatada ay darxumada hayso waa door ay qallafsanaanta cimilada gudato oo ay awggii danyarta mashaqo u geyeysiiso. Waxyeello-u-dagnaanta iyo kala qaybsanaanta bulshada waxaa si wadaag ah u xoojiya daciifnimada hay'adaha aan cidna metelin iyo colaada. Saamaynta cimilada, kuweeda tooska ah iyo kuwaan ahaynba, waxay si qiyaas kabbax ah u bartilmaameedsadaan maatada: sida haweenka: gabdha iyo dumar waaweynba; kuwaas oo ay u badan tahay in waxbarashada ka qadeen oo ay ku nool yihiin nolol ku salaysan qasmaamsi iyo u gagsashada tacaddiga, iyo yaraysiga gaboodfalka kufsiga iwm. Da'yartuna waxay eersataa qaxa iyo barakicinta cimilada ka asaasma. Taas oo rajoxumada ka dhalata barbaarta u horseedda in la gacanbidxeeya, taas oo iyadana keenta in da'yarta kansho looga qaybqaata hurinta colaadaha u helaan.

Saammaynta xun oo ay cimiladu ku leedahay hantida dabiiciga ah, ayaa, sida oo kale, shidaal u noqon kara goobaab ku meeraysigs telefka ah ee colaadaha: waaxyaha oo itaaldarnaada, kheyraadka oo luufluufa iyo tartanka. Meesha uu dhulka xaaluf yahay oo kheyraadkiisana ay ku loollamaan kooxo kala jaad ah oo ku kala tiirsan hab-nololeedyo kala duwan, waxaa dhacda in isrogrogga cimilada iyo isbeddelkeeda wax u dhimmaan isku dheellitirnaanta dhexdooda taalla oo ay sii hufjiyaan iskahor-immaadyada. Colaadda Soomaaliya, waxay runtii, taarikh ahaan, xiriir la leedahay, ku loollanka kheyraadka ay cimilada xaddidday iyo gacanbidxaynta qolooyinka la takoora. Dhulboobki baahsanaa ee taliski Barre waxaa inta badan keenay qorsho-siyaasadyo ku aaddanaa yahoobbiga dhulka (land grabbing) la beerto, kaas oo cimilada xiriir weyn la lahaa, noqdayna mid ka mid ah sababihi Soomaaliya u horseeday dagaalka sokeeye. Ganacsiga xoolaha nool, ayaa, sidoo kale, keenay in xandhaysiga xoolaha dib loo habeeyo, taas oo sasabtay in xooluhu bataan, taas oo iyadana, sii kordhisay culayska ay xoolaha ku hayaan carshin (dhulalka daaqa) iyo ceelbo (meelaha biyaha laga hela), xataa iyada oo ay tirada raacatada yaraatay. Kooxa hubaysan ayaa awood u yeeshay inay isku mar helaan fursad looga faa'ideysto hantida dabiiciga ah, iyo xoogga tiro badan oo rag da'yar oo dhaqaale ahaan dhexda ka baxay (oo baagamuuddo noqday) iyada oo ay shaqo waayiddooda, qayb ahaan, ugu wacnayd luufluufsanaanta hab-nololeedka miyiga.

Isbeddelka cimiladu wuxuu karkarina hayaa habheebyo (halisyo) badan oo kala kaan ah, kuwaas oo ay ka mid tahay, uguse weynayn, goobaab ku meereysiga abaarta ba'an iyo daadadka. Dhammaadka qarniga, isku celcelis, waxay u muuqataa in heerkulka Soomaaliya ka sare mari doona kan adduunka dhan ama gaari doona heer aan taariikhda aadanaha soo marin. Nurarki roobabka waa kuwo aan la laysku hallayn karin: inse roobabka soo kordhi doonaan, kordhid dhexdhexaad ah, ayaa ah arrin la fila haya qarnigan gudihiisa, hase yeesha e, waxaa la saadaalina hayaa, in Soomaaliya laba mid ku soo bixi karta: inay noqota meel si weyn oommane u ah, hannas iiyo gabaaddiir ah (si u dhow saxare dhab ah sida kan dalka Qatar) ama ku soo baxdo meel si weyn uga roob badan sida ay hadda tahay; noqotaa oomane-u-eke marna abaarsada marna aaran noqda (sida qaybo badan oo dalka Kenya). Haddii ay isbeddelladan rummoobaan, waxay saammayn weyn ku yeelan doonaan qaab-aageedyada dalka (kuwooda dabiiciga ah) iyo kuwa deegaankabo (ee dhul-beerashada aadanaha la xiriira).

Inta ay cimilada isbeddesho in la eg ayey korodhaa halista cimilada, marki laysu eego isbeddelka cimilada iyo isbeddelka dhaqan-dhaqaale

Soomaaliya waxaa soo foodsaara haysa halis ballaaran oo isbeddelka cimilada la xiriirta, oo ay ka mid yihiin, masiibooyinka ba'an ee cimilada iyo jirrabyada joogtada ah sida dawakh-kulaylka ama hanfi/halaso ruuqa. Dhibaatooyinka halista leh ee cimilada intooda badan waa dhibaatooyin marmar soo dhaca iyo kuwo halistooda daba-dheeraata, waxay labaduba, si aan la malayn karin, u wiiqaan dadka saboolka ah, waxayna u badan tahay in waxyeelladooda u soo badan doonaan in la eg inta isbeddelka cimilada kordho (jadwalka ES.1). Intooda badan (dhibaatooyinka halista ah ee isbeddelka cimilada) waxa ay si gaar ah u bartilmaansadaan danyarta iyo saboolka, taas oo uu keeno ku tiirsanaanta aadka ah ee danyarta iyo xantiirka ku tiirsan yihiin hab-noolaleedyo qallafsan iyo shaqooyin in qabto, qajeelaa, lagu qasban yahay in bannaanka loo baxo; iyo sida ay awood u lahayn inay ka fogaadaan saammaynta dhacdooyin cimileedka ba'an. Iyada oo la fila haya in isbeddelka cimiladu, si dhab ah, u kordhin doona darnaanta dhibaatooyinka ka dhalan doona, waxaa dhici karta in waxyeellada kororkani noqon mid aad u ba'an soona degdegsan doonta tobannaanka sano ee soo socda, waxaana jira shaki weyn oo ku aaddan ballaarnaanta baaxadda roobabka, inay da'aan, suurowda.

Shaxda ES.1 Soo koobidda halista iyadoo loo eegayo cabbiridda soo noqnoqda, saammaynta iyo isbeddellada

Aagga	Halista	Soo noqnoqodka	Qiimaha	Dhimashada	Xiriirka Faqriga	Abbaarka cimilada
Aafooyinka	Abaar	3	5	5	5	4
	Fatahaadda webiga iyo daadadka	3	4	2	5	4
	Fatahaadda Xeebaha	2	3	2	5	4
Beerashada iyo Dhaqashada xoolaha	Ayaxa	1	4		5	4
	Wansiixa Dalagga	5	3?		5	3
	Cayayaanka iyo cudurrada beeraha	2	3		5	3
	Dawakhkulayka	5	4?		5	5
	Helitaanka Daaqa	5	4?		5	4
	Cayayaanka iyo cudurrada xoolaha	5	4		5	3
Hantida Dabiiciga ah	Terrestrial ecosystems	5	2?		5	4
	Kalluumaysiga	5	2		4	4
Caafimaadka	Dawakha kulaylka	5	3	3	5	5
	Jirrooyinka qaniinka	5	3	5	4	3
	Cudurrada Mindhicirka	5	3?	3	4	5
Kaabayaasha Dhaqaalaha iyo adeegyada	Hoos u dhaca kaabayaasha	5	3?		3	4
	Kala dhantaalanka Tamrada	5	1		3	3
	Dhantaalanka bixiska biyaha	5	3?		4	4

Jeedaalo: halista waxaa lagu hayb soocaa miisaanka 5-dhibic ee tilmaame kasta sida soo socota: Saammaynta waxa lagu qiyaasaa dhacdo kasta, ama sanadkiiba dhacdooyinka la taabuda ama daba dheeraada ee kharash iyo dhimmasho. **Soo noqnoqoshada:** 1 = naadir (ka badan tobaneeyo sano); 2 = marmar (hal ama laba jeer tobankii sano); 3 = joogta ah (ugu yaraan 50% sanadaha); 4 = joogto ah (guud ahaan sanad walba); 5 = dabadheeraad ah (saammayn joogto ah, ma aha dhacdooyin degdeg a h oo aan kala sooc lahayn). **Kharashka dhaqaalaha**, oo ay ku jiraan burburka iyo khasaaraha: 1 = <$1 milyan; 2 = $1 milyan–$10 milyan; 3 = $10 milyan–$100 milyan; 4 = $100 milyan–$1 bilyan; 5 = > $1 bilyan. Sicir qiimahiisa aan si gaar ah loo hubin waxa lagu tilmaamayaa "?" **Dhimmashada** (haddii ay khuseyso): 1 = <10; 2 = 10-100; 3 = 100-1,000; 4 = 1,000-10,000; 5 = > 10,000. **Isku xirka saboolnimada** (haddii ay saammayntu si aan qiyaas lahayn u saamayso saboolka): 1 = aad u daciif ah (sabool ah aad uga yar kuwa kale; 2 = daciif (danyar yar oo saameeya); 3 = dhexdhexaad ah ama aan caddayn (saboolka ah ayaa saammeeya si la mid ah kuwa kale / aan caddayn); 4 = xoog leh (faqiir badan oo saammeeya); 5 = aad u xoog badan (faqiir aad u badan oo saameeya). **Isbeddelka cimilada** (waxay ka tarjumaysaa xoogga isbeddelka la filayo ee cimiladu walaacyada saamaynta leh ee khatarta ah, iyo sidoo kale xoogga saammaynta ay ku leeyihiin khatarta, maaddaama halist ugu badan ay noqon doonto habab adag oo ku lug leh keenayaasha badan): 1 = hoos u dhac xooggan; 2 = hoos u dhac daciif ah; 3 = isbeddel muuqda ma jiro; 4 = koror daciif ah; 5 = koror xoog leh.

Muddadan dhexe, dagnaan ka dhalata sababaha la xiriira (isu dheellitirnaanli'ida) tirada dadka iyo kobaca hantida, ayey u badan tahay, inay ka yimmaadaan waxyeellooyin ka halis weyn kuwa isbeddelka cimilada. Halis-cimileedyada qaar, si kastabo ha ahaatee, waxay u badan tahay inay, soo kordhin doonaan waxyeellooyin kadis ah oo cimilo-curisay ah, gaar ahaan kuwa la xiriira dawakh-kaliileedka.

Hadda, halista ugu daran ee Soomaaliya daganti u tahay waa masiibooyinka cimilada: abaar iyo fatahaadyo baOrriga ka dhaca. Kuwaas oo si gaar ah u waxyeelleeyaan dadka reer miyiga ah, oo abidna sabab u noqda barakaca ba'an ee ka jira gudaha Soomaaliya. Waxay leeyihiin waxyeellooyin bulsho iyo kuwa dhaqaale oo aad u ballaaran, sida carqaladeynta soo saarka iyo dhoofinta; salsalinta sugnaanta cuntada; boorrinta baylahsanaanta bulshada, kala dhantaalka midnimada iyo isku-duubnida dadweynaha; ugu dambeyntiina dhabqinta dedaallada xasilinta dowlladnimada iyo soo afjaridda colaadaha Soomaaliya. U caalhelidda dhibaatooyinka halista isbeddelka cimilada waxay huriweyti u tahay xasilinta dalka iyo u hayaanka horumarkiisa. In la xaqiijiyo horumarka suurtagalka ah ee miyiga iyo habnoolaleedka raacatada waa in la helo tab wax soo saarka miyiga iyo xandhaysiga xoolaha xoogga saaro, oo si weyn uga qaybgeliya tabkaca iyo koritaanka gadaalaha; dedaalkaas oo guushiisa ku xirnaan doonta la qabsi aad ah oo habnololeedka miyiga lala qabsiiya isbeddelka cimilada iyo iska caabbinta dhibaatooyinkiisa. Daadadku waxay leeyihiin saammayn dhaqaale oo ballaaran taasoo ka cad waxyeellada ay, had iyo jeer, gaarsiiyaan dadweynaha magaalooyinka; kaabayaasha dhaqaale iyo laamaha bixiya adeegyada muhiimka ah.

Xirmo labaad oo ka kooban halis-cimileedyo ayaa jira, kuwaas oo awood u leh kana suurowdda inay kordhaan. Lur-cimileedyo joogta ah ayaa dalagga iyo xoolaha, si isa soo taraysa, u waxyeelleen doona, oo sidaa darteed wax soo saarka miyiga hoos u dhigi doonta, taasoo keeni doonta in qaar ka mid ah hab-nololeedyada miyiga si caadi ah u fashilmaan, waa haddaan la helin roobab kuwi hore ka weyn. Ayaxuna, sidoo kale, waxay u badan tahay, in faafiddiisa iyo soo noqnoqodkiisaba kordhi doonaan. Culaysyada cadaadiya habnoolaleedyada ku salaysan hantida dabiiciga ah ayaa sii xoogeysan doona; iyada oo kalluumeysiga, si gaar ah u saammayn doona kor u kaca milicda qorraxda iyo heerkulka badda.

Cudurrada daba-dheeraada, iyagana, isbeddelka cimilada waa uu xoojin doona. Jirrooyinka caloosha ayaa si weyn u kordhin doona. Saammaynta guud ee xaaladaha is-beddelka cimilada, ee ku aaddan cudurrada qaniinka laga qaada iyo cayayaanka, iyo cudurrada dalagga iyo kuwa xoolaha, ayaa aad u adag in la saadaaliyo, kolki si gaar ah loo tixgeliyo deegaanka kakan isku jirjira ee halkan lagaga hadlaya, si kastaba ha ahaatee, waa hubaal in qaar ka mid ah cayayaanka iyo cudur-wadayaasha ay si weyn ugu tarmi doonaan isbeddelka cimilada. Wax ka qabadka walaac kordhay ee habnololeedyada miyiga waxa uu muhim u noqon doonaa awoodda iyo tayeynta waaxyaha beerashada, xandhaysiga xoolaha, iyo kalluumaysiga, si uu wax uga taro saboolnimada reer miyiga, una hirgeliyo geyllan lagu xaqiijiyo sugnaanta cuntada, dheellitirka ganacsiga, iyo ka qaybqaadashada kor u kaca iyo dhaqaalaha guud. Saammaynta caafimaadka bini'aadmigu waxay leedahay jaha-abbaaryo saammeeya raasamaal aadanaha, kuwaaso si ballaaran u tayeeya wax soo saarka iyo kobaca dhaqaalaha, gaar ahaan, marka la eego himilada hiigsanaysa in dhaqaalaha la gaarsiiyo heer warshado iyo taarufeynta waaxyaha adeegyada nolosha lafdhabarka u ah.

Mid kale oo (dhibaatooyinka) halista leh qayb ka ah oo aan hadda ahayn mid aad u muuqata, la filayase inay si weyn u carqaladayso horumarka la hiigsana haya gadaalaha: Qabanqaabinta la qabsiga waryeellooyinka halis-cimileedka u geysan doonaan qorshooyinka horumarka la hiigsana haya iyo hantiggashiga lagama maarmaanka u ah. Cadaadiska dawakhkulaylka ayaa la fila hayaa inuu si aad ah kor ugu kaco, heerkulka iyo roobabkana sii kordhiya: tani waxay si weyn u yarayn kartaa ribixa shaqada, intaas un maahan e, waxay naafayn kartaa tabta wax soo saarka beeraha iyo tabcashada xoolaha ee habnoolaleedka miyiga, si sidaas la mid ah, ayey u shiiqin kartaa waaxda dhismooyinka iyo jaadadka kale ee muruqmaalka mush-haar ku noolka ah ee magaalooyinka. Burburinta kaabayaasha dhaqaale iyo adeegyada huriwaaga ah ayaa iyana noqon doona mid waxyeella weyn u geysata joogtaynta beecmushtarka iyo shuushaaminta ganacsiga iyo dhaqaalaha magaalooyinka, haddii aan si waafi ah looga baaraandegin qorshaynta dhisidda hore iyo dib u hagaajinta kaabayaasha guud iyo kuwa gaarka ah loo leeyahay. Waxaa kale oo caqabo adag caalsaari doona waaxda biyasiinta magaalooyinka, in kasta oo culayskaas intiisa badan ka imman doona, kor u kaca tirada dadka iyo baahida la halmaasha. Gadaalaha fog, daadadka badda ayaa dhib weyn oo hakiyo ku noqon kara kala socodka ganacsiga iyo hormarka dhaqaale oo la hiigsanaya, waa haddii aan laga sii baaraandegin qaabeynta kaabayaasha iyo dekedaha magaalooyinka xeebta saaran, horayna looga sii ildayan waxyeellooyinka la fila kara.

La qabsiga waxyeellada isbeddelka cimilada waxyaabaha ugu mudnaanta badan waxa ka mid ah, basarinta waxyeellada isbeddelka cimilada; iyo caabbinta lurarkeed: iyo ka baylahtirka bulshada basanbaaska ballaaran ee isbeddelka cimilada iyo ka ildayashada waxyeellooyinkiisa mustaqbalka

Wax ka qabadka dhibaatooyinka cimilada ba'an iyo kuweeda soo noqnoqda ee abaarta iyo daadadka, wuxuu, ugu horreyn, u baahan yahay qorshe-siyaasadeedyo waxtaryo leh iyo maalgelin ku aaddan dhinacyada soo socda:

- **Maaraynta aafooyinka halis-cimileedka:** Tan waxaa ka mid ah, hawlgallo iyo maalgelin lagu xoojiyo u tabaabushaysadka qaabdhismeedka birmadka dhibta lagaga falceliya iyo adeegyada xogta cimilada ee hydromet (Adeegga Hydromet waxa uu bixiyaa xog-cimileedyo islamarkaas ah, oo ku aaddan: hawada, biyaha, digniinbixisyada ugu horreeyo iyo agabyada xogta cimilada si loo wargeliyo macaammiisha, iyaga oo laga hammiiqtiraya war wixi hawada, biyaha iyo cimilada ku saabsan); isku darka maaraynta halista iyo jar-u-deggidda iyo qabanqaabada la xiriirta waaxyaha muhimka ah; shabakadaha badbaadada bulshada ee la qabsiga qawjadaha (calamities) cimilada iyo istaraatijiyadda maalgelinta halista dhibaatooyinka qaranka.
- **Hab-nololeedka miyiga oo taaruf (resilient) ah iyo hantida dabiiciga ah oo gagsi leh:** Tan waxaa ka mid ah maalgelinta lagu tayeynaya habka loo maareeyo kaydinta: ciidda, biyaha, dhir-beer-xagnuujiska (agroforestry) ilaalinta carshinta; iyo gaarsiinta miyiga tamar waarta; iyo ilaalinta iyo maaraynta aagagga dabiiciga ee muhimka ah, oo ay ku jiraan xadaynta iyo xayndaabidda dhulqabadka barriga iyo dhul xeebeedka ay ku nool yihiin ama laga helo dhito-dhuleedyada waxtarka leh oo ilaalinta mudan; ilaalinta iyo dib u soo celinta kaydinta johorodleydda tafiirgo'a halista u ah. Maaddaama ay dowllladdu xoojinayso awooddeeda sharciyeynta iyo tan adeeg bixinta, maalgashigan waa in lagu kaalo qorsha-hawlleed ka ambabbaxa qaabka beerqodashada leelgaradka iyo cimila-ka-foofka ah oo kala duduwnaanta beerashada iyo silsilo-qiimeedka suuq-ballaarsiga ku salaysan, qaab-dhismeedka qorshaha (tusaale: dhulka iyo helitaanka kheyraadka iyo haynta, xeerarka dalag goosashada) iyo taageeridda hay'adaha maxalliga ah iyo kuwa bulshada si loo maareeyo hantida dabiiciga ah oona loo xaqiijiyo ahaysiinta hab-nololeedyada waaro oo kheyraadka ku salaysan, gaar ahaan maamulidda dhulka daaqa iyo kalluumaysiga; helidda kaabeyaasha suuqa dhijitaalka iyo ka caadiga ah si ay uga fududeeyaan ballaarinta maalgashiga gaarka ah; iyo shaacinta danaynta dhirta iyo wadataasha noolaha oo lala fangeliyo dhisidda qorshaha iyo jaangooyada maalgashiga ee waaxyaha muhimka ah.
- **Kaabayaasha Biyaha:** Hantigelinta kaabayaasha biyaha waxay kaali doontaa maaraynta aafooyinka halista ah iyo ahaysiinta habnoolaleedyo miyi oo gagsi leh: tani waxaa ka mid ah maalgelinta kaabayaasha kaydinta biyaha iyo beer-waraabiska; xaqiijinta in la helo ilo-biyeedyo u gagsan kara daadadka iyo abaaraha iyo kaabayaasha fayadhowrka iyo moosidda daadadka iyo biyo ka gaaciska goobaha xasaasiga ah. Maalgelinyada kaabayaasha biyaha waa in lagu dheellitiraa qaabdhismeed ballaaran oo isku-dhafa haya qaababka qorshaynta maaraynta kheyraadka biyaha iyo laammaha ku hawllan si loo jimmeeya dalabyada tartamma ee biyaha, gaar ahaan, kolki la tixgeliyo, cadaadiska soo kordhaya ee isbeddelka cimilada.

La qabsashada isbeddelka cimilada ee Soomaaliya waa in lagu saleeyo dedaallo lagu curyaamiyo xiriirrada

u dheexeeyo cimilada, dalaafsanaanta bulshada iyo colaadda. Jaanqaadka ugu horreeyo waa inaan lur la geysan- taas oo ah, in la xaqiijiyo xallinta dhibka inuu dhib kale ka dhalan- iyada oo la adeegsana haya tabta maaraynta halista bulshada oo lagu wargeliyey xaaladda bulsha iyo tan siyaasaddabo. Nabadaynta iyo dhexdhex-aadinta, waxaa loo baahan yahay inay ku salaysnaadaan, xog wargal ah oo laga haya isbeddelka cimilada iyo halista amniga waajahsan, taas oo loo marayo baanjiyid asaab-boon oo cimilada iyo bulshada lagu baaro. Xaqiijinta in dumarka, da'yarta, qolooyinka laga badan yahay iyo kooxaha kale ee nugulta ah helaan metelaad waafi ah oo sinnaan ku dhisan oo ka qaybgelisa qabanqaabada geeddisocodka qorshaha la qabsiga waxyeellooyinka isbeddelka cimilada, kaa oo ah falka ugu fiican ee looga xayndaaban kara saammayn bulsheedka ba'an ee maal-gashiga cimilida. Wada guulaysiga ahmiyadda weyn leh waxaa lagu gaarayaa hirgelinta milaykufulayaa-sha (barmaamijta) maaraynta habnololeedyada waara iyo hanti-dhuleedka asalka ah (kheyraadka dabiiciga ah) oo xoojiya ururada deegaanka iyo xarun bulsheedy-ada gacanta ka geysta dhisidda bulsho u gagsan karta waxyeellooyinka isbeddelka cimilada oo ka gaacin karta wadayaasha barakaca iyo asaayeha qaxa joogtada ah ee ka aloosan guda Soomaaliya. Wax ka qabashada dayac u dagnaanta iyo baylahsanida dadyowgga barakacay iyo ballaarinta mashruuca shaqaalaysiinta barbaarta, ayaa sida oo kale, dhabqin ama hakin kara isu gooshidda ka dhexaysa dhibaatooyinka bulshada iyo colaadaha.

Si horumarka la tiigsanaya waxyeellada isbeddelka cimi-lada looga xayndaabo, in laga geddista habnololeedyada miyiga waa arrin lammahuraan mase filnayn. Soomaa-liya, haddayba, si xawlli ah, uga socotaa magaaloobid (magaalo-degid) xad-dhaaf ah, taas oo waxa keenay ka qayb yihiin, waxyeellooyinka isbeddelka cimilada nolo-sha miyiga gaarsiiyey. Si aan baylahsanaanti miyiga tu magaalo loogu beddelin, iyo inuu marxalad-kala-guurka fududeeyo u guuridda dhaqan-dhaqaale ku tiirsan ganacsi, wax-soo-saar iyo warshadaysi baaxad yar, baanjiyidda cimilada waa in lagu sidko qorshooyinka horumarka. Gaar ahaan, maalgelinta waafiga ah iyo qor-shefulinta loo bahan yahay waa sida kuwan hoos ku sharxan:

- **Kaabayaal taaruf ah iyo magaalooyin lagu noolaan karo:** Tan waxaa ka mid ah dhismooyinka oo heer tayo rasmi ah loo cuskado iyo Qaabdhismeed gagsi leh; iyo jideynta anshi iyo xeerar heer qaran ah oo lagu maareeyo dhisidda kaabayaasha dadweynaha (sida dekedaha, waddooyinka, muulalka qashinqaadka, dhuumooyinka biyaha iyo xarkaha korantada iwm) iyo kuwa gaarka ah; iyo addeegyada iyo muurbulsh-eedyada; iyo maamul leelgarad ah oo maalgashiga dadweynaha lagu maareeya.
- **Magaalo-Dhisid Adkaysi leh:** waxa loo baahan yahay in laga gudbo qaabdhismeedka isaga dayashada iyo iska-dhista uun ku salaysan si loo gaaro yeelaal dhismo-magaaleed caqli-ka-foof ah si loo dhimmo waxyeellada isbeddelka cimilada; oo loo xaqiijiyo heli-taanka adeeg-bulsheedya waaro, sida tamarta, muurka iyo biyaha; oo ay ku jiraan wahdiyo (parks) cagaaran si loo yareeyo saammaynta kulayl-shiimeedka (heat island effects) magaalooyinka waaweyn.
- **Caafimaadka shicibweynaha iyo raasimaalka dadka:** Tan waxaa ka tirsan qaannuunnada caafimaadka iyo amniga ee laga rabo dhismooyinka dadweynaha iyo goobaha shaqada, si loo maareeya halista (ka imman karta) dawakh-kulaylka iyo daadadka; bix-inta gargaar caafimaadka degdega ah dhibta kaddib (goobfayeedyada guurguura, baaritaannka, iyo kahort-agga); Milaykufulayaasha (programmes) la socodka iyo kahortagga cudurrada qanniinka; iyo ololayaa-sha wacyigelinta iyo awaajiga shicibka ee ku aaddan dawakh-kaliileedka, biyo-siiska iyo fayadhowrka, cudurrada ka dhasha dhaqaaqilyada iyo shaafiyidda iyo badbaadada dhibka ka danbaysa.

Ujeeddada iyo Qaab-dhismeedka Warbixintan

Dib-u-eegistan halista isbeddelka Cimilada waxay ujeeddadeedu tahay, in si habaysan, oo heer tayo si rasmi ah oo loogu bogay u dhigan, si fududna loo daa-lacan karo, loo soo koobo wixi aqoon ama cilmi ah ee laga og yahay halista isbeddelka cimilada ee Soomaa-liya. Waxa ay ahaysiisay jiso jaangooyooyin tiro ahaan cabbir-hoosaadyo ah, si loo soo koobo loona barbardhigo waxyeellooyinka halista. Waxayna ka kooban tahay afar cutub:

- **Cutubka 1-aad:** Dulmar guud oo cimilada Soomaaliya indho-indhaynaya: waxa uu qeexayaa xaaladda cimilada Soomaaliya iyo sida ay u qaabayso juquraafiga dhulka iyo kan ku jaadan saammaynta falalka dadka iyo hababka wax soo saarka miyiga, waxa ay si la mid ah oo gaaban, u soo koobaysaa qorshooyinka cimilada ee hadda jira.
- **Cutubka 2-aad:** Isbeddelka Cimilada, Iskahorimaadka, iyo halis bulsheedyada: waxa uu baarayaa isdhexgalka ka dhexeeya cimilada, colaadaha hubaysan, iyo halis-bulsheedyada, si loo hado ama si waafi ah loogu fahmo, macnaha guud ee baylahsanida iyo in la aqoonsado waxyeellooyinka gaarka ah ee isdhexgallada.
- **Cutubka 3-aad:** Gantoobkan halista cimilada waxa uu koobina hayaa shan aagaag oo halista cimilida nooleha: aafooyinka cimilada, beer-qodoshada, xandhaysiga xoolaha, hantida dabiiciga ah, caafimaadka, kaabayaasha iyo adeegyada. Halis kasta, waxay ururisaa xogta hadda jirta waxayna tusinaysaa sida isbeddelka cimilada ee socda u saammayn doono darnaanta mustaqbalka ee waxyeellada halistaas.
- **Cutubka 4-aad:** Mudnaysiinta waxqabadka la qabsiga, wuxuu dib u soo koobayaa xogta guud ee laga helay halista kala duwan, waxayna kuwan ku xirayaan ajeendhooyinka horumarineed ee ballaaran ee gudaha Soomaaliya. Waxayna tilmaamaysaa mudnaan ballaaran iyo abbaarka wax ka qabadka cimilada marka loo eegayo qorshooyinka, ururrada, maalgashiga la taaban karo iyo aqoonta. Xogta waxaa kaabaya dib-u-jalleec habaysan oo ku aaddan fursadaha la qabsiga ee qaybaha kala duwan ee lifaaqa warbixinta ku cad.

Warbixinta waxaa loogu talaggalay inay noqoto il laga tixraaco iyo saldhig laga xog-siiyo gorfayn kale oo tan ka qotodheer. Maalgashiga iyo hawlgallada ay muujinayso waxay u baahan doonaan, in lagu kaalo, itifaallooyin cusub oo faahfaahsan, si loo aqoonsado faraggelinta ugu waxtarka badan iyo tillaabooyinka qaynuuniga ah ee loo baahan yahay si loo taabbaggeliyo. Gaar ahaan, camalka aqoonta cusub waa in ay ka mid noqota: (1) gorfaynta jaadadka iyo cabbiraadda ugu fiican ee hantiggelinta kaabayaasha biyaha, (2) isku dhafka xadaynta halista, kaabayaasha deegaanka iyo qorshe-magaaleedka si loo ogaado sargooyooyinka taarufka ah ee horumarinta adeegyada muhimka ah, iyo (3) qiimaynta suurtaggalnimada, xeeladaha iyo abbaar-maaleedyada kala kaanka ee halista. Bangiga Adduunka waxa uu qorsheynayaa baanjiyid dheeraad ah oo lagu lafaggura saammaynta cimilada iyo khiyaar-la-qabsiga u furan waaxyaha waaweyn, oo ay ku jiraan: hab-nololeedyada miyiga; kaabayaasha dhaqaale ee taarufka ah, iyo horumar magaaleedyo (leelkas iyo) cimilo-ka-foof ah; iyo sidoo kale qiimaynta iyo tijaabada qaannuunnada iyo qaannuunfulinta isbeddelka cimilada (CCIA) si ay u fududayso aqoonsiga tababka iyo hawlgallada asaabboon ee maamulidda cimilada ee dowlladda heer federaal iyo mid gobolba. Hawshan waxay tixraac laga warqaata u noqon doontaa diyaarinta warbixinta cimilada iyo horumarinta dalka (CCDR) ee Soomaaliya, baaritaan cusub oo udubdhexaad u ah kooxda Bangiga Adduunka kaas oo isku daraya jeedaalada waaxyaha muhimka ah iyo qaabaynta cimili-la-socodka ah ee dhaqaalaha baaxadda leh, si loo ogaado maalgashiga muhimka ah iyo dib-u-habaynta, iyo in laga tixraaco horumarka qaranka iyo qorshooyinka isbeddelka cimilada.

Chapter 1

Climate Overview

Somalia is an arid to semi-arid country lying at the eastern extremity of the Sahel. Its natural and human geography is shaped by its harsh climate. Intensive agropastoral production is only possible in limited wetter areas of the river valleys and uplands. These areas, and nearby or coastal cities, support the vast majority of the population. Climate is also highly variable, with frequent grave consequences for the marginal and climate-dependent livelihood systems that support much of the population. While the future climate will be hotter, there is profound uncertainty over future rainfall projections.

1.1 Geography and climate

Somalia has the longest coastline in mainland Africa, at 3,333 kilometers (km), yet much of its territory lies at moderate altitude, with a mean elevation of 410 meters above sea level (masl). Maximum elevations in the central and southern parts of the country are well below 1,000 masl, as the land descends gradually from the foothills of the Ethiopian highlands to the Indian Ocean, across extensive coastal lowlands. The northern part of the country, comprising Somaliland and Puntland, is dominated by highlands that form the spine of the Horn of Africa, including peaks over 2,000 masl, and leaving only a narrow lowland coastal strip in most places (map 1.1).

Somalia lies at the eastern extremity of the Sahel, and has an arid to semi-arid climate. Average annual rainfall is under 200 millimeters (mm) in much of the country, but is significantly higher in the northern highlands and in the south, where it ranges from 400 mm to 600 mm. Mean daily maximum temperatures exceed 30°C in most

Map 1.1 Somalia geography

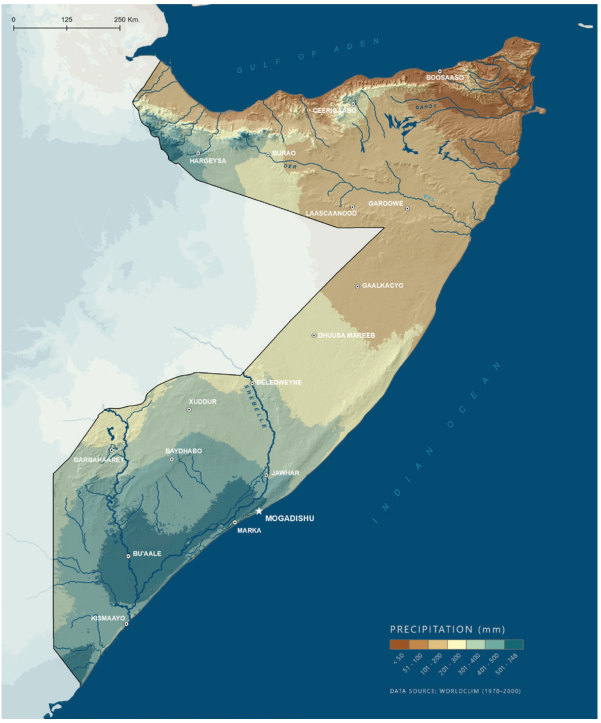
Source: World Bank Cartography Unit, June 2023.

areas, although they fall much lower in the northern highlands and are tempered by cool offshore currents along the eastern seaboard (map 1.2).

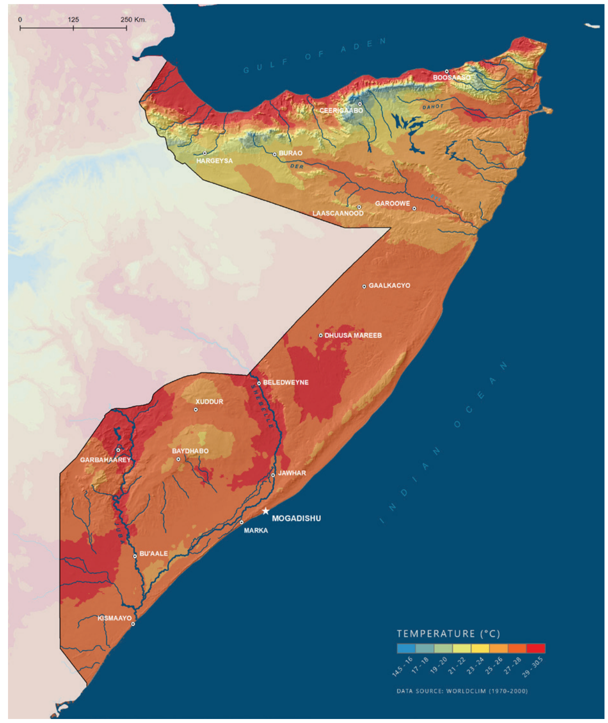
The north is dominated by large desert zones, with limited upland areas experiencing cooler and wetter climatic conditions. The central and southern regions are mainly semi-arid, with some areas reaching semi-humid conditions. A significant portion of Somalia's land area is therefore covered in desert and semi-desert ecosystems, with very little or only spare grassland vegetation (map 1.3). The rest naturally grades from sparse scrubland through

Map 1.2 Somalia rainfall and temperature

a. Total annual rainfall

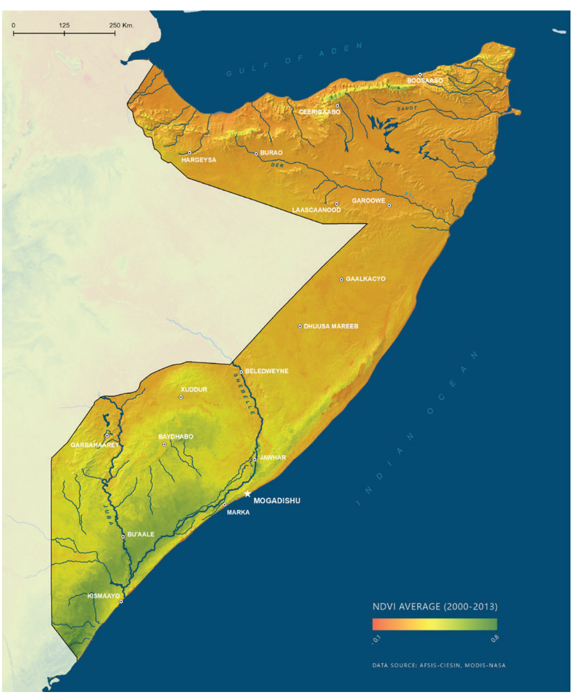


b. Average temperature



Source: Original calculations based on TerraClimate.

Map 1.3 Normalized Difference Vegetation Index for Somalia



Source: Original calculations based on TerraClimate.

to areas of dense savanna/open forest, depending largely on rainfall.

Somalia's biodiversity is generally arid-adapted and includes a high level of endemic and threatened species. Somalia lies in the Horn of Africa biodiversity hotspot—the only global biodiversity hotspot that is entirely arid, apart from the Succulent Karoo hotspot in southwest Africa. *Acacia-Commiphora* shrubland is the dominant vegetation in much of the country, characterized by bushes 3–5 m tall with scattered emergent trees up to 9 m. Endemic and threatened antelopes include the beira (*Dorcatragus megalotis*), dibatag (*Ammodorcas clarkei*) and Speke's gazelle (*Gazella spekei*). The Horn of Africa hotspot also contains more endemic reptiles than any other region in Africa. Somalia has no established protected areas, and much of its habitat is degraded. *Acacia bussei*, an evergreen, drought-tolerant tree which has provided fodder to pastoralists in times of drought, has been placed on the IUCN Red List of Threatened Species due to pressure from charcoal production.

There are four main land use systems. Over 50 percent of the country supports only extensive, nomadic pastoralism. Just 13 percent of the country's total land area is suitable for cultivation (FRS 2013), including seasonal agropastoralism and a much smaller irrigated agropastoralism zone located along the two main river valleys (Shabelle and Juba). A limited zone of oasis-based frankincense production lies along the central northern coast (map 1.4b). There is also a small area of denser forest in the extreme south and scattered pockets of mangroves mostly along the northern coast. Forests have been significantly degraded by large-scale charcoal production and grazing pressure.

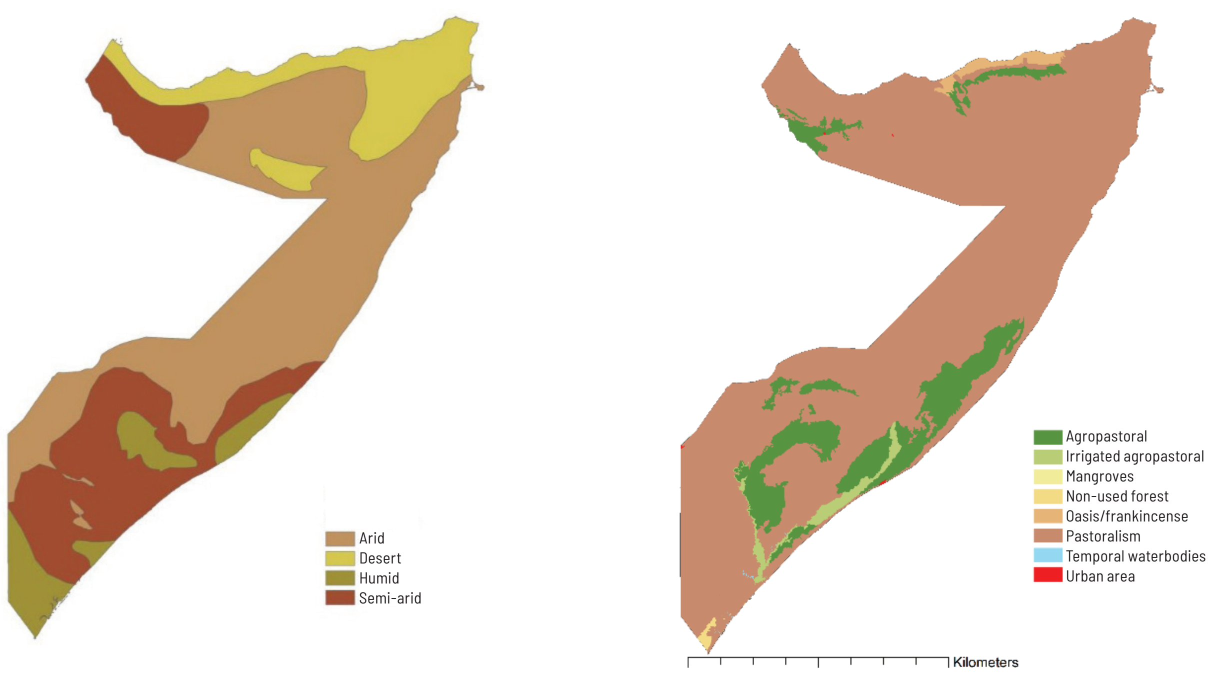
Despite the limited potential, agriculture remains central to Somalia's economic development and poverty reduction (FAO 2018). Population distribution within the country is strongly influenced by the location of agricultural zones (map 1.4 and map 1.5). Agriculture is mostly possible where there are alternative groundwater sources to support irrigation, particularly within the alluvial plains where shallow wells and permanent springs provide

Map 1.5 Population density in Somalia, 2020

Source: World Bank Group Spatial Agent using WorldPop data.

Map 1.4 Major climate and land use zones in Somalia

a. Climate zones **b. Land use systems**



Sources: Climate zones: World Bank Climate Change Knowledge Portal: Somalia; land use systems: Food and Agriculture Organization of the United Nations Somalia Water and Land Information Management (SWALIM).

supplementary water for irrigation (Boitt, Langat, and Kapoi 2018). Most of the northern part of Somalia is dry and cannot support rain-fed crop production except for small pockets of land around the settlements of Gebiley and Borama (map 1.4a). In the south, rain-fed crop production is practiced in the Shabelle and Juba river basins (Boitt, Langat, and Kapoi 2018). About two-thirds of the cultivable land is located here. Irrigation is restricted to the relatively fertile areas around the Shabelle River, where the main crops are maize, rice, sesame, cowpeas, bananas, papayas, lemons, grapefruit, and mangoes.

Cultivable land has long been central to Somali politics. It was central to patronage politics during the rule of Siad Barre (1969–91) and was fiercely contested by different clan-militia in the immediate aftermath of state collapse. Al-Shabaab continues to be active in these areas, building on a number of localized grievances (see Majid et al. 2021; de Waal 2020).

Crop production fell dramatically following the outbreak of the civil war in the 1990s, as many large-scale irrigation systems ceased to function. Production now meets only 22 percent of domestic cereal needs. Only 110,800 hectares (ha) are currently irrigated (IFAD 2021), and permanent crops (the mostly cash crops and fruits that are grown continually, as opposed to being in fallow rotation systems) are grown on just 25,000 ha (Jalango et al. 2021). Annual yields for staple crops are low, even by regional standards: 1 metric ton/ha (t/ha) for maize; 0.6 t/ha for sorghum and sesame (Jalango et al. 2021).

Conversely, livestock numbers are at record high levels, increasing stress on rangelands. Livestock, which remained one of the few viable commercial sectors in the wake of the civil war, are central to Somalis' economic and cultural life. They contribute almost 90 percent of total agricultural output, and provides food and income to more than 60 percent of the population (Maystadt et al. 2013). Nomadic pastoralism is the predominant livelihood for most rural communities (FRS 2013). Herders rely primarily on harvesting rainfall through an extensive network of reservoirs (*berkads*), and move closer to the Juba and Shabelle rivers during longer, more severe dry seasons. The most numerous livestock are sheep, goats, and camels, followed by cattle which are mostly located in the wetter south.

Somalia is also rapidly urbanizing. Around 54 percent of the population currently live in cities, and over 22 percent live in the two largest cities, Mogadishu and Hargeysa, alone. For comparison, in neighboring Kenya only around 28 percent of the population is urban. Rural-urban migration is accelerated by both climate disasters and conflict. Close to 20 percent of the Somali population is internally displaced, and around 75 percent of internally displaced persons (IDPs) live in cities (World Bank 2022c). Moreover, 85 percent of climate-induced IDPs do not wish to return to rural areas—compared with 74 percent of conflict-induced IDPs, according to a recent study (Samuel Hall 2021). Almost half of IDPs are female, and more than half are below 15 years of age,[1] which heightens their vulnerability to a range of risks and has consequences for access to opportunities in urban areas.

Although rapid urbanization is at least partly a response to rural climate vulnerability, it drives an increase in urban vulnerability. Half of Somalia's 10 largest cities are exposed to significant river or coastal flood risk, and the increase in makeshift and poorly planned housing greatly amplifies the risk. The challenges of meeting the requirements of the growing urban population—and ultimately growing a successful urban economy—are also linked to climate. Over 98 percent of urban households cook on traditional charcoal stoves, while most of the rural and nomadic population use firewood and inefficient biomass stoves (UNEP 2019). Only 36 percent of the country's population has access to electricity, almost all of whom are in urban areas, where access varies from around 60 percent in Mogadishu to just 23 percent in smaller cities (RCREEE 2022). Power generation is fragmented and highly inefficient; it is mostly provided by private sector energy service providers through diesel-powered mini-grids at very high cost. Renewables make up only 2 percent of generation capacity (RCREEE 2022). Water availability for Mogadishu is projected to be insufficient for its population by 2030.

There is very little service provision by the state. Urban utilities are generally provided by the private sector, nongovernmental organizations, or foreign agencies; and access to services hinges primarily on wealth and kinship

[1] Source: Somali High Frequency Survey - December 2017, Wave 2, which is representative for "secure" areas in Somalia.

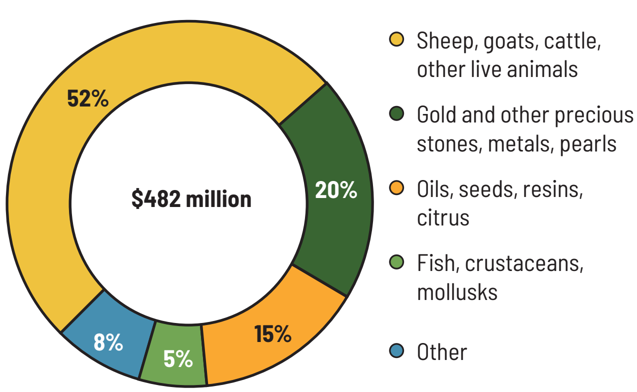
connections (World Bank 2020c). Most neighborhoods in Somalia's major cities are associated with a particular clan, on the basis of historical and current occupancy as well as demographic size. In cities already marked by a lack of basic services, newly urbanizing groups that lack a safety net are vulnerable to shocks; this is particularly the case for disadvantaged groups such as IDPs, the urban poor, members of minority clans, and women and youth.

Reliable data on the composition of Somalia's economy are scant, but a large proportion of it is climate affected. A significant proportion of Somalis are dependent on climate-sensitive rural livelihoods. Reliable figures on GDP or employment composition are limited, but rural production contributes the majority of Somali exports (figure 1.1).

1.2 Seasonality and variability

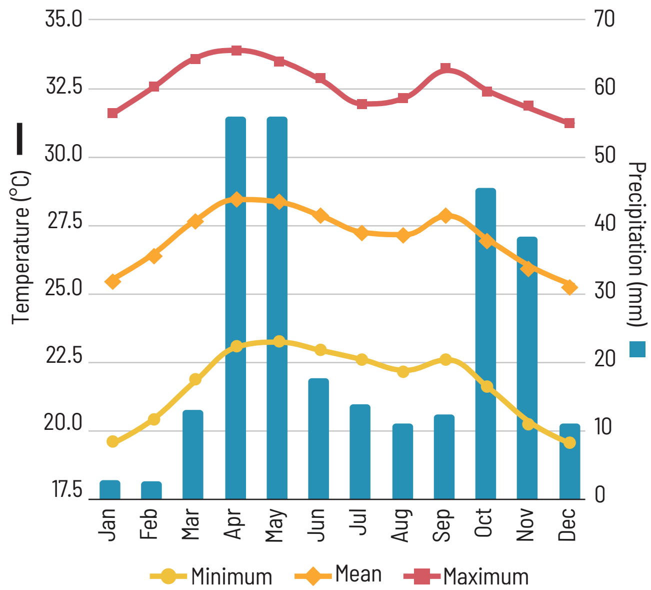
Somalia has four seasons. These are Jilaal: a warm, sunny and dry season from December to mid-March; Gu: the primary rainy season, starting in mid-March and running to June, with median rainfall totals varying between 384 and 432 mm (Rees, Omar, and Rodol 1991); Xagaa: a cool, dry, and somewhat cloudy season starting in July and lasting until mid-September; and Deyr: the secondary rain season, from mid-September to November. Average temperatures remain high throughout the year, although they peak at the start of each wet season (figure 1.2).

Figure 1.1 Composition of Somalia exports, 2021



Source: Observatory of Economic Complexity, Somalia Profile, accessed June 2023.

Figure 1.2 Monthly climatology for temperature and precipitation in Somalia, 1991–2020



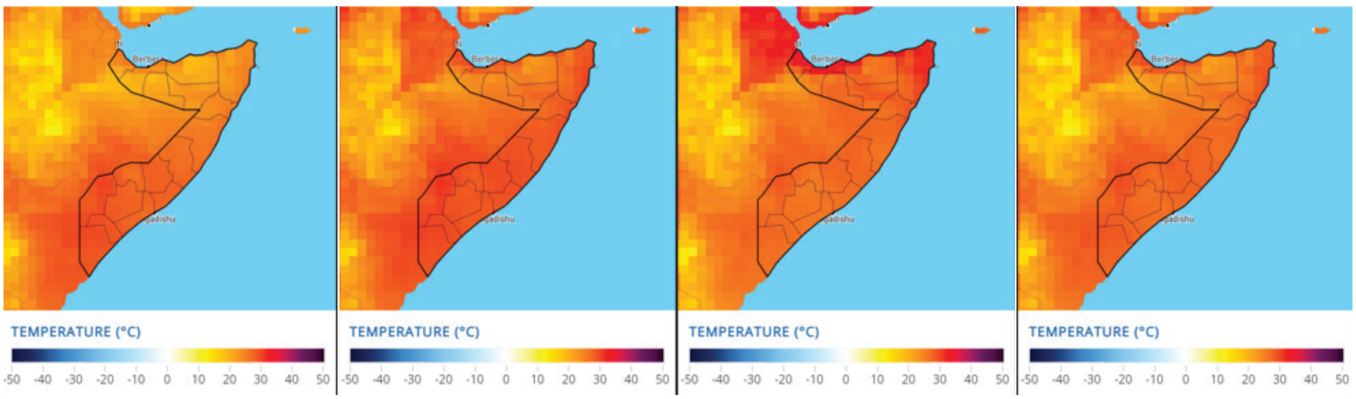
Source: World Bank Climate Change Knowledge Portal: Somalia.

The seasonal cycle is driven by a complex interaction of winds and ocean currents, and their impact is not uniform across the country. June to September are the hottest months in the northern regions, while temperatures peak around March in the southern parts of the country (map 1.6). The Gu rainy season is characterized by the southwest monsoons, which rejuvenate the pasturelands—especially on the central plateau—and briefly transform the arid landscape with lush vegetation. Precipitation intensifies in April across the country, except for the northeastern coastline, which receives the least rainfall during this season. The Jilaal season is very dry throughout the country; during the Haggai, however, some weather stations along the southern coast and in the northwestern regions receive significant amounts of rainfall, while others have almost no precipitation.

The bimodal rainfall system gives rise to two main agricultural seasons. The Gu tends to be the more important growing season in the south, and the Deyr is generally the main growing season in the north. Pastoralists migrate between wet and dry season grazing areas around each transition of the seasons (figure 1.3).

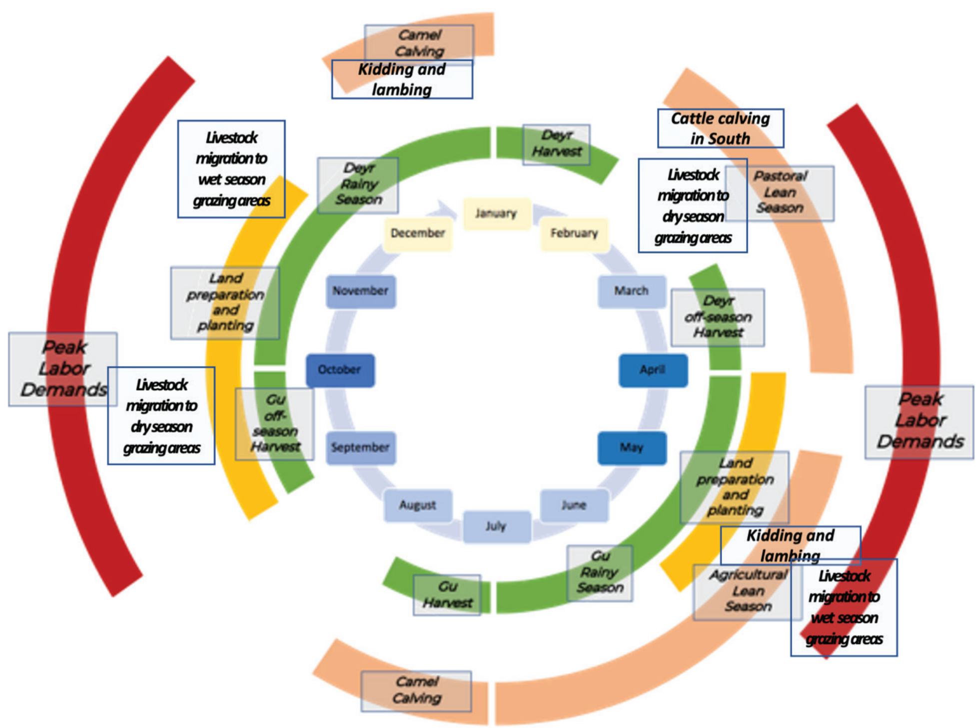
Map 1.6 Climatological seasonal mean temperature

a. December-February | b. March-May | c. June-August | d. September-November



Source: World Bank Climate Change Knowledge Portal: Somalia.

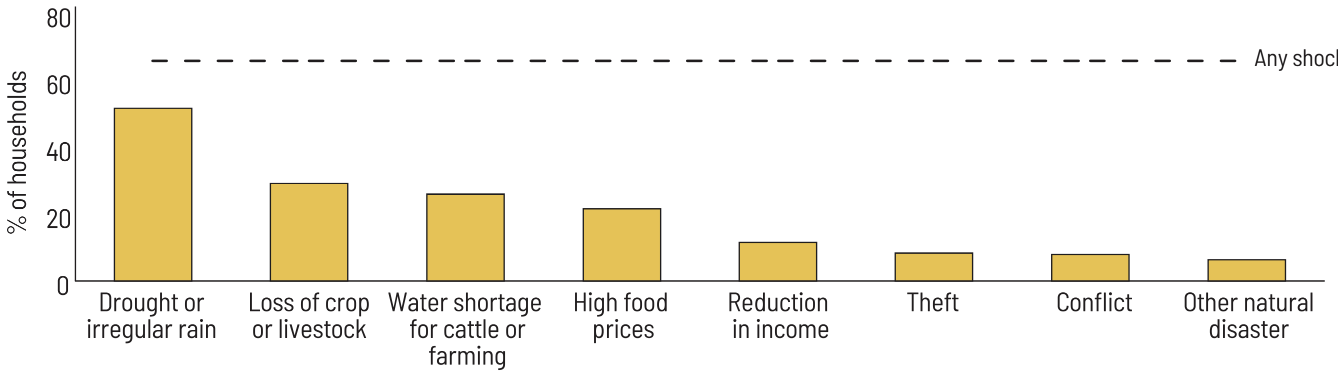
Figure 1.3 Key livelihood and labor cycles in Somalia's seasonal calendar



Source: Based on Famine Early Warning Systems Network (FEWS NET) Somalia Seasonal Calendar.

Although average precipitation is low across the country, it frequently takes the form of localized torrential rains. Subject to the complex interaction of air and ocean currents in the Inter-Tropical Convergence Zone, rainfall exhibits high spatial and temporal variability, both within and between years. The El Niño Southern Oscillation also brings more rainfall and flooding during El Niño and droughts in La Niña years. Unpredictability generally reduces agricultural yields, and extreme climate events have become increasingly challenging for food security.

Figure 1.4 Proportion of Somalis reporting experiencing shocks in the preceding year



Source: World Bank 2019b.

The cycle caused severe droughts in 1991/92, 2011/12, and 2016/17—exacerbating preexisting vulnerabilities in the Somali population (van Oldenborgh et al. 2017).

Drought is Somalia's costliest disaster and affects the largest number of Somalis every year (World Bank 2019b; figure 1.4). In rural areas, higher drought exposure decreased consumption by 19 percent, although households are affected by climate shocks throughout the country. Flooding affects housing, health, and livelihoods in both rural and urban areas. In 2020, about 2.1–2.7 million Somalis faced phase 3 (crisis) food insecurity or worse, primarily occasioned by drought and flood. The hotter weather conditions that year, preceded by strong vegetation growth, also gave rise to the worst outbreak of desert locust swarms in over 25 years, destroying tens of thousands of additional hectares of cropland and pastures (OCHA 2022b). At the start of 2022, following three failed rainy seasons and some of the lowest rainfall in 40 years, drought was already affecting millions of people.

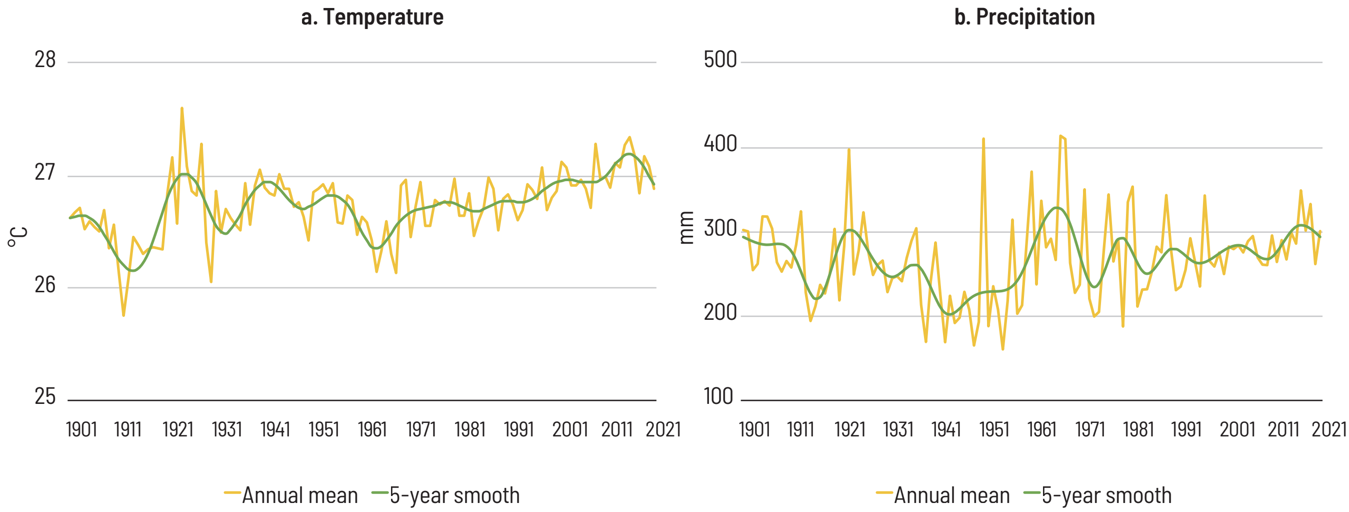
Since 2020, the combination of climate shocks, locust outbreaks, and COVID-19 have created a "triple shock." The expected outcome is that the share of the population living below the poverty line will rise even higher than the 69 percent estimated in 2019. This triple shock is also likely to have massive implications for displacement and associated vulnerabilities, such as gender-based violence, exacerbation of marginalization, and exclusion from supportive/protective networks. The extent to which these shocks interact and drive wider social vulnerability and institutional dysfunction is explored in the next chapter.

1.3 Climate change: recent past and near future

Climate change effects are already significant in Somalia. As figure 1.5 shows, average annual temperatures have risen over the period for which records are available. The period 1991–2015 was on average 1° hotter than prevailing ambient temperatures between 1901 and 1930. Precipitation trends are less distinct, but since the 1980s, the Gu rains have been declining in many parts of the country, with a serious impact on climate-sensitive agriculture and pastoralism (figure 1.6).

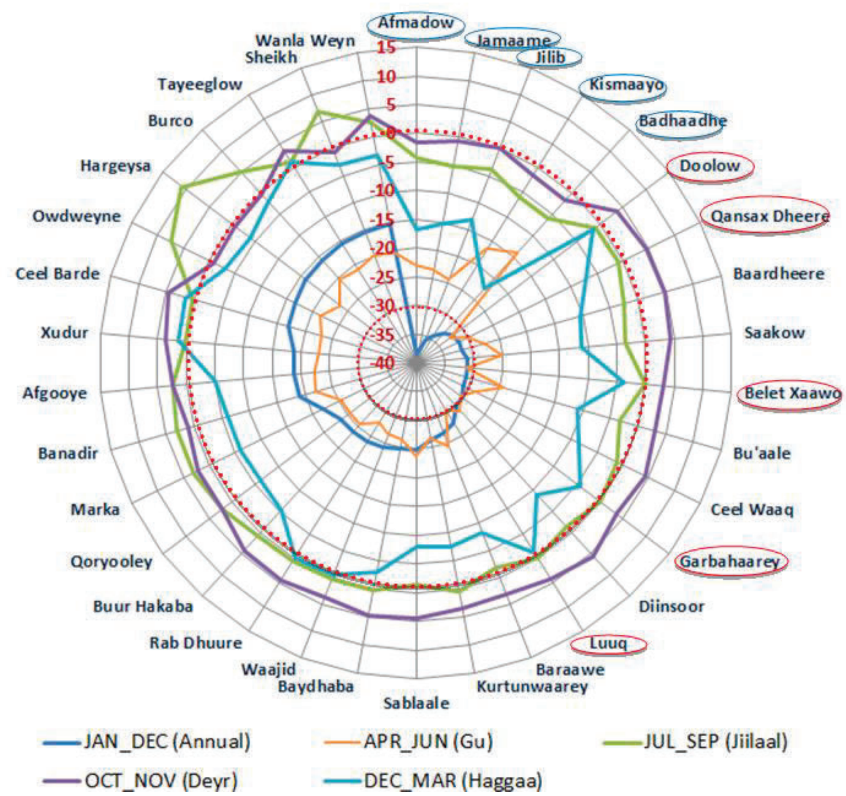
Current climate projections show the temperature in the Horn of Africa rising by at least 2°C over pre-industrial levels by 2080. Under a low-mitigation scenario (which remains the current global trajectory), average annual temperatures in Somalia may increase by between 3°C and 4°C by 2080 (figure 1.7). Rainfall trends are much less clear. Models generally predict that an increase in mean rainfall is most likely, but a wider range of uncertainty remains (figure 1.8). The broad implications are that by the end of the century, average temperature in Somalia is likely to be hotter than any current-day country (the current hottest country is Burkina Faso, with a mean annual temperature of almost 29.3°C). Lenton et al. (2023) define mean annual temperature over 29°C as falling outside the historical human climate niche. They estimate that most of the country's land area—effectively all of southern and most of central Somalia—will be exposed to such

Figure 1.5 Observed average annual mean temperature and precipitation profiles for Somalia, 1901–2021



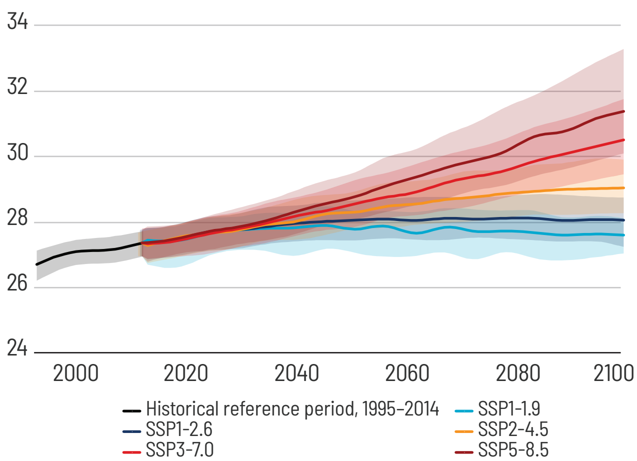
Source: World Bank Climate Change Knowledge Portal: Somalia.

Figure 1.6 Per decade change in mean annual and seasonal rainfall in selected districts



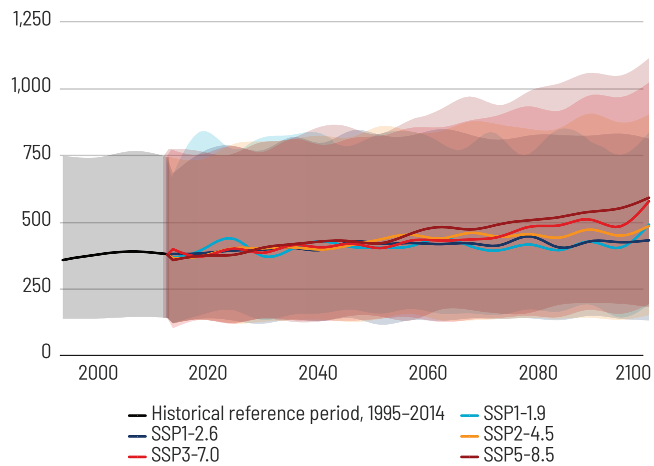
Source: FRS 2018.

Figure 1.7 Projected mean temperature



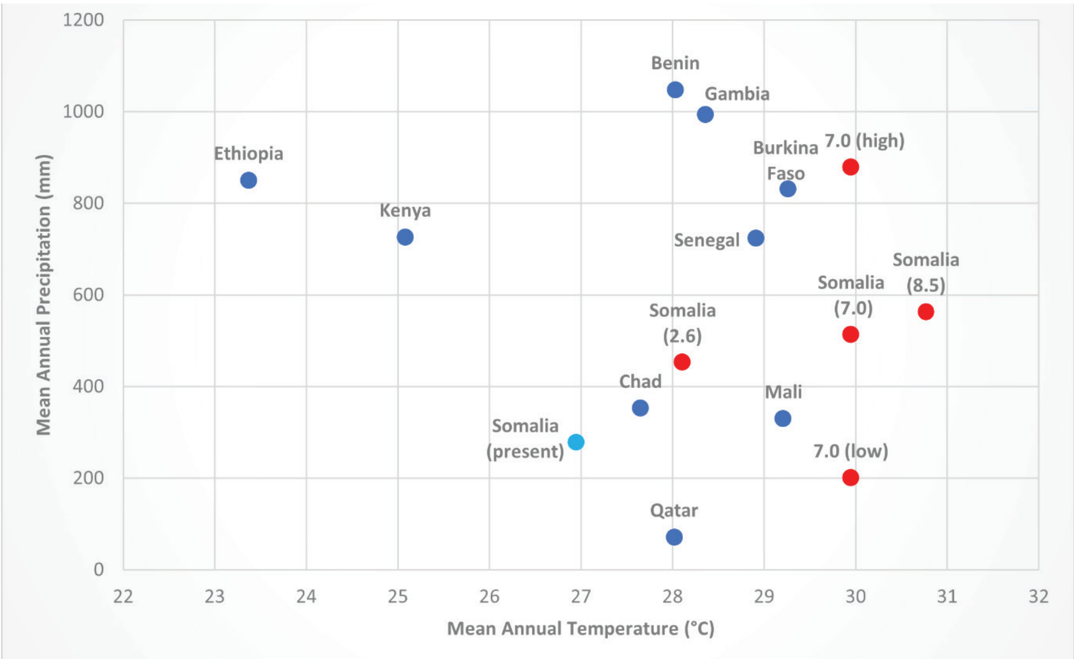
Source: World Bank Climate Change Knowledge Portal: Somalia.

Figure 1.8 Projected precipitation



Source: World Bank Climate Change Knowledge Portal: Somalia.

Figure 1.9 Somalia climate projections compared to current climate of other countries



Source: World Bank Climate Change Knowledge Portal: Somalia.
Note: Mean annual temperature and rainfall figures are for the current baseline period, 1991–2020, for Somalia (light blue) and other countries. For Somalia projections, 2.6 represents SSP1-2.6, 7.0 represents SSP3-7.0, and 8.5 represents SSP5-8.5 median projections for 2080–2099. "Low" scenario projections represent 10th percentile values and "high" represent 90th percentile values for rainfall under SSP3-7.0. Note that variation in rainfall outcomes is similar for other scenarios.

"unprecedented heat" within half a century, based on current emissions trends and policies.

Conversely, the feasible range of future rainfall outcomes includes both a large (greater than 50 percent) increase or decrease in average annual rainfall (figure 1.9). While a modest change in rainfall is perhaps most likely, it is possible that Somalia could either become significantly more arid (close to a pure desert country like Qatar) or significantly wetter (becoming a generally semi-arid country like Kenya). If realized, such changes would have profound effects on both natural and agricultural ecosystems.

A recent analysis (Ogallo et al. 2018) of climate change projections and the associated impacts on Somalia suggests a decreasing trend in rainfall leading up to 2030, followed by an increase in rainfall through 2070. The drying trend already observed during the Gu rains in Somalia is part of a regional pattern termed the "East African climate paradox" because of the discrepancy between observed decreasing rainfall trends and climate change model predictions for increasing precipitation. Recent research suggests that rainfall trends in the Horn of Africa are influenced by more than just surface temperatures in the Indo-Pacific oceans (Walker et al. 2020). The strength of easterly winds over the Congo basin and Gulf of Guinea—partly explained by relatively faster warming in the Sahel than the Congo—may more strongly influence outcomes over a number of decades, while variation in the Madden-Julian Oscillation activity explains around 18 percent of recent drying.[2] It has also been suggested that the East African paradox may exist because current models underestimate the effects of natural variability on East Africa's drought cycles (Powell et al. 2015).

If there is indeed a moderate increase in mean precipitation over the remainder of the century, once increased rainfall variation and evapotranspiration potential are factored in, it is likely that the incidences of both extreme flooding and droughts will increase, as indicated by the recent Intergovernmental Panel on Climate Change Working Group I report (IPCC 2021). Several measures of extreme climate outcome indicate a likely increase in extreme events (e.g., figure 1.10).

[2] The Madden-Julian Oscillation is the major fluctuation in tropical weather on weekly to monthly timescales. It is often characterized as an eastward-moving pulse of cloud and rainfall near the equator that typically recurs every 30–60 days.

1.4 Overview of national climate policies and initiatives

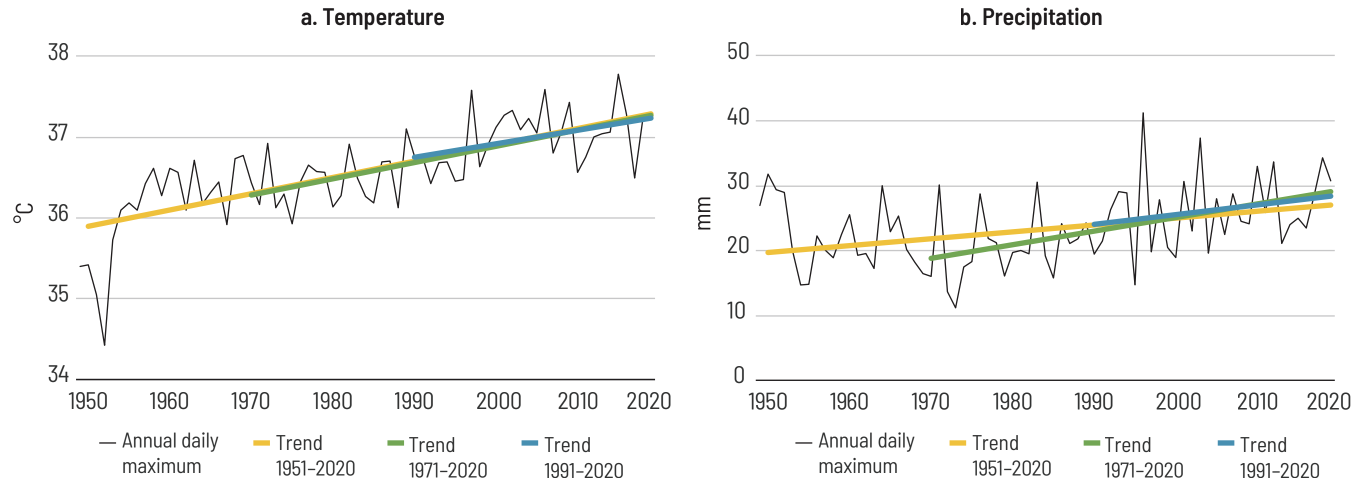
The newly founded Ministry of Environment and Climate Change (created in August 2022 to succeed the Directorate of Environment and Climate Change) has a national mandate to manage climate change in Somalia. The National Climate Change Committee—comprised of the prime minister, the director general of the Ministry of Environment and Climate Change, sectoral ministries, directors of governmental agencies, federal member state ministers for environment, the private sector, and civil society organizations—has the mandate for coordinating and supervising implementation of the country's climate change policy.

Additionally, the Cross-Sectoral Committee on Climate Change brings together officials from across government working on climate change. The committee is mainly used as a forum for information exchange, consultation, agreement, and support among government circles on climate change and the government's response to climate change. However, mainstreaming of climate responsibilities across multiple relevant agencies in government remains poorly defined. In addition, structural and systemic weaknesses—partly due to funding constraints—restrict the functions of the two committees, which have only met on an ad hoc basis.

The new ministry has adopted the Somalia National Environment Strategy and Action Plan (NESAP, 2022–2026) as a starting point for defining climate adaptation priorities. It aims to accomplish four strategic objectives:

- Improving environmental governance and enhancing resource mobilization for the effective management of natural resources and the environment
- Undertaking a comprehensive assessment of the state of Somalia's natural resources, environment, and potential climate risks

Figure 1.10 Trends in Somalia's largest daily maximum temperature and precipitation



Source: World Bank Climate Change Knowledge Portal: Somalia.

- Undertaking conservation initiatives to address urgent challenges in land degradation, biodiversity, aquatic and marine environment, and climate change
- Enhancing public awareness, participation, and behavior change on environmental protection, conservation, and climate change.

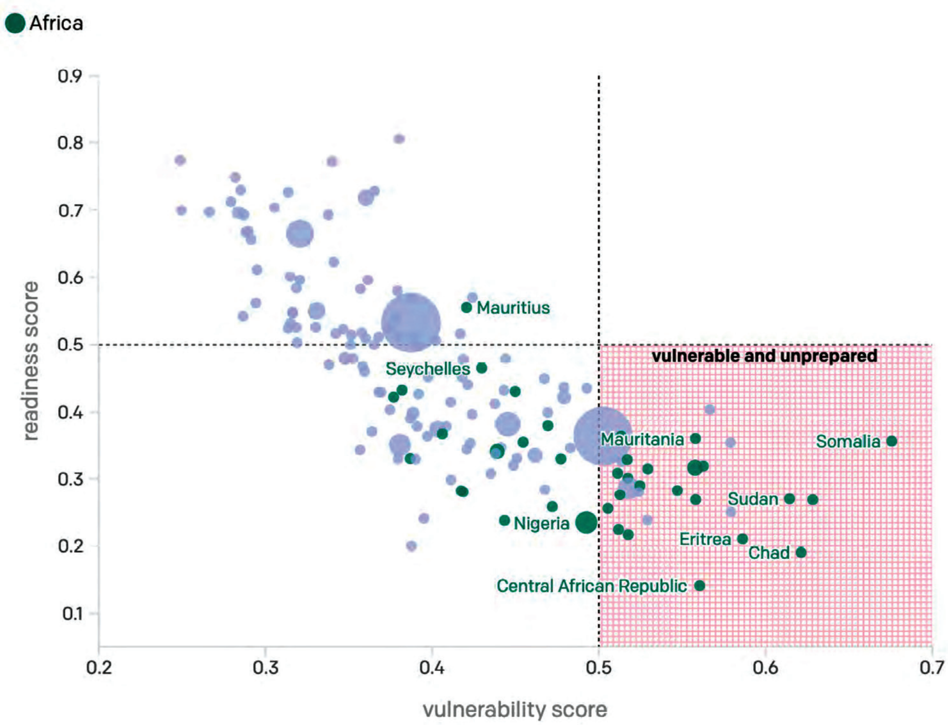
The Initial National Communication to the United Nations Framework Convention on Climate Change in 2018 outlined a national greenhouse gas inventory for Somalia and an analysis of mitigation and adaptation options. The Nationally Determined Contribution (NDC), filed in July 2021,[3] outlines a commitment to reduce greenhouse gases by 30 percent relative to a business-as-usual scenario that envisages a doubling of emissions by 2030. Most of Somalia's emissions come from the livestock and forest sectors, and the bulk of the emissions reduction commitments are related to efforts to reduce net forest loss, including some restoration activities. The 2013 National Adaptation Programme of Action (FRS 2013) identified floods and droughts as the most severe climate risks for Somalia, and grouped key adaptation activities into three main areas: sustainable land management, water resource management, and disaster management. Under the NDC, an estimated budget of close to $50 billion is proposed for adaptation across an expanded set of focal areas: agriculture and food security; water resource management and public health; disaster preparedness and management; coastal, marine environment, and fisheries; energy; forestry and environment; human settlements; and infrastructure. The first three categories account for $35 billion of proposed investment. A new National Adaptation Plan is currently under development. The Somalia National Climate Change Policy of 2023 outlines the institutional arrangements for addressing climate change.

Somalia is ranked by the Notre Dame Global Adaptation Initiative (ND-GAIN) methodology as the most climate-vulnerable country in the world. It is also rated as being unprepared for climate change (figure 1.11). Its readiness ranking is higher than some of its African peers because of the inclusion of its relatively high ease of doing business score, which is used as the sole indicator of economic readiness. On all other governance and social readiness indicators, Somalia scores very low.

The core Somalia climate change policy documents recognize Somalia's dire climate status and reference its ranking as one of the world's most vulnerable countries. The core policies emphasize the need for adaptation, particularly focusing on the adoption of climate-smart livelihoods, including adoption of resilient food crops and the use of livestock-rearing practices that require less water. Communities are also encouraged to have contingency plans and receive training to monitor climate risks

[3] Source: UN Climate Change NDC Registry.

Figure 1.11 Country Climate Vulnerability Index versus Readiness Index scores



Source: Notre Dame Global Adaptation Initiative (ND-GAIN).
Note: The figure plots Country Climate Vulnerability Index scores against Readiness Index scores. Dots are sized by population. Index values vary from 0 to 1; higher values indicate higher vulnerability or readiness.

in their area. Somalia's Ninth National Development Plan (2020–2024) identifies environmental and climate change as one of the most critical drivers of poverty, linked to food insecurity and reliance on food imports. It identifies a direct correlation between increasing frequency of climate emergencies and displacement and calls for improving the resilience of the traditional livestock and crop production sectors while diversifying away from climate-dependent sectors to achieve "climate-proof economic growth." These climate change adaptation priorities need to be reflected in sectoral plans and strategies and in effective action.

Table 1.1 summarizes the climate-relevant content of sectoral laws and policies in Somalia.

The federal government of Somalia has developed a disaster risk management policy framework. This framework includes a 2016 law to establish the Somalia Disaster Management Agency, which was subsequently merged into the Ministry of Humanitarian Affairs and Disaster Management. Disaster risk management mandates and institutions have been fragmented within the government. Forecasting and response initiatives are mostly coordinated and supervised by international partners[4] and generally implemented as stand-alone projects in specific areas, with limited capacity building, particularly at the federal member state level. The Somalia National Bureau of Standards runs the Food Security and Nutrition Analysis Unit and the Somalia Water and Land Information Management (SWALIM) project with support from the Food and Agriculture Organization of the United Nations (FAO). These provide a measure of climate-related information that is cascaded down to the federal member state level and frequently downscaled—and sometimes used by the administrations in the member states for general response and planning.

[4] Source: Global Facility for Disaster Reduction and Recovery Somalia web page.

Table 1.1 Climate-relevant sectoral laws and policies in Somalia

Law, policy, plan	Year enacted or prepared	Key climate messages
National Biodiversity Strategy and Action Plan	2015	Identifies climate change as a key driver of biodiversity degradation/loss and highlights role of biodiversity in addressing climate change
Somalia National Action Programme for the United Nations Convention to Combat Desertification	2016	Makes general link between climate change and desertification
Somali National Disaster Management Policy	2018	Recommends preparation of a national disaster risk reduction strategy, coordinated with climate change and sustainable development policies
Power Master Plan for Somalia	2019	Recognizes high greenhouse gas emissions from diesel generators in use nationwide
National Environment Policy	2019	Outlines national guidelines on ameliorating effect of climate change on waste management, biodiversity loss, coastal pollutions, and general management of Somalia's natural resources at both the federal government and federal member state levels
Somalia Social Protection Policy	2019	● Identifies climate risks as key drivers of vulnerability and food insecurity in Somalia ● Recognizes need for resilience building and diversification of livelihoods, and role of social protection in building household and community resilience and supporting livelihood recovery
Environmental Social Impact Assessment Regulations	2020	● Require integration of climate change vulnerability assessment and priority adaptation and mitigation actions by developers and proponents during the preparation of strategic environmental and social assessments ● Require climate change vulnerability assessment and priority mitigation and adaptation actions to be included in environmental and social impact audits
National Voluntary Land Degradation Neutrality Targets 2020	2020	Recognizes that addressing land degradation will contribute toward mitigating and adapting to climate change
Somalia National Food Fortification Strategic Plan (2019–2024)	2020	Notes that food security and nutrition has remained critical or stressed over the years, in large part due to climate change and reliance on rain-fed agriculture
National Drought Plan	2020	● Aims to design drought monitoring and early warning system for adoption by Somali government and relevant stakeholders ● Recognizes role of climate change in intensifying drought
National Water Resource Strategy (2021–2025)	2021	● Includes extensive references to the impacts of climate change on water resources, including the quality of groundwater ● Assumes that mean annual rainfall shall increase by 1%, 3%, and 4% by 2030, 2050, and 2080, respectively (using 1981–2000 reference period)
Somalia National Environment Strategy and Action Plan (2022–2026)	2022	In one of its four objectives, calls for a comprehensive assessment of the state of Somalia's natural resources, environment, and potential climate risks
Somalia Drought Response Plan	2022	Makes links between a changing climate and the occurrence of La Niña resulting in prolonged, persistent drought and food insecurity
National Environmental Management Act	2023	Refers to climate change and its management as one of the functions of the act
Food Security Crisis Preparedness Plan	2023	Under preparation with the support of the Somalia Crisis Recovery Project

Climate and disaster risk management is increasingly featured within the national conversation around political stabilization and development trajectories, including in mainstream and social media. This increased interest is reflected in meaningful steps on the ground:

- In May 2021, the Somali government signed a **memorandum of understanding with the African Risk Capacity** (ARC) with the aim of helping the country better prepare and plan for, and respond to, extreme weather events and natural disasters. This agreement provides access to tools and support for preparing, planning, and responding to extreme weather events and natural disasters. It also provides the opportunity to ensure financial preparedness is in place, and to utilize disaster insurance as a member of the ARC risk pool.
- In December 2021, the Ministry of Humanitarian Affairs and Disaster Management launched the **National Platform for Disaster Risk Reduction**. The aim of establishing the platform is to facilitate a unified, risk-informed approach to disasters that pulls together all relevant knowledge, information, and institutional capacities in Somalia.
- In August 2022, a prominent **Special Envoy for Drought Response** was appointed to spearhead government efforts to elevate and coordinate drought response both nationally and among international partners.

Despite the rapid expansion of climate-related policies supported by international partners, Somalia's financial and human capacity to convert high-level policies into practical measures, or implement much of this agenda on the ground, remains nascent. The federal government is focused on resolving the fragility crisis first, dedicating much resources and time to security challenges from extremist groups. Government capacity to deliver even basic services is very low. The new Ministry of Environment and Climate Change is struggling to attend to the enforcement of basic environmental regulations, let alone more ambitious climate policies. The ministry has no resources or equipment for data collection, and lags in the dissemination of climate policies and scientific communication.

According to the government's own analysis during the NDC preparation process, there are structural and systemic weaknesses in the management of climate change. The challenges include a lack of financial capacity, given the government's limited tax revenues, which are 4.4 percent of gross domestic product (Khan and Khan 2022), and the ongoing challenges of strengthening the government's fiscal position. Other challenges include the dearth of targeted, actionable climate policies and an ongoing inability to enforce laws due to the political and security situation. A stable bureaucracy, effective capacity development, and significant climate finance will be needed to realize many of Somalia's stated climate goals.

Chapter 2

Climate Change, Conflict, and Social Risks

In Somalia, climate crises have historically been influenced by political factors—specifically, conflict and political instability (Maxwell and Majid 2016). Impacts of the climate and conflict emergencies compound and cascade, increasing human insecurity and limiting in situ adaptation options to the changing climate (Thalheimer and Webersik 2020). COVID-19 has recently added another layer of interacting vulnerability. Social control measures are more challenging for internally displaced persons (IDPs) living within densely populated camps with low access to running water for handwashing (Karamba and Salcher 2020); also, IDPs are more vulnerable to increases in commodity prices as well as to impacts on relief agencies' budgets.

This chapter examines the interactions between climate, armed conflict, and social risks, both to better understand the wider context of vulnerability and to identify particularly harmful interactions. The chapter is organized into four subsections.

- The first briefly summarizes the **literature on conflict and climate change**, which broadly indicates that although there is no general direct causal link between climate change and conflict (von Uexkull and Buhaug 2021), the relationship between the two is shaped by a series of social conditions (e.g., political economy, state and political interventions, institutions) and channeled through indirect pathways, particularly relating to resource scarcity and displacement.
- The second reviews the **recent history of conflict in Somalia** and the related social conditions that interact with climate, conflict, and social vulnerability.
- The third subsection examines evidence for **specific linkages between conflict and climate change in Somalia**. While climate change does not directly drive conflict, it complicates and exacerbates related stresses and vulnerability. Climate-induced social stress may directly trigger conflict and/or the erosion of institutions that would otherwise mitigate conflict risks. Climate impacts on natural resources may also fuel the pernicious cycle of conflict, weak institutions, and resource degradation and competition.
- Finally, the fourth subsection outlines **markers of social vulnerability** in Somalia that are interwoven with conflict, climate hazards, and their social outcomes. These need to be taken into account to understand social implications and to target adaptation and resilience programs.

2.1 Conflict and climate change: an overview

Over the last decade, there has been an explosion of research on the links between climate change and conflict (Koubi 2019). The emerging consensus appears to be that there is no robust, uniform connection between climate change and the onset of conflict between states, and perhaps also within states. For every study that finds a clear connection between climate change and war, another finds no such link (see for instance, Hsiang, Burke, and Miguel 2013; Buhaug et al. 2014).

The Intergovernmental Panel on Climate Change (IPCC) finds, with medium confidence, that "At higher global warming levels, impacts of weather and climate extremes, particularly drought, by increasing vulnerability will increasingly affect violent intrastate conflict" (IPCC 2022a, 15). Academic authors also find that climatic conditions *may* lead to the outbreak of violent conflict in some subnational regions, particularly those dependent on agriculture, and in combination with other socioeconomic and political factors such as a low level of economic development and political marginalization (IPCC 2022b).

A set of recent studies commissioned by the World Bank illustrate how conflict and climate crises can lead to the destruction of livelihoods and consequential impoverishment, distress migration, loss of assets, food insecurity, breakdown in social cohesion, and trauma for communities, households, and individuals. More indirectly, conflict and climate crises can lead to the breakdown in traditional governance institutions—thus fueling future rounds of violence, hindering the ability of communities to resolve resource conflicts, and hampering the ability of both formal and informal institutions to address the impacts of climate change. Conflict also contributes to the breakdown in state authority in different parts of the Horn of Africa and reduces the likelihood of cross-boundary cooperation. For instance, a study on the outbreak of desert locusts that have affected Somalia found that one of the major factors behind the outbreak across the Horn of Africa (and in the adjoining Republic of Yemen) was conflict, which had impeded joint action in the front-line countries, and the actual spraying of pesticides to control swarms (World Bank 2022b).

There are two main pathways through which climate change shapes social risk and conflict that are most prominently identified in the literature on links between climate change and conflict. These are (1) resource scarcity (which affects social cohesion and creates/aggravates group-based tensions) and (2) displacement. Institutions, including both formal and informal community and civil society organizations, play a key role in shaping these pathways.[1]

About 40 percent of all intrastate conflicts can be linked to the exploitation of natural resources (UNEP 2021). There is growing evidence that links increased temperatures and drought to conflict risk in Africa, particularly in populations that depend on agriculture and natural resources. Climate-related risks are affecting resource availability and intergroup competition across the Horn of Africa, particularly around water, livelihoods, migration, and political power. Risks of conflict linked to competition over natural resources are more likely when they happen against the backdrop of a long history of social, economic, and political exclusion and marginalization (Doti 2010), and in a fragile context where state capacity is nascent. By exacerbating scarcity of key resources in a region where transhumance pastoralism/agropastoralism is an important livelihood activity, climate change can both aggravate resource-based conflicts and intensify general social vulnerability and social fractures. All of these general descriptions fit in Somalia, where they are layered onto legacies of past conflicts, historical grievances, and existing intergroup animosities.

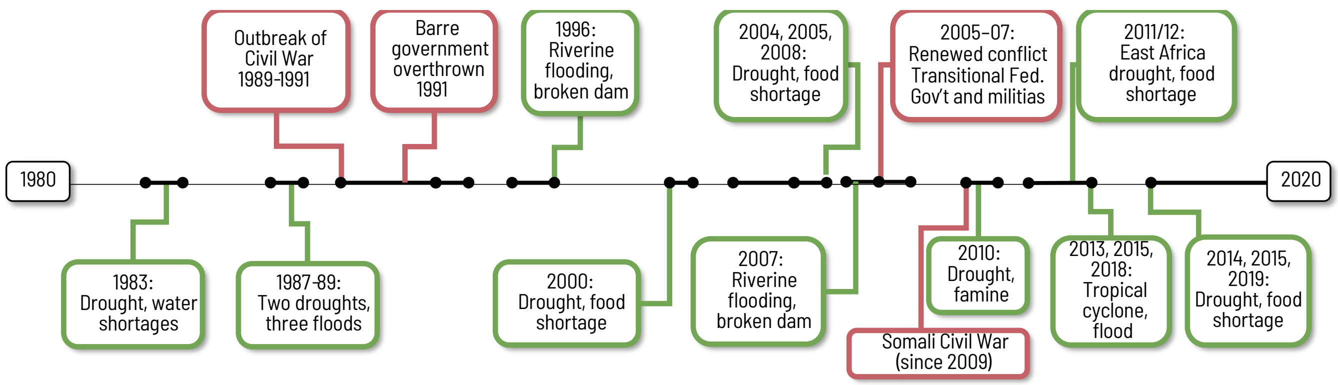
The literature on displacement suggests that climate and conflict shocks have the potential to trigger migration cascades with implications for international security (Abel et al. 2019; Missirian and Schlenker 2017). But whether mobility driven by climate crises increases violence at the destination depends on a number of factors, including linkages between the displaced and host communities, the level of economic interrelationship and dependence, and governmental policies (Ide and Scheffran 2014; Koubi 2019). Causality is typically contested. For instance, while Ash and Obradovich (2020) and Kelley et al. (2015) find a positive association between drought-induced migration and violence in the Syrian Arab Republic, Selby et al. (2017) and Zhang et al. (2019) find no evidence of a direct relationship. In Somalia, it is clear that displacement increases both the vulnerability of displaced groups and social risk, but there is little clear evidence of a resultant increase in conflict.

Correlations between drought and conflict do not necessarily imply causation. Drought and conflict coexist mostly in countries or regions that already suffer from adverse climatic conditions, are highly dependent on agriculture for income and food generation, have little capability to cope with climatic changes, and are characterized by preexisting tensions and conflict (Ide and Scheffran 2014). In Somalia, even broad spatial or temporal correlations between climate shocks and conflict events are difficult to establish as they are both so

[1] In fact, the most commonly accepted definition of "institutions" is by Douglass North, who refers to institutions as the "rules of the game" or the "humanly devised constraints that shape human interaction" (North 1991).

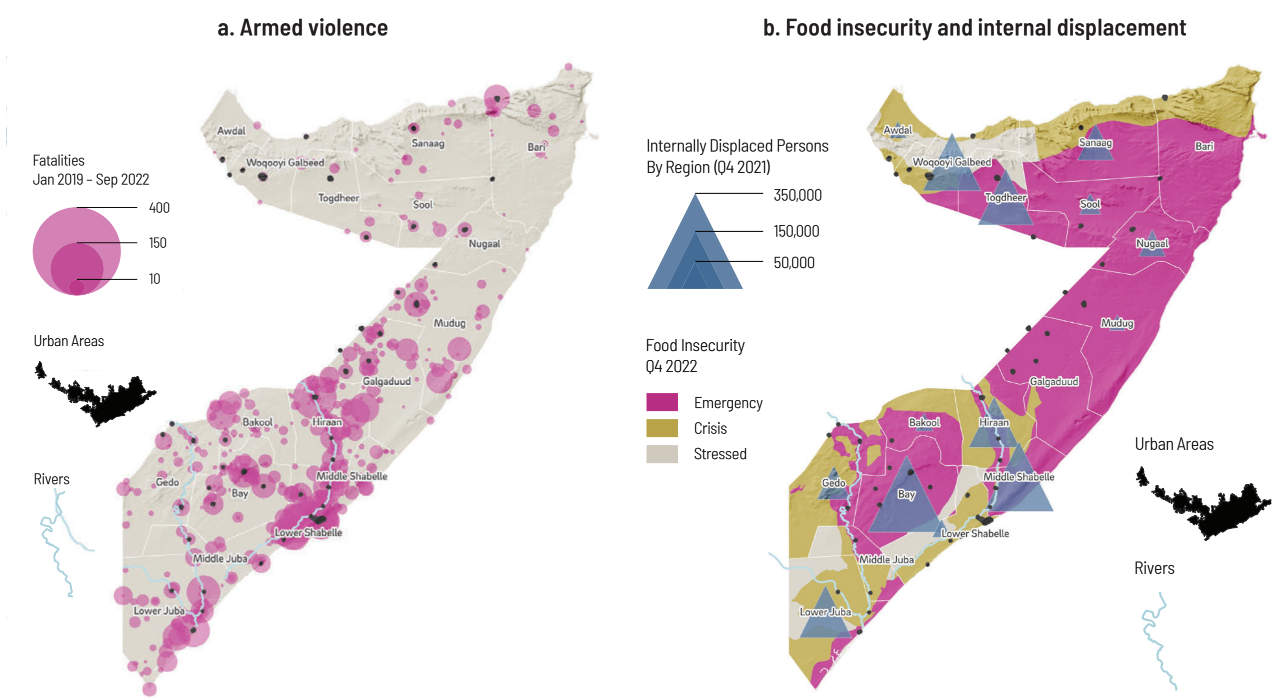
widespread (figure 2.1 and map 2.1), and detailed socioeconomic data are scant, with efforts on poverty and drought impact data collection in Somalia having ramped up only in the past five years (Pape and Wollburg 2019). However, many of the conditions that shape vulnerability to climate change (such as weak and fragmented institutions and populations with preexisting vulnerabilities) also increase the likelihood of climate-conflict interactions, and are further aggravated by armed conflict (Buhaug and von Uexkull 2021). Identifying specific interactions and causalities in an individual setting requires closer examination.

Figure 2.1 Timeline of conflict and extreme weather events in Somalia



Source: Conflict data (red boxes): ACLED database; disaster data (i.e., extreme weather events) (green boxes): EM-DAT, the International Disaster Database.

Map 2.1 Violence, food insecurity, and internal displacement across Somalia



Source: NUPI and SIPRI 2022 based on data from ACLED, Africapolis and Natural Earth.

2.2 Conflict and social context in Somalia

Somalia's enduring challenges are interconnected and have long historical roots, which preceded the formal collapse of the Somali state in 1991 (Menkhaus 2014). These challenges include emergent state capacity, corruption, remnants of warlordism, predatory armed groups, fragmented and contested state authority, exclusionary politics, and political violence. Both the specific history of conflict and the structural factors that influence it have links to climate. In particular, the shape and intensity of competition over natural resources has been formed by Somalia's climate and continues to be affected by climate change. This in turn has influenced the social divisions and hierarchies, and the political economies that have driven conflict. The general level of social vulnerability is also in part a function of the harshness of the Somali climate.

A brief history of conflict in Somalia

The former Italian territory of Somalia and the British territory of Somaliland achieved independence in June–July 1960. Somaliland was independent for a period of four days in June 1960, before the territory's leaders joined former Italian Somalia in a political union following the latter's independence. After a brief period of multiparty politics, Siad Barre came to power in 1969 in a military coup, and mobilized Somali society in pursuit of nationalist and modernizing ideals (Majid et al. 2021). By the 1970s, Somalia appeared to be inexorably moving along the path to modern statehood, with expanded education, a somewhat capable bureaucracy, and efforts to subsume the clan system under the structures of the modern state (Lewis 1989).

This changed after Somalia invaded the Ogaden region of Ethiopia in 1977 and was resoundingly defeated. As the brunt of the blame for the military misadventure was attributed to Barre, challenges to his rule increased, and the regime's focus changed purely to survival. Much of Somalia's foreign assistance was diverted or stolen. The once-professional security services became predatory, advancing the interests of empowered clans—including through land grabs—depriving thousands of farmers (many from disadvantaged clans) of their land and livelihoods (Menkhaus 2007, 2014; de Waal 2015).

Widespread land appropriations followed. These were often facilitated by the regime's agricultural policies and land titling laws, which disrupted customary land tenure arrangements and traditional agricultural patterns (Norton 2009). Another key change to Somalia's political economy, closely linked to both land and climate change, was the gradual commercialization of the livestock trade. Commercialization led to a huge growth in the number of livestock being herded, even as fewer people herded livestock. The reconfiguration of the pastoral economy increased the pressure on grazing lands and water resources (Samatar, Salisbury, and Bascom 1988; Samatar 1987; de Waal 2018). Development intervention by the state—such as efforts to increase water sources—began to be viewed with suspicion, as these efforts were perceived as encouraging migration by herders from other clans and land grabs. In the dryland grazing areas, disputes over access to water cisterns (*berkads*), increasing sedentarization, and enclosure of reserves led to—and continue to lead to—violent clashes, fueled by the ready availability of weapons.

The changes to the social and political economy of pastoralist livelihoods, combined with land appropriations, and the instrumentalization of clan-based conflict were overlaid on group-based grievances against Barre, and led to civil war breaking out in the 1980s. The state collapsed, and Somaliland declared independence in 1991. In the immediate aftermath of Barre's overthrow, the various opposition factions splintered, and warfare began to focus on control over resources and land, finally resorting to looting of homes and assets, and then food relief. Particularly ferocious fighting took place around control over centers of commerce and revenue, such as the Mogadishu port and airport, Kismayo City, and other local airstrips (Majid et al. 2021). Those conflicts remained largely unresolved, and the fighting shifted to disputes over more local issues, such as smaller towns and the farmland along the Shabelle River. By the end of 1992, numerous local wars were being fought across south-central Somalia between different armed groups. The leaders of these various militias financed their operations through a combination of looting and extortion, foreign patronage, and political credit—including offers of future positions.

Following a year of catastrophic warfare from 1991 to 1992,[2] United Nations (UN) and U.S. engagement began. A ceasefire was negotiated, and the UN Operation in Somalia (UNOSOM) mission was launched, dominating the political scene until the UN withdrawal in 1995 (Bradbury and Healy 2010). The early 1990s also saw the emergence and consolidation of an independent business class. As exports of primary goods such as livestock, bananas, and charcoal grew significantly, businesspeople began to import consumer goods, including textiles, sugar, and cigarettes—but also khat and weapons. With the de-escalation of open conflict in the mid-1990s, major financial companies from other regions started to invest or reinvest in Mogadishu, collaborating with warlords to ensure the protection of their property (Marchal 2002). Between the middle and the end of the 1990s, many businesses re-established themselves in Mogadishu, changing from single-clan ownership models to multiclan shareholding structures (Hagmann and Stepputat 2016). This period saw the establishment of more advanced industries, including the spread of telecommunication companies and the opening of small factories. Over time, Somali business owners separated themselves from the clan unit politicians and warlords who had dominated the political and security arena in the early 1990s. While at first businesspeople financed armed factions in return for protection, they began to fund their own security forces, and later on, turned to local Sharia (Islamic) courts. By 1999, the business class had become an independent political force (Menkhaus 2007; International Crisis Group 2011).

Although Islamists had made sporadic efforts to gain a political foothold in Somalia, their efforts had, for the most part, been unsuccessful. This changed with business finance for Islamic courts in the late 1990s—motivated primarily by economic rather than religious or ideological reasons. The Islamic courts had originally emerged as a network of Sharia courts exercising lineage-based jurisdiction, and later coalescing as a cross-clan umbrella movement known as the Islamic Courts Union (ICU) in 2006 (Barnes and Hassan 2007). They offered "reputational benefits and social capital," and professing piety and adherence to Islam allowed businesspersons to lower transaction costs and signal trustworthiness through piety. But most importantly, unlike clan unit–based political-military organizations which were inevitably confined to certain localities and established checkpoints on their boundaries that exacted payments from traders, Islamists were able to control larger territories crossing clan or ethnic lines without internal checkpoints, and were able to establish trust and enforce contracts on the basis of common Islamic faith and law (Carrier and Lochery 2013; Ahmad 2014).

The early 2000s were also characterized by multiple efforts to create a central state in Somalia. For many elites, state-building was a desirable ongoing project, since it was closely connected to the availability of external resources in the form of developmental, humanitarian, and security cooperation funds (Menkhaus 2017). However, the various political groups/organizations emerging from externally supported peace talks struggled to assert legitimacy and authority. The first of these was the Transitional Federal Government (TFG), formed in 2004 through negotiations led by the Intergovernmental Authority on Development. The ICU took advantage of the TFG's weakness, however, to establish unified control over Mogadishu for the first time in 16 years; and by September 2006, it controlled most of the country apart from the provisional capital Baidoa, which the TFG managed to hold with Ethiopian military protection (Majid et al. 2021). While the ICU enjoyed a degree of popular support during the period that it was in power, it also splintered as moderate and more extreme groups (including the group that was to become al-Shabaab) vied for leadership. Meanwhile, away from Mogadishu, some of the federal member states, most notably Puntland and Jubaland, began to take shape

In 2006, on the back of a sustained diplomatic campaign, Ethiopia invaded Somalia and routed the ICU forces, whom they suspected of being under undue Eritrean influence (Majid et al. 2021; Marchal 2011). With the approval of the UN Security Council, the African Union Mission in Somalia (AMISOM) was deployed to the capital in 2007 to protect the TFG, sparking violence on the part of

[2] In just four months during this time period, an estimated 25,000 people were killed and 2 million were displaced internally.

al-Shabaab. In April 2022, AMISOM was succeeded by the African Union Transition Mission in Somalia. Both the formation of the TFG in 2004 and its successor, the Federal Government of Somalia, in 2012 marked the return of what is ostensibly a central state institution. After peaceful elections in 2016, a new government was formed in 2017 committed to embark on a development trajectory (World Bank 2018). A successful election provided for a peaceful change in administration in May 2022.

Al-Shabaab, however, continues to be engaged in active conflict against the federal government, carrying out terrorism attacks in Mogadishu and other major population centers. It controls large territories in the southern part of the country, though it has been pushed back by recent governmental campaigns. Violent clashes between various power factions also continue to occur throughout Somalia (Nunez and Pape 2022), often resulting from inter-clan cleavages involving localized land ownership disputes, political power, and conflict over resources such as water and pastureland (Barrow 2020). These clashes are exacerbated by the existence of numerous private militia, loyal to local leaders rather than formal government institutions (Menkhaus 2014; Webersik, Hansen, and Egal 2018). In fact, al-Shabaab accounts for only a minority of the total recorded conflict incidents over the last decade, although with a slight upward trend (figure 2.2).

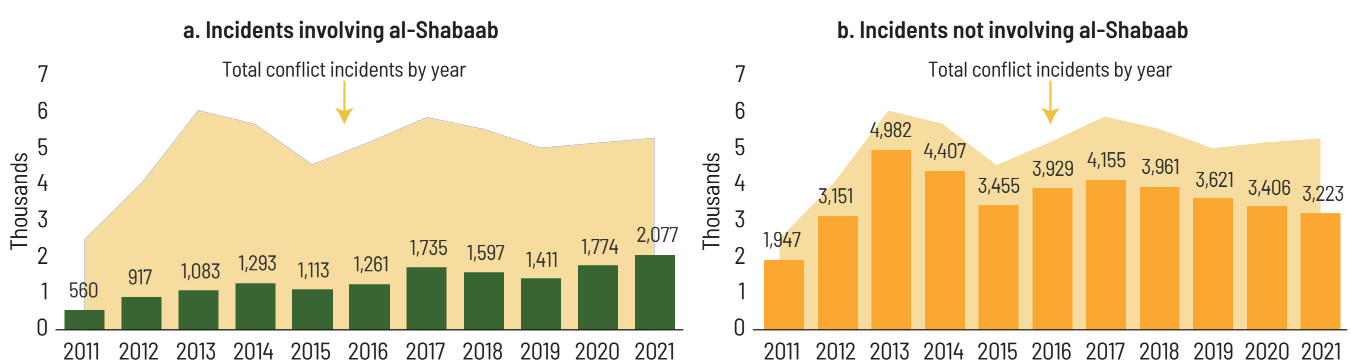
Structural factors influencing the relationship between climate and conflict

Despite improvements in political stability, Somalia remains fragile. Political processes such as elections continue to be overlaid on traditional power-sharing arrangements, and politics is persistently transactional and monetized in nature. A variety of structural factors that have shaped past conflict and its links to climate persist, and present challenges to building a more inclusive political system.

Vulnerable population

Large numbers of people in Somalia are dependent on pastoral and agropastoral livelihoods which are climate exposed, and there has been little public or private investment in the sector (World Bank 2020a). As with many other parts of East Africa, large numbers have dropped out of the sector due to the combined effects of climatic crises and the constant need to adapt to changing political, economic, and climatic conditions to gain a living (Lind, Sabates-Wheeler, and Kohnstamm 2016; Maxwell and Majid 2016; Robinson, Zimmerman, and Checchi 2014). As people drop out of pastoralism, large numbers also move to Somalia's underresourced cities, increasing the environmental pressures on them (World Bank 2020b). Somalia also imports much of the food that it consumes and is therefore disproportionately affected

Figure 2.2 Conflict incidents in Somalia with and without al-Shabaab involvement, 2011–21



Source: Original calculations from ACLED data.

by disruptions in global supply chains. This means that increases in production-related risks to global agriculture and food prices caused by increased warming and extreme weather events are likely to have outsized impacts on the country (Schewe, Otto, and Frieler 2017).

Whether formally numbering among IDPs or not, the displaced typically lose social support networks and add to the large numbers of vulnerable people who have been affected by conflict and climatic crises. Minority groups, persons living with disabilities, and youth face additional forms of social exclusion. All forms of vulnerability are deeply gendered, with women and girls confronting significant gender disparities, including high levels of sexual and gender-based violence (GBV). Many vulnerabilities intersect and compound each other; a young female IDP belonging to a minority clan is likely to be disadvantaged on multiple counts. More discussion of vulnerable groups is provided in section 2.4.

Clan dynamics

Despite being one of the most ethnically homogeneous countries in Sub-Saharan Africa, Somalia's population is divided into more than 500 clans and subclans, though 4 major clans dominate (The Economist 2013). The word "clan" is used elastically by Somalis to refer to lineage groups at different levels of aggregation, where these different levels have different social and political meanings and characteristics (Majid et al. 2021). Lineage therefore provides multiple potential identities that can be drawn upon, depending on circumstance and initiative. In the fighting for resources at the national level immediately after state collapse in 1991, conflict was organized according to the highest level of clan aggregation—that is, by dividing fighters into one of the four principal clan families: Darood, Diir, Hawiye, and Isaaq. In local politics, other sub-aggregations (clan or subclan) become more salient (de Waal 2015). During the battles for Mogadishu in the immediate aftermath of state collapse, some of the fiercest fighting took place between Hawiye subclans led by rival warlords (de Waal 2020).

Clan identity retains a great deal of salience within the organization of Somali politics and conflict in the country, and in conditioning vulnerability and resilience, especially when it intersects with regional, gender, class, and religious identities:

- **It plays a key role in military mobilization.** Clan identity acts as the basis on which financial support is raised from diaspora donors and provides a way of organizing command structures. This is a legacy of efforts by the former dictator Barre to stave off challenges to his rule by developing kinship-based networks of clients, and exploiting local and personal rivalries between these networks (Reno 2018; Compagnon 1998). Clans only became firmly established as political, administrative, and military entities in the period leading up to civil war and during the external peace-making interventions that followed (Balthasar 2017). Mobilization of clan affiliations in political conflict had long been a prominent feature of Somali politics, but Barre repoliticized, repurposed, and intensified lineage competition for the purposes of ensuring his own political survival (Compagnon 2013), transforming the nature of clan warfare in Somalia, adding deeper antagonisms, and creating interlocking cycles of violence aimed at redressing real and perceived injustices.
- **Clan identity and social groupings are a source of resilience during external shocks and times of hardship.** Social group dynamics acquired increased salience after the dissolution of the state, where personal networks have become an important source of resilience, acting as sources of information, security, and material support; and allowing for a measure of mutual accountability within social groups (Simons 1997). This is described in greater detail below.
- **As external actors and Somalis have tried to reconstruct a centralized formal state in Somalia (especially after 1993), they have used clan identity as a basis for spatial and political organization (Mosley 2015; Hoehne 2016).** To an extent, the structure of the federal member states reflect an assumed distribution of clan families, and the parliamentary system is organized according to the 4.5 system, which stipulates that the four major clan groups receive an equal share of seats with the other clans sharing the remainder. Clan quotas are then further subdivided between subclans (SSF 2017).

Resource competition and political economy

Control of its scarce arable land has been closely connected to power in Somalia's recent political history in ways that intersect with climate change (Jaspars, Adan, and Majid 2019). During Barre's government in the 1970s and early 1980s, there was intensive cash cropping in the fertile land along and between the rivers, relying on cheap and exploitable labor. Land grabs started with the Italian colonizers, and were followed by politicians, civil servants, and merchants who could register the land, dispossessing the clans that inhabited the riverine areas and were not well represented politically. Land-grabbing set the scene for the so-called "liberation" of these areas by clan-militia at the height of the civil war period, and created persistent disputes over land. Land- or resource-based disputes are very common in Somalia, generally involving clan politics or issues over imagined clan "homelands" (*deegaan*). Competing claims of ownership are also common in urban areas, frequently over land that was once public or either looted or vacated by fleeing households (RVI and HIPS 2017).

After state collapse in the late 1980s, clan-based militias fought for control over resources. This resulted in widespread looting, theft, and the collapse of large-scale irrigation schemes, as well as displacement and famine among those who had already been marginalized. Finally, after 2000, various forms of Western- and Ethiopian-backed governments were introduced, with a coincident rise of Islamist movements. This in turn led to a resumption of conflict, large-scale displacements, and famine or humanitarian crises in 2008, 2011, and 2017. It is in this third period that the impacts of climate crises have been the most visible and have intersected with Somalia's history of conflict and predatory governance practices.

Minority groups today comprise a significant share of IDPs, who are often concentrated in urban centers and lack adequate access to services, security, and social and political representation. Underrepresented among the diaspora, marginal groups also lack access to charity networks and international remittances—both critical coping mechanisms for better-placed social groups—thereby increasing their vulnerability to economic, conflict, and climate-related shocks. Without sufficient representation and voice through clan systems, the needs of minority groups have not been sufficiently integrated into humanitarian assessments, thus limiting their access to emergency assistance and rendering their vulnerability more acute.

Legacy of conflict and institutional weakness

There is a long history of predatory state intervention in Somalia, as dominant groups have sought to use the mantle of the state to pursue their own narrow economic and political agendas (Hagmann et al. 2018). Since before the civil war, a small elite has controlled wealth, politics has remained transactional, institutions are often co-opted, governmental revenues and aid diverted or subverted, and a security stabilization strategy reliant on African neighbors subordinated to wider regional security dynamics. Further, corruption levels in Somalia are among the highest in the world, with the country ranking 178th of 180 on Transparency International's 2021 Corruption Perceptions Index.[3] Low levels of institutional capacity and high corruption remain interlinked, and trust in the state to deliver services for the general public good is therefore low (World Bank 2021b).

Local, community, and private institutions

In the absence of a functional state and formal institutions, traditional dispute resolution mechanisms, clan support networks, diaspora remittances, and civil society groups have all played a role in helping communities adapt to, cope with, and mitigate the impacts of diverse shocks for more than 30 years. They have done so in at least three ways.

- **Clan support structures act as a basic collective social insurance system and increase household and community resilience.** Clan support structures play a role in channeling remittances and investments, as well as the contributions of expertise from the Somali diaspora. Remittances represent approximately 28 percent of gross domestic product (similar to that contributed by official development assistance) and offer an essential lifeline to many communities and households. Remittances are not, however, distributed

[3] Source: Transparency International 2021 Corruption Perceptions Index .

equally, but "tend to be concentrated within particular social groups, lineages and extended families, especially within Somaliland, Puntland and the central regions of Somalia due to the history of migration from these areas" (Majid, Abdirahman, and Hassan 2017). Marginalized groups receive less diaspora support and are therefore more vulnerable in times of crisis. The processes involved in the provision of remittances are underlined by notions of trust and efficiency. Clan and religious networks play an important role in building trust, especially in contexts such as Somalia where formal financial institutions are limited (Majid et al 2021). The clan lineage system operates both as an information network and a form of financial guarantee. The Somali hawala or money transfer system, for example, is also strongly rooted in networks of trust based on lineage relations, though many have moved beyond these affiliations, as they have expanded their businesses domestically, regionally, and globally (Lindley 2010).

- **Community organizations can play a key role in local peace and reconciliation efforts, contributing to social cohesion.** In the absence of formal justice, traditional mechanisms governing inter-clan relations and/or Sharia have served to protect many (although vulnerable groups are often prevented from attaining justice when facing more powerful groups). Localized reconciliation efforts throughout the country have often been led by clan elders, religious leaders, civil society activists, and the business community. For instance, Somali civil society actors played an important role in supporting international efforts to negotiate peace in the contested town of Galkayo, with the final agreement being signed by a range of political, military, and civil society figures, including prominent women in Galkayo as well as the highest customary authority, suggesting widespread buy-in (Majid, Theros, and Abdirahman 2020).
- **Community and business organizations have played a role in the provision of public goods and services.** The collapse of the state saw the emergence of local civil society organizations, nongovernmental organizations, think tanks, media associations, and religious groups, often supported by the business community, to offer public services, many of which continue to this day. These services include provision of educational facilities and health care services. These services are not uniformly distributed and tend to be concentrated in urban areas. During periods of climatic and economic crisis, this results in multiple service providers (neighborhood, communal, state, public, and private actors) offering households and neighborhoods a range of services, including power, water, education, and health care—usually for a fee, complicating any distinctions between "private" and "public" and making it harder for vulnerable households and displaced persons to access these services (World Bank 2020c).

2.3 Evidence for specific climate and conflict linkages in Somalia

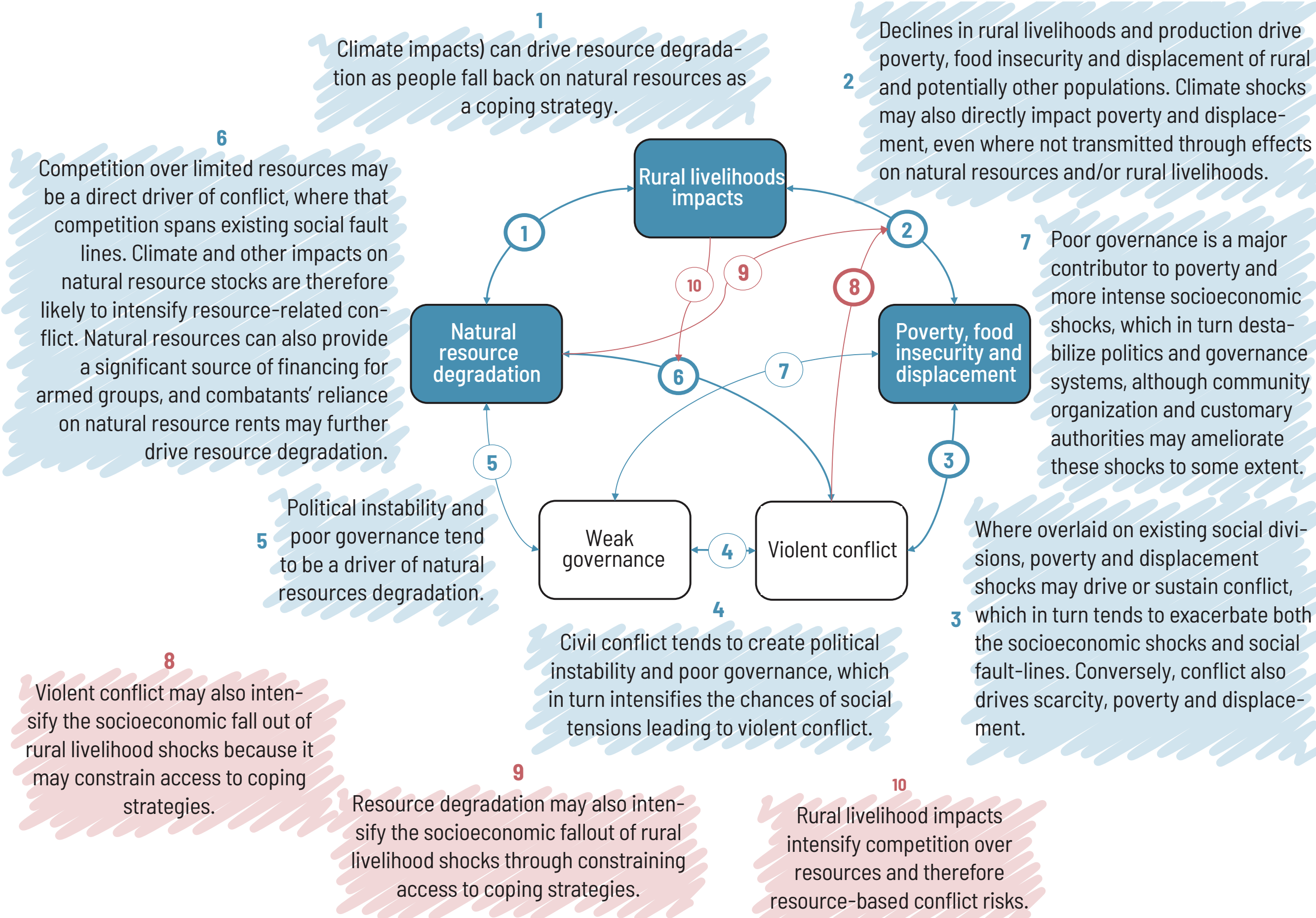
A highly simplified conceptual framework of linkages between risk elements that may be (at least partly) driven by climate change impacts and/or influence conflict outcomes is presented in figure 2.3.

This section focuses on reviewing the evidence within Somalia for linkages 1–3 and 4–6. These roughly correspond to the two areas of linkage shown in the figure, that is, climate change (1) causing social impacts (including displacement) that increase civil tensions and exacerbate conflict, and (2) exacerbating conflict over scarce resources.

Climate impacts on natural resources and rural livelihood impacts, driving food insecurity, displacement, and conflict outcomes [linkages 1, 2, 3]

Several studies have examined the role of extreme weather on vulnerable populations and conflict in Somalia. These studies suggest that changes in weather and climate-related events adversely affect socioeconomic conditions, exacerbate displacement situations in the region (Owain and Maslin 2018), and conflict indirectly through food insecurity (Anderson et al. 2021; Maystadt and Ecker 2014).

Figure 2.3 Conceptual framework examining the links between risk elements directly affected by climate events (blue boxes) and those that may be indirectly affected (white boxes)



Note: Blue arrows (1–7) indicate direct linkages between risk elements (several of which have the potential to become positive feedback loops). Red arrows (8–10) indicate "intensifiers"—i.e., ways in which a risk element can exacerbate the negative interaction between two other elements.

Somalia has endured multiple severe drought episodes since 1965, as well as floods and storms. Since 2012, an average of 1.78 million people per year have been affected by extreme weather and associated disasters, with droughts accounting for the largest share.[4] Two consecutive below-average rainfall seasons (fall 2010 and spring 2011) devastated livestock and crop production, causing an increase in food prices and leading to severe famine.[5] Since then, famine conditions have been averted through provision of emergency funding and food aid across Somalia during drought events (Heslin and Thalheimer 2020).

Climate shocks are becoming more frequent and severe as a result of global climate change and leave less time to recover and prepare for the next climate or conflict shock. The compounding of climate and conflict impacts also occurs because armed groups such as al-Shabaab make humanitarian work pretty much impossible. Countries that experience combined crises of extreme weather and conflict displacement tend to have the worst levels of food insecurity. Individuals forced to flee abandon their fields and livestock, seeking shelter at displacement sites

[4] Source: EM-DAT database.

[5] Sources: Integrated Food Security Phase Classification IPC-CH Dashboard; World Bank Open Data.

located far from markets. Often, they become trapped in repetitive displacement and deepening food insecurity (IDMC 2022).

Both conflict and drought have led to large-scale internal displacement.[6] The 2016/17 drought decreased levels of already scarce natural resources while leading to the additional displacement of approximately 1 million Somalis.[7] Figure 2.4 displays the number of new IDPs requiring food aid since 2016 in relation to their primary cause of displacement (recognizing that multiple causes are often intertwined). Flood and drought are the first and second largest peaks and the largest cumulative sources of displacement; displacement due to conflict is more constant across years.

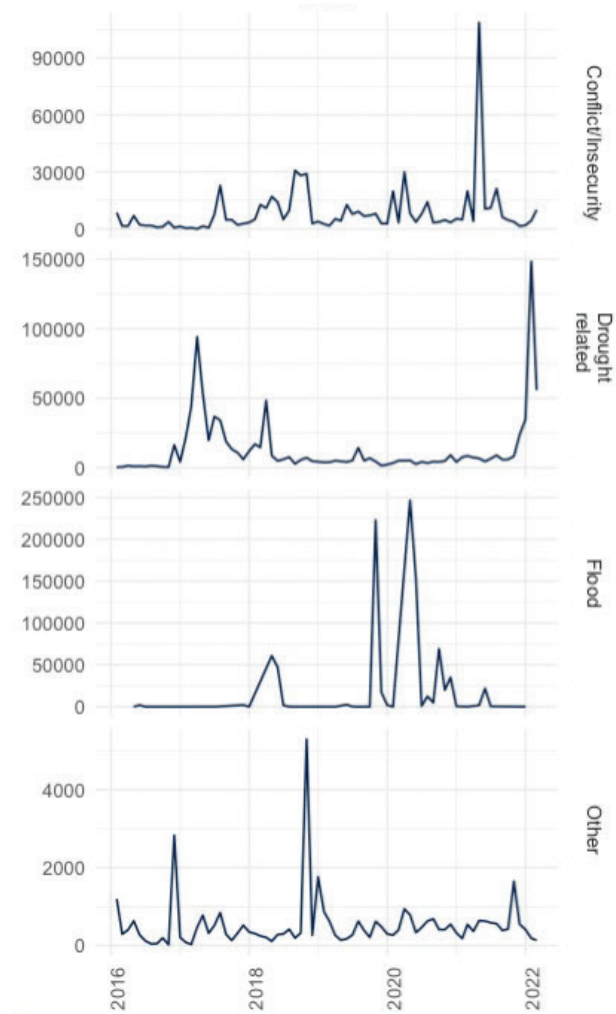
Statistical analysis of displacement, conflict, and weather data over 2016–18 shows that temperature anomalies from 1°C to 2°C (which commonly occur in Somalia) led to an approximate 10-fold increase in IDPs. A reduction from 100 mm to 50 mm in monthly rainfall is associated with an approximate doubling of IDPs, and a further reduction in precipitation from 50 mm to 0 mm leads to another fourfold increase in predicted IDPs (Thalheimer, Schwarz, and Pretis 2023). Conflict events were also strongly statistically related to displacement. Although a statistical interaction between climate and conflict was not found, humanitarian aid has long been a source of lucrative profit for Somalia's elites (some of which is then used to fund armed groups), and humanitarian distribution sites have often been targeted for attacks (Jaspars, Adan, and Majid 2019; Jaspars and Majid 2021).

IDPs present a range of acute needs, typically dominated by food and livelihood support (figure 2.5), which can put significant stress on the resources of host areas and populations. High youth unemployment associated with shocks and displacement is also believed to have contributed to al-Shabaab recruitment (UNDRR 2022; El-Bushra and Gardner 2016). Boys have been enticed to join armed groups in exchange for food in South Sudan; similar dynamics are likely in Somalia. However, the

[6] Source: United Nations High Commissioner for Refugees (UNHCR) Operational Data Portal, Somalia Internal Displacement.

[7] Source: United Nations High Commissioner for Refugees (UNHCR) Data Portal- Refugee Situations, Horn of Africa Somalia Situation.

Figure 2.4 Number of IDPs recorded by UNHCR as requiring food aid, by primary reason of displacement

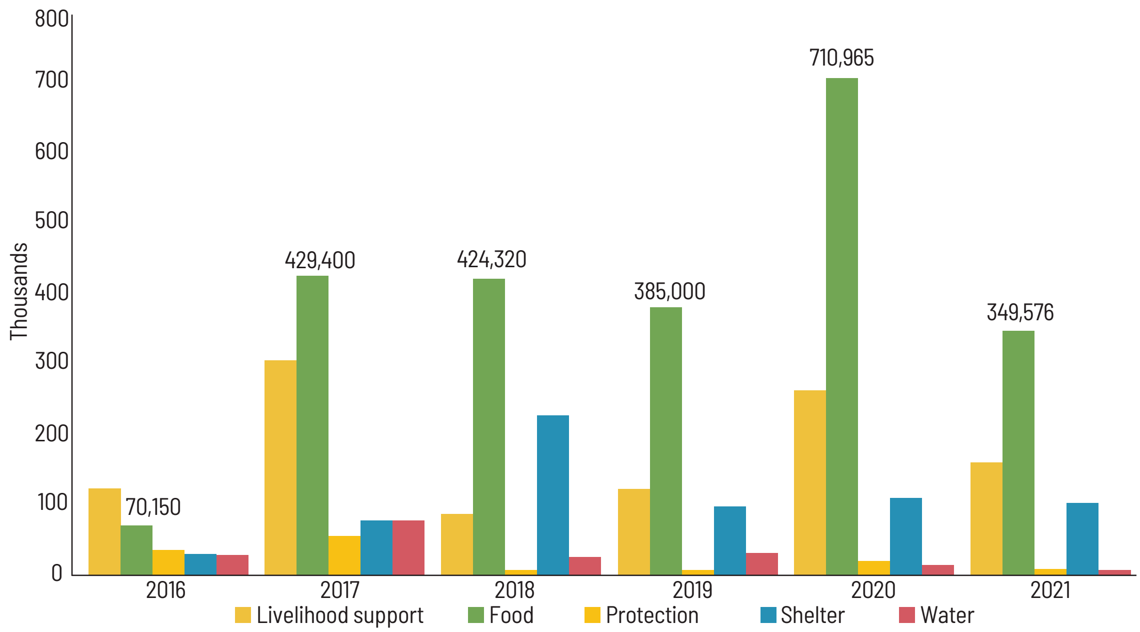


Source: United Nations High Commissioner for Refugees (UNHCR) Data Portal, Somalia Internal Displacement.

direct statistical evidence for IDPs contributing to conflict in their destination region remains weak (Thalheimer, Schwarz, and Pretis 2023).

Even if a strong direct linkage between adverse social impacts of climate change and conflict (linkage 3 in the schema in figure 2.3) has not been clearly established, it is widely accepted that the combined social impacts of climate and conflict contribute to maintaining weak institutions and governance in Somalia—which in turn exacerbates or at least perpetuates conflict. Therefore linkages 7 and 4 are likely to provide a further, indirect

Figure 2.5 Aggregated priority needs of newly displaced people, summarized across all displacement reasons, across Somalia during 2016–2021



Source: United Nations High Commissioner for Refugees (UNHCR) Data Portal, Somalia Internal Displacement.

pathway through which social vulnerability exacerbates conflict.

Direct linkage between weak natural resource governance and conflict [linkages 4, 5, 6]

Small-scale conflict over land resources is widespread in Somalia and is considered to aggravate the existing resource scarcity and humanitarian crisis (Thulstrup et al. 2020). Somalia's history of nationalizing land has allowed for patronage between the state and influential clan members and political elites, while marginalizing vulnerable groups such as those living in displacement, and increasing conflict (Dehérez 2009). Protracted land-based conflicts have also weakened customary natural resource management systems, rendering traditional dispute resolution mechanisms ineffective or disempowered (Vivekananda et al. 2019). Customary law has become an ineffective tool to settle the growing number of resource conflicts, often driven by extreme weather and becoming increasingly complex and virulent. In such situations, shifts in resource access and competition have a high potential to both escalate into violent conflict and to further degrade the resource base.

The emergence of piracy illustrates the complex links between natural resource–based conflict, poor natural resource management, and transactional politics in Somalia. Some authors argue that piracy originated from resentment at the presence of both legal and illegal foreign fishers in Somali waters, combined with weak fisheries governance and an absence of legal recourse to address territorial disputes (Devlin et al. 2020). In reality, the rise and fall of piracy in Puntland was also deeply enmeshed in larger contests between elites over control of territory and lucrative receipts from sale of fishing licenses (Dua 2017). Elites also instrumentalized the fear of piracy (in which some members of the administration were complicit; see UN Monitoring Group for Somalia and Eritrea 2013) to extract rents and support from external actors. Security actors created ostensibly for anti-piracy operations in Puntland, for instance, served essentially as a tool of political dominance for incumbent political leaders (see UN Monitoring Group for Somalia and Eritrea 2012).

A pernicious cycle of resource scarcity, conflict, and weak governance is thus well established. It may be further exacerbated by direct impacts of conflict on natural resources through the reliance of armed groups on natural capital. During a key period of al-Shabaab control of southern Somalia (2006–12), charcoal production drove the loss of over 7 percent of remaining forest (Rembold et al. 2013), while earning al-Shabaab $38–$56 million, strengthening its ability to both conduct attacks and expand recruitment (Dek 2021; Ujunwa et al. 2021). Even following a charcoal export ban, Kismayo port is alleged to be a major conduit for illegal charcoal, involving local businesspersons, political leaders in the Jubaland administration, al-Shabaab, and units of AMISOM (Majid and Abdirahman 2021).

Climate change can further drive this cycle through its direct and indirect impacts on resource scarcity. Degradation of Somalia's natural resources is mainly driven by recurrent droughts and poor natural resource management—and is particularly driven by charcoal production and overgrazing (World Bank 2020b)These are connected, as recurring droughts have led pastoralist communities to turn to the illegal charcoal trade as an income source (Bolognesi et al. 2015). Loss of forests and soils have also rapidly increased Somalia's vulnerability to drought, leading to a vicious cycle (Lwanga-Ntale and Owino 2020; Menkhaus 2014). One study shows that one-third of Somalia's land degradation stems from the loss of vegetation and soil moisture declines, which have led to a decline in crop production. Poor agronomic practices and tree cutting are major causes of land degradation in Somalia, which in turn has led to significant declines in agricultural productivity (Omuto, Balint, and Alim 2014). Impacts of drought can also compel pastoralists to change their migration patterns, moving into new territories, often controlled by hostile clans, with the potential to spark conflict. While community-level conflict resolution mechanisms do exist, they are not always successful, especially when conflicts occur with greater frequency.

2.4 Vulnerability and social risks[8]

Despite some progress, social vulnerability and fragility remain high in Somalia. Social fragmentation is a prevalent feature of Somali society, and in the absence of trusted public institutions, communities increasingly rely on informal networks and traditional structures. Certain categories of citizens stand out as more disempowered and disadvantaged than others. These groups are discriminated against in existing legal and political institutions, through social norms and values, and by the clan-based system of power relations that underpins social organization. Markers of exclusion—some of which have already been touched on in this report—include gender, ethnic and/or clan identity, geography (e.g., rural/urban), social and/or economic class, age, education, religion, livelihood, family status, displacement, and disability. These markers of exclusion intersect and compound each other—access to natural and material resources, including land and water, livestock, employment, self-employment, business development, credit facilities, wealth creation opportunities depend, to varying degrees, on whether an individual is: a man, a woman, a minority group man or woman, an IDP or a young man, as well as clan kinship network and increasingly, what form of Islam one follows (Musse and Gardner 2013). This section discusses aspects of social identity that particularly impact climate vulnerability.

Clan dynamics and marginalized groups

Historical patterns of clan-based domination have perpetuated systems of marginalization and exclusion of minority groups. These minority groups include, but are not limited to, the Rahanweyn or Digil/Mirifle minority clan families; the Bantu; Benadiri; Bajuni; and certain occupational groups. They are either fully agricultural (e.g., the Somali Bantu group), agropastoral (e.g., the Rahanweyn), or artisanal specialists (e.g., the Tumaal)—and therefore have been among the worst affected by climatic crises. They have historically experienced institutionalized

[8] This section draws heavily on World Bank Open Data. Additional references are cited where they have been drawn on.

marginalization through land expropriation and resettlement processes such as under the Barre regime's Hawl iyo Hantiwadaag (Program and Resource Sharing) policy—which was ostensibly aimed at counteracting the effects of climate change, but was used as a tool for rewarding the regime's clients.

They have also experienced serious human rights abuses, and the current 4.5 formula perpetuates their political exclusion. They have limited access to educational, employment, and sustainable livelihood opportunities and often lack the necessary networks (including among diaspora) to access other resources, including physical and political protection and remittances. Minority groups also comprise a significant share of IDPs, who are often concentrated in urban centers and lack adequate access to services, security, and social and political representation. As a consequence, they are particularly vulnerable to economic conflict and climate-related shocks, and receive limited humanitarian assistance. In the context of intensifying competition over land and resources, they face a particularly high risk of dispossession by dominant clan groups.

Gender

Somalia's socioeconomic indicators are among the lowest in the world for both males and females, but gender disparities are especially stark. The Gender Inequality Index for Somalia is 0.776 (1.0 = complete inequality), and the country performs particularly poorly on health, empowerment, and economic measures. For almost two decades now, women's incomes have become crucial for household survival, irrespective of whether there is a male individual within the household. Nonetheless, women continue to be excluded from political and public decision making and have limited space (even at the community level) to exercise agency and participate in society. Despite having played an especially dynamic role in Somali society as community mobilizers and peace builders, women and girls are assigned social and legal status within the clan system, and confront multiple dimensions of disempowerment and discrimination across most categories of social, economic, and human development (Musse and Gardner 2013).[9] In the context of climate, several aspects of vulnerability are heavily gendered:

- **Gendered livelihood risks.** Women's livelihoods are often disproportionately affected by climate change. Although both Somali men and women are reliant on climate-sensitive economic activities such as agriculture, livestock, and fisheries, women are more likely to be engaged in subsistence-level production. Consequently, their livelihood and food security are more sharply affected by climate-induced downturns in production (Somalia Institute for Development Research and Analysis 2019). Women are also more likely to engage in agricultural value chains that require less land and capital due to gender-inequitable inheritance laws, as well as limited collateral availability compared to men. They also are less mobile and less likely to employ productive inputs or utilize available extension services. These factors collectively reduce women's agricultural productivity, as well as their ability to reorganize production in the aftermath of climatic shocks—posing a greater risk to women's livelihoods amid climate change relative to men (FAO 2021; UN Women 2022). Women and girls typically shoulder most of the burden for household care-giving tasks and domestic chores. These burdens often intensify during climatic disasters and forced displacement events, as women are left to care for sick or ailing family members while men depart to find work in nearby cities and regions. Household coping strategies such as migration and family separation are extended, contribute to school dropouts of boys and girls, and require women to bear disproportionate responsibilities in terms of care work and to travel increased distances in search of water and firewood (FGS 2018). Women consequently have less time to engage in productive activities, leading to a reduction in incomes at a time when other livelihood sources are threatened (Chaudhry and Ouda 2021). According to FAO data, households dependent on women for food security are more likely to have poor food consumption and are more likely to skip meals in the context of shock-induced production downturns (FAO 2021). World Bank data also find that IDP

[9] Minority groups and the internally displaced face similar challenges.

families with single female caregivers are more likely to be poor compared to non-IDP families (Hanmer and Rubiano-Matulevich 2022).

- **Gendered human capital risks.** Women and girls in Somalia contend with several risks to their education and health in the context of climate change. Increased domestic workloads can lead to increased likelihood of lowered school attendance or complete dropout for girls relative to boys. When faced with a choice between educating their daughters or their sons, Somali households often prioritize boys' education. Faced with insecure livelihoods, Somali households have also been observed to force girls into early marriage, which poses a range of risks to their continuation in education, as well as their physiological development (Coome and Hussein 2020). Women and girls eat last and least within households affected by drought, which poses risks to their health and physiological development (CARE International 2022). This is especially concerning in the context of Somalia, a country with some of the highest maternal and infant mortality rates in the world, coupled with high total fertility and adolescent childbearing trends (UN Women 2022). Climatic variability affects women's and girls' health in other ways. Climate-induced water scarcity increases reliance on unsafe or contaminated water sources, increasing the incidence of waterborne diseases such as cholera and diarrhea, especially among women and girls engaged in water collection.
- **Gendered protection risks.** Increased risk of GBV—including exploitation, harassment, and abuse—is one of the major risks Somali women and girls face in the wake of natural disasters, climate-induced environmental degradation, and displacement. According to reports from service providers, there has been a 10 percent increase in rape in areas affected by the current drought, and a 17 percent increase in other forms of reported GBV. Household stress, changing gender dynamics as women begin taking on bread-winning roles to offset livelihood losses, and men's use of negative coping mechanisms, such as khat chewing, all increase the already widespread risks of intimate partner violence. Women and girls further face heightened risks of nonpartner violence, harassment, and abuse, particularly amid conditions of climate-induced environmental degradation. Most households depend on women and girls to arrange household supplies of water and fuel (most commonly woodfuels).[10] As climate change increases the scarcity of these resources, women and girls are pushed to undertake increasingly arduous and risky journeys. Many have had to evolve coping strategies, such as traveling during the daytime and in large groups, to reduce their risks (SIPRI 2019, 2022). Almost 50 percent of households in Somalia are female headed, but this number may be up to 80 percent among IDP settlements (Hanmer, Rubiano-Matulevich, and Santamaria 2021), where women face numerous protection risks stemming from increased work outside the home, poor safety arrangements in and around camps, limited access to survivor support services/remedies, and disruption of traditional clan mechanisms to handle incidents of violence or harassment. According to a survey of 20 IDP settlements, female respondents across the country reported being unsafe in locations inside or directly outside their settlements, particularly while using latrines (cited as unsafe by 63 percent of respondents), water access points (cited as unsafe by 51 percent of respondents), and aid distribution points (cited as unsafe by 35 percent of respondents). The weak physical shelters in camps—often constructed from plastic, cloth, or cardboard—serve to heighten protection risks for women and girls in displacement. Aid distribution at IDP camps can often be a contested process, leading to tension and conflict between different ethnicities and clans—which often boils over into violence against women and girls from rival communities. Lacking secure or assured access to aid, women—especially those from female-headed households and minority communities—may also engage in precarious livelihoods and/or trade (or be forced to trade) sexual acts for food, money, or access to markets or aid (Hanmer, Rubiano-Matulevich, and Santamaria 2021; Oxfam 2018). Humanitarian support programs prioritize "life-saving" assistance; therefore GBV service provision and survivor support remains low compared to the needs, and women's medium- to long-term needs more generally—such as maternal health and nutritional care services—are not adequately met.

[10] Sources: Thulstrup et al. (2020); and World Bank Data Portal, People using at least basic drinking water services (% of population).

Youth

Somalia's population is young: three-quarters of its population is under the age of 30 (UNFPA 2014). Nonetheless, youth continue to be excluded from both formal and customary institutions, and tend to lack access to critical assets such as networks and family support, education, and employment. An additional layer of vulnerability comes from living in a rural environment, at IDP camps, or pursuing a nomadic lifestyle compared with living in an urban setting with greater access to resources. Young women are even more disadvantaged than young men, especially internally displaced women and girls and those living in rural areas.

While youth face a number of challenges that prevent their full participation in economic, social, and political life, perhaps the most critical challenge is unemployment and underemployment, and more generally the absence of sustainable livelihood opportunities. An expanding youth population with little education or training is exerting extreme pressure on already saturated labor markets and is confronting limited opportunities to earn an income. Unskilled and uneducated youth are most vulnerable to economic shocks and least likely to find work in the formal economy. These youth are most vulnerable to climate shocks and likely to embark on irregular migration journeys (*tahriib*) as a coping mechanism (Ali 2016) or to be recruited into armed groups (El-Bushra and Gardner 2016). Female youth, constrained by mobility restrictions and sociocultural expectations, may face increased risks of GBV and early/forced marriage.

Finally, almost 2 million youth under age 25 live in displacement due to violence, conflict, and extreme weather events across Somalia (IDMC 2022). About 76 percent of displaced boys and 71 percent of displaced girls are enrolled in schools (IDMC 2020). Displaced children with disabilities face an additional burden in enrolling in schools and receiving needs-specific support (IDMC 2021).

Forced displacement

An estimated 3 million people were internally displaced in Somalia at the end of 2021,[11] and they are among the poorest people in the country. Displacement often worsens socioeconomic marginalization and exclusion. Forced displacement predominantly affects socially and politically marginalized groups, which then confront conditions of poverty and deprivation that extend from lost assets and livelihoods. Minority group status, gender, disability, and dislocation from clan-based and patronage networks all contribute to entrenched marginalization and wider experiences of exclusion. Disconnected from traditional mechanisms for support and protection, IDPs are rendered more vulnerable, less able to restore viable livelihoods and living conditions, and less equipped to integrate into the society of the host community. At designated IDP settlements, they risk exploitation under a system of "gatekeeping," where patrons extract benefits from the settlement population and its humanitarian assistance (World Bank 2020c). Three-quarters of IDPs (74 percent) live below the poverty line (World Bank 2019b), and many confront serious constraints to accessing basic services, including improved water and sanitation; and essential services such as health, education, employment, and markets (World Bank 2019b). IDPs are vulnerable to disease, GBV, forced eviction, and extortion. Women and children comprise 70–80 percent of IDPs (OCHA 2020). They are the most vulnerable among the displaced and face multiple constraints, including protection challenges, lack of access to adequate shelter, limited education, few economic opportunities, and lack of control over critical resources (FGS 2018).

The internally displaced are especially vulnerable to the effects of climate events, such as drought and flooding. Displacement can also compound the effects of drought in areas where IDPs choose to settle by increasing competition for scarce resources. They faced higher risks during the COVID-19 pandemic, especially because of the limited space in temporary shelters and internal displacement camps.

[11] Source: Internal Displacement Monitoring Centre, Somalia Country Profile.

Chapter 3

Risk Summaries

This chapter reviews the existing knowledge of climate risks across five broad themes: **climate disasters**, **agriculture and livestock**, **renewable natural resources**, **health**, and **infrastructure and services**. It aims to provide a systematic and accessible inventory of major biophysical risks in Somalia related to climate, and to indicate how these are likely to evolve with climate change.

To provide a basis for comparison between risks, a number of semiquantitative indexes are used to assess them, as described below and summarized in figure 3.1.

- **Frequency** is conveyed by a five-point scale denoting whether risk events are (1) rare (multidecadal); (2) occasional (once or twice a decade); (3) frequent (at least 50 percent of years); (4) routine (generally every year); or (5) chronic (impacts are constant, not associated with discrete acute events).
- **Economic cost** per event—or per year for routine or chronic events—is assessed on a five-point scale according to whether the approximate expected value of damage and loss falls into the following orders of magnitude: (1) <$1 million; (2) $1–$10 million; (3) $10–$100 million; (4) $100 million–$1 billion; or (5) >$1 billion.
- **Mortality** (where applicable; this only refers to direct human mortality) is assessed on a five-point scale according to whether the approximate expected number of lives lost per event—or per year for routine or chronic events—falls into the following orders of magnitude: (1) < 10; (2) 10–100; (3) 100–1,000; (4) 1,000–10,000; or (5) > 10,000.
- **Poverty linkage** assesses whether the impact disproportionately affects the poor according to the following five-point scale: (1) very weak (poor much less affected than others); (2) weak (poor less affected); (3) neutral or unclear (poor affected similarly to others/unclear); (4) strong (poor more affected); or (5) very strong (poor much more affected).
- **Climate trend** reflects the strength of the expected change in climate stressors influencing risk, as well as the strength of their influence on the risk, according to the following five-point scale: (1) strong decrease; (2) weak decrease; (3) no clear trend; (4) weak increase; or (5) strong increase. Because most risks are influenced

Figure 3.1 Explanation of index scales used to assess risk

Frequency	1 Rare 2 Occasional 3 Frequent 4 Routine 5 Chronic
Economic cost	1 <$1 million 2 $1–$10 million 3 $10–$100 million 4 $100 million–$1 billion 5 >$1 billion
Mortality	1 < 10 2 10–100 3 100–1,000 4 1,000–10,000 5 > 10,000
Poverty linkage	1 Very weak 2 Weak 3 Neutral or unclear 4 Strong 5 Very strong
Climate trend	1 Strong decrease 2 Weak decrease 3 No clear trend 4 Weak increase 5 Strong increase

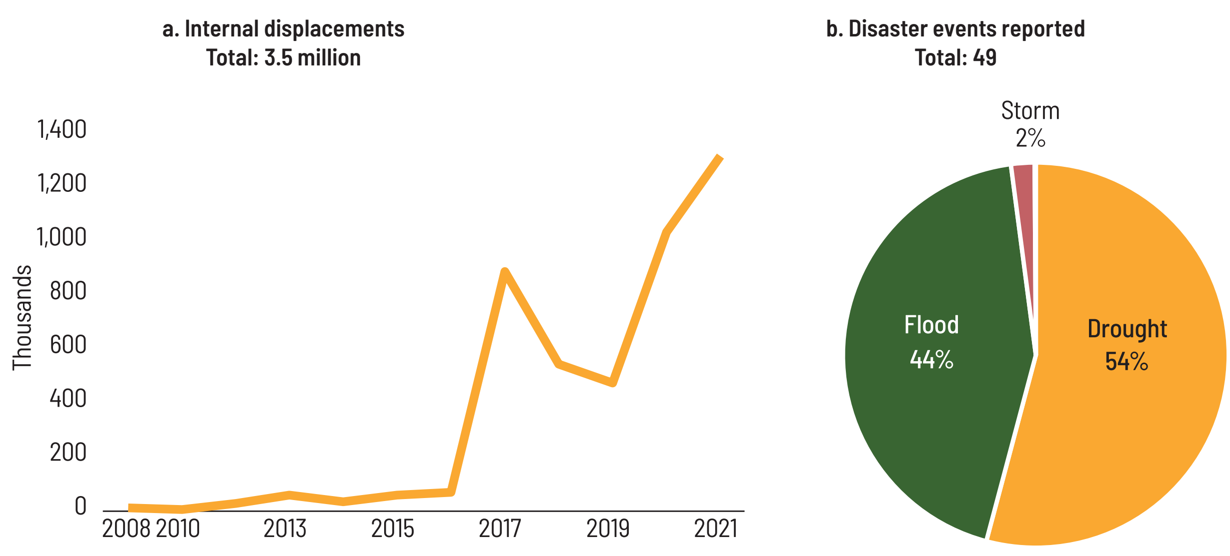
by a wide variety of factors, this metric focuses only the likely change in the *climate* factors—and not, for instance, on socioeconomic factors—that may drive exposure or vulnerability to the risk.

Note that although these indexes are based on broad scales, and often orders of magnitude, there is still considerable uncertainty in their assignment. This climate risk review is not intended to provide a definitive assessment, but rather a best estimate based on currently available information—which should be subject to further review and improvement in the future. There is also no single or definitive way to categorize risks, as many overlap and interact. For instance, this review does not have a separate section on risks to water resources, as these drive a range of more specific risks, including to crop production, livestock, power generation, and water supply.

3.1 Climate disasters

Somalia faces a range of climatic hazards. These have enormous impacts on the county's population and economy. Figure 3.2 illustrates the number of weather-related disasters between 2008 and 2021, along with the number of people newly displaced each year due to these disasters. In 2022, the numbers increased yet further, with over 1.17 million displaced since the end of 2021 (IOM 2022). The main causes of the vast majority of weather-related disasters are droughts and floods, with the ongoing drought a key driver of displacement in 2022. Rising temperatures will also increase heat stress, with associated risks to both health and productivity.

Figure 3.2 Weather-related disasters in Somalia, 2008–21



Source: Based on International Displacement Monitoring Centre Dashboard, Somalia.

DROUGHT

Risk	Distribution	Frequency	Economic cost	Mortality	Poverty linkage	Climate trend
Drought	Whole country	Frequent	>$1 billion	> 10,000	Very strong	Weak increase

This section covers the multisectoral impacts of drought events—that is, discrete events where both soil moisture and the availability of surface water are extremely limited. The impacts of more general hot and dry conditions that are not specific drought events are covered in other sections of this chapter.

Nature of risk

Droughts are Somalia's costliest natural disasters. They can occur anywhere in the country, as much of Somalia is either arid or semi-arid and drought-prone.

Recent droughts have affected the entire country. Figure 3.3 shows the drought conditions and numbers of people affected in August 2022 and provides an example of the spatial and human impacts of drought.

Magnitude of impact

In recent years, successive droughts linked to major changes in climate and weather patterns, combined with high levels of conflict and insecurity, have devastated the rural economy. This has resulted in chronic food insecurity and very large numbers of internally displaced persons (IDPs). In addition, the transhumant corridors for livestock have been affected by civil strife, affecting mobility. Mobility is important to Somali pastoralists as a strategy to respond to the spatial-temporal heterogeneity of forage resources. Barriers to mobility have contributed in a significant way to the increased severity of drought impacts in the country.

Extremely large numbers of people have been affected by Somalia's recent droughts. In August 2022, 7.6 million people were directly affected by drought, including over 1 million displaced by drought (OCHA 2022a). Figure 3.4 shows the trend in numbers of people displaced by drought since 2016; figure 3.3 provides a snapshot of the large numbers affected in early April 2022.

The recurrent droughts have had a significant impact on poverty. A World Bank study of the 2016/17 drought identified significant adverse impacts on poverty, consumption, and hunger (Pape and Wollburg 2019). These impacts were particularly significant in rural areas, where the poor rely mainly on agriculture and have limited access to infrastructure and basic services. The study estimated that renewed drought shocks could lead to a significant increase in poverty.

A postdrought needs assessment of the 2016/17 drought provides an illustrative snapshot of the economic impacts (FGS 2018). Following four poor rainy seasons in succession, more than half the population needed humanitarian assistance. Economywide loses totaled over $3.25 billion, with recovery interventions requiring a further $1.77 billion.[1] This level of impact undermined development gains made in previous years. The drought severely affected agricultural production—the main driver of Somalia's economy—with livestock and crop losses affecting 17 out of 18 regions in the country; there were significant price increases for key staples. Gross domestic product (GDP) growth (which was recovering before the drought) dropped by around 1.4 percent from the previous years; and wages temporarily dropped by around 6.9 percent during the acute drought period, although they rapidly recovered (increasing slightly) soon after the drought broke.

Analysis of single drought events does not capture the compound economic and livelihood impacts of successive droughts with only limited recovery periods in

[1] In this analysis, losses were only projected until the end of December 2017. In practice, economic recovery and reconstruction after an event of this scale requires several years. The recovery cost provided here is almost certainly an underestimate of the full recovery costs.

Figure 3.3 Somalian regions affected by drought in August 2022

OPERATIONAL PRIORITY AREAS BY DISTRICT

	OPERATIONAL PRIORITY 1	OPERATIONAL PRIORITY 2	OPERATIONAL PRIORITY 3
NUMBER OF DISTRICTS	32	34	8
AFFECTED POPULATION	4.6M	3M	273K
INTERNALLY DISPLACED PERSONS	658K	341K	16K

OPERATIONAL PRIORITY ONE

Indicates severe drought impact for all indicators and low levels of response

Areas prioritized for immediate activation of area-based coordination (ABC) and rapid response mechanism (RRM)

OPERATIONAL PRIORITY TWO

Indicates moderate drought impact for most indicators

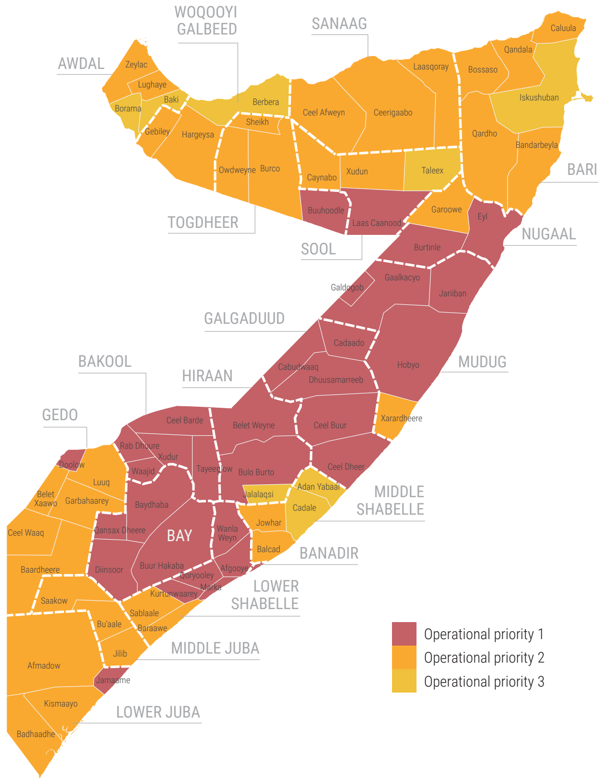
Areas prioritized for phased activation of area-based coordination (ABC) and rapid response mechanism (RRM)

OPERATIONAL PRIORITY THREE

Indicates relatively low drought impact for all indicators

Regular cluster response and inter-cluster coordination continues

Continuation of monthly monitoring to assess drought impact

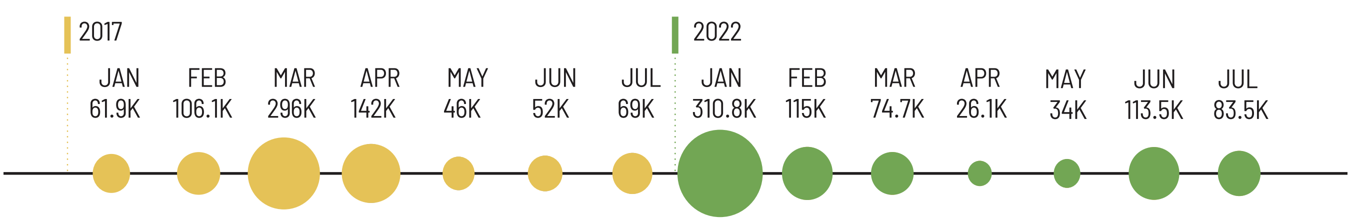


AFFECTED POPULATION BY REGION

REGION	% OF POPULATION AFFECTED
Bakool	68%
Bay	67%
Gedo	61%
Mudug	60%
Nugaal	59%
Galgaduud	58%
Lower Juba	56%
Hiraan	53%
Middle Juba	52%
Sool	52%
Togdheer	50%
Bari	49%
Sanaag	46%
Banadir	40%
Middle Shabelle	40%
Lower Shabelle	37%
Woqooyi Galbeed	34%
Awdal	31%

Source: Adapted from OCHA 2022a.

Figure 3.4 Trend of drought-driven internal displacement, 2016–22



Source: Adapted from OCHA 2022a.

between. Neither does it adequately account for the joint impacts of drought and flood occurring in similar time periods. Because these events can also trigger conflicts, the combined economic impact is far-reaching and complex. To date, there has been no attempt to quantify these multiple, multisectoral, multiyear impacts.

Mortality rates are unclear but may be extremely high. Although UNICEF reports relatively small numbers for the current drought (e.g., around 500 deaths for the first six months of 2022), these numbers are acknowledged as "just the tip of the iceberg" because many deaths go unreported (UNICEF Somalia spokesperson Victor Chinyama, as cited in Dhaysane 2022). UNICEF (2022a) estimates that the severe drought-related famine of 2011 killed about

260,000 people in Somalia—more than half of whom were children. The main causes of death were malnutrition, diarrhea, and measles. Relief access was also significantly hampered by insecurity, mainly due to activities of the al-Shabaab group.

While income- and gender-disaggregated figures are scarce, drought predominantly affects livelihoods of farmers and pastoralists, and therefore some of the poorest households are most affected. For a variety of reasons, as discussed in chapter 2, livelihood impacts affect women and female-headed households disproportionately. Drought is also the biggest single driver of internal displacement, which creates a raft of additional vulnerabilities, particularly for women and other vulnerable groups.

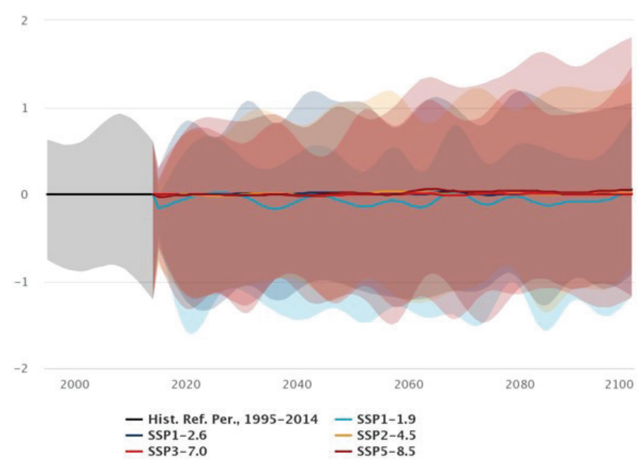
Climate drivers

While low levels of precipitation are a key driver of droughts, higher temperatures cause greater evapotranspiration, which also contributes to reducing soil moisture. Generally, in Somalia, evaporation potential is greater than precipitation across the country. There are a few localized areas in southern parts of Somalia, around Jilib and Baidoa, where for a few months of the year higher rainfall than evaporation can be experienced.

Drought conditions are influenced by patterns of land use. These are frequently characterized by overgrazing (e.g., around water points, and more broadly due to restricted grazing patterns often as a result of conflict) and localized deforestation (often for fuelwood). These practices lead to compacted soil structure and exposed slopes, resulting in increased runoff and reduced infiltration when rains occur, and therefore magnifying drought impacts.

The projected warming of the next decades indicates the Horn of Africa may continue to be drought-vulnerable, due to increased evapotranspiration and more erratic precipitation, even if there is a slight increase in mean rainfall. Severe and prolonged droughts are highly likely to be a prominent feature of Somalia's future climate for decades to come, although long-term trends are uncertain due to the range of potential precipitation outcomes (figure 3.5).

Figure 3.5 Projected annual SPEI Drought Index



Source: World Bank Climate Change Knowledge Portal: Somalia.
Note: Negative values of the Standardised Precipitation-Evapotranspiration Index (SPEI) indicate higher likelihood of drought—i.e., this graph is suggesting outcome is uncertain, but a slight trend toward increasing drought is more likely.

FLUVIAL AND PLUVIAL FLOOD

Risk	Distribution	Frequency	Economic cost	Mortality	Poverty linkage	Climate trend
Fluvial and pluvial flood	Whole country	Frequent	$100 million–$1 billion	10–100	Very strong	Weak increase

Somalia is highly vulnerability to fluvial, pluvial, and coastal floods. This subsection considers climate risks and impacts associated with fluvial and pluvial floods (including flash floods), which have similar climate drivers. The next subsection considers coastal flooding risk, which is subject to different climate drivers.

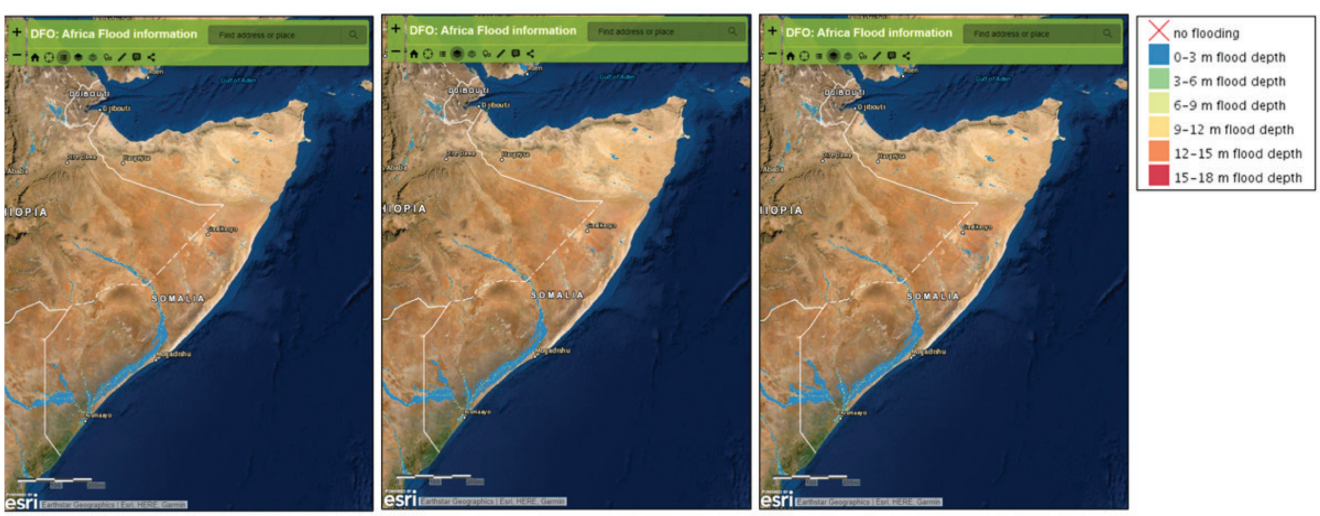
Nature of risk

The highest flood risk areas include agricultural areas and several towns in the Shabelle and Juba basins at risk of fluvial flooding. However, flash flood risk occurs throughout the country, and the largest cities are also exposed albeit to a lower level of risk (map 3.1). In the Juba and Shabelle river basins—which rise in Ethiopia where the headwaters are subject to different weather patterns from Somalia—floods can happen even during drought periods, compounding the adverse impacts of both. A recent World Bank study estimates that between 15 and 20 percent of Somalia's total population is exposed to a 15 centimeter (cm) or more flood risk. In the Juba and Shabelle basins, this figure rises to between 20 and 30 percent (Rentschler and Salhab 2020).

Fluvial (river) floods are common along Somalia's two major rivers. The Shabelle and the Juba flood regularly after the Gu (March–June) and Deyr rains (October–December). These regular flood events have positive impacts and are used for flood recession cultivation in the lowland floodplains of both rivers. The flooding also provides lush pasture for both livestock and wildlife. However, in years when the rainfall is very heavy, either locally or upstream in Ethiopia where both rivers rise, flooding can be far more severe. When this occurs, it results in major loss and damage to crops, pastures, and settlements in the rivers' floodplains. Flooding is often made worse when riverbanks are deliberately breached to access water for irrigation during the dry

Map 3.1 Flood depth simulations for different return periods

a. 10-year flood depth | b. 20-year flood depth | c. 100-year flood depth



Source: Dartmouth Flood Observatory; flood depth data from EU Joint Research Centre.

season. Map 3.2 shows river breakages during early 2022, illustrating how the flood risks remain even in the middle of a prolonged drought period.

Limited and/or unmaintained infrastructure, including retaining walls and water catchment or redirection systems (Gure 2021), expose communities to the effects of floods annually, often with disastrous results for smallholder farmers and rural economies.

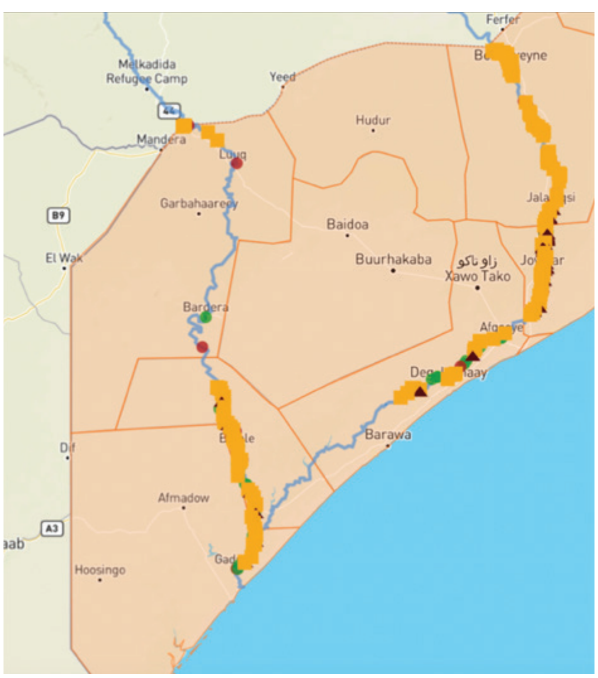
Flooding of Beledweyne city (population over 250,000), on the upper reaches of the Shabelle River, is now a regular event. Around 80 percent of the city was flooded in 2019, with inundation lasting several weeks and causing widespread damage and disruption. Anecdotal evidence suggests flooding here is increasing in frequency and extent. Similarly, widespread flooding in the alluvial valley around Jowhar, in the middle Shabelle, routinely results in extensive damage to agriculture as well as closing Jowhar airport and the Beledweyne-Jowhar-Mogadishu highway. Although there are floods in this area every year, in wet years the inundated area is far larger and disruptions far greater. This flooding leads to widespread displacement of the local population, stops farmers reaching markets, floods pit latrines which then contaminate water sources and spread waterborne disease, while standing water increases the occurrence of malaria (MEWR 2021).

Pluvial and flash floods are a result of localized rain storms. They can disrupt communications by damaging road surfaces and small bridges, and/or causing power and telephone lines to fall.

Magnitude of impact

Economic impacts of floods can be severe and long-lasting. Postdisaster analysis of the 2019 floods estimated loss and damage of over $260 million, with recovery needs amounting to around $350 million (FGS and World Bank 2019). Economic losses were estimated at $72 million in the year immediately following the floods; $39 million the following year; $35.1 million in the third year; $31.6 million in the fourth year; and $28.4 million in the fifth year. Table 3.1 summarizes the damage to different sectors. Table 3.2 shows the financial cost of both loss and damage as well as the estimated costs of postflood recovery.

Map 3.2 River breakages along Juba and Shabelle Rivers in February 2022



● **OPEN (O):** Breakage point where a recent (< 1 year) flood originated is still open, and has no signs of intervention/rehabilitation on the latest analyzed images.

▲ **OVERFLOWS (Of):** Portion of the river embankment where water overflows have recently occurred (< 1 year). Overflows generally take place along shallow portions of the embankments, which could be submerged for several hundred meters during the flood.

■ **POTENTIAL (P):** A point along the embankment where there is potential for flooding to occur. Clear indicators of flood potentiality, such as recent vegetation removal, embankment erosion, closed with sand bags, water spillage or other signs representing a potential embankment weakness have been identified. These indications are supported by DTM analysis, multitemporal analysis and/or direct field observations.

● **CLOSED (C):** Breakage point where an old (>2 years) flood originated and that has been fixed using either heavy machinery or sandbags. No flooding has been detected recently, so this point may be considered CLOSED as the situation is stable. Interventions by heavy machinery are permanent, while those by sandbags are temporal, subject to new floods.

Source: FAO SWALIM, Flood Risk and Response Information Management System, Juba and Shabelle River Breakages, accessed February 2022.

Table 3.1 Summary of damage caused by the 2019 floods

Sector	Type of damage	Comment
Agriculture (crop production/livelihoods)	Crops and livestock assets and lost harvest	Less than many other floods events, as these 2019 floods were localized and limited compared with previous major floods
Housing	4,640 fully damaged housing units; 15,613 partly damaged units	Urgent and immediate needs for shelter; increased population displacement
Transport	Over 320 km of road and 23 bridges damaged; 5% of road embankments destroyed	Damage to roads disrupts many economic activities, hinders school access, and delays relief operations
Water, sanitation, and hygiene	64 boreholes; 272 shallow wells; 58 water pans damaged	Immediate impacts on water supply for humans and livestock
Education	Schools in 14 districts damaged by flooding; nearly 34,000 pupils affected	Losses include those associated with losses of school learning materials and equipment, and provision of temporary learning spaces
Health	15 health facilities damaged	Losses include additional costs for treatment of acute watery diarrhea/cholera cases for the next 12 months, and losses incurred in replacing health supplies and equipment.
Disaster risk management/ flood risk management	Impacts to relief supplies and warehouses, monitoring equipment, and gauging stations	Losses include relief coordinating and delivery expenses
Displacement	Damages and losses to infrastructure in 154 formal IDP settlements; particularly damaged housing and shelter	Losses include damaged water resources and impeded access to health services
Food security	National levels of food insecurity (IPC3 and 4) increased from just under 10% to around 17% immediately following floods	Data not sufficiently differentiated to provide an exact proportion of this increase linked to the floods; the humanitarian response required significant additional finance

Source: Adapted from FGS 2020.

Table 3.2 Total financial costs of loss and damage and recovery needs of 2019 floods ($)

Sector	Damages	Losses	Total effect	Short-term needs (6–12 months)	Medium term needs (1–3 years)	Total needs
Transport	94,806,623		94,806,623			115,382,276
Housing	26,470,853	—	26,470,853			33,657,690
Education	25,951,817	3,094,545	29,046,362	21,242,411	13,581,214	34,823,625
Health	1,239,982	40,999,040	42,239,022			46,015,018
Water, sanitation, and hygiene	8,895,566	20,480,616	29,376,182			24,801,800
Agricultural and pastoral livelihoods				28,043,377		28,043,377
Disaster and flood risk management	6,080,400	9,025,000	15,105,400	6,401,400	35,576,900	41,978,300
Displacement	9,019,500	15,976,763	24,996,263			25,000,000
Grand total	172,464,740	89,575,964	262,040,704	55,687,188	49,158,114	349,702,086

Source: FGS 2020.

Systematic and comprehensive assessment of flood risk and costs is challenging. Simple hydrological models can make broad predictions of potential exposure, but detailed on-the-ground data on assets and also the state of flood defenses are typically lacking.

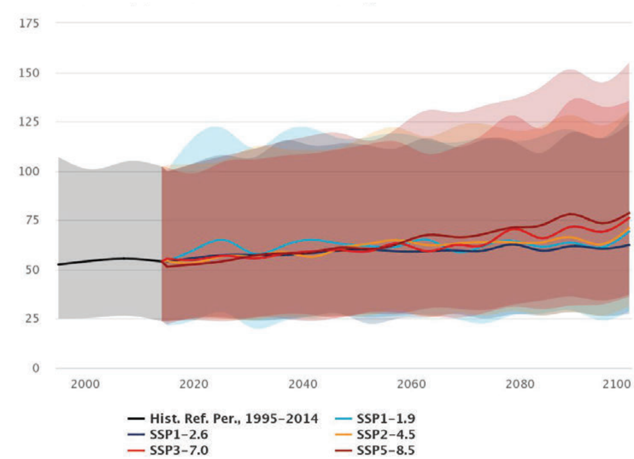
Agriculturalists and the urban poor are typically the most exposed to floods. Floods can have a severe adverse impact on the livelihoods and well-being impact of poor households. Assets are lost and damaged in floods, increasing vulnerability. Floods can drive poor households that are emerging from poverty but have no savings back into it. Limited access to land and housing often forces poorer households, in both rural and urban settings, to live in flood-prone areas (Le Sage and Majid 2002; Rentschler and Salhab 2020). Floods are also a major driver of internal displacement, and therefore a cause of long-term social vulnerability that compounds other categories of risk.

Climate drivers

Flood risk is primarily driven by rainfall variability. However, the temporal and spatial scales differ between flood types, with pluvial flooding driven by local and immediate events, whereas fluvial flooding responds to precipitation across river catchments, often accumulating over a period of weeks.

Somalia already has very high variability in rainfall, and this will continue in the future. Interannual variability is projected to increase relative to the present day, resulting in more frequent wetter and drier years relative to the mean. Heavy rainstorms are projected to increase in frequency and intensity. Figure 3.6 shows the upward trend (and considerable uncertainty) in five-day cumulative precipitation. Dry spells may also increase in frequency and duration (Richardson et al. 2022). There is considerable uncertainty in flood projections, however, due to the wide range of potential outcomes in mean annual precipitation.

Figure 3.6 Variability and trends of average largest five-day cumulative precipitation across seasonal cycle, 1971–2020



Source: World Bank Climate Change Knowledge Portal: Somalia.

Table 3.3 **shows the projected economic impact of riverine floods up to 2080.** Note that these figures are for flood events with a 25-year return period. The rapid increases in urban damage costs reflect the rapidly increasing urbanized proportion of Somalia's population. In addition, most climate models indicate that by midcentury the flood return period in East Africa will halve (Arnell and Gosling 2016)—that is, a flood event that, based on historical data, will occur every 25 years, will likely occur closer to once every 12 years later in the century. So, severe flood events will almost certainly occur more frequently. In between the 25-year return period events referred to in table 3.3, less severe flooding will likely occur more frequently and more severe flooding less frequently—all with significant costs, as discussed above.

Climate projections for Ethiopia show very similar patterns of increased rainfall variability and increased frequency and intensity of rain storms (Richardson et al. 2022). This suggests that heavy rainfalls in the Ethiopian headwaters of the Juba and Shabelle Rivers will continue to trigger floods downstream in Somalia, probably with greater frequency.

Table 3.3 Projected impacts of floods with a 25-year return period, excluding damage to crops and livestock

Riverine flood impact	2010 (baseline)	2030	2050	2080
Damage (annual, $ million)	270	2,700	10,000	38,000
Affected population (thousand people)	9,300	13,000	16,000	18,000
Affected proportion of total population (%)	7.3	9.6	9.7	9.5
Affected GDP (annual, $ million)	320	1,200	3,000	9,000
Proportion of GDP (%)	7.24	9.57	9.65	9.38
Proportion of GDP (%)	0.03	0.07	0.09	0.13

Source: World Resources Institute Aqueduct.
Note: The World Resources Institute's Aqueduct flood risk tool uses a cascade of models within the Global Flood Risk with IMAGE Scenarios (GLOFRIS) modeling framework. The methodology is described in full by Ward et al. (2020).

COASTAL FLOODING

Risk	Distribution	Frequency	Economic cost	Mortality	Poverty linkage	Climate trend
Coastal flooding	Whole coastline	Occasional	>$10–$100 million (individual events)	10–100	Very strong	Weak increase

Nature of risk

Much of Somalia's coast is low-lying and the whole coast is identified as vulnerable to storm surges. Sea level rise will add to this vulnerability. In future, rising sea levels will threaten coastal communities, especially in the south of the country, including Mogadishu (PIK/Adelphi 2022).

The whole of Somalia's coastline is threatened by rising sea levels. The large, and rapidly growing, coastal cities of Mogadishu and Kismayo are likely to face significant coastal flooding challenges without adaptation measures (table 3.4). Possible losses of crops and livestock, along with losses to trade and fisheries resulting from damage to ports, jetties, and boats, will increase the economic costs of coastal floods still further.

Table 3.4 Mogadishu urban agglomeration: annual GDP loss to coastal floods, no adaptation

Mean annual loss (% city GDP) 2005	Mean annual loss (% city GDP) 2050
0.038	0.415

Source: Hallegatte et al. 2013.
Note: The no adaptation scenario in 2050 takes into account a 40 cm sea level rise and subsidence.

Saltwater intrusion into coastal areas has a negative impact on fresh water sources (rivers, streams, and wetlands). It salinizes both drinking and irrigation water, making offseason agriculture more challenging. Saline water intrusion into drinking increases the risk of high blood pressure in pregnant women and increases infant mortality (Scheelbeek et al. 2016). Salinity stemming from sea level rise can severely damage roads through land subsidence, blistering, cracking, and pulverization, and lead to increased maintenance costs (Brookings 2020).

Magnitude of impact

There are already a significant number of people exposed to coastal flooding. Around 110,000 live below the high tide mark and 170,000 live below the maximum storm surge level with a one-year return period (Kulp and Strauss 2019). Losses to urban infrastructure are already estimated to be significant (table 3.5).

Those households most vulnerable to coastal floods are those that do not have sufficient assets to easily move from locations at risk from flooding, particularly the urban poor. Broader economic impacts may accumulate because coastal flooding has the potential to substantially increase damages to ports and other coastal infrastructure, with knock-on impacts on Somalia's ability to manage imports and exports. In smaller coastal settlements, the combination of sea level rise and increasingly frequent and severe storms will potentially disrupt livelihood systems based on fisheries and/or the cultivation of coastal areas.

Climate drivers

There is a lack of research on current and projected impacts of sea level rise and coastal inundation in Somalia. Very simple projections can be mapped using interactive tools employing global data sets, based on a combination of projected sea level rise under various climate models combined with known elevations of coastal areas. While these tools indicate that most of Somalia's shoreline is threatened, they cannot show the degree to which this affects coastal communities and livelihood systems and are probably not sensitive enough to indicate the impact of individual severe storms and cyclones, which are likely to increase in severity and frequency. In particular, the tools cannot indicate whether changes are slow enough for coastal communities to move, adapt to, and mitigate the potential impacts. Map 3.3 gives an example of information for Somalia provided by a sea level rise mapping tool.

Climate projections point to rising sea levels and increased likelihood of cyclones and storm surges. The increases in extreme weather and sea conditions are linked to rises in sea surface temperature. A warmer ocean intensifies cyclone activity and heightens storm surges. The destructive impact will generally be greater when storm surges are accompanied by strong winds and make landfall during high tides (Brecht et al. 2012).

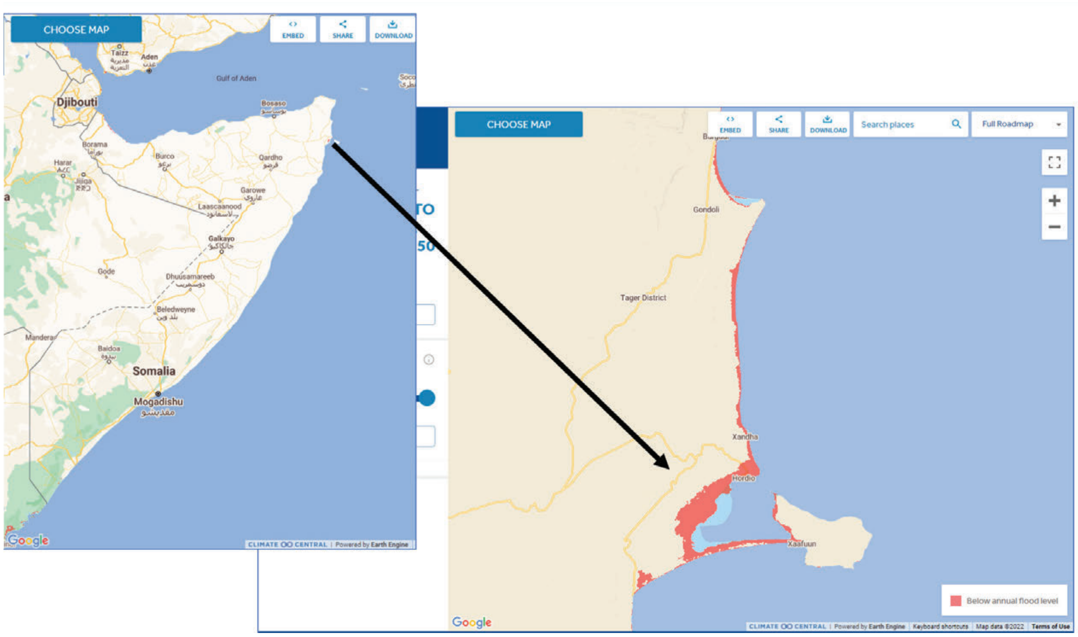
Representative Concentration Pathways (RCPs) 2.6 (low greenhouse gas emissions scenario), 4.5 (approximate current trajectory emissions scenario), and 8.5 (high greenhouse gas emissions) all project sea level rise of around 20 cm by midcentury. The projections then diverge, with end-century mean projections for each RCP ranging between 60 and 40 cm (figure 3.7). Projected increases in the frequency and strength of storm surges is likely to significantly increase Mogadishu's flood risk by 2050 (CityCORE Africa 2020).

Table 3.5 Projected impacts of coastal flooding with a 25-year return period, excluding damage to crops and livestock

Coastal flood impact	Baseline 2010	2030	2050	2080
Urban damage (annual, $ million)	25	200	650	2,500
Affected population (thousand people)	3	10	14	24
Affected GDP (annual, $ million)	1.3	9.2	27	120
Proportion of GDP (%)	0.03	0.07	0.09	0.13

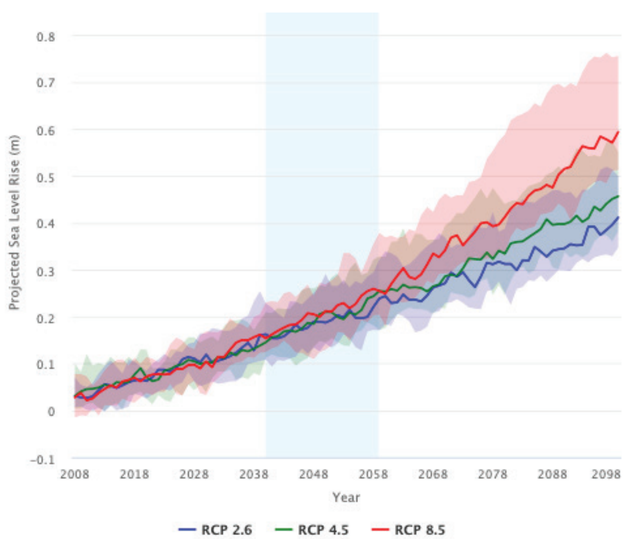
Source: World Resources Institute Aqueduct.
Note: These figures are derived from a global data set with limited direct empirical inputs, and hence should be treated with some caution. The World Resources Institute's Aqueduct flood risk tool uses a cascade of models within the Global Flood Risk with IMAGE Scenarios (GLOFRIS) modeling framework. The methodology is described in full by Ward et al. (2020).

Map 3.3 Example of areas under threat to sea level rise



Source: Climate Central Coastal Risk Screening Tool, Somalia, Land Projected to Be Below Annual Flood Level in 2050.

Figure 3.7 Somalia: projected rise in sea level



Source: World Bank Climate Change Knowledge Portal: Somalia.

The modest sea level rise projected over the course of the rest of the century will not place a significantly larger land area at risk (Kulp and Strauss 2019). However, demographic growth will mean that a significantly larger population is exposed in future. A recent study indicates a significant increase in the number of people living in low elevation coastal zones in Somalia, with the increase most marked in urban settings—reflecting Somalia's rapid urbanization (table 3.6).

Table 3.6 Somalia: population living in low-elevation coastal zones by 2030 (millions)

Year	Urban	Non-urban
2000	0.13	0.45
2030	0.84	0.78

Source: Brookings 2020.

Coastal infrastructure (especially ports) will be at increased risk from the higher sea levels. Because ports have long life spans, future sea level rise needs to be incorporated into the design of new coastal infrastructure now. In Somalia's major port cities, rapid population growth and the government's capacity to manage and plan housing and infrastructure are likely to have as great a contribution to inundation risks as climate-related factors.

3.2 Agriculture and livestock

Agriculture, including crop production and livestock husbandry, is essential to the livelihoods of the majority of Somalia's population that lives in rural areas. It is also essential to the country's food security and economic growth prospects. The largest driver of the economy, the sector accounts for up to 65 percent of GDP,[2] the great majority of which comes from livestock. Approximately 49 percent of Somalis (or 6–7 million people) still live in rural areas. Of this population, slightly more than half derive their livelihood directly from nomadic pastoralism, while slightly less than half depend on crop cultivation (World Bank and FAO 2018). Agricultural extension services and advice are very limited in Somalia, and productivity is low.

Animal products are Somalia's largest exports. Camel milk production had an estimated market value of $3.3 billion before the beginning of the current extended drought period (FGS 2018)—which, for livestock, was in 2014. Data from the Food and Agriculture Organization of the United Nations (FAO) show that the country had 14 million sheep, 13 million goats, 7 million camels, and 5 million cattle as of 2016, worth approximately $9.6 billion at national market prices in Somalia.[3] The quantity of hides and skins is comparable to the late 1980s level, at about 7 million pieces a year (World Bank and FAO 2018). The country produced 100,000 tons of beef and approximately 60,000 tons of camel meat in 2013. With global demand for livestock products expected to double by 2050 (Rojas-Downing et al. 2017), the sector provides significant strategic opportunities for further growth.

However, livestock production is coming under increasing threat. Reasons include climate change–related water shortages, lack of availability of and access to good pasture, invasion of unpalatable plant species, deforestation and other forms of land degradation, animal diseases, and natural shocks such as drought (FRS 2018). Shortages of fodder and water contribute to reduced productivity and reproductive performance of livestock. This includes slow growth rate of animals, loss of body condition, reduced milk production, and poor reproductive performance in mature animals. Change in temperature may compromise the quantity and quality of forage by increased lignification of plant tissues and reducing digestibility and rate of degradation. Changing climate conditions are also influencing the abundance of important pests and diseases in the livestock sector.

Impacts to agriculture and livestock have very direct poverty implications. Pastoralists have the highest poverty rates in the country and are poorly integrated into the wider national economy, including limited access to veterinary services (Plaza and Cerruti 2022). This severely limits opportunities to manage climate risk to livestock effectively and efficiently. Rural poor households' limited assets and social networks mean they are unable to substitute for income and subsistence food losses resulting from livestock loss and crop failures. Even moderate losses can cause severe hardship, and distress sales can severely compromise poor rural households' abilities to reestablish secure livelihoods. Failure of successive growing seasons is a major driver of internal displacement. Displaced households frequently abandon their agricultural assets, making it very difficult to reestablish their livelihoods at a later stage.

Rural livelihoods are also characterized by specific gender roles and considerable gender vulnerability. Although both Somali men and women are reliant on climate-sensitive economic activities such as agriculture, livestock, and fisheries, women are more likely to be engaged in subsistence-level production, providing over 60 percent of the labor. Consequently, their livelihood and food security are more sharply affected by climate-induced downturns in production (Somalia Institute for Development Research and Analysis 2019). Women are also more likely to engage in agricultural

[2] According to IFAD (2021); GDP figures are, however, subject to considerable debate.

[3] The last livestock census in Somalia was conducted in 1975.

value chains that require less land and capital due to gender-inequitable inheritance laws, as well as limited collateral availability compared to men. They are less mobile and less likely to employ productive inputs or utilize available extension services. Women have weak land tenure rights and limited access to extension services, and the most valuable agricultural assets (land and livestock) are primarily owned by men. In times of crisis, such as the current ongoing drought, men migrate looking for pastures and water for their livestock or move to urban centers looking for work. Women remain at home with children and the elderly, sometimes moving to IDP camps or to small towns for petty trading. While the aim of these strategies is to access resources and security, in practice they expose women to additional security threats (World Bank and FAO 2018).

LOCUSTS[4]

Risk	Distribution	Frequency	Economic cost	Poverty linkage	Climate trend
Locusts	Whole country	Rare (for major outbreaks)	\$100 million–\$1 billion	Strong	Weak increase

Nature of risk

Locust infestations in Somalia are periodic and can cause massive damage to both crops and pasture. The sequences of events that lead to a major outbreak are complex and difficult to predict, but depend on climate patterns both within and outside the country.

In 2018, two major cyclones dumped rain in a remote area of Saudi Arabia, leading to an 8,000-fold increase in desert locust numbers. By mid-2019, winds had pushed the insects into the Horn of Africa, where a wet autumn further boosted their population. An unusual cyclone in Somalia in early December 2019 (Cyclone Pawan) finally tipped the situation into a true plague, the worst of its kind in more than 70 years. By February 2020, Somalia declared a national emergency as large swarms of locusts spread across East Africa (BBC News 2021; Nuwer 2021) (figure 3.8). Desert locusts were reported to be eating as much as 1.8 million metric tons of vegetation a day across 350 square kilometers, destroying more than 175,000 acres of farmland in Somalia and Ethiopia alone (Qasim 2020). As rainfall increases due to climate change in Somalia, locust outbreaks are also expected to rise in frequency.

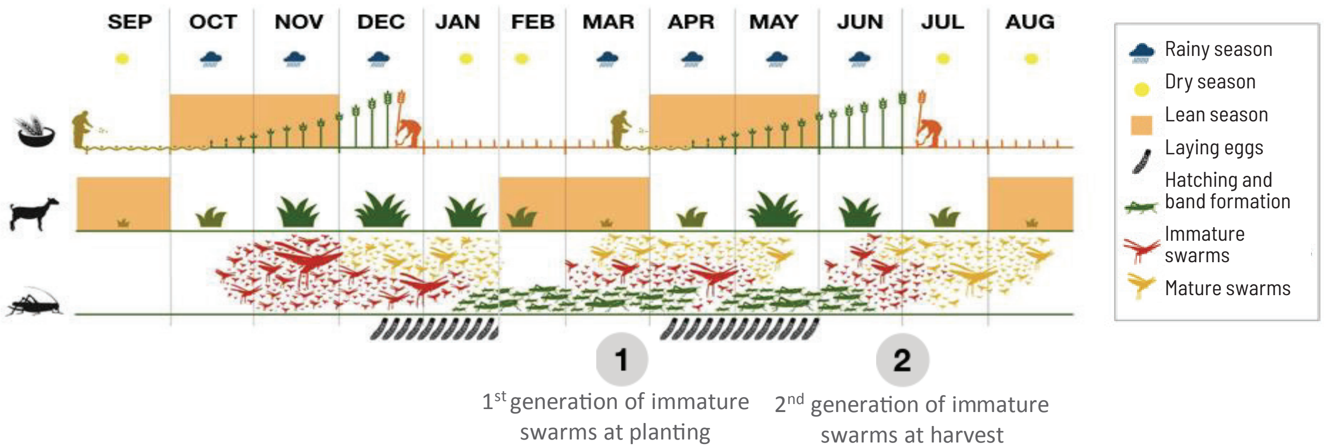
Magnitude of impact

Detailed estimates for losses associated with the recent locust outbreak are not available for Somalia, as other major climate impacts were affecting crops and livestock production at the same time. However, FAO (2020b) states that "crop and fodder losses from desert locust can range up to 100 percent." Also, an assessment of losses from the Republic of Yemen in 2020 came to \$222 million, over 90 percent of which was related to livestock (Republic of Yemen 2021).

Desert locust control measures risk contributing to further environmental degradation and costs. There is an overreliance in East Africa and in Somalia on the use of persistent organic pollutants, including highly toxic and harmful organophosphates such as Chlorpyrifos, banned

[4] Locust plagues are treated separately from other agricultural and livestock pests because they affect both on a massive scale, and the climate drivers are also quite distinct.

Figure 3.8 Somalia's agricultural calendar and desert locust life cycle



Source: FAO 2020a.

in Europe. In much of the region, governments resorted to the use of millions of liters of highly toxic organophosphates to control transboundary swarms (Müller et al. 2021).

As discussed above, impacts to agriculture and livestock are strong drivers of poverty and displacement, and exacerbate other forms of vulnerability, particularly gender.

Climate drivers

While it is not possible to predict desert locust outbreaks with accuracy, an increase in cyclone activity in the western Indian ocean is likely to increase the frequency of locust swarms in Somalia.

As rainfall increases due to climate change in Somalia, locust outbreaks are expected to rise in frequency. Desert locusts generally thrive in wetter conditions, which allows immature swarms to rapidly complete their maturation (ICRC 2020); and higher rainfall extremes, often associated with floods, have been more frequent over recent decades (Ogallo, Ouma, and Omondi 2017). A new study has shown a connection between the 2019/20 desert locust upsurge in East Africa and the role of warming anomalies in the Indian Ocean (Müller et al. 2021). An Intergovernmental Panel on Climate Change report states that Indian Ocean warming anomalies "are anticipated to occur twice as often, which could also increase the occurrence of pest outbreaks" (IPCC 2022a, 795).

CROP STRESS

Risk	Distribution	Frequency	Economic cost	Poverty linkage	Climate trend
Crop stress	Crop agriculture regions	Chronic	$10–$100 million	Very strong	No clear trend

Nature of risk

Somalia is already severely water stressed, which is a significant factor in the country's low agricultural yields. The agricultural sector faces significant exposure to water-related climate risks, and the likelihood of increasing impacts of water stress.

Prolonged drought periods, high temperatures, increased dry spells at critical points in crop growing seasons, and decreases in rainfall all have negative impacts on production. Crop yields are particularly sensitive to water stress in the middle portion of the growing season. For example, reducing soil moisture by 30 percent from historical averages has been linked to an 18 percent reduction in global maize yield (Garris 2019).

Magnitude of impact

Somali cereal production levels have not increased in the past 60 years. In fact, from 1972 to 2012, cereal production per capita *decreased* by 66 percent (Keogh 2021). Sorghum production achieved a peak of 330,000 tons in 1988: by 2011, this had fallen to just 50,000 tons (Warsame et al. 2022). The yields of important cereal crops are very low, even by regional standards: sorghum (0.6 tons/hectare) and maize (1 tons/hectare), representing just about half of the average yields in neighboring Kenya and Ethiopia. As a result, Somalia relies significantly on agricultural imports to meet the food needs of its people, spending nearly $1.5 billion in 2015, up from an annual average of only about $82 million in the late 1980s (World Bank and FAO 2018).

The largest single reason for the decrease in crop production is probably the collapse of large-scale irrigation systems during the war in the 1990s. Lack of agricultural investment and extension also contribute to low yields per hectare. However, Somalia's erratic weather patterns and prolonged dry spells are a constant constraint on production, particularly in the absence of widespread irrigation. Already, rainfall during the short rainy season has traditionally been generally low and insufficient to justify cropping systems (Rees, Omar, and Rodol 1991). In recent years, most parts of the country have experienced drought conditions once every three years (Haile et al. 2019).

Reliable and systematic data for Somalia's agriculture sector are limited. It is estimated that crop production accounted for 10 percent of Somalia's GDP between 2013 and 2016 (World Bank and FAO 2018), representing approximately $600 million in 2016. World Bank estimates cereal production in 2020 at approximately 177,000 metric tons.[5] Other estimates show that gross crop production averaged between $300 million and $700 million in the 2010s (Zanini et al. 2018).

Studies have typically suggested a high level of current crop losses in Somalia due to climate change of around 30–50 percent. The Somalia Agriculture Technical Group (SATG) estimates average grain losses in southern Somalia at 20–30 percent of the total harvest and that losses may exceed this range in some cases. The SATG notes that loss is on the order of 50,000–80,000 tons per year, which translates to an economic loss of between $15 million and $20 million. These figures may include impacts of extreme events, but given their partial nature, annual losses most likely lie in the range of $10–$100 million.

As discussed above, impacts to agriculture are strong drivers of poverty and displacement, and exacerbate other forms of vulnerability, particularly gender. More than 6 million people already face acute food insecurity. Prolonged droughts on the back of heat, and recurring

[5] Source: World Bank DataBank, Cereal production (metric tons) Somalia.

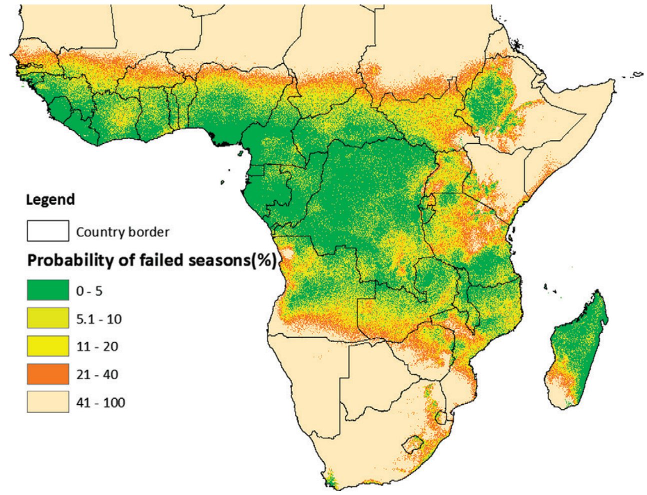
famines, are likely to make food security increasingly challenging, especially in combination with ongoing and projected future increases in global food prices.

Climate drivers

Rising temperatures between the months of September and March may cause the soils in Somalia to become drier. Dry spells may increase in frequency and duration, and the projected increase in temperature will also increase evapotranspiration and hence crop water demand (Richardson et al. 2022). Despite the probability of modest increases in overall rainfall, the more pronounced increase in temperature is likely to have a greater impact on crop production, with an increasing probability of failed growing seasons (map 3.4).

Effects will differ across different crops, and yield projections show high uncertainties. Staple Somali crops such as maize, sorghum, and millet will struggle with rising temperatures. Projections suggest crop yields across Sub-Saharan Africa will decrease by 10 percent under warming scenarios of 2°C, and up to 20 percent beyond 2°C (Carleton 2022). Beyond a temperature increase of 3°C, all present-day cropping areas for maize, millet, and sorghum in Somalia are likely to become unsuitable. However, the greatest determinant of yields will be water availability, and the high uncertainty in predictions for Somalia means there are currently no robust predictions. Recent models suggested cowpeas are likely to show a positive trend in yields; rice yields are also projected to improve. However, projections for millet show high interannual variability, and no clear trend in yields can be derived (PIK/Adelphi 2022).

Map 3.4 Drought risk by 2050



Source: Shiferaw et al. 2014.
Note: Figure shows the probability of a failed growing season due to drought in 2050 under the IPCC's A1 scenario.

CROP DISEASES AND PESTS

Risk	Distribution	Frequency	Economic cost	Poverty linkage	Climate trend
Crop diseases and pests	Whole country	Occasional	\$10–\$100 million	Very strong	No clear trend

Nature of risk

Climate conditions affect the prevalence and spread of diseases, pests, vectors, and weeds, which all have an impact on crop productivity (Lamboll, Stathers, and Morton 2017). Extreme weather events can destabilize agricultural systems, compromising crop defenses and creating niches that allow pests and weeds to establish themselves (Myers et al. 2017; Rosenzweig et al. 2001).

The fall armyworm is an invasive pest species native to South America that has been found in Africa in the last decade, with major impacts on maize and sorghum production. In 2016, an outbreak hit Somalia after affecting neighboring Kenya and Ethiopia. Severe outbreaks usually coincide with the onset of the wet season, especially when the new cropping season follows a long period of drought (Goergen et al. 2016); there are strong indications of the link between outbreaks and climatic changes (IPPC Secretariat 2021).

Fungal infections of crops are also climate related and can produce toxins harmful to human health. A study conducted by Queen's University Belfast on Somali crops found that levels of aflatoxin B1, a toxin linked to development of liver cancer, were over 400 times higher than the level permitted by the European Union. The team from Queen's University collected 140 samples from maize, sorghum, and wheat in 2014, and found out that all of the maize samples and almost all of the sorghum samples were contaminated with various amounts of toxins (Wielogorska et al. 2019).

Magnitude of impact

There are no systematic figures on losses due to agricultural disease and pests in Somalia, but some partial estimates are available.

There is no Somalia-specific data on fall armyworm prevalence. However, a study of 12 major maize-producing countries in Africa estimated the average national production loss at between 11 percent and 45 percent (Day et al. 2017). Applying the same rates to the Somalia situation suggests yield losses of between 10,491 and 42,919 metric tons for maize and 14,708 and 60,170 metric tons for sorghum, averaged over 10 years, meaning annual losses in the range of \$3 million.

Poor households, which do not have the resources to invest in effective crop protection measures, are less able than more affluent households to manage crop pests and diseases effectively. Crop failures (from whatever cause) result in severe hardship and food insecurity for poor rural households, as they lack the assets and networks to diversify income and food sources.

Climate drivers

Projected increases in temperature, an increase in the frequency of extreme weather events, and warming sea temperatures are likely to combine to shift weather patterns in ways that provide suitable environments for an increasing incidence of crop pests and disease. This will affect agricultural livelihoods and food availability across the region (Richardson et al. 2022). There may be a reduction in the prevalence of some vectors if climatic conditions become too warm or humid for them to thrive. At present, however, making robust predictions of likely pest and disease impacts is not possible, as there is inadequate understanding of the specific relationships between weather events, including seasonal patterns, and the severity of impact of individual pests and disease.

Climate shocks may increase the levels of fungal infections and toxins in the food that makes it to harvest in Somalia. There are some data to show that frequent droughts are linked to significantly increased toxins in maize, sorghum, and wheat, the main staple foods in the country. There is a likelihood of droughts and heat stress creating a conducive environment for bacteria to grow in these crops, thus damaging maize stalks and making it easier for plant pathogens to thrive.

HEAT STRESS ON LIVESTOCK

Risk	Distribution	Frequency	Economic cost	Poverty linkage	Climate trend
Heat stress on livestock	Whole country	Chronic	$100 million–$1 billion	Very strong	Strong increase

Nature of risk

Physiological heat stress is caused predominantly by the combination of temperature and relative humidity, and affects livestock productivity and pastoralist livelihoods (Myers et al. 2017). Heat stress decreases livestock productivity through reduced food intake and weight loss, reduces the chances of survival, and reduces fertility (Bernabucci et al. 2010; Lallo et al. 2018; Nardone et al. 2010). It reduces poultry egg production and quality and has an adverse impact on goats and sheep production (Salama et al. 2014). The main response strategy to livestock heat stress is higher water consumption, which is challenging where availability of water resources is already constrained, as in much of Sub-Saharan Africa (Porter et al. 2014).

Magnitude of impact

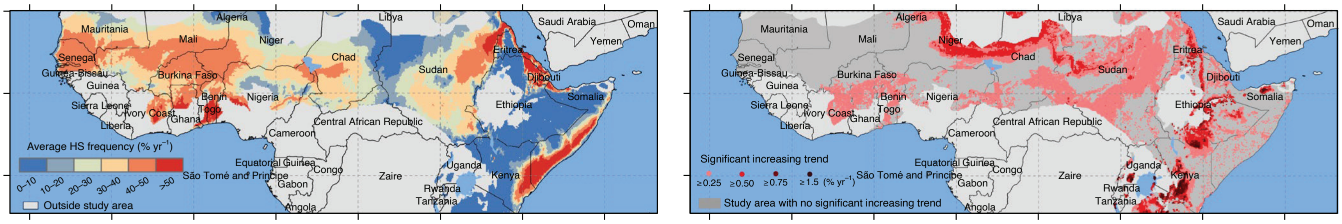
The frequency of severe heat stress for livestock is estimated to have increased significantly within the recent past in 4–19 percent of East Africa (map 3.5, map 3.6). It is most pronounced for dairy cattle (26 percent of the area). Heat stress risks for sheep and goat production only increased 4–7 percent (Rahimi et al. 2022).

Heat stress will likely impair cattle and camel feed intake and performance in the lactating period. Mid-lactating dairy cows may show a higher decline in milk production (–30 percent) when exposed to higher temperatures. Heat stress may increase the loss of body fluids due to sweating and panting and result in an altered water balance of the body and the osmolarity of cells. Heatwaves, which are projected to increase, may directly threaten livestock and cause higher-than-normal mortality. Heat stress can increase livestock vulnerability to disease, reduce fertility, and reduce milk production. Average frequency of detrimental heat stress events for milk production during 2001–20 has been estimated at 77 days per year (approximately 21 percent of the year), and is more frequent in coastal areas of the Greater Horn region, where it exceeds 50 percent of the days in a given year (Rahimi et al. 2022). Over the past two decades, the frequency of heat stress events detrimental to milk production has significantly increased ($p \leq 0.05$) by ≥0.25 percent to ≥1.5 percent year in Somalia.

In sheep, there is an association of heat stress and impaired reproduction in female sheep (Romo-Barron et al. 2019). Heat stress decreases the duration of estrus in cycling ewes (by about 7.09 hours) but increases the length of the cycle (by about 0.5 days). Heat-stressed ewes are 2.4 times less likely to become pregnant than non-heat-stressed ewes. Ewes exposed to heat stress during the first third of gestation are approximately 12 times more likely to have embryo mortality. Furthermore, if exposure to heat stress occurred for moderate periods,

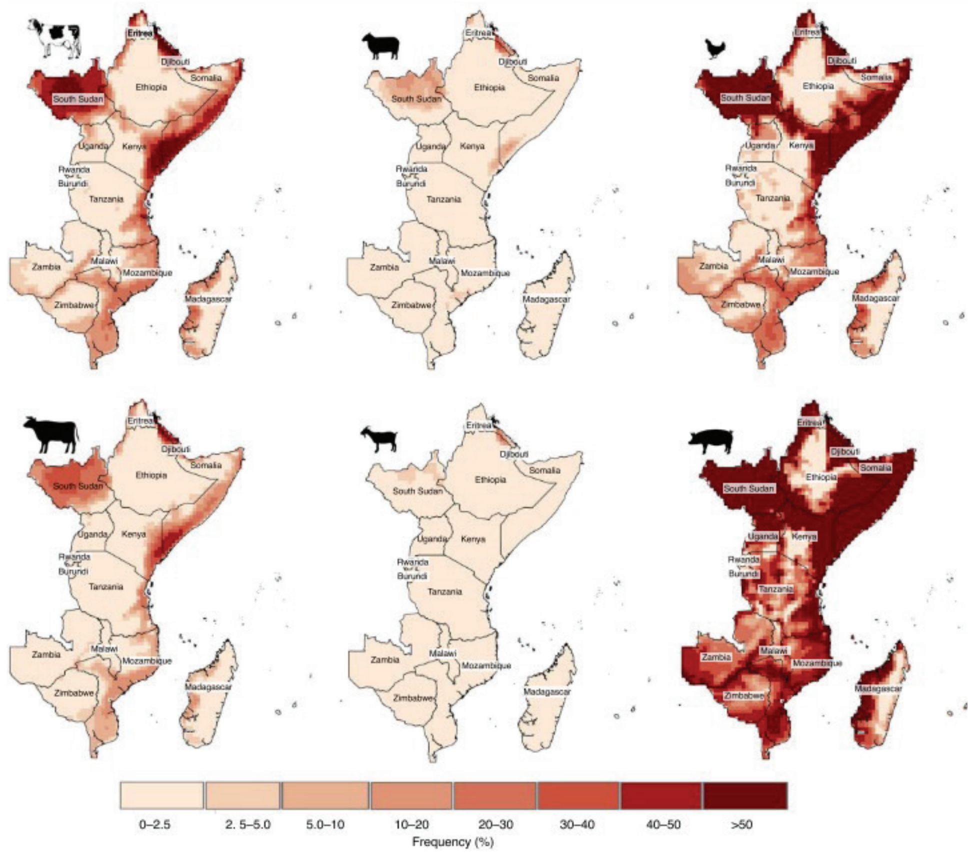
Map 3.5 Long-term average annual heat stress and regional significant trend, 2001–20

a. Annual heat stress **b. Regional significant trend**



Source: Rahimi et al. 2022.
Note: The percentage of days of the year with severe/danger heat stress conditions by livestock categories are dairy cattle (6%), beef, (4%), sheep (1%), and goats (1%).

Map 3.6 Average frequency of days with severe/danger heat stress per year for dairy cattle, sheep, poultry, beef cattle, goats, and swine, 1981–2010



Source: Rahimi et al. 2021.

the incidence of embryo mortality increases approximately 26-fold (Romo-Barron et al. 2019). In general, heat stress conditions affect sexual behavior and reduce sexual activity and sperm quality, resulting in poor conception and leading to reduced lambing rates (Dwyer 2009).

Goats are considered well adapted to the tropical climate (Sejian et al. 2018), but their adaptive responses significantly hamper their productivity. The impact of elevated ambient temperature is 12 percent, 3–10 percent, and 4 percent reduced growth, milk, and meat production, respectively. Goats begin experiencing heat stress when exposed to 38°C and above with a Temperature Humidity Index of above 75 (Aleena et al. 2018; Battini et al. 2014).

Camels respond to heat stress through several physiological processes such as decreasing dry matter intake, milk yield, and reproduction. Heat stress thus has a considerable influence on camels' overall production and reproduction performance (Habte et al. 2021). Heat stress leads to physiological change and decreased dry matter intake, leading to reduced milk yields of around 35 percent (Rhoads et al. 2009); it also affects milk chemical composition (Pragna et al. 2017).

Cattle herd composition among Somalian lactation cows is as follows: dairy, 21 percent; dry cows, 56 percent; heifers, 14 percent; and bulls, 9 percent. Among dairy cattle, the probability of severe/danger heat stress events in any given year ranges from 40 to 50 percent in some areas in the southern part of Somalia to over 50 percent in the northern parts. Beef cattle production is less sensitive to heat stress than dairy cattle production, ranging from mild to no heat stress in the northern parts of Somalia to 45–50 percent in the south.

Mean annual production from Somalia's livestock sector is estimated to total over $3 billion, a large majority of which is accounted for by milk production. Given the high potential for heat stress impacts, current losses are roughly estimated to lie in the range of hundreds of millions of dollars.

As discussed above, sectoral impacts have strong links to poverty, gender, and other forms of social vulnerability.

Climate drivers

The International Livestock Research Institute projects a drastic increase in the number of days of extreme heat stress per year over the coming decades, which is expected to adversely affect livestock production and productivity in Somalia. Average maximum temperatures and the number of very hot days each year (daily maximum temperature above 35°C) are projected to increase with high certainty across the country, with central Somalia—an important area for livestock—particularly affected. Climate projections indicate that there will be significant increases in the number of days with dangerously high wet bulb temperatures; the greatest increase will be at the hottest time of year—April/May (see discussion under section 3.4 for more detail; wet bulb temperatures are discussed in box 3.1).

FODDER AVAILABILITY AND QUALITY

Risk	Distribution	Frequency	Economic cost	Poverty linkage	Climate trend
Fodder availability and quality	Whole country	Chronic	$100 million–$1 billion	Very strong	Weak increase (given probability of future more severe growing conditions)

Nature of risk

Decreased rainfall and subsequent stresses on grassland quality may threaten pasture and feed supplies, reducing the amount of quality forage available to grazing livestock. Some areas in Somalia will experience longer, more intense droughts, resulting from higher annual temperatures and reduced precipitation.

Late-onset or early cessation of the rainy seasons can degrade pasture and force longer and further migrations. Increasing temperatures decrease pasture production, and result in poorer quality of forage species. Similarly, higher temperatures are associated with increased lignification in plant tissues and decreased digestibility of forage, directly affecting forage supply for livestock. All these factors combine to jeopardize livestock productivity, undermining pastoral production systems and increasing the risks of poverty and displacement.

Magnitude of impact

There are little data specifically on the impacts to Somalia's livestock sector of climate-related impacts on forage. Given the general value of the sector, recent drying conditions, and the fact that around 30 percent livestock mortality can typically result from drought conditions, the current impact (in nondrought conditions) is still expected to fall in the range of over $100 million.

As discussed above, sectoral impacts have strong links to poverty, gender, and other forms of social vulnerability. Widespread droughts in Somalia have caused herders to sell more of their livestock than they would under normal conditions, resulting in plummeting livestock prices and deteriorating rural incomes. Reduced availability of livestock products in local rural and urban markets affects food security—especially affecting the poor, who struggle to meet rising prices resulting from lower productivity. Decreased livestock productivity has substantial impacts on Somalia's wider economy, as livestock products represent such a sizable proportion of both internal and export markets.

Climate drivers

Prolonged droughts and intense rainstorms both have adverse impacts on fodder availability and quality. Current climate projections indicate increasing temperatures; while there is high uncertainty in rainfall projections, it is likely that water scarcity will moderately increase in most areas. Intense rainstorms are projected to become more frequent and severe. This will make it increasingly difficult to raise livestock and could result in extended areas of the country becoming unsuitable for livestock production by the end of the century. Such an outcome would be devastating for Somalia's rural livelihoods and food security.

Increases in atmospheric carbon dioxide can increase the productivity of grass species and scrubland on which livestock feed. However, the quality of some of the forage found in pasturelands decreases with higher carbon dioxide.

LIVESTOCK PESTS AND DISEASES

Risk	Distribution	Frequency	Economic cost	Poverty linkage	Climate trend
Livestock pests and diseases	Livestock-raising areas , particularly of southern Somalia	Chronic and episodic (depending on pest/ disease)	$100 million–$1 billion	Very strong	No clear trend

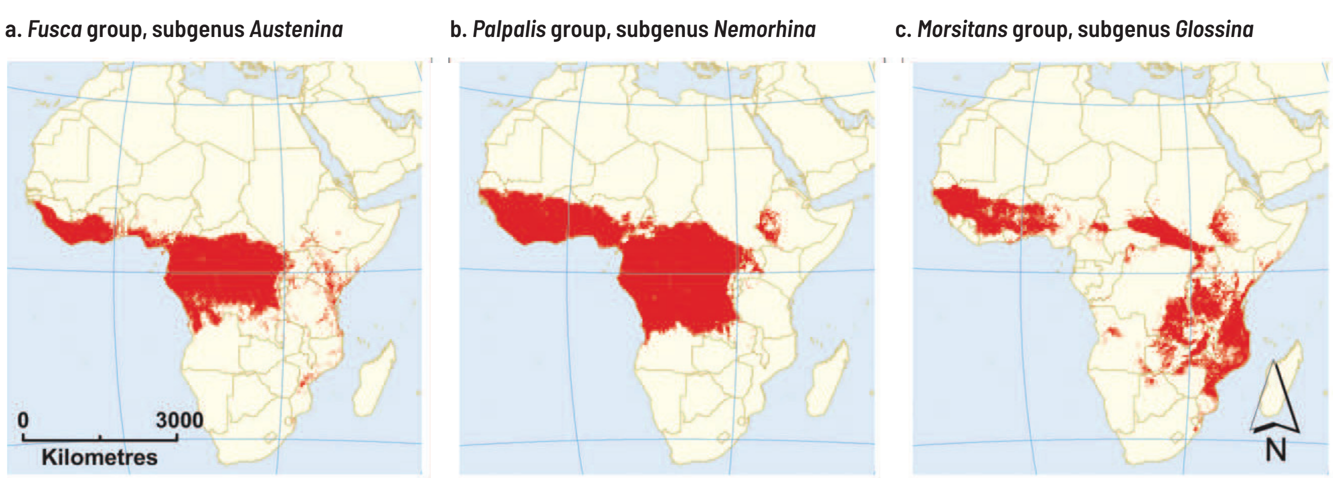
Nature of risk

Climate change shifts key environmental factors that influence the abundance of pests, pathogens, and vectors that affect livestock.

African animal trypanosomiasis (AAT) is one of the major constraints on the livestock industry in Africa. In Somalia, *Glossina pallidipes*, *G. austeni*, *G. brevipalpis*, and *G. longipennis* have been reported; with the *G. pallidipes* species being the most widely distributed Trypanosoma species. They are vectored by various species of tsetse fly, whose distribution is climate sensitive and shown in map 3.7. Although *Trypanosoma evansi* is present throughout the year—for instance, in camels—prevalence rates are usually higher during the rainy months than during the dry months. Cecchi et al. (2008) found a minimum prevalence of just over 5 percent during the dry season and a maximum of over just over 20 percent during the wet.

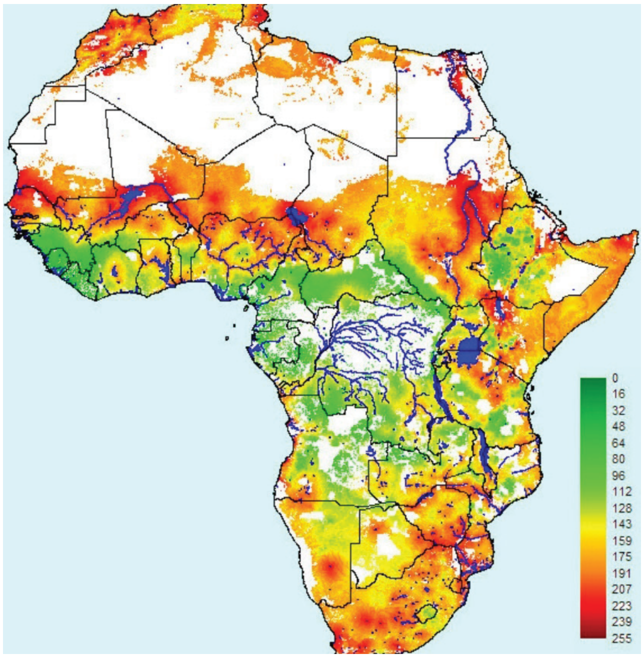
Rift Valley fever (RVF), a zoonotic disease causing destructive outbreak in livestock and humans, is primarily transmitted by *Aedes aegypti* mosquitoes. There is some evidence that very low, undetected levels of RVF remain circulating in livestock between outbreaks (Iacono et al. 2018). While outbreaks are generally associated with heavy rainfall, they can also occur during droughts when limited standing water concentrates mosquito larvae. Somalia has suitable environments for RVF (map 3.8). In East Africa, over half of recent El Niño occurrences have been accompanied by RVF outbreaks (FAO 2017), although outbreaks do not occur every year or even regularly. Once an outbreak is established, it can be further spread by *Culex* spp. mosquitoes transmitting infected blood. Ticks and biting midges may also be able to spread the virus. Among livestock, cattle, camels, and small ruminants, mortality rates range from 10 to 40 percent, with young animals most at risk (MAPA, n.d.).

Map 3.7 Predicted areas of suitability for three tsetse fly groups (subgenera) in Africa, 1999



Source: Cecchi et al. 2008.

Map 3.8 Epidemic suitability map for Rift Valley fever in Africa



Source: Clements et al. 2006.
Note: Based on weighted linear combination. Suitability scores range from 0 (completely unsuitable) to 255 (completely suitable).

Locust outbreaks (discussed above) also have severe impacts on pastures and therefore the livestock sector.

Potential changes in veterinary practices, including an increase in the use of parasiticides and other animal health treatments, are likely to be adopted to maintain livestock health in response to climate-induced changes in pests, parasites, and microbes. This could increase the risk of pesticides entering the food chain or lead to evolution of pesticide resistance, with subsequent implications for the safety, distribution, and consumption of livestock products. This in turn can lead to a ban on Somali products, especially by Gulf Cooperation Council countries.

Magnitude of impact

The 2006/07 RVF outbreak in Somalia is estimated to have resulted in total economic losses to the livestock sector of around $470 million at 2007 prices (FAO 2017). The average annual losses to camel milk and meat production from one species of trypanosome has been estimated at a couple of hundred million dollars (Salah, Robertson, and Mohamed 2015)—implying losses across all livestock from that disease alone could be about twice as high.

Outbreaks of livestock disease can also result in significant losses of exports due to the imposition of import bans in market countries.

As discussed above, sectoral impacts have strong links to poverty, gender, and other forms of social vulnerability.

Climate drivers

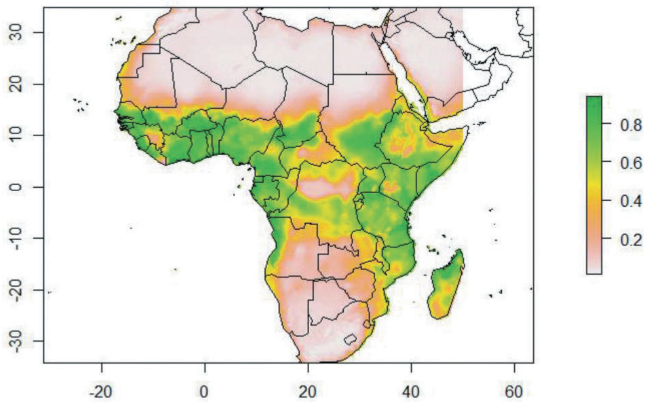
Changes in rainfall and temperature, the interaction between them, and their subsequent impact on the wider natural environment all have different influences on the spread and incidence of individual livestock pests and diseases. Effects are species specific, and in many cases poorly characterized. Given this fundamental lack of knowledge, as well as the significant uncertainty around future rainfall regimes, the overall effect of future climate change on the incidence of livestock pests and diseases is unknown, although some predictions can be made.

Changing rainfall patterns and rising temperatures will affect the geographic range and incidence of vector-borne diseases, increasing their incidences in areas that are currently not suitable for transmission (Richardson et al. 2022). *Ae. aegypti* (the vector for RVF) is expected to be favored by temperature and rainfall increases, hence RVF incidence is likely to increase in the future (Diallo et al. 2022). Map 3.9 and map 3.10 show, respectively, current and projected incidence of *Ae. aegypti* across Africa, including Somalia. Historically, RVF outbreaks have been most severe in the southern-central parts of Somalia and in future may become more common in the north of the country (Diallo et al. 2022). Projected future increases in the frequency and severity of El Niño events will pose serious challenges for managing RVF outbreaks.[6]

Predicted increases in temperature are also expected to spread the tsetse fly, and therefore African trypanosomiasis. Highland areas that are not currently suitable for the tsetse fly are likely to grapple with African

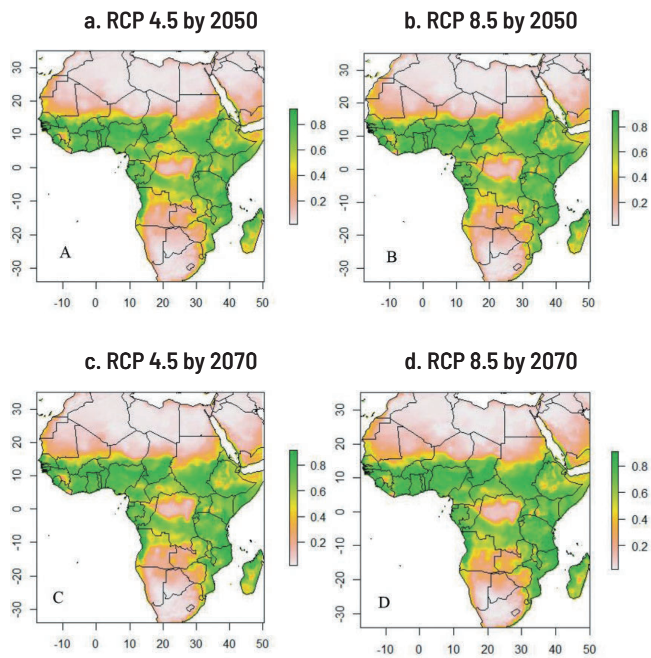
[6] See for example, Ying et al. (2022).

Map 3.9 Current habitat suitability in Africa for *Ae. aegypti* associated with dengue fever incidences



Source: Sintayehu et al. 2020.
Note: Gray to green colors indicate the gradient of suitability from low to high.

Map 3.10 Future habitat suitability in Africa for *Ae. aegypti* associated with dengue fever incidences



Source: Sintayehu et al. 2020.
Note: Gray to green colors indicate the gradient of suitability from low to high.

trypanosomiasis by 2050, as projected warming and increasing rainfall amounts force tsetse flies out of former habitats (Nnko et al. 2021).

Increased flooding of fragile ecosystems can also lead to outbreaks of desert locusts, African RVF, tsetse fly, or other vector-borne diseases, as well as to outbreaks of animal diseases as *berkads* (water reservoirs) become contaminated (FRS 2013).

3.3 Renewable natural resources

Climate change puts a wide variety of stresses on natural ecosystems, which are particularly vulnerable when they are already degraded and fragmented. In addition to the intrinsic value of Somalia's highly endemic biodiversity, its woodlands provide the vast majority of household energy and have long been renowned for production of the aromatic resins frankincense and myrrh. Two types of commercial frankincense are collected, usually during the Xagaa season: *maydi* from *yagcar* trees (Boswellia frereana) and *beeyo* from *moxor* trees (*Bowellia sacra*). These trees are mostly confined to the mountainous areas of northwest Somalia, although some cultivation occurs. Most of Somalia's coast lies within prominent upwelling zones; it also has important marine resources, particularly commercial stocks of tuna and lobster.

TERRESTRIAL ECOSYSTEMS

Risk	Distribution	Frequency	Economic cost	Poverty linkage	Climate trend
Terrestrial ecosystems	Whole country	Chronic	$1–$10 million	Strong	Weak increase

Nature of risk

Higher temperatures and changing precipitation regimes pose a variety of risks to natural ecosystems. Heat- and water-stressed ecosystems will likely lose diversity and become more susceptible to various pests, diseases, and invasive species. Shifts in ecological boundaries could result in wholesale replacement of ecosystems, and are likely to be associated with severe biodiversity loss where dispersal of plants and animals is restricted and/or transitions occur rapidly (e.g., through ecological tipping points such as changes in fire regime). Degradation of ecosystems increases the climate vulnerability of agropastoral communities by impairing environmental services that support their livelihood systems. In return, stressed households may resort to extractive and unregulated use of biodiversity as a coping mechanism in response to climate shocks.

Forests cover at least 10 percent of Somalia (Jalango et al. 2021), although most of this is classified as low-density wood, with closed forest cover limited to less than 3 percent of the country. Somalia's forests contain 394 million metric tons of carbon in living forest biomass.[7] FAO (2015) estimates that the annual deforestation rate in Somalia is 76,757 hectares, representing more than 1 percent of the forest area, primarily due to unsustainable grazing and cutting of trees for charcoal production. Direct impacts of climate change are uncertain.

Climate change is expected to have a significant influence on rangeland ecosystems, even though the magnitude and direction of these changes are very uncertain. Due to rising temperatures, increased frequency and intensity of extreme events, and shorter growing periods, wetlands and riverine systems are increasingly at risk of being converted to other ecosystems with plant populations being displaced and animals losing their habitats. Changing climate conditions are believed to increase the threat of infestation of bare and degraded lands in northern and southern Somalia by *Prosopis juliflora*. Prosopis has already colonized vast swathes of land, and directly affects the livelihoods of thousands of pastoralists. Its tolerance to droughts means that it will continue its invasions into drier grasslands and rangelands.

No assessments have been made of the likely impacts of climate change on Somalia's wetlands, but climate change is expected to fundamentally alter Sub-Saharan Africa's freshwater ecosystems. Impacts include warming of surface water, changes in hydrological patterns, thermal stratification, eutrophication, and extreme weather events (Harrod et al. 2019; Islam et al. 2020). In response to changes in climatic conditions, changes to aquatic species' distribution, phenology, extinctions, and biological adaptations (e.g., changing metabolic, growth, and reproduction rates) are expected (Macusi et al. 2015; Muringai, Mafongoya, and Lottering 2022). Inland fisheries are a small, but locally important sector in Somalia, and wetlands have a wider value through their importance in maintaining water supplies for local populations and livestock.

Magnitude of impact

The value of Somalia's terrestrial ecosystems has not been systematically assessed, much less the impact climate change is having upon it. Somaliland and Puntland account for about 90 percent of the world's production of frankincense, representing an annual export value of $7.3 million (SLU 2019). The total market and nonmarket value of woodfuel production must be significantly higher.

[7] Source: Mongabay Environmental News, Somalia Forest Information and Data.

No accounting has been made of the value of environmental services provided by Somalia's natural habitats. Although the costs of current impacts of climate change are not known, it is assumed that these would be in the range of at least a few million dollars.

Impacts on natural ecosystems will particularly affect the rural poor, and especially women, as they are more likely to depend on natural resource–based livelihoods both for regular income and as a coping mechanism in response to other economic shocks.

Climate drivers

There are no reliable estimates on how climate change might affect tree cover or natural ecosystems in Somalia. The largest impacts will be driven by changes in the pattern of rainfall and soil moisture, which remain highly uncertain. Some projections for 2080 indicate that tree cover might increase by as much as 24 percent, based on the possibility of increasing rainfall (PIK/Adelphi 2022). Actual impacts will be determined by an interplay of climate and anthropogenic pressures; any climate-related stress on natural ecosystems (which is inevitable) will probably exacerbate the loss of native biodiversity overall.

MARINE FISHERIES

Risk	Distribution	Frequency	Economic cost	Poverty linkage	Climate trend
Marine fisheries	Coastal areas	Chronic	$1–$10 million	Strong	Increase

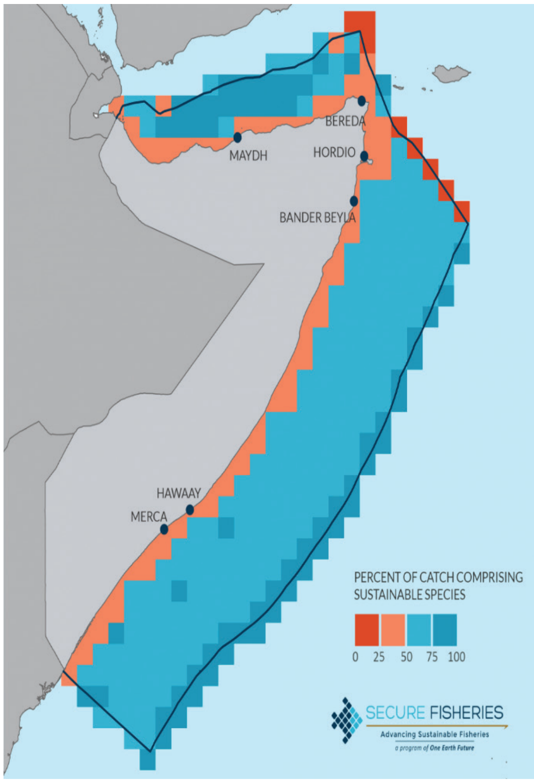
Somalia's offshore fisheries (beyond 24 nautical miles from the coast) are based on migratory species, such as oceanic tunas, with pronounced seasonal patterns of abundance in Somali waters. A vast proportion of the offshore fishery catch is taken by foreign-owned fishing boats and landed elsewhere. Much of this is considered illegal, unreported, and unregulated (IUU) fishing (UNIDO 2021) and is poorly documented (FAO 2005), but it is clear that very little of the value flows back to Somalia, although some license fees are collected. Coastal fisheries are focused on the narrow continental shelf (map 3.11), and dominated by subsistence and artisanal fishers. This is the main source of Somalia's fisheries exports, primarily mollusks and crustaceans.

Despite the country's substantial marine resources, Somalia's fisheries sector is undeveloped and/or underperforms in relation to capturing national value. Fisheries contribute only about 1–2 percent to Somalia's GDP (SomInvest 2022), make up at least 8 percent of exports, and employ around 70,000 people (SATG 2018). Fish consumption by Somali households is reported to be one of the lowest in the world (MEP 2021b).

The productivity of Somalia's fisheries is driven by cold upwelling in the western Indian Ocean. This upwelling is the fifth largest in the world and very stable (figure 3.9). It is seasonal rather than permanent, occurring during the southwest monsoon (May–September). The Somali upwelling has three parts (Chatterjee et al. 2019):

- **Northern part:** current-induced upwelling centered at approximately 10°N on the northern limb of the Great Whirl

Map 3.11 Fishing zones in Somalia



Source: UNIDO 2021. Map from Project Baldwyn: Secure Fisheries.

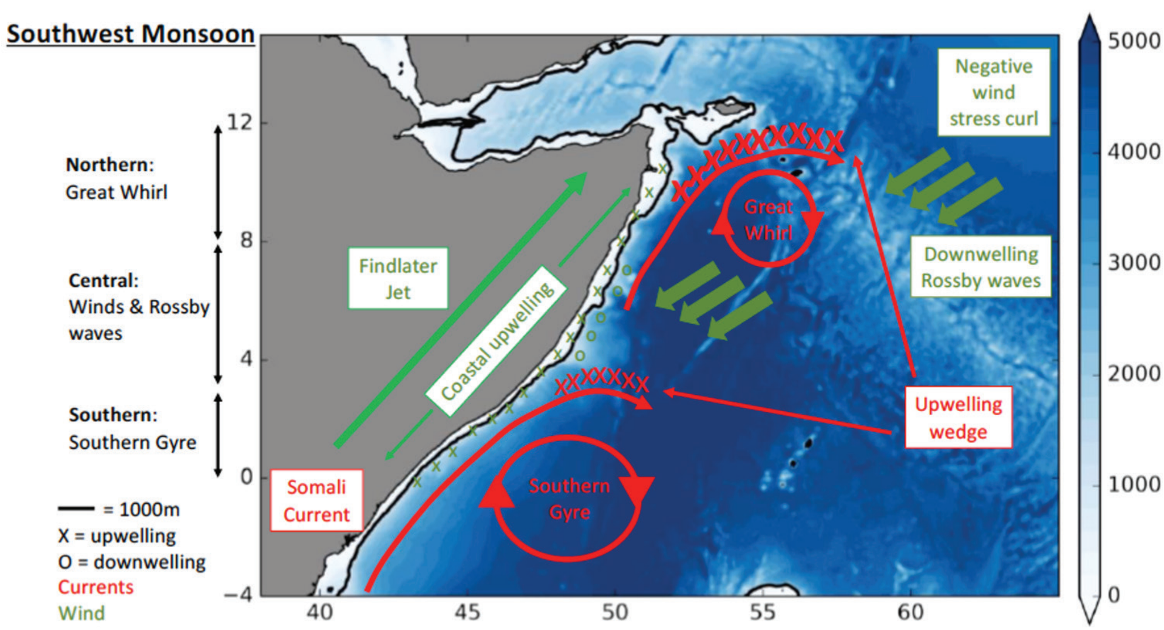
- **Central part:** wind-induced coastal upwelling, which is opposed by downwelling Rossby waves[8]
- **Southern part:** current-induced upwelling centered at approximately 4°N on the northern limb of the Southern Gyre.

In addition, the Findlater jet, a cross-equatorial low-level wind that originates with the southwest monsoon, induces strong Ekman upwelling—a coastal wind-driven upwelling that brings cold water from the deep to the surface layers along the entire eastern Somali coast.

The upwelling brings deeper, cooler water (up to 5°C cooler) to the surface. There, its rich nutrients result in large phytoplankton blooms that begin at the coast and flow eastward into the open ocean, underpinning fishery productivity in the western Indian Ocean. The most productive region is the narrow strip along Somalia's

[8] Rossby waves are huge, undulating movements of the ocean that stretch horizontally across the planet for hundreds of kilometers in a westward direction. They are so large and massive they can change the Earth's climate conditions (source: National Oceanic and Atmospheric Administration, What is a Rossby wave?).

Figure 3.9 Schematic of the Somali upwelling and its associated mechanisms



Source: MEP 2021a.
Note: Data are plotted on a latitude and longitude grid, overlying the bathymetry of the region. The color bar on the right shows the bathymetry values (in meters), with light shades indicating shallow zones and dark shades indicating deep areas.

coastline, extending out to the 200 meter (m) isobath. This region also roughly aligns with Somalia's Exclusive Economic Zone (EEZ), extending 200 nautical miles from the coast, where it has rights to regulate the fishery.

Nature of risk

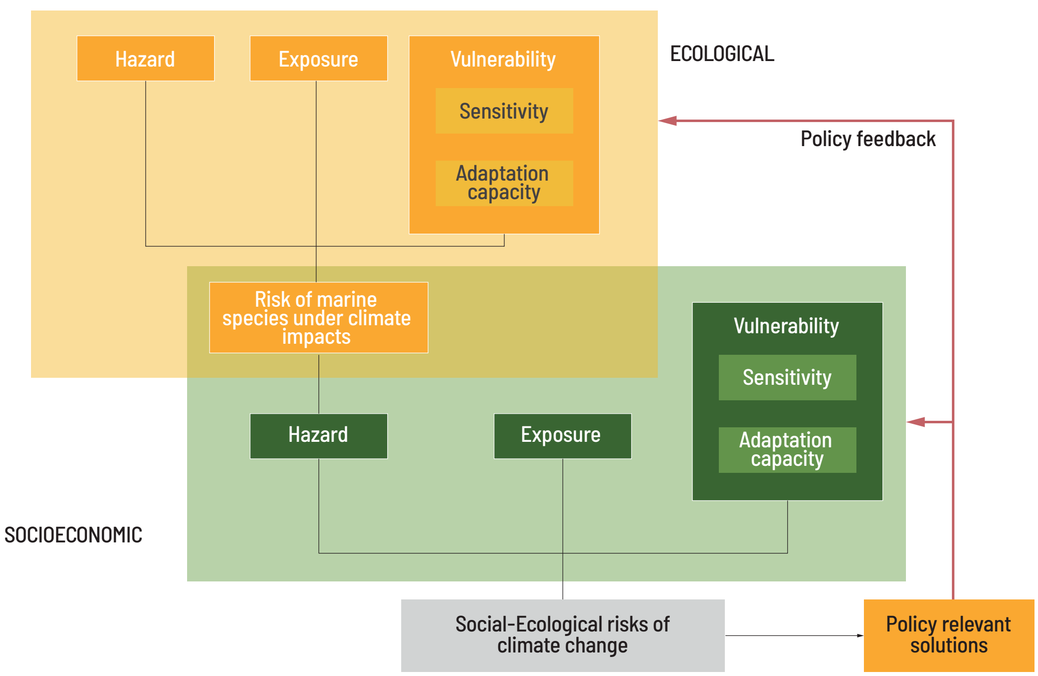
Climate impacts on marine fisheries are expected to be mainly dependent on two processes:

- Climate-driven shifts in the Somali upwelling reducing productivity
- Increases in water temperature (and therefore decreases in dissolved oxygen) driving away active species that are intolerant of low oxygen levels (especially oceanic migrants, such as tuna).

To date, the Somali upwelling not only has little interannual variability (unlike some other oceanic upwellings) but also does not seem to be affected by other extreme ocean temperature events such El Niño and the Indian Ocean Dipole. However, climate change is already altering ocean conditions off Somalia's coast, particularly water temperature and various aspects of ocean bio-geochemistry (World Bank 2021a).

A socioecological risk assessment for Somalia's fisheries (figure 3.10) placed Somalia in a high risk category. Its overall risk score was 68 out of 100, based primarily on its lack of adaptive capacity, although exposure was rated as low, due to the low relative importance of the fisheries industry to the country's economy and use of fish as a food source in Somalia (table 3.7).

Figure 3.10 Linked socioecological risk framework



Source: World Bank 2019a.

Table 3.7 Individual component risk scores for Somalia's fisheries within its EEZ

Hazard	Adaptive capacity	Exposure	Sensitivity	Vulnerability	Risk
84	5	9	21	68	68

Source: World Bank 2019a.

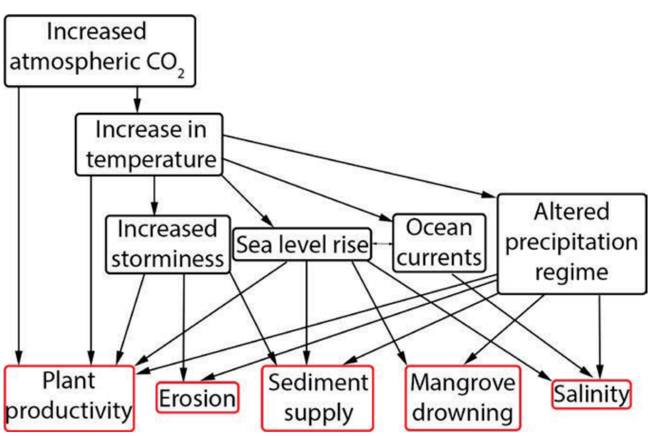
The Somali mangroves are important habitats to fish (particularly as spawning grounds for coastal species) and are critical for conservation of marine biodiversity, as well as providing a range of other environmental services. Somalia's mangroves are threatened and the current annual rate of mangrove deforestation is around 1 percent per year. Mangrove degradation is mostly a consequence of direct human pressures on the coastal and marine environment, particularly given the lack of protected reserves in Somalia, but these pressures are exacerbated by rising sea levels, high sea temperatures, and other factors linked to climate change (Mumuli and Oduori 2010) (figure 3.11).

Magnitude of impact

Domestic (commercial) fishing has been conservatively estimated at around $135 million annually (SomInvest 2022). Future catch reductions to 2100 due to climate impacts range between 9.5 percent (RCP 2.5) and 60.9 percent (RCP 8.5) as shown in table 3.8. Interpolating from this to current impacts from historical warming of at least 1°C provides the estimate given here of the magnitude of current costs.

Many coastal communities that rely on fisheries are poor and relatively marginalized. Gender roles are also pronounced in fisheries, with women largely restricted to onshore processing and marketing jobs. Overall, impacts in the fisheries sector are expected to show similar patterns of poverty and gender linkage to other rural livelihoods.

Figure 3.11 Conceptual framework of principal impacting factors of climate change and how they are likely to negatively influence mangrove communities



Source: Ward et al. 2016.

Climate drivers

Recent modeling under RCP 8.5 indicates future impacts by the end of the century as follows (MEP 2021b):

- **By the end of the century, the Somali upwelling system will persist, but will be approximately 20 percent less productive overall in the main upwelling zone and season.** The reduced primary productivity will cascade through the food web, amplifying the loss of food availability at each trophic level.
- **Localized increases in primary productivity have the potential to support localized fisheries** throughout the century if they are not reef-dependent.
- **By the end of the century, an overall rise of 4°C in sea surface temperature is projected for both monsoon seasons.** During the southwest monsoon, mean sea surface temperatures are projected to reach >28°C by 2030, >29°C by 2050, and >31°C by 2100.
- **More than a 3°C rise relative to baseline conditions is considered catastrophic for most coral species, which in Somalia will occur as early as the 2050s.** Some more naturally thermally tolerant corals, such as those in the Arabian Gulf, may persist toward the end of the century. The response of the reef systems in Somalia and the impact on the fisheries supported by these habitats will therefore depend on coral diversity and density, which is not known for Somalia.
- **The surface waters of the Somali EEZ and upwelling region will become unsuitable thermal habitat for adult yellowfin and bigeye, and for tuna larvae from as early as the 2060s.** Adult skipjack are more tolerant of higher temperatures and may persist in surface waters in the region until the 2080s. Toward the end of the century, skipjack and yellowfin are likely to shift distribution to cooler surface waters (north and east), whereas bigeye may be able to increase residency in deeper layers and remain in the Somali region. All projections point toward tuna surface fisheries becoming less significant in the Somali EEZ from 2080 onwards.

Table 3.8 Percentage changes in maximum catch potential under low and high greenhouse gas emissions scenarios, by 2050 and 2100

Model	Low greenhouse gas emissions scenario (RCP 2.6)		High greenhouse gas emissions scenario (RCP 8.5)	
	2050	2100	2050	2100
Dynamic Bioclimate Envelope Model	–10.30	–9.52	–22.39	–60.89
Multispecies Size Spectrum Ecological Model	–15.46	–11.01	–19.06	–36.53

Source: World Bank 2019a.

- The projected decline of 0.5 milligrams/liter in surface oxygen by the end of the century (due to increases in temperature reducing solubility and restricting ventilation from subsurface layers) during both monsoon seasons is not sufficiently low to become a limiting factor for many species.

Table 3.8 summarizes projected decreases in potential catch for both RCP 2.6 and RCP 8.5 emissions scenarios.

Climate change is likely to have a substantial impact on mangrove ecosystems in Somalia. This is due to the consequences of the projected sea level rise of 1.1 to 3.8 m, changing ocean currents, increased intensities of storms, increased temperatures, changes in precipitation, and increased carbon dioxide at global scales (Ward et al. 2016). Climatological forecasts by the Intergovernmental Panel on Climate Change (IPCC) show that oceanic pH may decline by 0.07–0.31 and mean atmospheric carbon dioxide concentrations will increase to 441 parts per million (ppm) from 391 ppm with significant impacts on mangroves (Alongi 2015). In the event of negative impacts on mangroves, economic impacts on ethnic communities surviving on coastal biodiversity resources in Somalia are expected.

3.4 Health

HEAT STRESS ON HUMANS

Risk	Distribution	Frequency	Economic cost	Mortality	Poverty linkage	Climate trend
Heat stress on humans	Whole country	Chronic	\$10–\$100 million	100–1,000	Very strong	Strong increase

Nature of risk

High temperatures and humidity put physiological stress on human bodies, reducing productivity and eventually leading to a range of chronic and acute health problems (box 3.1). Losses to human productivity due to heat stress have the potential for significant adverse economic impacts.

Cardiovascular diseases are often identified as a risk factor for heat-related hospitalization and death. During extreme heat events, people with existing cardiovascular disease are at greater risk of hospitalizations and death. The reasons for this are not yet fully understood (figure 3.12). Some of the effects of extreme heat on adverse cardiovascular events can been explained in the context of heatstroke. However, many cardiovascular events occur without heatstroke and, in these cases, the mechanisms remain unclear. It is likely that heat exposure increases the amount of oxygen that the heart requires to maintain optimal function (myocardial oxygen requirement) (Chaseling et al. 2021).

Mortality rates during heatwaves can be high. For example, 70,000 deaths were attributed to the 2003 European heatwave (Robine et al. 2008). Risk factors are not only cardiovascular disease. Old age, chronic illnesses, some medications, social isolation, and a lack of access to adequate cooling are also identified as contributing to mortality during heatwaves. There are no data covering the numbers affected or the economic costs explicitly related to the association between heat events and cardiovascular disease for Somalia or elsewhere.

Very hot days, with daily maximums over 35°C, are already common in Somalia, and show a clearly increasing trend (figure 3.13).

Heat stress will affect agricultural production, as rising daytime temperatures and more frequent heatwaves lower the productivity of people working on key activities such as sowing, weeding, and harvesting. Occupational heat-related mortality is 35 times higher among agricultural workers compared to workers from other industries. Agricultural workers in Somalia are often exposed to hot environmental conditions. Hyperthermia from exertion and environmental conditions during agricultural work can trigger a range of symptoms and may lead to the death of workers.

Somalia's cities and towns are all likely to experience urban heat island (UHI) effects (box 3.2; figure 3.14). The projected increasing frequency and severity of heatwaves over the rest of the century (see map 3.12) will almost certainly increase the additional UHI-induced temperatures Somalia's urban populations will experience.

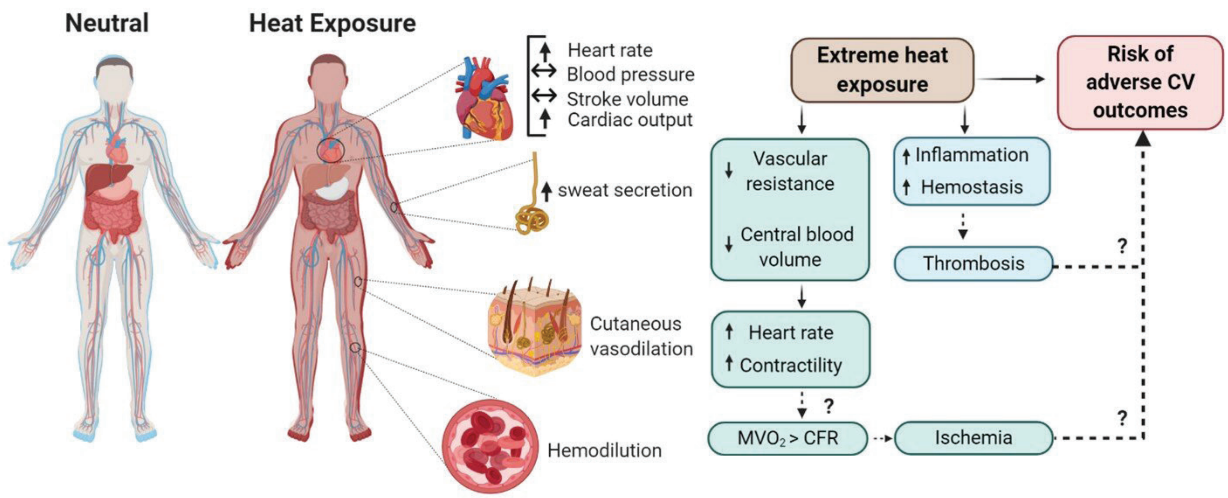
Poorer urban populations are usually the most affected by UHI effects. This is because these populations live in crowded conditions, with limited tree cover and open green areas; and their buildings are poorly constructed, poorly insulated, and have metal roofs (Li et al. 2021). In Somalia, IDP settlements are also at particular risk. In addition, UHI can cause smog to form, trapping particulate

Box 3.1 An explanation of heat risk and temperature

The physiological impact of heat is determined by both temperature and humidity (as high humidity impedes the body's ability to shed heat through sweating) and is measured by "wet bulb temperature" (the temperature of a thermometer covered with a moist towel). Wet bulb temperature approaches dry bulb temperature as relative humidity rises to 100 percent, as the cooling effect of evaporation is lost. Prolonged exposure to wet bulb temperatures above 35°C is fatal. Sustained exposure to wet bulb temperatures above 32°C makes vigorous physical activity difficult and potentially dangerous.

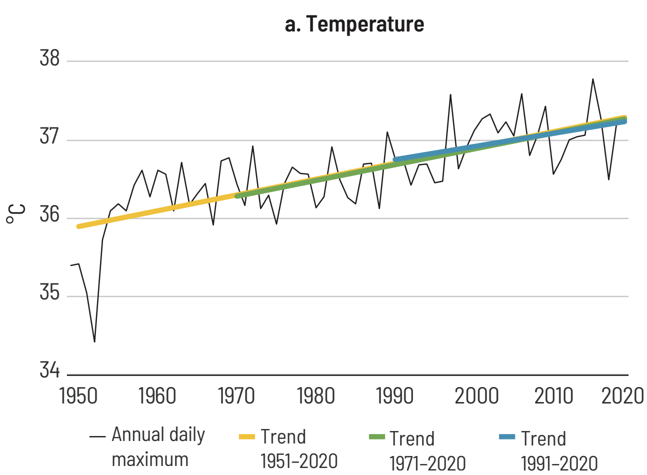
Heat stress is also sometimes measured by a Heat Index (sometimes referred to as "apparent temperature." This measure also combines temperature and humidity. But while wet bulb temperature reflects heat in sunlight, the Heat Index indicates shade temperatures and is more representative of how hot it feels indoors in a building without additional cooling. A wet bulb temperature of 32°C is roughly equivalent to a Heat Index temperature of 55°C.

Figure 3.12 Association between heat events and cardiovascular events



Source: Chaseling et al. 2021.

Figure 3.13 Maximum of daily max-temperature: annual trends and trends per decade



Source: World Bank Climate Change Knowledge Portal: Somalia.

Box 3.2 What are urban heat Islands?

"Heat islands are urbanized areas that experience higher temperatures than outlying areas. Structures such as buildings, roads, and other infrastructure absorb and re-emit the sun's heat more than natural landscapes such as forests, grasslands and water bodies.

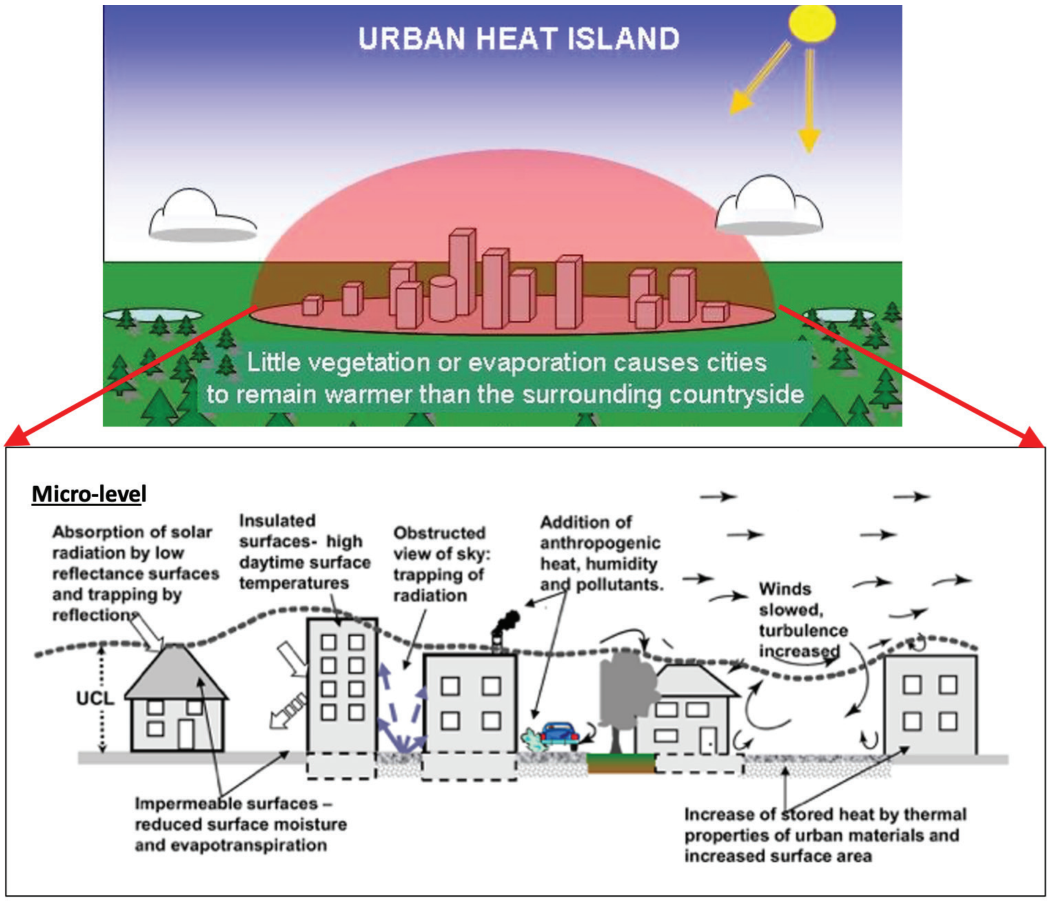
"The annual mean air temperature of a city with one million or more people can be 1 to 3°C warmer than its surroundings, and on a clear, calm night, this temperature difference can be as much as 12°C. Even smaller cities and towns will produce heat islands, though the effect often decreases as city size decreases."

Source: U.S. EPA 2008.

matter and other urban pollutants into aerosols that harm human health.

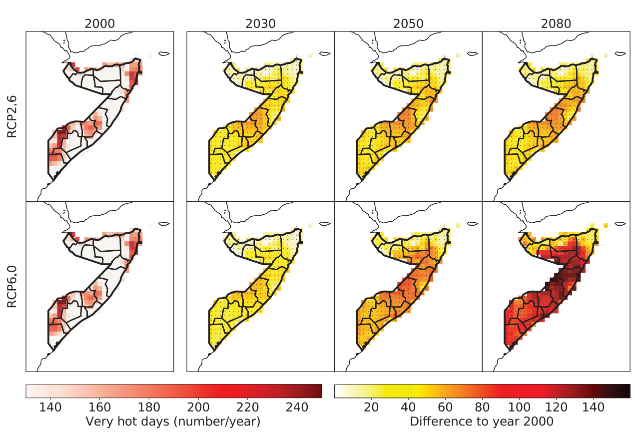
There is a close connection between flooding and UHIs (Richards and Edwards 2018). The extra warming caused by a UHI may lead to upward, turbulent air motion, which in turn triggers precipitation. Urban surface roughness, and the presence of aerosols from air pollution, can also induce precipitation. In Somali cities where storm drainage systems are nonexistent, increased precipitation will exacerbate urban flooding, which in turn will negatively affect socioeconomic aspects of urban welfare. There is a growing recognition that both flooding and UHIs need to be tackled together and prioritized in city planning.

Figure 3.14 Urban heat island



Source: Adapted from CUER 2017 and Government of Canada 2020.
Note: UCL = urban canopy layer, the layer of air in urban areas beneath the mean height of the buildings and trees.

Map 3.12 Projections of the annual number of very hot days (daily maximum temperature above 35°C) for different greenhouse gas emissions scenarios



Source: PIK/Adelphi 2022.

Mogadishu and Kismayo may have some UHI impacts mitigated due to their coastal location with regular onshore breezes. As yet, no studies have specifically looked at the impact of UHIs in any Somali urban settlement.

Magnitude of impact

Heat stress results in lost labor productivity as people adapt physiologically (sweating) and behaviorally (self-pacing). Where heat stress exceeds the body's ability to maintain a comfortable core temperature, a range of heat-related illnesses can occur (Cheung, Lee, and Oksa 2016). High temperatures can exacerbate cardiovascular disease (Cosselman, Navas-Acien, and Kaufman 2015), stroke, renal diseases (Barraclough et al. 2017), neurodegenerative diseases (Killin et al. 2016), and type 2 diabetes

(Cook, Wellik, and Fowke 2011). Extreme temperatures can be fatal.

The poor are particularly vulnerable to heat stress. They frequently live in housing with inadequate insulation and cooling, and lack the resources to make improvements that would shelter them from extreme heat or allow them to move to cooler locations. Many poor peoples' occupations add to their exposure to heat risk as they frequently need to work outdoors regardless of the temperature (e.g., in agriculture or construction-related activities). In these situations, individuals may be reluctant to respond to physiological or public health warnings. Poor families may be unable to access or pay for medical care to treat heat-related health problems (Gronlund 2014).

There are no Somalia-specific studies on the impacts of heat on labor productivity. A recent diagnostic covering several locations in East Africa provides some insights (Kruse et al. 2021). This study used three levels of work, each with different metabolic rates, indicated in watts (W): low intensity (200 W) such as light clerical work; medium intensity (300 W); and high intensity (400 W), representing construction or agricultural labor. The analysis for Mombasa (of the locations analyzed, the nearest in climatic conditions to Somalia) indicated that, by end of century, productivity losses under RCP 6.0 will exceed 13 percent for 400 W, 7.7 percent for medium-intensity work, and 2.5 percent for low-intensity work. Under RCP 2.6, losses were still substantial for high-intensity work, at 5.6 percent; there was a 2 percent loss for medium work and a negligible 0.1 percent loss for light work.

Another study, based on increases in temperature rather than RCPs and/or time periods, provides different levels of impacts for Somalia (table 3.9) with considerably higher productivity losses at higher temperatures—especially for higher-intensity work such as agriculture (Roson and Sartori 2016). In this analysis, Somalia is clustered with a number of small East Africa countries, including small island states, which do not necessarily share similar initial levels of productivity or identical future climate impacts, possibly making the specific findings less robust.

Based on an existing temperature rise of 1°C, and on an assumption that the value of agricultural and other exposed forms of labor exceeds $1 billion, the current cost of heat stress is conservatively estimated to lie in the range of $10–$100 million per year.

Table 3.9 Heat impacts on labor productivity, by sector (percentage change)

Agriculture				
+1°C	+2°C	+3°C	+4°C	+5°C
−3.51	−7.73	−12.82	−18.21	−24.87
Manufacturing				
+1°C	+2°C	+3°C	+4°C	+5°C
−1.23	−3.14	−5.54	−8.41	−11.84
Services				
+1°C	+2°C	+3°C	+4°C	+5°C
0.00	−0.11	−1.33	−2.88	−4.81

Source: Roson and Sartori 2016.

Current heat-related mortality is estimated at around 2 deaths per 100,000 people (or over 300 in total) per year (PIK/Adelphi 2022). The poor are at much higher risk of heat stress due both to exposure being most severe for those engaged in physically demanding work outdoors (agricultural workers and construction laborers) and to lack of access to cooling solutions (air conditioners, cold water, etc.).

High temperatures can add to electricity demand as more people use air conditioning more frequently and at higher cooling rates. A study in Thailand indicates that temperature increases of 1.7°C–3.4°C by 2080 would increase peak electricity demand by 3.7–8.3 percent in 2050, and 6.6–15.3 percent in 2080, even assuming no increase in air conditioning usage (Parkpoon and Harrison 2008). These figures are probably conservative as, in practice, higher temperatures combined with economic and social development over coming decades will mean that more people use air conditioning, and electricity demand directly linked to climate change will increase significantly.

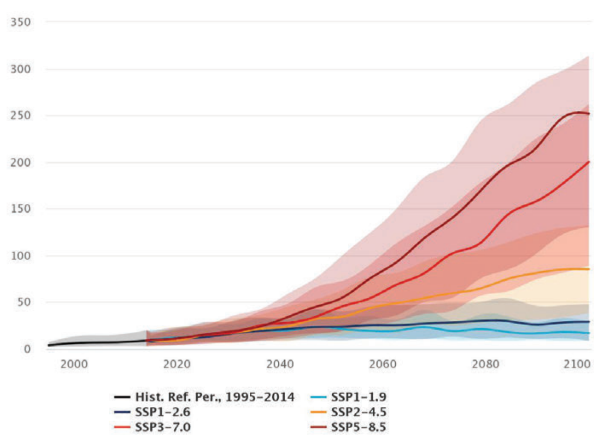
Climate drivers

The number of very hot days each year (with daily maximum temperature above 35°C) is projected to increase with high certainty all over Somalia, with central Somalia

being particularly affected (PIK/Adelphi 2022) (map 3.12). In addition, higher rainfall may increase humidity. Climate projections indicate there will be dramatic increases in the number of days with dangerously high wet bulb temperatures, and the greatest increase will be at the hottest time of year—April/May (figure 3.15 and figure 3.16).

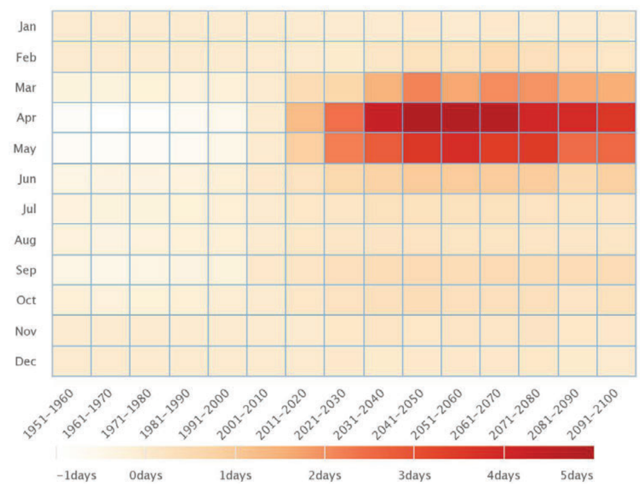
Under RCP2.6, heat-related mortality is projected to intensify from 1.3 deaths in 2000, to 3.2 deaths per 100,000 people per year until 2030 and to 3.6 deaths per 100,000 people per year until 2080 with high certainty (multimodel median) (figure 3.17). Under RCP6.0, projections indicate significantly higher heat-related mortality, though with a larger range of possible future conditions. Projections range between 5.8 and 11.4 deaths per 100,000 people per year until 2080 (very likely range), with a median across projections of 10 deaths per 100,000 people per year until 2080 if there is no adaptation to hotter conditions (PIK/Adelphi 2022).

Figure 3.15 Projected days with Heat Index >35°C



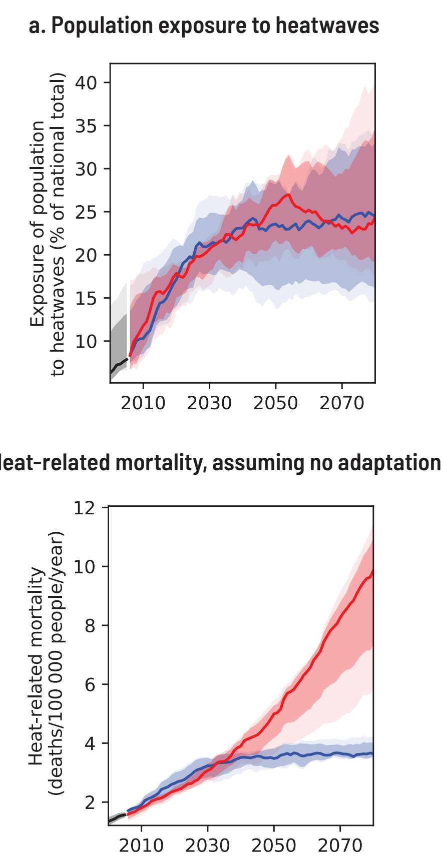
Source: World Bank Climate Change Knowledge Portal: Somalia.

Figure 3.16 Projected days with Heat Index >35°C anomaly



Source: World Bank Climate Change Knowledge Portal: Somalia.

Figure 3.17 Impact of heatwaves on Somalia's population, under different climate projections—RCPs 2.6 (blue) and 6.0 (red)



Source: PIK/Adelphi 2022.

VECTOR-BORNE DISEASE

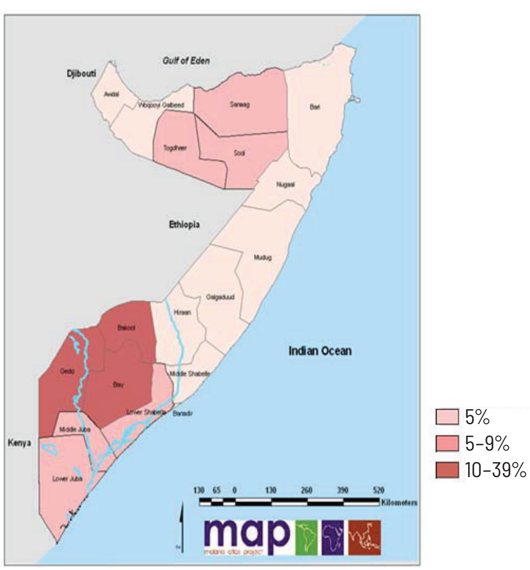
Risk	Distribution	Frequency	Economic cost	Mortality	Poverty linkage	Climate trend
Vector-borne disease	Whole country	Chronic	$10–$100 million	> 10,000	Strong	No clear trend

Nature of risk

Changing rainfall patterns and rising temperatures will affect the geographic range and incidence of vector-borne diseases, potentially increasing incidence of malaria, dengue, and RVF. These diseases are all transmitted by mosquitoes, whose range is largely determined by temperature, humidity, and the availability of standing water.

- **Malaria** is vectored by *Anopheles* spp. mosquitoes. While the whole country is at risk, prevalence is highest in southern parts of the Central South Zone (map 3.13 and table 3.10).
- **Dengue** is mainly transmitted by the *Aedes aegypti* mosquito and primarily associated with urban environments in East Africa. All of Somalia is considered at risk for dengue, but the risk is higher in the southern half of the country. There have been large outbreaks in Somalia's cities—for example, the 2011 epidemic centered on Mogadishu (Kyobe Bosa et al. 2014). Urban environments appear to scale up dengue transmission because multiple sources of clean water for breeding increases the available habitat for vectors. Detailed information on the distribution, vector competence, and insecticide susceptibilities of *Ae. aegypti* and other dengue vectors are lacking in Somalia (and the rest of Africa).
- **RVF** is also primarily transmitted by *Ae. aegypti*. The whole country has suitable environments for RVF. The virus appears to survive in the dried eggs of *Ae. aegypti* mosquitoes. When these mosquitoes hatch during wet years, epidemics can occur. There is some evidence that, very low, undetected levels of RVF remain circulating in livestock between outbreaks (Iacono et al. 2018). While outbreaks are generally associated with heavy rainfall, they can also occur during droughts when limited standing water concentrates mosquito larvae. In East Africa, over half of recent El Niño occurrences have been accompanied by RVF outbreaks (FAO 2017), although outbreaks do not occur every year or

Map 3.13 Prevalence of Plasmodium falciparum malaria in different regions



Source: Ministry of Health 2010, Food Security and Nutrition Analysis Unit surveys 2004–07.

Table 3.10 Epidemiological profile by zone

Zone	Epidemic potential	Populations at risk
Somaliland	High	All age groups
Puntland	High	All age groups
Central Zone	Moderate	All age groups, but particularly pregnant women and children under 5
Southern Zone	Moderate-low	Pregnant women and children under 5

Source: Ministry of Health, n.d.

even regularly. Once an outbreak is established, it can be further spread by *Culex* spp. mosquitoes transmitting infected blood. Ticks and biting midges may also be able to spread the virus. The female *Aedes* spp. mosquito can transmit the virus directly to her offspring (vertical transmission) via eggs leading to new generations of infected mosquitoes. This is not the case for *Culex* spp. mosquito.

Although primarily seen as a livestock disease, RVF also infects humans, especially those living close to livestock. Human-to-human transmission has not been documented (WHO 2018), but virus titers in infected humans are high enough to infect mosquitoes and introduce RVF into new areas (NJDA 2003). In humans, the disease usually presents with mild flu-like symptoms, although a significant proportion (up to 8 percent) develop severe conditions which can have long-lasting health impacts. Documented human death rates are usually less than 1 percent (WHO 2018), but where herders are remote from health care facilities, mortality rates of 12 percent have been documented (MAPA, n.d.).

Magnitude of impact

There are only limited data on malaria prevalence in Somalia. Recent (2020) official figures indicate 57 cases per 1,000 people per year (about 90,500 cases),[9] but this very low figure almost certainly underestimates the true number significantly, as data collection and reporting faces great capacity and financial challenges. The World Health Organization (WHO) provides a much higher median figure of 829,649 cases for 2020 (WHO 2022). All these figures are estimates, given the paucity of health sector data at the national level.

The economic costs of any illness are a combination of household costs and health system costs associated with care of infected individuals. Household costs include direct medical expenses, transportation, and opportunity costs of the time lost due to illness. The economic costs of individual cases of malaria vary greatly, depending on whether the infection is uncomplicated or severe. WHO data suggest that around 90 percent of malaria case are uncomplicated (WHO 2022).

There have been no specific studies on the economic costs of malaria in Somalia. Recent research in Mozambique—a country comparable for its low levels of household income and underresourced health sector—found the median costs of malaria care to society (i.e., costs to both households and the health system) were $7.80 per uncomplicated case and $107.64 per severe case (Alonso et al. 2019). Combining these figures with the WHO's current incidence figures each year and assuming 10 percent of cases are severe, suggests a current total economic cost close to $15 million per year in Somalia.

Poor individuals are more likely to sleep without bed nets, are less likely to prioritize paying for insect repellents, and have limited access to medical care when they fall ill. They also are more likely to live in lower-quality housing situated close to vector-breeding sites. These circumstances place them at high risk from vector-borne diseases. High incidences of vector-borne disease can increase health inequities and act as a brake on socioeconomic development (Campbell-Lendrum et al. 2015).

Little is known about the level of dengue infection in Somalia because of weak surveillance and reporting systems. Dengue epidemics emerge from time to time in Somalia, but the trigger(s) is poorly understood. Public health responses in affected urban areas are based on widespread insecticide spraying. About 5 percent of those infected die (Guha-Sapir and Schimmer 2005).

There has been no specific research into the economic costs of dengue in Somalia, nor estimates of total numbers infected annually. Africa has around 16 percent of all global dengue infections, equating to around 62.4 million cases each year (Guo et al. 2017). Assuming dengue incidence in Somalia is proportionally similar to the incidence across Africa, this implies that between 2 and 4 percent of the population is infected each year—which is about half the incidence rate for malaria. Assuming dengue has similar economic costs to Somali society as malaria suggests an average annual economic cost of $5–$8 million a year, and significantly more in years with severe outbreaks.

[9] World Bank Open Data.

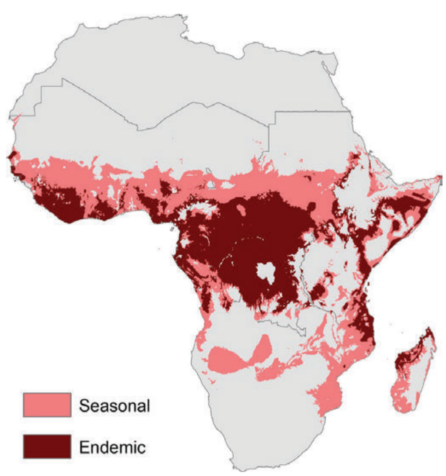
Although everyone is at risk for malaria and dengue, the burden of disease falls disproportionately on the poor, who can least afford either avoidance or treatment measures. Research indicates that climate change is increasing the spread of vector-borne illnesses such as malaria, dengue fever, and Zika virus, all of which are linked to worse maternal and neonatal outcomes (Oberg et al. 2021).

Economic losses from RVF can be significant. While the main losses are due to the loss of livestock and the knock-on impacts on livestock trade, RVF epidemics severely affect food security, especially among those dependent on livestock for food and income. Long-term illness and disability resulting from RVF infection impair farmers' ability to resume their normal economic activities (Peyre et al. 2015). Following the 2006–07 outbreak across East Africa, average human health costs incurred by Kenyan households with a reported human case were valued at $120 for every household (Orinde et al. 2012). Assuming a similar cost in Somalia, the estimated 30,000 human cases resulting from the 2006–07 outbreak could amount to costs of up to $3.6 million.

Climate drivers

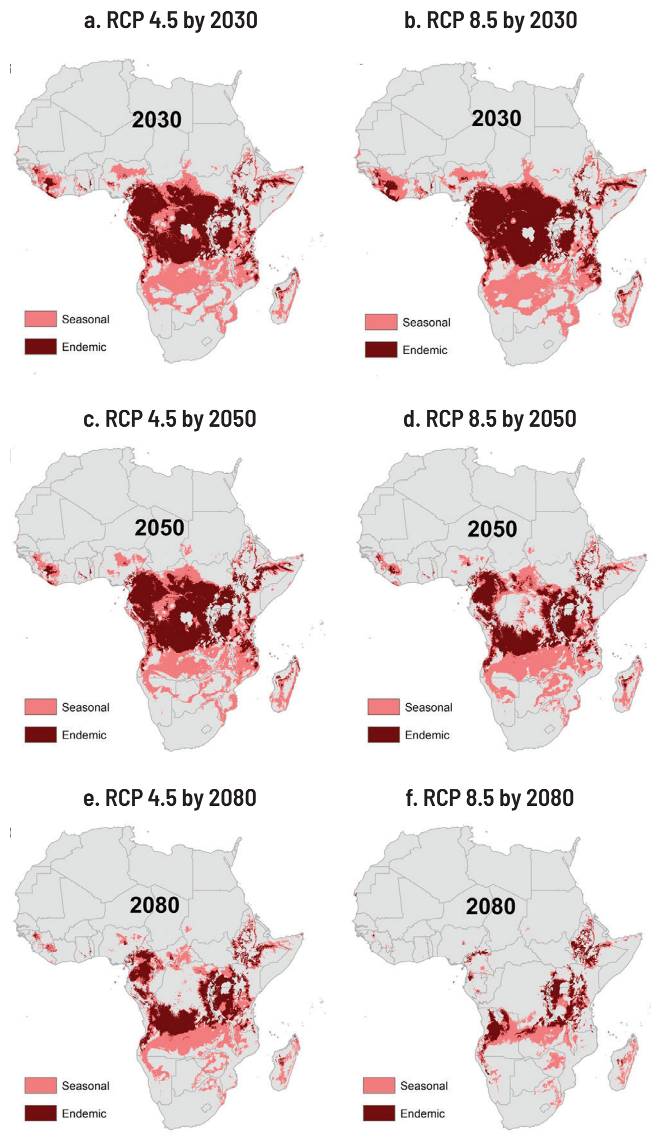
Recent modeling of malaria prevalence across Africa suggests that the incidence of malaria in Somalia will reduce over time (see map 3.14 and map 3.15). This is in contrast with the rest of East Africa, where a rise in endemic cases of malaria is projected across the region, along with fairly constant levels of seasonal prevalence up to midcentury. Both endemic and seasonal risk areas are projected to shrink in Somalia—and also across a significant area of Africa more generally—by 2080. The projected changes are primarily driven by shifts in suitable habitats for *Anopheles* spp. mosquitoes, determined by the interplay of both temperature and humidity, with many areas exceeding the heat tolerance limits of *Anopheles* spp. mosquitoes.

Map 3.14 Baseline (current) malaria prevalence in Africa



Source: Ryan, Lippi, and Zermoglio 2020.

Map 3.15 Modeled output of malaria transmission



Source: Ryan, Lippi, and Zermoglio 2020.

Conversely, *Ae. aegypti* is expected to be favored by temperature increases, and hence dengue incidence is predicted to increase in the future (Diallo et al. 2022). Map 3.10 shows projected incidence across Africa, including Somalia. These projections suggest that over the coming decades, dengue risk may increase moderately, especially in the north of the country. Somalia's rapidly increasing urban population is also likely to fuel future dengue incidence.

As *Ae. aegypti* is also the primary vector for RVF, rising temperatures may see an increase in RVF outbreaks, especially if intense rainstorms become more frequent. Historically, RVF outbreaks have been most severe in the southern-central parts of Somalia and in future may become more common in the north of the country. While outbreaks are generally associated with heavy rainfall, they can also occur during droughts when limited standing water concentrates mosquito larvae. In East Africa, over half of recent El Niño occurrences have been accompanied by RVF outbreaks (FAO 2017). Projected future increases in the frequency and severity of El Niño events (see, e.g., Ying et al. 2022) will pose serious challenges for managing RVF outbreaks.

GASTROINTESTINAL DISEASES

Risk	Distribution	Frequency	Economic cost	Mortality	Poverty linkage	Climate trend
Gastrointestinal diseases	Whole country	Chronic	\$10–\$100 million	100–1,000	Strong	Increasing

Nature of risk

There is a well-understood strong positive association between the prevalence of gastrointestinal diseases and high temperatures. For example, the incidence of salmonellosis increases with temperature. There is a similar positive relationship between temperature and gastrointestinal infections in children (Ghazani et al. 2018). In addition, widespread outbreaks of many waterborne diseases such as cholera, cryptosporidium, *E. coli* infection, giardia, shigella, typhoid, and viruses such as hepatitis A have strong links to extreme weather events (WHO 2003).

Floods frequently contaminate drinking water sources and increase the prevalence of diarrhea and other waterborne diseases. During droughts, restricted access to clean water and/or large numbers of displaced people crowded together with inadequate access to water and sanitation can give rise to rapid increase and spread of diarrheal diseases.

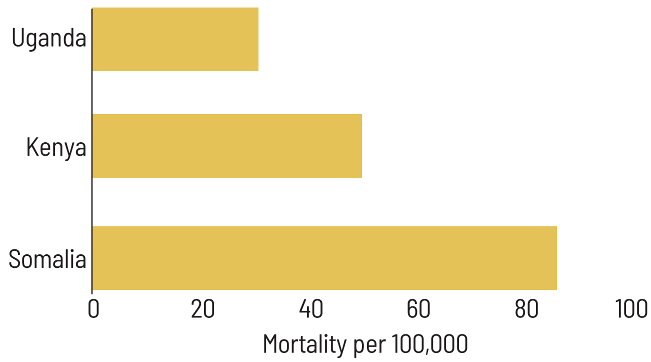
Magnitude of impact

In Somalia, the risks of waterborne disease are high with or without changes to the climate. Only 52 percent of the country's population has access to a basic water supply, and around 28 percent of the population has to defecate in the open. Both short- and longer-term productivity losses are inevitably linked to infection with waterborne disease in adults. Associated mortality rates are also significant. In 2019, diarrheal diseases were one of the top five causes of mortality across all age groups in Somalia (Richardson et al. 2022). Estimates from 2016 indicate a mortality rate attributed to unsafe water, sanitation, and hygiene (WASH) of around 86 per 100,000 of Somalia's population. This compares to around 51 per 100,000 in Kenya and 32 per 100,000 in Uganda (figure 3.18).[10]

Data on the economic costs of gastrointestinal diseases are sparse. There are indications that the cost burden may be on the order of 1 percent of GDP or more: a recent World Bank study in Tanzania found that the overall cost of inadequate WASH is around 3.5 percent of GDP, with the health component of that accounting for around 1.5 percent of GDP (World Bank 2023).

Any increases in the number, severity, and extent of hot days, floods, and droughts are likely to increase the risks of gastrointestinal diseases. However, there are no data that indicate the rate at which this risk may change alongside changes in climate and weather patterns.

Figure 3.18 Mortality rate attributed to unsafe water, unsafe sanitation, and lack of hygiene



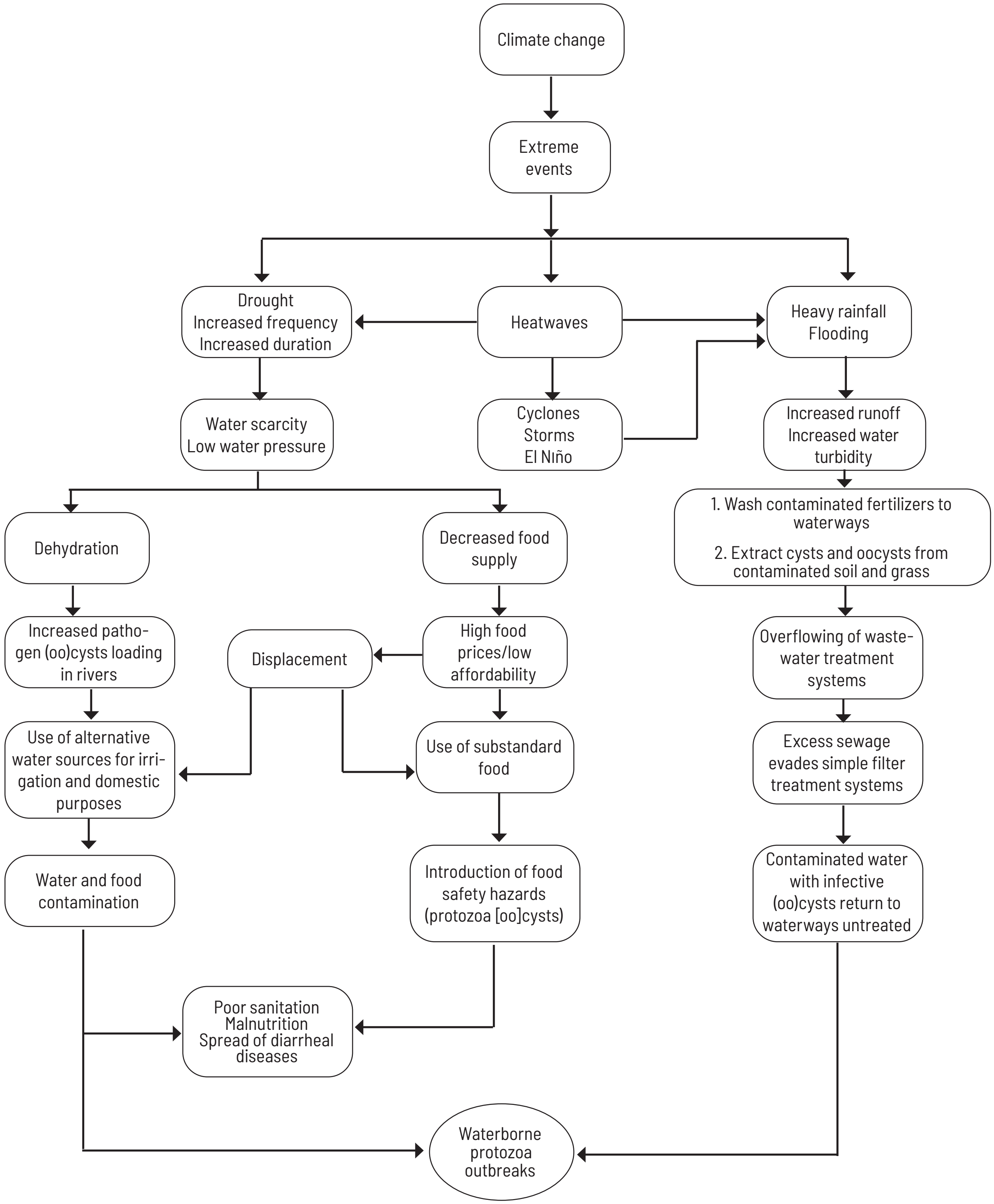
Source: World Bank Open Data.

Climate drivers

Waterborne disease is driven by both floods and droughts. Floods wash fecal matter and other contaminants into water sources. In addition, the replication and survival of the common pathogens causing diarrhea is enhanced as temperatures rise (Carlton et al. 2016). Diarrhea and other waterborne diseases are also linked to severe droughts when access to clean water is restricted. Figure 3.19 illustrates the links between climate change and waterborne diseases.

[10] World Bank Open Data.

Figure 3.19 How extreme weather events impact the status of waterborne protozoa diseases



Source: Adapted from Ahmed, Guerrero, and Karanis 2018.

3.5 Infrastructure and services

DEGRADATION OF INFRASTRUCTURE

Risk	Distribution	Frequency	Economic cost	Poverty linkage	Climate trend
Degradation of infrastructure	Whole country	Chronic	$10–$100 million	Neutral	Increasing

Nature of risk

Climate change brings multiple risks to the transport sector. Both road and air transport are particularly vulnerable to flooding and high temperatures. Harbors are most vulnerable to storm surges and sea level rise. Table 3.11 on the next page provides an overview of key climate risks for different transport subsectors.

Climate-resilient buildings need to provide, at a minimum, affordable homes and workplaces that are safe from flooding, can withstand high winds and cyclones, and provide comfortably cool working and living environments. As Somalia rapidly urbanizes, urban growth faces the dual challenges of low development and poverty. Buildings that respond to shifts in weather patterns, alongside people's shelter and work needs (especially those of people on low incomes), either do not exist, are not affordable, or are insufficient in scale. Instead, there is a rise in substandard buildings and slums (Del Pero et al. 2021).

Somalia is ranked lowest of all African countries in the African Development Bank's Africa Infrastructure Index (AfDB 2020). Around 90 percent of the Somalia's primary roads require extensive rehabilitation: only 13 percent of its roads are paved (2,860 km out of the total 11,434 km), with the remaining earth or gravel (map 3.16). Poor maintenance has impaired the quality of many roads, including paved routes. Seasonal flooding frequently makes roads inaccessible or impassable. A 2016 African Development Bank assessment found identified 90 percent of paved roads as deteriorated and beyond their design life. Nevertheless, even though most roads are in poor condition,

Map 3.16 Somalia's roads network

Source: World Food Programme, 2013.

Table 3.11 Potential climate impacts on Somalia's transport subsectors

Subsector	Potential impact from climate hazards
Roads	● Extreme precipitation and flooding can prevent access to roads by motorists or maintenance crews; it also poses risks to drainage systems by overwhelming them with water and storm debris ● Extreme temperatures can cause road buckling ● Some types of asphalt binder have exhibited sensitivity beginning at 42°C, particularly if combined with truck traffic ● There is a potential for significantly reduced operational capacity above 46°C due to impacts on both the road surface and vehicle operation ● Thresholds for damage to roads and drainage systems are often observed at the 50- to 100-year flood level ● Bridges, which are often designed with higher thresholds in mind, may be susceptible to 100- to 500-year floods ● Strong winds have been observed to affect road usability above 62 km/hour and pose a significant hazard above 119 km/hour ● Winds over 150 km/hour may cause damage to permanent road signage ● Winds over 225 km/hour may cause stress to bridges ● Extreme weather conditions can also affect the health and safety of transport workers and passengers ● There is an employee health and safety risk possible above 30°C and a high risk above 40°C
Aviation	● Extreme temperatures can cause buckling of airport runways, pavements, and access roads ● Flooding can inundate and damage runways and parked aircraft ● Storm surge and sea level rise can inundate assets and equipment at low-lying coastal airports; Mogadishu airport is at particular risk ● Exposure to saltwater can cause short-circuiting and accelerated corrosion of electrical equipment ● Extreme temperatures can reduce aircraft lift and require longer takeoff runs ● Extreme weather conditions can affect the health and safety of aviation workers and passengers
Marine Transport	● Storm surge and flooding can damage marine port buildings and equipment, including damage to structures from increased wave and water loads and increased corrosion due to exposure to saltwater ● Sea defenses, breakwaters, quays, and jetties may require additional construction to raise their height as sea level rises ● Extreme precipitation can increase erosion and sedimentation around harbors and access channels ● Extreme temperatures can cause buckling of ports' paved surfaces and access roads ● Changes in extreme precipitation can result in the need for additional dredging ● Extreme weather conditions can affect the health and safety of marine transport workers and passengers

Source: Based on World Bank, Climate and Disaster Risk Screening—Sector Screening Guidance Note: Transportation Sector.
Note: Flood impacts are dealt with in the subsections on fluvial and pluvial flood and coastal flooding.

Somalia's Rural Access Index is relatively high, at 31 percent.[11] This reflects the country's high level of urbanization and a population distribution pattern whereby many people live along a few corridors that have relatively good connectivity (World Bank 2017).

There are no available data indicating the proportion of Somalia's paved roads built using asphalt suited to the ambient temperatures. Tarmac is viscoelastic, meaning it can soften and melt if temperatures are high enough. If temperatures then cool, the tarmac becomes brittle and easily breaks up under heavy traffic loads. Together, these effects lead to a rapid deterioration of road surfaces. The temperature of paved road surfaces can be 20°C–30°C hotter than the surrounding air temperatures; so in a hot country like Somalia, the potential risk to paved road surfaces is high. This risk can be mitigated if suitable bitumen (or other modern polymer binder) is used (Jyothis and Sailor 2022).

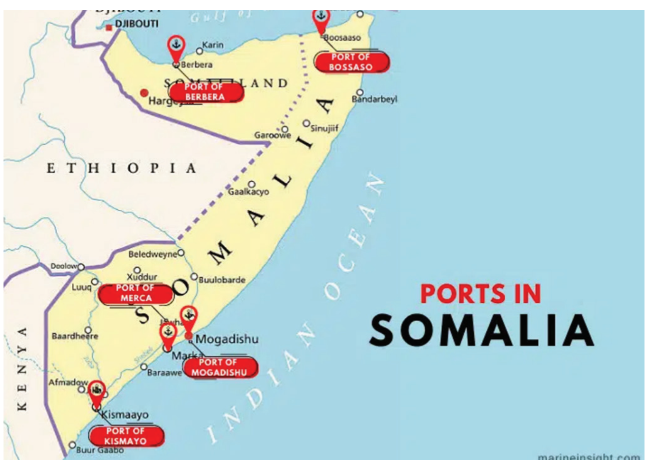
[11] The World Bank's Rural Access Index measures the proportion of people living within 2 km of an all-season road.

Before the civil war, Somalia had 15 operational ports and facilities. However, in recent years, only four ports—Mogadishu, Bossaso, Berbera, and Kismayo—have been fully operational (MPWR&H 2019; AfDB 2016) (map 3.17).

Sea level rise will require strengthening port's sea defenses and possibly raising the heights of jetties and quays. (See subsection on coastal flooding.) No specific assessments or plans have been made to adapt Somalia's existing ports to projected rises in sea level.

Limited connectivity has a significant impact on key economic and social sectors, such as trade, agriculture, fisheries, health, and education. Improvements in the road network—both as connectivity for residents and to facilitate regional trade—have the potential to pay dividends for national development, but will take many years and billions of dollars of investment (World Bank 2022a).

Map 3.17 Somalia's ports



Source: Bhattacharjee 2022.

Magnitude of impact

Understanding the cost of current climate conditions on infrastructure is challenging. A robust estimate would require detailed knowledge not only of actual and/or opportunity costs of infrastructure maintenance within Somalia, but also comparator data across different locations to apportion costs attributable to climate conditions vis-à-vis usage rates (e.g., traffic volumes). This information is generally lacking. Based on unit costs for different road classes from other African countries, a ballpark figure for the cost of keeping Somalia's current road network well maintained would be on the order of several million dollars. The current cost is therefore estimated to lie in the range of $10–$100 million, given that climate conditions are only partially responsible for these costs. That is a conservative estimate, in that it only considers one major class of infrastructure.

Climate change impacts on infrastructure threaten the entire economy, and particularly those who rely most on trade. It also imposes unique burdens on the urban poor; those living in informal settlements; and vulnerable groups such as IDPs, women, children, the elderly and disabled, and minority populations. In addition, poor housing conditions can make the inhabitants more susceptible to climate-linked health problems (Borg et al. 2021).

Climate drivers

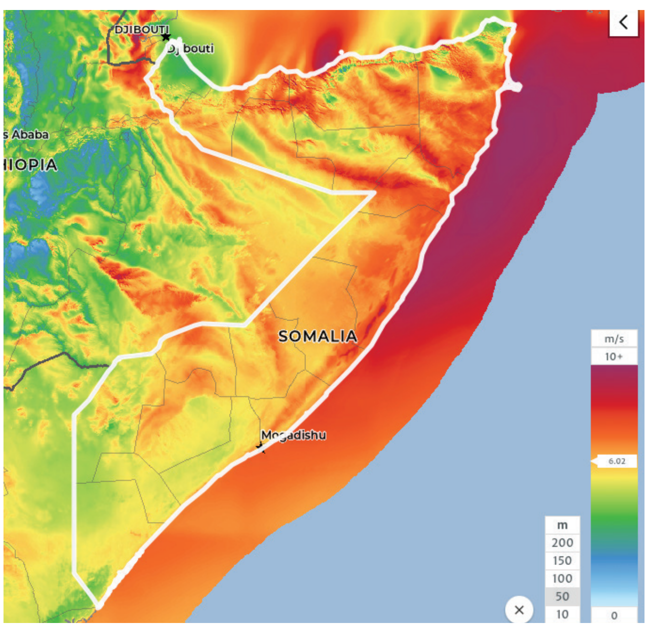
Increases in the frequency and intensity of floods, storms, and heatwaves, along with sea level rise, all create risks of damage and disruption to urban, power, and transport infrastructure. Mitigating the potential adverse impacts of these climate-linked factors will add to the costs of infrastructure development.

DISRUPTION OF ENERGY SUPPLY

Risk	Distribution	Frequency	Economic cost	Poverty linkage	Climate trend
Disruption of energy supply	Whole country	Chronic	>$1 million	Neutral	Increasing

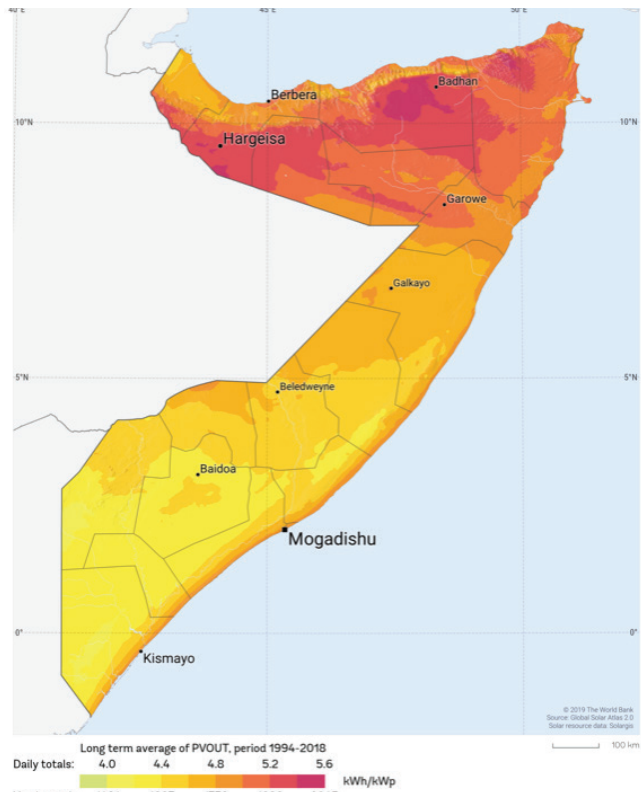
Woodfuels remain the overwhelming source of domestic energy in Somalia. Electricity supply is fragmented and extremely limited, based on mini- and micro-grids operated by private sector energy service providers (ESPs). Almost all of these are currently powered solely by diesel generators (Aynte et al. 2022), but there are a few hybrid mini-grid systems that combine diesel with wind and/or solar power.[12] Overall, there is great potential for Somalia to develop renewable energy resources. More than 50 percent of Somalia has wind speeds greater than 6 m per second, which are excellent for electric energy production (map 3.18). In addition, Somalia has one of the highest daily averages of total solar radiation in the world—averaging between 2,900 to 3,100 hours of sunlight per year (RCREEE 2022)—which indicates excellent photovoltaic energy potential (map 3.19).

Map 3.18 Somalia: mean windspeed at 50 m (m/s)



Source: Global Wind Atlas.

Map 3.19 Somalia: photovoltaic power potential



Source: Global Wind Atlas.

There are several current approaches to developing Somalia's energy sector. Chief among these are prioritizing renewables that are effective in terms of both reach and affordability, and expanding and connecting services offered by existing ESPs,[13] including opportunities to scale

[12] NESCOM, a large ESP in Garowe, and BECO, a large ESP in Mogadishu, are two examples of successful hybrid systems. Details of these experiences are documented by Aynte et al. (2014).

[13] See for example World Bank (2021c).

up hybrid systems that combine solar and wind power with diesel generators (World Bank 2022a). Building a national grid along with interconnectors from neighboring Kenya and Ethiopia, are also key priorities in Somalia's Power Master Plan. This would result in power imports based largely on hydropower, especially any sourced from Ethiopia.

Nature of risk

Climate hazards such as droughts, floods and storms have the potential to damage energy infrastructure and disrupt energy supply. Direct lightning strikes or creeping currents from lightning may damage electricity distribution equipment. Floods and high winds can cause breaks in transmission lines, and flooding can inundate substations. Renewable energy sources based on freshwater flows, wind, and solar are all directly dependent on weather patterns. High temperatures can also reduce the efficiency of thermal power plants and transformers. For example, a 1°C rise in ambient air temperatures may reduce the thermal efficiency of a thermal power plant by 0.1–0.5 percent, with a total capacity loss, including decreasing efficiency of cooling processes and shutdowns, of between 1.0–2.0 percent for each 1°C increase in air temperatures.

The current relevance of these risks to Somalia is low, as there are currently no large thermal power plants, and very limited distribution infrastructure or power generation based on renewables. Nevertheless, as Somalia develops, it will need to rely increasingly on renewable power generation and extensive transmission infrastructure.

Magnitude of impact

Current economic costs resulting from climate-linked damage to power generation and transmission infrastructure are low because there is so little infrastructure. These costs will increase as the power sector develops, expands, and is exposed to new risks (Sieber 2013). The investments required to upgrade Somalia's power supplies and ensure they are resilient to climate impacts run to billions of dollars. It is important that investment, even modest investment, take account of climate risks to ensure the resilience of infrastructure to weather hazards and to keep emissions in check.

Only a small proportion of the population presently has access to electricity; in general terms, the poor have the least access. This means that the impact of failures in power generation, transmission, and distribution have less adverse poverty impacts than they would in countries with a more developed power sector. Nevertheless, risks to poor households' short-term electricity access are not as severe.

Climate drivers

The largest increase in risk will come from the increase in assets exposed to climate impacts as power generation and supply systems are developed. The nature of those systems will determine the precise nature of the risks, and therefore climate trends. However, increasing temperature, and increasing and concentrated rainfall and storms, will increase general disruption; and more sporadic rains and increased evaporative losses may affect the reliability of hydropower production.

DISRUPTION OF WATER SUPPLY AND SANITATION SERVICES

Risk	Distribution	Frequency	Economic cost	Mortality	Poverty linkage	Climate trend
Disruption of water supply and sanitation services	Whole country	Chronic	$10–$100 million	10–100	Strong	Increasing

Nature of risk

Somalia has limited water resources. The Juba and Shabelle are the country's only two permanent rivers and both are important water resources for humans and livestock, as well as for irrigation. In the arid north of the country, all rivers are ephemeral, flowing for only short periods after rainfall events. Around 97 percent of available water is used for livestock and agriculture, leaving just 3 percent for urban and domestic use. Most of the population, especially in the north, depends on groundwater (mainly shallow wells and boreholes) for domestic water supply, livestock, and small-scale irrigation. Many of these water sources are unprotected, poorly managed, and polluted (World Bank 2020b). Rising temperatures and changes in runoff patterns—within Somalia and also upstream in Ethiopia—are expected to influence the future yield of both groundwater and shallow water (Gökçekuş, Kassem, and Yusuf 2022) (table 3.12).

The current drought has dried up strategic water sources, and a lack of accessible drinking water is a major driver of internal displacement, overwhelming national response capacities. By early 2022, up to 80 percent of water sources across the country were drying up, including the Shabelle and Juba Rivers whose water levels were at times below historic minimum levels (UNICEF and WASH Cluster 2022).

Most groundwater is highly saline and well above the accepted standard for drinking water. Only around 26 percent of the country's population has access to safe drinking water; in southern parts of the country, only 20 percent have access to clean drinking water (FAO 2018).

Some preliminary survey work has been done to understand the potential to exploit deep groundwater supplies. However, the potential groundwater resource is largely unmapped. While there appears to be potential here, groundwater quantity and quality in the north of the country is poor. A study in Puntland and Somaliland found that across all aquifers, only 30 percent of groundwater samples were below the safe standards for consumption (SWALIM 2012). In addition, extracting deep groundwater will be very expensive due to significant investment requirements to successfully complete drilling in a place where water is scarce and then pipe the water to where it will be used (Godfrey, Hailemichael, and Seerle 2019).

Water and sanitation services are underdeveloped in Somalia. Only 56 percent of the population has access to a basic water supply (figure 3.20). In addition, a lack of regulation means that private water suppliers charge high prices, forcing families to fetch water from far and from unsafe open wells (UNICEF and WHO 2021). Women and girls sometimes risk physical or sexual assault at water points, while the time spent collecting water also limits possibilities for both work and school. This affects not only women and girls, but also communities and the wider economy.

Increasingly frequent climate change-linked droughts will bring added stress to this sector. The effect of the current drought provides an insight on the impact of generalized drought conditions on water access and availability. A recent survey, covering 15 of Somalia's 18 regions, found that around 65 percent of households had no access to safe drinking water, with the current ongoing drought being a major reason for this (SCS 2022) (box 3.3).

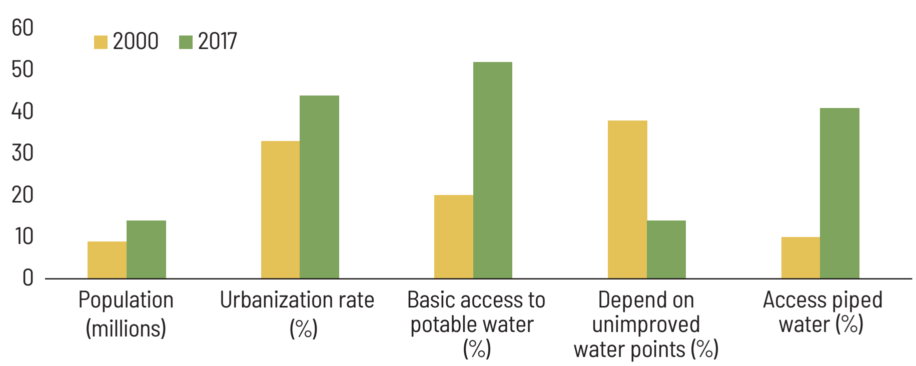
Rural areas and IDP camps have high levels of open defecation (figure 3.21). Poor hygiene practices create a considerable risk for waterborne disease outbreaks, especially cholera, as well as the risk of transmission of other

Table 3.12 Potential climate impacts on water sector

Subsector	Potential impact from climate and geophysical hazards
Land use/water-shed management	● Water flows can be altered by increased evapotranspiration or shifts in the amount and timing of stream flow ● Heavy rainfall events can reduce the effectiveness of erosion control measures in watersheds ● Surface runoff may increase in volume due to higher rainfall intensities and therefore enable the collection of more water in shallow dams and local aquifers ● Rain-fed agriculture may turn less productive due to higher evaporation losses and less runoff infiltrating the soil surface
Dams and reservoirs	● Heavy precipitation can cause erosion and sedimentation to occur in waterways, reducing reservoir capacity ● Strong winds can lead to the overtopping of dams and reservoirs
Water supply	● High temperatures and drought can increase water demand for industrial use, cooling in energy generation, or irrigation ● Extreme precipitation can increase runoff and introduce new contaminants into the water supply, increasing the pollutant load, while low water levels as a result of drought can lead to higher concentrations of contaminants ● Droughts can reduce recharge to surface and groundwater supplies, requiring the development of new and additional water sources ● Sea level rise can lead to salinization of coastal groundwater resources
Wastewater	● High temperatures may increase algal blooms and pathogens and decrease dissolved oxygen, necessitating enhanced wastewater treatment ● Heavy rainfall events can cause sewers to overflow and can result in flooding in combined sewer systems ● Strong winds can disrupt electricity supply, affecting pumping and treatment systems
Sanitation	● Extreme precipitation can inundate latrines and cause overflow
Riverine flood protection	● Flash floods can damage the structural integrity of embankments and dikes
Juba and Shabelle basin development	● Increased rainfall variability in upstream Ethiopia may cause both more floods and worsening dry conditions in the basins ● Irrigation infrastructure systems can be damaged ● Due to worsening water scarcity, upstream Ethiopian authorities may invest in new dams, irrigation schemes, and urban supplies, and thus reduce downstream runoff to Somalia

Source: Based on World Bank, Climate and Disaster Risk Screening—Sector Screening Guidance Note: Water Sector.

Figure 3.20 Access to potable water for households in Somalia



Source: Adapted from World Bank 2020b.

Box 3.3 Recent findings on water access and availability across 15 regions

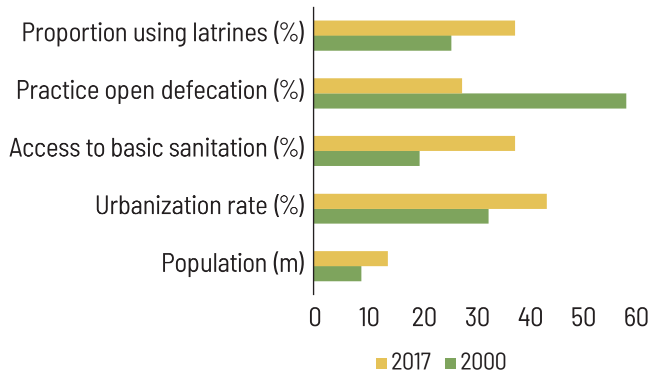
- About two in every three households were unable to collect enough water to meet their needs.
- The average amount of water used was 9 liters/person/day, which is 50 percent less than recommended.
- Fifty percent of households were relying on unsafe sources of drinking water, and only 11 percent were treating their drinking water before consumption. This was lowest in Galmudug and Jubaland.
- The regions most affected by water shortage were: Mudug and Woqoyi Galbed (both with 95 percent of households), Gedo (80 percent of households), and Togdher and Bakool (both with 76 percent of households).
- Fourteen percent of households indicated that at least one episode and/or at least a case of either diarrhea, dysentery, or other water-related diseases in their household. In Galmudug the figure was 36 percent.
- The incidence of common waterborne diseases in communities increased to an average of 45 percent (52 percent in Southern State).
- Thirteen percent of households reported children experienced cough, diarrhea, or respiratory illness in the previous three weeks.

Source: SCS 2022.

gastrointestinal, viral, and vector-borne diseases (SIWI 2019). Nevertheless, compared with other Sub-Saharan African countries, Somalia has relatively high access to improved sanitation for its level of GDP per capita (World Bank 2018).

At present, water sector governance is generally weak, though reportedly better in Puntland and Somaliland. There are low coverage rates for drinking water, particularly in rural areas. Somalia also lacks technical and institutional capacity to collect and use accurate and timely hydrological information. As a result, water

Figure 3.21 Proportion of households with access to basic hygiene and sanitation in Somalia



Source: Adapted from World Bank 2020b, based on UNICEF Joint Monitoring Program, 2019.

resource development schemes are not necessarily optimally designed and managed (World Bank 2020b). Weak technical and institutional capacity presents a major risk to effectively meeting additional, climate-linked challenges to water resource development. As the country urbanizes rapidly, it is important to ensure that any WASH infrastructure investment takes account of future population needs.

Magnitude of impact

By late 2022, around 6.4 million Somalis required either emergency or a longer-term sustainable water supply (WASH Cluster Somalia 2022). These numbers are not only linked to the current drought, but also due to displacement caused by insecurity. This illustrates the scale of needs and the level of vulnerability that any future climate shocks will exacerbate. The vast majority of those needing WASH assistance are IDPs and other poor communities in urban settings. Women and girls are particularly affected because they usually have the primary responsibility for collecting and using water at the household level.

There are no detailed data on the costs of inadequate water supply. A recent World Bank study in Tanzania found the overall cost of inadequate WASH around 3.5 percent of GDP, with a component of that being the labor cost of fetching water, equivalent to around 1.9 percent of GDP (World Bank 2023). Assuming similar figures apply to Somalia would imply a total cost on the order of several tens of millions of dollars per year.

In 2016 (most recent World Bank data), the mortality rate attributed to unsafe water sanitation was 86.2 per 100,000—the second-highest in Africa. Over 50 percent of WASH-linked mortality is children under two years of age (UNICEF 2022b). There has been some improvement in access since then to at least basic sanitation services—at around 32 percent as of 2020, which puts Somalia in the middle range of African countries.[14]

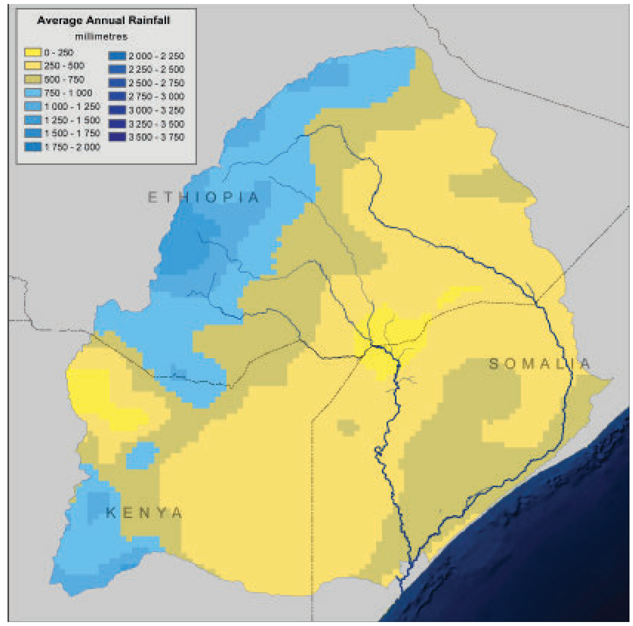
Climate drivers

The vast majority of the flow in Somalia's main rivers comes from rainfall in Ethiopia (map 3.20, map 3.21).

As discussed above, although there is a high degree of uncertainty around rainfall projections, it is likely that both surface water shortages and periodic flooding will become more common in future. Climate models for both Somalia and Ethiopia suggest a likelihood of a slight increase in mean precipitation, but a high level of uncertainty (figure 3.22, figure 3.23).

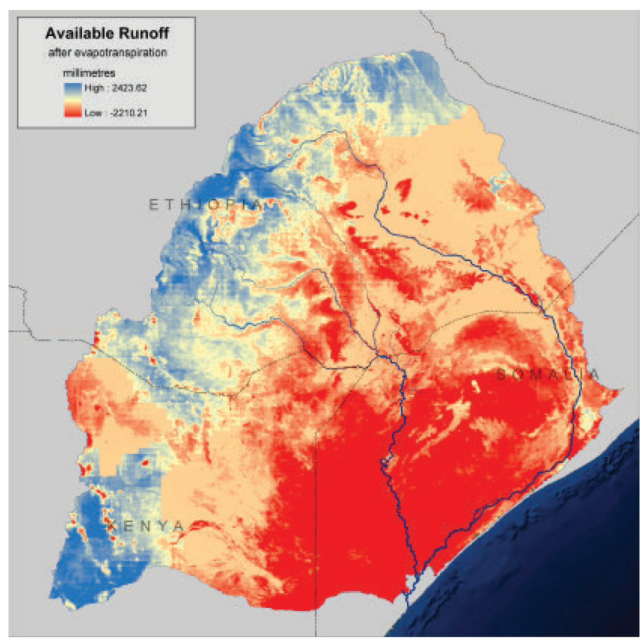
[14] World Bank Open Data.

Map 3.20 Juba–Shabelle river basin average annual rainfall



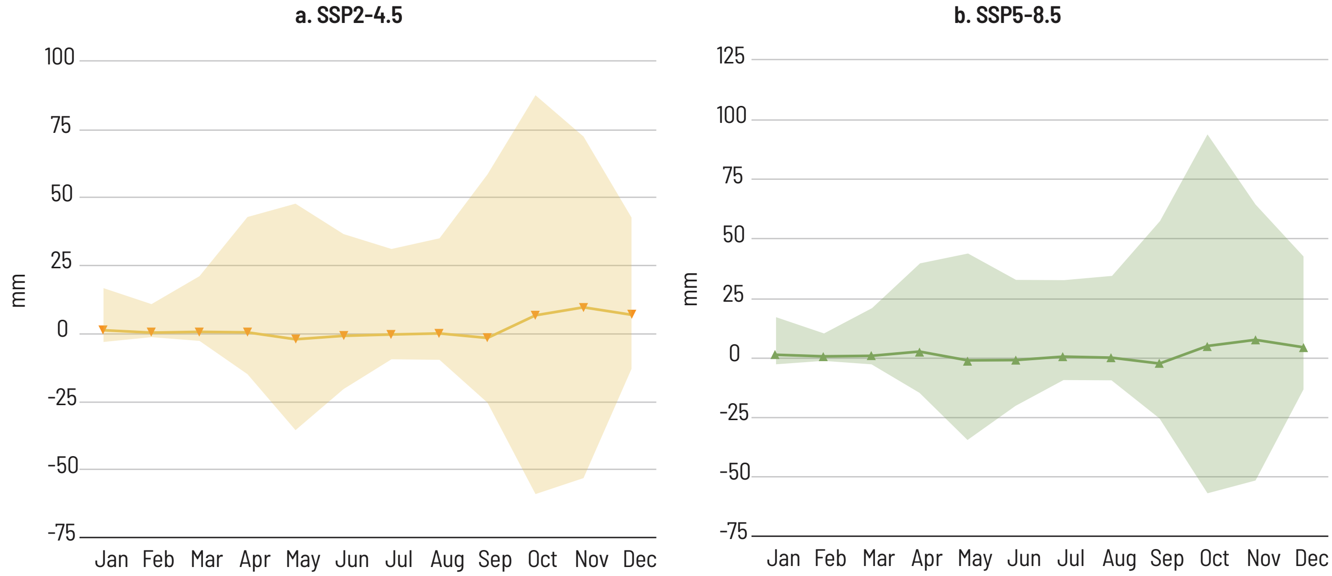
Source: UNEP 2010.

Map 3.21 Juba–Shabelle river basin modeled available runoff



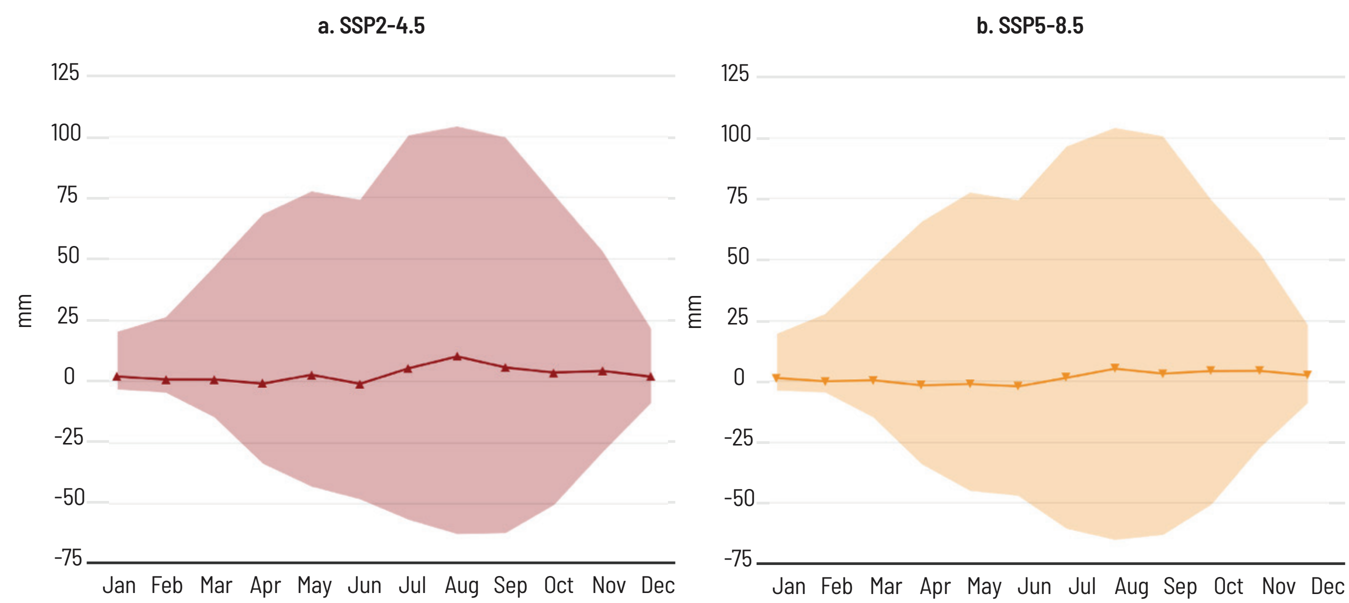
Source: UNEP 2010.

Figure 3.22 Somalia: projected precipitation anomalies



Source: World Bank [Climate Change Knowledge Portal](#).

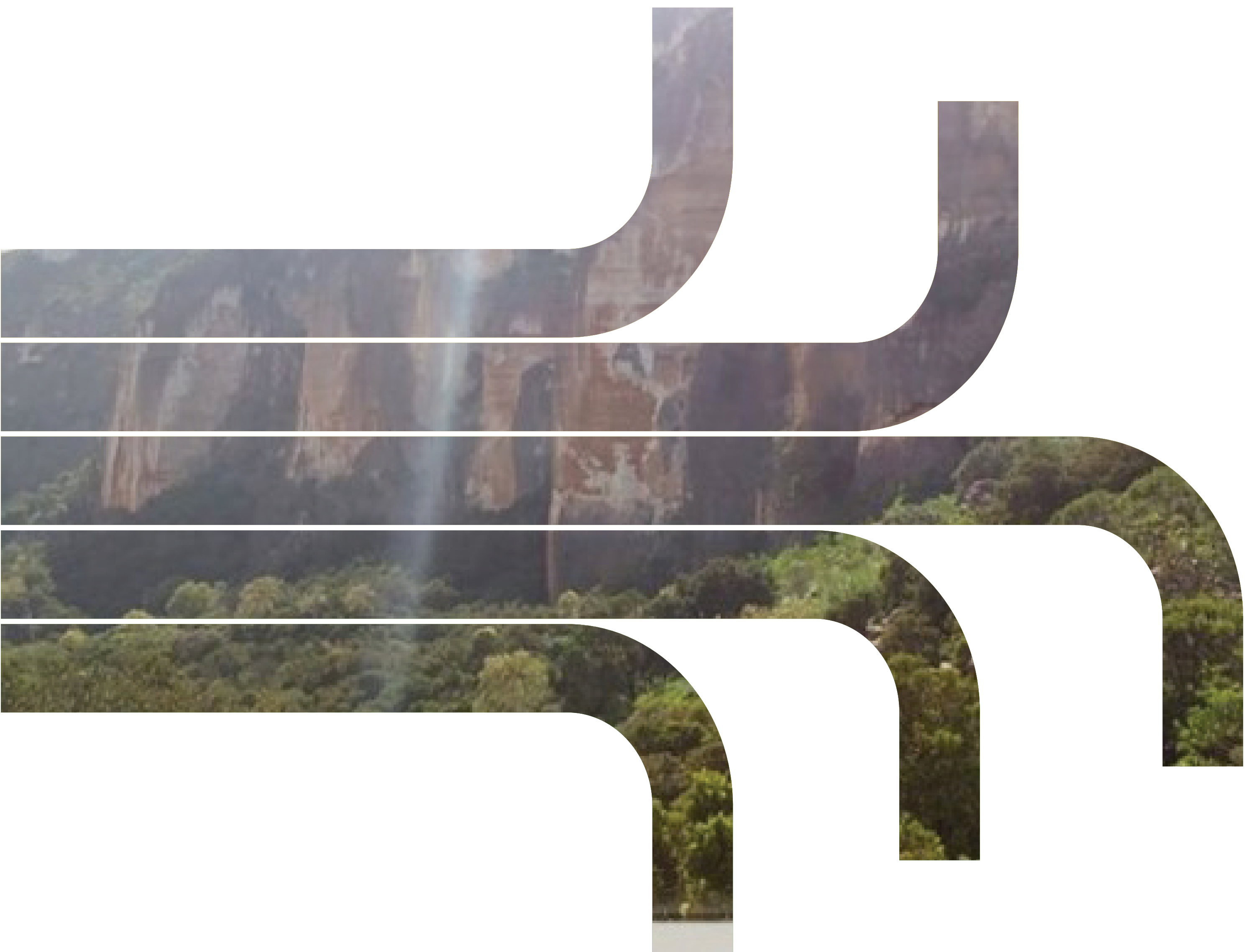
Figure 3.23 Ethiopia: projected precipitation anomalies



Source: World Bank [Climate Change Knowledge Portal](#).

Chapter 4

Prioritizing Adaptation Action



This chapter recaps the overall findings across different risks and links these to the broader development agenda within Somalia. Broad priorities and approaches for climate action are identified in relation to policies and institutions, physical investments, and knowledge.

4.1 Adaptation and development

Climate adaptation in Somalia must be rooted in its development and growth trajectories. Low per capita gross domestic product (GDP) and high rates of poverty make economic development an overriding imperative that any climate adaptation program must support. Conversely, climate impacts—not just on assets and production systems currently in existence, but also on future ones—must be considered to ensure growth pathways are climate resilient. Broadly, there are three methods to increase economic resilience to climate change:

1. **Reduce the biophysical impacts of climate change and extremes**—for example, by building protective structures to contain floodwaters or growing crop varieties that are more resilient to drought.
2. **Moderate the socioeconomic consequences of those impacts** through provision of alternative livelihood options (i.e., enhancing individual or community coping strategies), adaptive social safety nets, insurance, or other types of assistance.
3. **Diversify toward production systems and economic sectors that are inherently less vulnerable** to climate change, or at least where the impacts of climate change can be more readily addressed. Note that climate-related risks to different sources of growth may include international policy and market risks, as well as direct risks from direct climate impacts within the country.

General economic development tends to automatically improve methods 2 and 3, while providing additional resources for investment in and better targeting of methods 1 and 2. Climate-resilient growth should pursue all three methods to enhance the robustness and sustainability of economic development. In Somalia, growth is an imperative in its own right and for climate adaptation; proactive and science-informed adaptation is also an imperative for growth.

The two major pillars of the Somali economy—foreign transfers and agricultural and rural production—already face sustainability challenges, and potential pathways for further growth and diversification will have to be considered in light of climate risks. Consumption exceeds GDP by 60 percent in Somalia, with the difference primarily funded by foreign transfers—both private remittances from the diaspora and official development assistance. The other major pillar of the economy is agricultural and rural production, including crops, livestock, fisheries, and forest products. Although 70 percent of GDP is generated in cities and 74 percent of employment is non-agricultural—mostly from low-value service jobs—the economic injections and primary production that support Somalia's GDP are likely based on foreign transfers and agricultural production (Karamba 2021). Agricultural and rural production systems face significant sustainability challenges from inadequate natural resource management and increasing climate pressures. Remittances will likely decline as first-generation diaspora reach retirement age. Official development assistance would also be expected to play a decreasing role in the economy as the country stabilizes and develops.

Structural change is occurring rapidly in Somalia. The country has one of the highest population and urban growth rates—2.9 percent and 4.2 percent, respectively, in 2020—across Africa. A young population (about 70 percent of Somalia's population is under the age of 30) and fast-growing cities can be powerful catalysts for economic growth and innovation, if the challenges these pose for expanding service delivery can be met, and if security constraints and exogenous shocks can be ameliorated.

A number of potential sources of future economic growth and diversification have been identified in Somalia, but these are also associated with differing climate risks:

- Development of **agriculture, livestock, and fisheries value chains** has considerable potential, but these value chains are based on inherently climate-sensitive production systems. Rural labor is also exposed to risks of heat stress, and transport of rural products is highly exposed to climate extremes. The Rural Access Index for Somalia is also low, transport costs from the countryside to cities are high, and reliability is low due to high climate vulnerability in the rural road network.
- **Transnational trade** (the entrepot economy) is already significant. Much of it is likely informal, as evidenced by the fact that transshipped gold is one of Somalia's largest exports but is absent from official import figures. Somalia's ports could play a much larger role in connecting Ethiopia and other East African countries to markets in the Middle East, Europe, and Asia, but will need climate-resilient infrastructure both at the ports and in their connections to overland transportation modes.
- Development of **low-tech manufacturing industries** will increasingly have to accommodate international supply chain standards, including green production requirements. An urban manufacturing economy is also dependent on overcoming climate risks to human capital and the livability of urban centers.
- Potentials for **offshore oil and gas production** will have to navigate the fundamental changes international climate policies will exact on prices and standards, as well as ensure climate-resilient port facilities.

4.2 Decoupling climate and conflict

As discussed in chapter 2, climate impacts in Somalia are deeply and intricately intertwined with social fragility and conflict. Climate shocks have a severe impact on natural resources and rural livelihoods, and these are directly linked to major crises of food insecurity and displacement. Furthermore, the cycle between resource-based conflict, weak governance, and further resource degradation exacerbating the conflict is well established in Somalia. Exploitation of natural resources has also funded armed groups. Climate therefore contributes to social impacts and tensions, and reinforces and deepens various forms of social vulnerability, weak governance, and conflict. Efforts to tackle the climate crisis must take into account, and respond to, climate's role in the larger complex crisis in Somalia.

The first step to disrupting the linkages and breaking vicious cycles between climate, social fragility, and conflict is to do no harm. Interventions undertaken to address one dimension of the problem must not exacerbate the other; this can be ensured by employing social safeguards tools informed by the social and political context. Care must be taken to avoid security and stabilization operations undermining livelihoods and the climate coping capacity of local communities—for example, by blocking access to markets, banning certain livelihoods, or fueling displacement. Peacebuilding and mediation need to be climate security–risk informed, including through appropriate social and climate screening (Broek and Hodder 2022; Ginnetti and Franck 2014). Similarly, implementation of climate adaptation measures can inadvertently create new and additional pressure on natural resources such as land or water, entrench existing inequalities in access to natural resources, and thereby increase livelihood insecurity. In Somalia, these impacts have in the past reinforced existing grievances and compounded to create conflict risks, as occurred under the Barre regime's Hawl iyo Hantiwadaag (Program and Resource Sharing) policy. A key measure to avoid such outcomes is to ensure that women, youth, disadvantaged clans, and other vulnerable groups have full and equitable representation in the adaptation planning process.

Wherever possible, win-win solutions should be identified to address both dimensions of risk in tandem, so that climate adaption efforts are pro-peace, and peace and security interventions are pro-adaptation. One major win-win area is through the implementation of sustainable livelihoods and natural resource management programs, which strengthen local institutions and social structures that help build social and climate resilience. Addressing land and resource-based conflicts, and strengthening natural resource management systems through building the capacity of and trust in formal and informal institutions, would help disrupt the vicious cycle around natural resource–based conflict. An internationally renowned example of a measure taken to target and disrupt specific climate-conflict linkages is when the United Nations Security Council enacted a charcoal export ban from Somalia in 2012. This was intended to cut off a key funding source for al-Shabaab, but reducing forest degradation also has climate mitigation and adaptation benefits.

A second key area is to ameliorate Somalia's internal displacement crisis. Addressing the vulnerability of internally displaced persons (IDPs) and expanding youth employment disrupt the linkage between social crises and conflict. The importance of addressing displacement in the context of extreme weather events has been increasingly recognized in the humanitarian aid and disaster risk community to break cycles between biophysical shocks and famine/displacement outcomes. In Somalia, this would involve integrating disaster risk reduction, climate adaptation, and sustainable development with humanitarian assistance, human rights, and refugee protection. With an increasing amount of the population, including IDPs, being food insecure, safety net programs such as cash-for-food initiatives must be strengthened, and made more adaptive through incorporating weather and disaster forecasting. To this end, strengthening preparedness (including early warning systems, contingency planning, evacuation planning, and resilience-building strategies and plans) and developing innovative approaches (such as anticipatory action) to avert, minimize, and address displacement related to the adverse impacts of climate change are crucial (Thalheimer, Simperingham, and Jjemba 2022).

4.3 Prioritizing risks and adaptation options

Table 4.1 provides a summary of the results of the review of climate risks in chapter 3, in the form of semiquantitative metrics characterizing the risks.

Most climate risks faced by Somalia are either high-frequency events or chronic (continual) processes. This emphasizes the importance of considering changes in general climate conditions, not just climate extremes. However, in Somalia's already extreme climate, even the most severe extreme events—that is, floods and droughts—occur with high frequency. Almost all climate risks also affect the poor disproportionately. Most—climate disasters, all impacts on rural livelihoods, and heat stress—are strongly linked to poverty, due to the high reliance of the poor on rural livelihoods and outdoor labor, and their inability to protect themselves from extreme events. As discussed in chapter 2, climate impacts intersect with a variety of other social risk factors, such as gender, age, clan, and displacement, to reinforce and worsen patterns of social vulnerability.

A large majority of climate risks in Somalia are likely to increase with climate change. However, in most cases, the increase in the climate drivers may not be dramatic over the coming decades, and there is significant uncertainty due to the very wide range of potential rainfall outcomes. Over the medium term, for most of these risks, increases in impacts are likely to be driven by increased exposure due to population growth and increases in assets more than by intensification of climate factors. Some risks, though, are likely to see very dramatic climate-driven increases, particularly those associated with heat stress.

Currently, the most critical risks—those that already have massive human and economic impacts likely to persist or worsen—are the major climate disasters: drought and inland flooding. These have particularly severe impacts on rural populations, driving much of the internal displacement crisis affecting Somalia. They have wide-ranging social and economic consequences on production and exports, food security, social vulnerability and cohesion, and ultimately help entrench Somalia's

Table 4.1 Summary table of Somalia's climate risks with magnitude and trend measures

Sector	Risk	Frequency	Economic cost	Mortality	Poverty linkage	Climate trend
Climate disasters	Drought	3	5	5	5	4
	Fluvial and pluvial floods	3	4	2	5	4
	Coastal flooding	2	3	2	5	4
Agriculture and livestock	Locusts	1	4		5	4
	Crop stress	5	3?		5	3
	Agricultural pests & disease	2	3		5	3
	Heat stress on livestock	5	4?		5	5
	Fodder availability	5	4?		5	4
	Livestock pests and disease	5	4		5	3
Natural resources	Terrestrial ecosystems	5	2?		5	4
	Fisheries	5	2		4	4
Health	Heat stress	5	3	3	5	5
	Vector-borne disease	5	3	5	4	3
	Gastrointestinal disease	5	3?	3	4	5
Infrastructure and services	Degradation of infrastructure	5	3?		3	4
	Disruption of energy supply	5	1		3	3
	Disruption of water supply	5	3?		4	4

KEY:

	Frequency	Economic cost	Mortality	Poverty linkage	Climate trend
1	Rare	<$1 million	< 10	Very weak	Strong decrease
2	Occasional	$1–$10 million	10–100	Weak	Weak decrease
3	Frequent	$10–$100 million	100–1,000	Neutral or unclear	No clear trend
4	Routine	$100 million–$1 billion	1,000–10,000)	Strong	Weak increase
5	Chronic	>$1 billion	> 10,000	Very strong	Strong increase

Note: Impact is figured per event, or per year for routine or chronic events, for economic cost and mortality. **Frequency** ranges from rare (multidecadal), to occasional (once or twice a decade); to frequent (at least 50% of years); to routine (generally every year); to chronic (constant impact, not discrete acute events). **Economic cost** is figured in $ and includes damage and losses; those that are particularly uncertain are denoted with a "?" **Mortality** is indicated if applicable. **Poverty linkage** is whether impact disproportionately affects the poor, with a very weak link meaning the poor are much less affected than others, weak less affected, neutral affected similarly to others, strong affected more, and very strong meaning the poor are much more affected than others. **Climate trend** reflects strength of expected change in climate stressors influencing risk, as well as the strength of their influence on the risk (as most risks will be complex processes involving many drivers).

governance and conflict crises. Managing these risks is imperative to stabilizing the country and facilitating its development. The potential for rural production systems to contribute significantly to future growth will depend on adaptation and climate-proofing of rural livelihoods. Flooding has wider economic impacts because of its effects on urban populations, infrastructure networks, and the delivery of key services. Flood resilience will be critical to managing the risks to all other potential growth sources, due to the risks flooding poses to both urban production as well as to the movement and trade of goods.

A second set of risks are currently significant and have the potential to increase. Climate stress on crops and livestock will increasingly affect rural production, unless a significant increase in rainfall is rapidly realized (a possible, but unlikely outcome, which would require reversal of recent rainfall trends). The viability of current pastoralism systems, which provide for the majority of rural production, may be increasingly threatened. Locust outbreaks are also likely to increase in frequency. Stress on other natural resource-based systems will intensify, with fisheries particularly affected by rising sea temperatures. Although the current contribution of fisheries to the Somali economy is modest, they have considerable potential. Current health-related burdens will also be exacerbated by climate change. Gastrointestinal disease will significantly increase. The overall effects of changing climate conditions on vector-borne disease and crop and livestock pests and diseases are much harder to predict, given the specific and complex ecologies involved; it is almost certain, however, that some pests and pathogens will be greatly boosted by climate change. Once again, addressing increasing stresses on rural livelihoods will be critical to the ability of agriculture, livestock, and fisheries to ameliorate rural poverty, improve food security, improve the balance of trade, and contribute to overall economic growth. Human health impacts have a set of implications for human capital that affect productivity and growth more broadly, particularly in relation to efforts to industrialize the economy or develop higher-value service sectors.

Another set of risks are not currently very prominent but have the potential to significantly disrupt future development. Designing resilience to these risks into future development plans and investments is critical. Heat stress is expected to increase dramatically with projected increases in temperature and precipitation; this could significantly reduce labor productivity not only in agriculture and other rural production systems, but also in construction and other forms of low-paid urban labor where workers have little access to cooling. Disruption of infrastructure and key services will also be a major drag on the development of trade and urban economies if not tackled in the planning and design of public and private infrastructure. Urban water supply could become a major challenge in future, although much of the change will be driven by the increase in population and demand rather than climate. Over the longer term, coastal flooding could pose a significant constraint to trade and urban development if not accounted for in port infrastructure and vulnerable coastal cities.

The tables in the appendix summarize major climate adaptation options relevant for Somalia across key sectors. Based on the information in those tables and the discussion of risk categories above, the remainder of this chapter discuses some indicative areas of adaptation priorities. At this level of analysis, the priorities remain very broad and, given the wide range of important climate risks Somalia faces, the lists of relevant measures are extensive. Most are already cited in Somalia's Nationally Determined Contribution. More detailed work on key sectors and risk will be needed to identify and prioritize specific interventions and investment options, and to assess their economic, social, and environmental feasibility.

4.4 Policy and institutional measures

As summarized in chapter 1, Somalia has already developed a set of wide-ranging climate policies, but these mostly remain very high level, recognizing the importance of climate action and identifying broad areas for action. Considerable work is still required to develop policy frameworks that mandate or incentivize specific priority actions and to build institutions capable of implementing, enforcing, and monitoring these. Almost all physical adaptation interventions will require policy and administrative measures to support their implementation, including provision of climate-informed technical guidelines and standards, and capacity-building within government agencies to implement or promote measures. Beyond these supporting measures, policy and institutional actions are particularly important to (1) establish core resilience measures such as the mainstreaming of climate-informed planning and design, (2) facilitate or incentivize private action, and (3) correct perverse incentives that promote greenhouse gas emissions or climate vulnerability.

To help reduce and manage the current critical impacts of extreme events, improve social resilience, and provide a foundation for resilient growth, disaster risk management is a key area for policy and institutional development. To this end, the following actions should be taken, many of which could be outlined in the National Disaster Risk Reduction Strategy that is being developed:

- **Strengthening the national disaster preparedness and emergency response architecture.** This could include, for example, establishment of a National Emergency Operations Center, and decentralization of similar structures to the state and district levels, to support preparation for and coordination of disaster response; and strengthening of hydromet and climate information systems, including early warning systems and tailored information services to support planning and resilience in key sectors.
- **Integrating disaster risk management into strategic planning for key sectors.** Sectors could include integrated water resource management, agriculture and land management, environment, and urban development, among others. This integration should be complemented by climate-informed spatial planning, including planning for resilience of key infrastructure networks, resilient urban planning, and rural land use planning.
- **Establishing resilient construction standards and national building codes, to eventually be linked to spatial planning and zoning systems.** To further support public investment, climate-smart public investment management systems should be adopted, including tools for screening and identifying climate risk in investment appraisal. Developing a public-private partnership regulatory framework could support leveraging and incentivizing private investments and risk sharing for climate-smart investments.
- **Establishing adaptive and predictable social safety nets.** These safety nets should be targeted to poor and vulnerable households and communities, and be able to provide rapid additional assistance in the aftermath of a disaster. This latter objective would involve linkage to a well-maintained unified social registry, a mobile-based cash payment system, and a community-level network to support rapid outreach and community mobilization for social protection service delivery.
- **Developing a National Disaster Risk Financing Strategy.** This strategy should be based on feasibility studies for a range of potential disaster and climate risk financing mechanisms and tools, ranging from sovereign risk financing to agricultural insurance products.

Resilience of rural livelihoods and natural resources can also be promoted through a range of policy and institutional measures to address the considerable current risks, and provide a basis for further growth of rural production systems:

- **Improving extension support for climate-smart agricultural diversification.** Topics to be addressed include the selection of more resilient crops/varieties/breeds, their effective cultivation/husbandry, pest and disease control, and improved land and water management techniques. Extension support and guidance also should be extended to marketing and value chains, including digital agricultural services encompassing agri-forecasts, climate-smart practices and market information and linkages; developing feed and fodder trade to assist pastoralists in the timing of livestock sales; and improved postharvest handling, processing, and storage to improve sanitary and quality standards (and therefore export markets).
- **Establishing policy frameworks and support to local and community institutions for natural resource management and sustainable resource-based livelihoods.** This support should particularly be extended for entities involved in rangeland and fisheries management. Topics to be covered include land and resource access and tenure, and seasonal and technical regulations.

- **Mainstreaming forest and biodiversity concerns in policy development and investment planning within key sectors.** This mainstreaming would be accomplished through environmental risk management tools (including strategic environmental assessment and environmental impact assessment) and land use planning.
- **Establishing integrated water resource management planning systems and institutions.** These should be established for farmer-led irrigation, flood control, soil and water conservation, and the management of key river basins, among other areas.

Public health policies should begin to consider climate needs. Climate stresses may not revolutionize public health priorities, but will intensify or complicate pressures in a number of areas where the needs are already significant, including the following:

- Health and safety regulations for public buildings and work spaces, particularly to manage risks of heat stress and floods
- Postdisaster emergency health provision (e.g., mobile clinics, screening and prevention programs) in coordination with broader disaster response architecture and institutions
- Vector control programs, including active control programs, infrastructure standards, and public awareness
- Public health awareness campaigns on heat stress; water, sanitation, and hygiene (WASH); vector-borne disease; and postdisaster health and safety.

4.5 Physical investments

Many physical investments for climate adaptation will need to be undertaken by private individuals, such as farmers and property owners, and companies. The role of the state would be primarily to provide appropriate climate information, technical guidance, incentives, and regulatory requirements to facilitate them to act in their own best interests, as per multiple areas of the policy measures discussed above. The largest investments by the state will probably be in public infrastructure (e.g., transport, power supply, and urban development), where the primary objective will rarely be climate focused, but climate resilience will need to be built in, in accordance with climate-informed planning and design specifications as discussed above, typically at some significant incremental cost. In a few cases, retrofitting existing infrastructure may be required, but the high costs of retrofitting and the limited existing infrastructure assets in Somalia mean this would rarely be needed. Rather, infrastructure resilience should predominantly be built into the construction of new, and the maintenance and replacement of existing, infrastructure.

In all cases, detailed sectoral analyses, often involving modeling of climate impacts, will be needed to prioritize adaptation investment based on the following.

- **Urgency.** Given the high degree of uncertainty around medium and longer-term climate outcomes in Somalia, it will be important to prioritize responses to *current* and *immediate*, rather than to uncertain future conditions. This becomes more complicated in the case of infrastructure investments that have long economic life spans and/or may strongly influence patterns of future development and vulnerability over long periods. For instance, a road surface does not have a very long life span, and therefore the choice of surface material may be determined largely by current climate conditions, but the choice of where to place a new road or significantly upgrade an existing road may easily have multidecadal implications on wider patterns of economic activity and spatial development. Various tools are available to support climate investment decision making under uncertainty.
- **Synergy with development objectives.** Given very limited financial resources in relation to the scale of needs, and the imperative to prioritize inclusive growth, investments that bring clear benefits for sustainable development will need to be prioritized over those that competing for resources. As noted at the start of this chapter, national development planning should be informed by climate risks, and adaptation planning needs to be focused around key growth sectors.

Beyond building resilience into future public infrastructure in general, two areas of climate-related public investment stand out with regard to priority risks faced by Somalia. The first area is investment in water infrastructure aimed at improving the security of water resource availability and management across multiple sectors. Specific studies will be required to identify appropriate locations and types of investment, as well as to understand downstream implications of the following:

- **Water storage and irrigation infrastructure.** Small-scale schemes, such as subsurface dams and farmer-led irrigation are proving effective, but consideration might also be given to the viability of options for larger schemes as well.
- **Flood and drought-resilient WASH infrastructure.** In the longer run, the viability of desalination to supply water to coastal cities may also need to be assessed.
- **Flood defenses for critical locations.**

The second area is public investment in support of natural resource management, including the following:

- **Soil and water conservation/agroforestry/rangeland management.** Most on-farm measures would primarily be private actions, but public funding would still be needed to facilitate large-scale uptake of adaptation measures by individual farmers. This would include public investment in (1) demonstration sites and extension services; (2) support to community institutions; (3) digital and physical market access infrastructure; and (4) potentially large-scale subsidy, payment for environmental service, or labor-intensive public works schemes.
- **Sustainable rural energy provision.** This would include training and support for switching to alternative energy sources, efficient stoves, and regulation and management of woodfuel supply chains.
- **Protection and management of key natural habitats.** This would include the establishment and management of terrestrial and coastal protected areas, and active restoration of critical habitats, such as protective forests, nursery grounds, wetlands, key biodiversity areas, and ecological corridors (especially across altitudinal and climate gradients).

4.6 Knowledge agenda

Effective adaptation in Somalia will require considerable effort to generate and apply knowledge to overcome data gaps and more fundamental uncertainty. There is, for instance, huge uncertainty about the current or future economic costs of climate change—in many cases, even at the order-of-magnitude level. At the same time, Somalia must make the most of its limited financial and human resources through strategic investment in knowledge management. In particular, this will mean taking opportunities to develop knowledge partnerships whereby the country can leverage international science and research, particularly in fundamental areas such as hydrometeorological modeling and development of drought-tolerant crops and livestock, and focus on applied local research to support their application. It will also mean investing in information access, provision of digital information systems, and tailoring of knowledge products to specific audiences to equip civil society with the information resources needed to address climate challenges.

Analysis and knowledge management should accompany all areas of adaptation to identify specific interventions, review their feasibility along multiple dimensions, evaluate their performance, and share lessons. Some critical areas of knowledge to support investments include (1) analysis of different types and scales of water infrastructure investments under a range of scenarios to select optimal technical options and assess trade-offs between upstream and downstream populations; and (2) integrating hazard mapping with spatial infrastructure and urban planning to identify robust strategies for development of key services. Beyond physical investments, there are a wide variety of risk finance approaches and tools that could support Somalia, from sovereign risk pools or funds, through development of private insurance markets, to large-scale agri-insurance schemes. However, their financial feasibility needs to be carefully evaluated in relation to the climate risk and wider socioeconomic conditions in the country.

For some climate risks, there is pronounced uncertainty over their future extent and severity, which may demand more basic research as well as monitoring of actual outcomes. For instance, there is very limited understanding of the risks posed by a variety of human, livestock, and crop diseases and pests. Linking models to monitoring systems would test and improve knowledge on the scale and distribution of risks, as well as helping to improve forecasting and the tailoring of climate information services for early warning of major events, such as Rift Valley fever or locust outbreaks.

Given deep uncertainty in future climate trajectories, as well as their influence on certain biophysical outcomes, the risk of maladaptation must be taken seriously in Somalia. Accordingly, this risk must be incorporated into investment analytics through sensitivity analysis for a range of climate outcomes, and/or by using other tools to support decision making under uncertainty. Maladaptation may involve suboptimal investments (e.g., a large water storage project when smaller distributed structures would have been more cost-effective), ineffective investment (e.g., a water storage structure no longer fit for purpose because the rainfall is either much lower or higher than predicted), or harmful investments (e.g., a water storage structure that is causing more losses to downstream users than local benefits). In the Somalia context, the risk of externalities from insufficiently assessed investments exacerbating social tensions and conflict is a very real concern. The time frame over which uncertainty in future climate outcomes needs to be considered also depends on the expected economic life of the investment involved. A decision on the type of surface material to apply to a road may only need to consider the likely climate conditions over a handful or years, but a decision as to where to site a new road or substantial upgrade may need to consider the climate implications of long-term changes to patterns of spatial development that may result.

Adaptation Options

Table A.1 Disaster risk management

Adaptation option (action)	Who/where	Scale of investment	Timing	Uncer-tainty	Development synergy	Comment
Disaster risk management (DRM) strategy						
Refine and implement existing national DRM strategy	National and regional governments, development partners Nationwide	>$1 billion	Immediate	Medium	High	• High cost because of scale of ongoing and future disasters • Uncertainty medium due to current dependence on external support for implementation and limited national capacity
Adopt and include Drought Cycle Management (DCM) approach into DRM strategy and implementation, including integrating disaster contingency planning with DCM approach	National and regional governments, development partners Nationwide	>$1 billion	Immediate	Low	High	• Much experience in East Africa in practical application of DCM that can be drawn on • High cost because of scale of ongoing and future disasters
Strengthen government's planning and delivery capacity for disaster preparedness and response	National and regional governments, development partners Nationwide	<$1 million	Immediate	Low	High	• Less reliant on external support for both planning and delivery • Cost reflects capacity building, not ongoing response costs
Strengthen community-based DRM capacity through training and capacity building	National and regional governments, development partners Nationwide	$1–$10 million (additional capacity-building support only)	Immediate to < 5 years	Low	High	• Local/indigenous environmental skills and knowledge can provide a strong foundation for community inputs into DRM • DRM capacity building and planning can be integrated with broader community development/livelihood-focused support; many development co-benefits

(continued)

Table A.1 Disaster risk management *(continued)*

Adaptation option (action)	Who/where	Scale of investment	Timing	Uncertainty	Development synergy	Comment
DRM strategy (continued)						
• Policy/directive on women's representation and participation in DRM system as civil service staff and in governance/decision-making bodies • Policy/directive to ensure provision of maternal and reproductive health care, menstrual hygiene management, psycho-social support, and gender-based violence response as essential services within the overall DRM framework	National and regional governments, development partners Nationwide	<$1 million	Immediate	Low	High	• Ensuring effective inclusion of women and other vulnerable groups in DRM decision making • Ensuring provision of post-disaster essential services includes specific support for women
Climate information systems/hydromet and early warning[a]						
• Improve the provision of hydromet services by building institutional capacity to provide and effectively share both general and sector-specific hydromet forecasts (short-term and long-range/seasonal) including early warning systems (EWS) • Upgrade the national hydromet monitoring system, including data management capabilities	National and regional governments, development partners Nationwide	$10–$100 million	Immediate to < 5 years	Medium	High	• Increase investment in hardware, software, and skills to build Somalia's capacity to manage these systems • Reduce reliance on external support • Long-term investments needed to maintain and modernize systems over time; will fail without this • Seasonal forecasts assist farmers and herders plan • Delayed forecasts are not useful
Establishment of National Emergency Operations Center and National Disaster and Response Systems	National and regional governments, development partners	$50–$100 million	Immediate	Low	High	• Government fully committed and engaged • Reduced ability of government to effectively respond, leading to high impacts on vulnerable population and assets
Integrate EWS and DCM approach	National and regional governments, development partners Nationwide	<$1 million	Immediate	Low	High	• EWS integrated into and informs all sectoral planning • Cost reflects cost of integrating EWS and DCM, not the cost of implementing disaster response activities

(continued)

Table A.1 Disaster risk management *(continued)*

Adaptation option (action)	Who/where	Scale of investment	Timing	Uncertainty	Development synergy	Comment
Adaptive social safety nets (postdisaster assistance)						
Focus Safety Net programs/initiatives on activities that build resilience to future climate-linked disasters	National and regional governments, development partners Nationwide	<$100 million–$1 billion	Immediate to < 5 years	Low	High	Humanitarian assistance to meet immediate postdisaster needs (such as cash and food for work) can combine with longer-term actions and investments that build local assets, capacity, and skills that improve resilience.
Policy/directive to develop a scalable model for shock-responsive safety nets to offset postdisaster human capital losses for women, girls and other designated vulnerable groups	National and regional governments, development partners Nationwide	<$1 million	Immediate	Low	High	Ensuring the needs of women and other vulnerable groups are explicitly addressed in design of postdisaster safety net programs
Disaster risk finance						
Include a climate and disaster risk financing (CDRF) strategy as an integral component of DRM plans	National government	<$1 million	Immediate	Medium	High	Limited capacity to implement a CDRF strategy
Clarify realism of/opportunities for establishing a National Drought Fund	National government	<$1 million	Immediate	Medium	High	• Establishing a National Drought Fund is in National Drought Plan (2020) but no detail provided on financial structure • Reduce dependence on donor finance for DRM
Strengthen government capacity to take informed decisions on disaster risk finance, based on sound financial/actuarial analysis	National government, development partners	$1–$10 million	Immediate	Medium	High	Needs continued robust analysis/information to inform decisions

(continued)

Table A.1 Disaster risk management *(continued)*

Adaptation option (action)	Who/where	Scale of investment	Timing	Uncer-tainty	Development synergy	Comment
Disaster risk finance (continued)						
Mitigate disaster risk	National govern-ment, development partners, private sector Nationwide	$100 million–$1 billion	Immedi-ate to < 5 years	Medium	High	● Large costs spread across country; can be cost-effective compared to cost of long-term, repeating humanitarian response cost ● Agricultural insurance prod-ucts can reduce vulnerability of farmers and pastoralists ● Limited insurance options at present

Sources: OCHA 2021 (DRM strategy); Oxfam, n.d. (drought cycle management); Hydromet Working Group (hydromet).

a. The Famine Early Warning System Network (FEWS NET) coordinates an EWS primarily focused on food security. It includes global weather hazard reports, based on the U.S. National Oceanic and Atmospheric Administration's global weather forecasts. The Food and Agriculture Organization of the United Nation's (FAO's) Somalia Water and Land Information System project (SWALIM) has developed the Flood Risk and Response Management Information System (FRRMIS), which provides data to support an EWS. In the past this has proved difficult to implement and costly. SWALIM monitors river breakages and supports a mobile phone–based alert and EWS known as DIGNIIN. While far from perfect, these systems have been heralded as steps in the right direction, and access and use are continually refined and improved. In 2021, FAO and the government of Somalia agreed on a process to transfer SWALIM capabilities to the government. In 2020, the Ministry of Humanitarian Affairs and Disaster Management established the Multi-Hazard Early Warning Centre (which covers floods and drought) in Mogadishu, using remotely sensed products and improved approaches to dissemination. In recent years, the government has been working, with support from partners including the World Bank, to improve weather, climate, and water (hydromet) services, including early warning services. Chaired by the Ministry of Energy and Water Resources, the Hydromet Working Group—which also includes the Ministry of Humanitarian Affairs and Disaster Management, the Ministry of Agriculture and Irrigation, and the Somalia Civil Aviation Authority—is working to establish a unified National Meteorological and Hydrological Service.

Table A.2 Health

Adaptation option (action)	Who/where	Scale of investment	Timing	Uncertainty	Development synergy	Comment
Surveillance, monitoring, and early warning						
Enhance disease early warning systems and emergency response plans based on climate and environmental data for conditions that may increase selected diseases	MOH, regional governments, development partners, NGOs; support from MOECC Nationwide	<$1 million	Immediate	Low	High	● Higher investment figure represents maintaining surveillance over the longer term ● Uncertainty rated medium, as incomplete data can undermine surveillance effectiveness
Enhance surveillance and monitoring systems to track climate-related disease occurrence, including during and after an extreme event	MOH Nationwide	$1–$10 million	Immediate to < 5 years	Medium		
Improve dialogue and collaboration with neighboring countries' health ministries to improve monitoring of climate-linked health risks	MOH	<$1 million				
Controlling climate-linked vectors and pathogens						
Develop and maintain effective vector surveillance and control programs that incorporate climate change concerns	MOH Nationwide	$1–$10 million	Immediate	Low	High	● Higher investment figure represents maintaining surveillance over the longer term ● Investment includes continuous training cycles ● Especially important in densely populated locations ● Higher investment cost if major changes to infrastructure needed
Develop more/wider use of rapid diagnostic tests			< 5 to < 10 years			
Consider possible impacts of infrastructure development, such as water storage tanks, on vector-borne diseases	MOH, MOPWR Nationwide	<$1 million to $1–$10 million	Immediate to < 10 years			
Increase vaccination rates for RVF and other vector-borne diseases (where vaccines exist)	MOH Nationwide	$10–$100 million	< 5 to < 10 years	Medium		
Strengthening public health information						
Develop public information systems that inform public of health risks and encourage appropriate behavior during an extreme event	MOH Nationwide	<$1 million	< 5 years	Low	High	Targeted, clear public information can reduce health impacts during and after disasters
Public health awareness campaigns for flood-related diseases, particularly in densely populated urban areas/informal settlements	Central and local governments, NGOs All major urban centers		Immediate			

(continued)

Table A.2 Health *(continued)*

Adaptation option (action)	Who/where	Scale of investment	Timing	Uncer-tainty	Development synergy	Comment
Postdisaster health support						
Ensuring safe water supplies in recovery from drought and floods	MOH, regional governments Nationwide	<$1 million	Immediate	Low	High	Guidance and directions for technical teams restoring water supplies after a disaster
Provide clear guidance on emergency health response priorities and reestablishing functioning health centers after a disaster	MOH Nationwide	<$1 million	Immediate	Low	High	Cost reflects preparation of guidelines and developing and providing training for health sector staff

Source: Based on UNDP 2019.
Note: MOECC + Ministry of Environment and Climate Change; MOH = Ministry of Health; MOPWR = Ministry of Public Works and Reconstruction; NGO = nongovernmental organization; RVF = Rift Valley fever.

Table A.3 Agriculture and livestock

Adaptation option (action)	Who/where	Scale of investment	Timing	Uncertainty	Development synergy	Comment
Water storage and irrigation						
Invest in soil and water conservation infrastructure such as terraces, subsurface dams, and rainwater harvesting	MOA, NGOs, development partners	>$1 billion	Immediate to < 10 years	Low	High	● Long-term support required to cover large rural population ● Can be integrated with support for climate-smart agriculture
Invest in upgrading and expanding irrigation in Juba and Shabelle river basins	MOA, development partners	>$1 billion	Immediate to < 10 years	Low	High	Irrigated agriculture is a key component to ensuring national food security
Incorporate requirement to enhance rainwater harvesting through water ponds for both livestock and wildlife in large linear infrastructure projects (e.g., roads, fiber-optic cables)	World Bank, government of Somalia, private sector, development partners	$1–$10 million	> 20 years	Low	High	● Low cost ● Requires political goodwill ● Has high returns
Climate-smart agriculture						
Enhance agronomic management capacity of smallholder farmers climate-smart/sustainable practices suited to changing weather patterns	MOA, NGOs, development partners	>$1 billion	Immediate to < 10 years	Low	High	● Much experience in East Africa (and globally) to draw on ● Long-term support needed to cover large rural population
Agricultural/livestock pests and diseases						
Control desert locusts, tsetse, RVF, armyworm, etc., through scaled-up surveillance, monitoring and control	MOA, development partners	$1–$10 million	Immediate (so ready when needed)	Low	Medium	Requires political commitment to prioritize, even when no locust threat
Scale up pest and disease monitoring capabilities	MOA	$1–$10 million	Immediate	Medium	High	Uncertainty rated medium, as monitoring effectiveness largely depends on efficiency of government vet and extension service in general; inadequate/late response or incorrect advice can increase rather than decrease vulnerability to pest/disease outbreaks
Protect lives and livelihoods by prepositioning and delivering supplies to food-insecure households at risk of locust invasion, including planting and replanting packages	MOA	$10–$100 million	Immediate	Low	High	● Use similar delivery mechanism to existing Food Aid operations ● Integrate with rural development programs
Prioritize risk management of Aflatoxin and fumonisin exposure	MOA, MOH Cereal production areas	$1–$10 million	Immediate to < 5 years	Medium	High	Requires extensive public education and considerable staff time

(continued)

Table A.3 Agriculture and livestock *(continued)*

Adaptation option (action)	Who/where	Scale of investment	Timing	Uncer-tainty	Development synergy	Comment
Research and technology transfer (livestock)						
Research and promote animal breed diversification to ensure availability of livestock suited to climatic conditions	MOA Livestock production areas	$10–$100 million	< 5 to <20 years	Medium	High	● Draw on existing research in countries with similar environments ● High cost to cover combined research, breeding, and dissemination ● Limited capacity in-country for advanced research
New interventions, such as modifications of diet composition, to increase livestock feed intake and compensate for low feed consumption due to heat stress						
Evaluate the possibilities for improving thermal tolerance of Somali livestock using genetic tools						
Research and technology transfer (crops)						
New investments in plant breeding in Somalia, and especially in cultivars that can withstand high levels of heat stress	MOA	$10–$100 million	< 5 to <20 years	Medium	High	High cost to cover combined research, breeding and dissemination
Enhance agronomic knowledge and management capacity of smallholder farmers to use climate-smart/sustainable practices, suited to changing weather patterns	MOA, NGOs, development partners	>$1 billion	Immediate to < 10 years	Low	High	● Long-term support required to cover large rural population ● Use participatory approaches for extension (e.g., Farmer Field Schools) ● Wealth of experience on participatory approaches to improving crop and farm productivity that can be drawn on
Include indigenous knowledge and participatory approaches for crop research and experimentation	MOA, NGOs					

Note: MOA = Ministry of Agriculture and Irrigation; MOH = Ministry of Health; NGO = nongovernmental organization; RVF = Rift Valley fever.

Table A.4 Biodiversity and forests

Adaptation option (action)	Who/where	Scale of investment	Timing	Uncer-tainty	Development synergy	Comment
Policy mainstreaming						
Use social and environmental impact studies to screen new policies that include need for land use planning to ensure biodiversity and climate change factors	MOECC Nationwide	< $1 million	Immediate	Low	High	● Integrating biodiversity with action on climate change ● Utilize indigenous knowledge to adapt to climate change in forests and biodiversity landscapes ● Prioritize biodiversity hotspots
Payments for ecosystems services (PES)						
Explore opportunities to use PES to protect forests, watersheds, and other biodiverse areas						Opportunities to provide added value to biodiverse areas, especially standing forests, and provide compensation for improved protection of forests as carbon reserves by local communities
Land use planning						
Participatory catchment-level planning to ensure pastoral access to water and pasture resources available in forest ecosystems in Somalia	MOECC, MOA Pastoral areas	$1–$10 million	Immediate to < 5 years	Medium	High	● Costs here are just for planning processes ● Maladaptation possible without good technical support ● To include capacity building for the Somali government
Develop conservation corridors to connect fragmented forest	MOECC, MOA Nationwide in forest areas	$10–$100 million	< 5 years to < 20 years	Low	High	Can be integrated with other rural development programs
Alternative natural resource-based livelihoods						
Diversify livelihoods with community forest enterprises/nontimber forest products	MOA, NGOs, development partners Nationwide in forest areas	$10–$100 million	Immediate to < 20 years	Medium	High	● Can be integrated with other rural development programs ● Livelihood diversification can be challenging in a constrained economy

(continued)

Table A.4 Biodiversity and forests *(continued)*

Adaptation option (action)	Who/where	Scale of investment	Timing	Uncer-tainty	Development synergy	Comment
Sustainable rural energy						
Investing in alternative energy, especially renewables	Ministry of Energy and Minerals Nationwide, especially urban areas	5	Immediate to < 10 years	Medium	High	● To reduce impact on forests ● Major health co-benefits through reducing indoor air pollution ● Uptake of fuel-efficient stoves often very slow ● Limited availability of LPG; storage and transport facilities inadequate; high cost for poor households to use LPG can be barrier to entry
Support switch to alternative sources and fuel-efficient stoves	MOECC, NGOs	\$10–\$100 million	Immediate to < 10 years	Medium	High	
Regulate and license wood and charcoal supply chains		\$1–\$10 million				● Developing regulations for of supply chains is low cost; enforcement is long term and relatively expensive ● Existing vested interests in (unregulated) supply chain are often firmly entrenched and politically powerful

Note: MOECC = Ministry of Environment and Climate Change; MOA = Ministry of Agriculture and Irrigation; NGO = nongovernmental organization.

Table A.5 Fisheries

Adaptation option (action)	Who/where	Scale of investment	Timing	Uncer-tainty	Development synergy	Comment
Regulate fisheries						
License and enforce fishing licenses for foreign-owned fishing boats in Somalia's coastal Exclusive Economic Zone	National and regional governments	\$10–\$100 million	Immediate to < 5 years	High	High	• Government capacity to negotiate fishing agreements very low • Capacity to enforce agreements very low • High investment in fisheries monitoring craft required
Improve management of coastal habitats						
Conserve and protect mangroves	• Ministry of Environment and Climate Change • Ministry of Fisheries and Marine Resources Suitable coastal habitats	\$1–\$10 million	< 5 years	High	Medium	• Limited mangroves in Somalia • Limited short-term development gains
• Improve conservation and management of sensitive coastal ecosystems, such as coral reefs and seagrasses • Identify, establish, and regulate marine protected areas	Ministry of Fisheries and Marine Resources Suitable coastal habitats	\$10–\$100 million	< 5 to > 10 years	High	Medium	• Limited capacity to effectively protect remote coastal ecosystems • Limited short-term development gains

Source: UNIDO 2021 (licenses).

Table A.6 Transport

Adaptation option (action)	Who/where	Scale of investment	Timing	Uncertainty	Development synergy	Comment
Transport operations (road and air travel, road construction)						
Shift construction schedules to cooler parts of the day to address health and safety concerns and avoid vehicle overheating and deterioration	Private sector Nationwide	$1–$10 million	Immediate	Low	High	• MOTCA responsible for policy and contract technical specification • Regional governments responsible for policy and specification in some regions, depending on political settlement • Private sector responsible for design and managing construction
Monitor stream bed flow and bridge scour	MOTCA					
Integrate emergency evacuation procedures into standard operating procedures	MOTCA, private sector					
Increase payload restrictions on aircraft at high-altitude or hot-weather airports	MOTCA					
Retreat/relocate						
• Plan for community relocation in coastal areas • Convert coastal land uses to establish natural buffer zones	Local and national governments Coastal zones	$100 million—>$1 billion	< 5 to < 10 years	Medium	High	Requires further, location-specific, assessments of flood risk from sea level rise (including cost effectiveness and uncertainty)
Relocate roads and airport runways further inland			< 5 to > 20 years			Relocation very expensive, with high additional social and political costs
Strengthen policies, planning, and systems						
• Identify transportation-related development goals important to the country, community, or sector • Identify inputs and enabling conditions necessary to achieving transportation-related development goals • Integrate climate information into system planning to assess climate impacts on transportation infrastructure and understanding adaptation needs and economic implications • Improve coordination of policies and programs across government agencies to address additional pressures imposed by climate change • Improve finance for transportation systems that are more adaptive and better designed for a changing climate, including through private sector investment and incentives; ensure consideration of climate risk in financing approaches • Strengthen disaster planning/response for transportation infrastructure/services	MOTCA, other ministries/departments as appropriate Nationwide	$1–$10 million to $10–$100 million	< 5 years	Low	High	Changes to policy and planning are required to guide climate-resilient transport sector investments

(continued)

Table A.6 Transport *(continued)*

Adaptation option (action)	Who/where	Scale of investment	Timing	Uncer-tainty	Development synergy	Comment
Building capacity to manage a climate-smart transport sector						
● Capacity building and training to help prepare for and cope with hazards or build longer-term resilience ● Budgeting processes that account for additional maintenance costs to address increasing damages from hazards	MOTCA Nationwide	\$1–\$10 million	< 5 years	Low	High	Capacity strengthen-ing required to support a climate resilient invest-ment in transport sector
Urban transport infrastructure						
Investment in roads and other transporta-tion options for both formal and informal settlements, with a focus on green infrastructure	Central and local govern-ments, private sector Initially, key routes	\$10–\$100 million to >\$1 billion	Immedi-ate to < 10 years	Low	High	Significant economic and sustainable devel-opment co-benefits

Source: Based on World Bank, Climate and Disaster Risk Screening—Sector Screening Guidance Note: Transportation Sector.
Note: MOTCA = Ministry of Transport and Civil Aviation.

Table A.7 Energy

<table>
<tr><th>Adaptation option (action)</th><th>Who/where</th><th>Scale of investment</th><th>Timing</th><th>Uncer-tainty</th><th>Development synergy</th><th>Comment</th></tr>
<tr><td colspan="7">Transmission and distribution (T&D)</td></tr>
<tr><td>Specify more effective cooling measures/equipment for substa-tions and transformers</td><td rowspan="3">Energy service providers, all T&D networks</td><td rowspan="3">$10–$100 million</td><td rowspan="3">< 5 to < 10 years</td><td rowspan="3">Medium</td><td rowspan="3">High</td><td>Key threats:
• High temperatures can reduce electricity-carrying capacity of lines
• Can increase losses within substations and transformers</td></tr>
<tr><td>Reinforce existing T&D struc-tures and build underground distribution systems</td><td>Key threat:
• Strong winds can damage T&D lines</td></tr>
<tr><td>Build redundancy into power systems and increase decentral-ization of power generation</td><td></td></tr>
<tr><td colspan="7">Energy supply</td></tr>
<tr><td>Invest in clean energy and energy efficiency</td><td>Government and private sector

All urban centers</td><td>$10–$100 million to >$1 billion</td><td>< 5 to < 10 years</td><td>Low</td><td>High</td><td>• Investment requirement depends on specific energy investment
• Significant co-benefits for economic prosperity and green growth</td></tr>
<tr><td colspan="7">Renewable energy use</td></tr>
<tr><td>Policy/directive to expand use of small-scale off-grid solar energy (cooking, heating, lighting, and water extraction) solutions, and implement affirmative programs for women-owned businesses to transition into renewable energy</td><td>Government

Nationwide</td><td><$1 million</td><td>Immediate</td><td>Low</td><td>High</td><td>Ensuring the needs of women and other vulnerable groups are explicitly addressed in renewable energy development and roll-out</td></tr>
</table>

Source: Based on ADB 2012.

Table A.8 Cities/urban

Adaptation option (action)	Who/where	Scale of investment	Timing	Uncertainty	Development synergy	Comment
Climate-resilient infrastructure						
• Develop and implement higher structural design standards for new or renovated buildings and infrastructure • Utilize climate-resilient materials and designs that account for a changing climate	Government and private sector (all sectors) Nationwide	\$10–\$100 million to >\$1 billion	Immediate to < 10 years	Medium	High	Key threats: • Cyclones, severe lightning, etc., can destroy power infrastructure and disrupt supplies and any offshore activities • Possible soil erosion and damage to infrastructure
Relocation of storage yards for buses and train cars out of flood-prone areas to reduce risk of damage or loss of this equipment	Central and local governments All major urban centers with coastal or riverine flood risk					
Urban design to mitigate heat island effect						
Increase tree and vegetation cover	Local government, NGOs, private sector All major urban centers	\$10–\$100 million	< 5 to < 10 years	Medium	High	• Requires space to plant trees • Often difficult to identify suitable opportunities in informal settlements or established built areas
Install green roofs		\$10–\$100 million				• Scaling up requires individual household action for construction and maintenance • Establishment cost may be too high for poor households • Requires robust roof construction to bear weight of soil and vegetation
Install cool roofs	Local government, NGOs, private sector All major urban centers	\$100 million–\$1 billion (assumes grant to householders to install)	< 10 years > 20 years	High	Neutral	• Too costly for many poor households • Limited supply of suitable materials/coatings
Install cool pavements		\$10–\$100 million				• Scaling up requires local administration to plan/manage • Hard to estimate net costs or benefits based on temperature reduction alone • Greatest overall value when multiple benefits (e.g., improved storm water management and water quality) are included in evaluating impact

(continued)

Table A.8 Cities/urban *(continued)*

Adaptation option (action)	Who/where	Scale of investment	Timing	Uncertainty	Development synergy	Comment
Urban design to mitigate heat island effect (continued)						
• Adjust building codes toward designs with better cooling properties • Public information campaigns to promote cool buildings, as well as ways of adapting existing buildings to provide cooler environments	Government and private sector All urban centers	<$1 million	< 5 to < 10 years	Low	Moderate	Suitable technologies/designs exist, including many low-cost options.
Storm water infrastructure						
Short-term clearance/disposal of solid waste from drains to prevent clogging	Local government	<1 million (localized planting) to $10–$100 million (large-scale infrastructure or afforestation)	< 5 to < 10 years	Medium	High	• To be effective, clearance needs to be sustained over time • Significant economic and environmental co-benefits
Investment in green infrastructure and ecosystem planning to improve natural storm water function (e.g., contour planting, terracing, afforestation for erosion control)	Central and local governments					
Buildings						
• Retrofit of old buildings and improved design of new buildings (if residents remain in vulnerable location) to address lower structural quality of homes in informal settlements • Stricter risk disclosure requirements for housing developers	Central and local governments, private sector All major urban centers	$10–$100 million to >$1 billion	< 5 to < 10 years	Medium	High	Requires political and staff investment for sound enforcement
Relocation of key infrastructure and assets out of flood-prone areas						
Relocation of commercial activities (for example, ports and industry, storage yards), located in flood risk areas of coastal cities or in river floodplains	Central and local governments, private sector All major urban centers with flood risk	$100 million–$1 billion	Short-medium term	Medium	High	Requires effective policies and planning processes to be in place

(continued)

Table A.8 Cities/urban *(continued)*

Adaptation option (action)	Who/where	Scale of investment	Timing	Uncertainty	Development synergy	Comment
Coastal infrastructure						
Build sea walls or other structural investments to protect against coastal flooding	Central and local governments, private sector Coastal urban centers with flood risk	\$100 million–\$1 billion	Short-medium term	Low	High	
Food security						
Development of city-level food storage infrastructure and promotion of urban agriculture	Central and local governments, private sector, NGOs All major urban centers	\$10–\$100 million to \$100 million–\$1 billion	Immediate to < 5 years	Medium	High	• High priority due to current high levels of food insecurity • Low technical capacities can undermine urban agriculture initiatives

Source: World Bank 2011.
Note: NGO = nongovernmental organization.

Table A.9 Water and sanitation

Adaptation option (action)	Who/where	Scale of investment	Timing	Uncertainty	Development synergy	Comment
Water infrastructure						
Construction of water, sanitation, and hygiene (WASH) infrastructure to ensure whole population has access to safe water supplies	Central and local governments National/ regional	>$1 billion	Immediate to < 10 years			• Major investments required. • Immediate development and health co-benefits • Initial investments should focus on densely populated locations (urban/IDP camps), where cost-effectiveness is highest
Strengthening/relocating/realigning pipes for aquifers, wastewater treatment plants, and other infrastructure in coastal areas or river floodplains	Central and local governments All major urban centers with coastal or riverine flood risk	$10–$100 million	Short-medium term	Low	High	Requires effective planning processes to be in place
Legal and regulations						
Support regulation of the Xeer (customary water management laws) in a consultative manner that allows the regulator to act as a partner, facilitating reaching agreements that ensure safe water supplies	Government	$1–$10 million (including ongoing support over time)	< 5 years	Medium	High	
Social, economic, and political factors						
Strengthen institutional capacity of managing agency to appropriately utilize/expand budget, increasing funds available for operations, maintenance, and repairs	Government, development partners National and regional	$10 million	< 5 years	Low	High	
Ensuring women's access to and decision-making power over competing water resources (e.g., women's participation in water user associations)	Central and local governments, NGOs National and regional	$1–$10 million	Immediate	Medium	High	
Developing and enforcing urban planning and zoning for slums and refugee camps to provide water, wastewater, and sewage services in the future	Central and local governments, development partners Slums and refugee camps	$1–$10 million	< 5 years	Medium	Medium	

(continued)

Table A.9 Water and sanitation *(continued)*

Adaptation option (action)	Who/where	Scale of investment	Timing	Uncer-tainty	Development synergy	Comment
Solid waste management						
Improved solid waste–handling practices (e.g., proximity to drinking water supply, corrosive-resistant containers) to prevent leakage and contamination, particularly in densely populated urban areas/ informal settlements	Central and local govern-ments, private sector All major urban centers	\$10–\$100 million	Immedi-ate	High	High	Requires significant political and staff investment—without signif-icant political support, elites may capture planning processes for their own advantage and under-mine potential environmental benefits

Source: Based on World Bank, Climate and Disaster Risk Screening—Sector Screening Guidance Note: Water Sector.
Note: IDP = internally displaced person.

Table A.10 Societal change and development

Adaptation option (action)	Who/where	Scale of investment	Timing	Uncer-tainty	Development synergy	Comment
Policy coherence						
Align all government policies to address the challenges of climate change	Federal government	<$10 million	Immediate	Low	High	Federal policy must come together and aim for managing climate change risks
Population growth						
Engage and educate public leaders (community, faith, clan) in addressing linkages between rapid population growth and future food and water security	Federal and federal member state governments, development partners	<$10 million	Immediate	High	High	● Sensitive issue, but societal discussion is needed. Train and engage, e.g., imams of local mosques in long-term water and food security. ● Family norms are changing across the world, but not in Somalia. There are many reasons for this, one of which is poverty. This change needs to start with men, rather than women. Unlike men, women want far fewer children (today 5-6). Build on this, promote women's interests.
Through public leaders, sports and culture stars, and government, address a key driver of today's rapid growth: number of children per man (today 10–12)	Governments, national NGOs, clan groups, etc.	<$10 million	Immediate	High	High	
Support women's groups, interests, opportunities, training, etc.	Governments, national NGOs, clan groups, etc.	<$10 million	Immediate	High	High	
Conflict and reconciliation						
Engage clan and faith leaders in training and understand the future and what challenges it contains	Government, development partners	<$5 million	Immediate	Medium	High	Conflicts are an outcome of resource scarcity (land, water, food) and thus directly linked to managing climate change
Research and studies						
Initiate comprehensive studies on how Somalia can feed itself in a difficult future.	Government, development partners	<$3 million	Immediate	Low	Medium	Domestic food production will not increase much, implying a dependency on imported food—from where, how to pay, how to distribute?
Initiate comprehensive studies on finance, growth, and trade; a key issue is how to boost export and diaspora remittances to pay for imported food	Government, development partners	<$3 million	Immediate	Low	Medium	National financial systems will be massively affected by climate change. How, what, where, why? How to counter the effects?

(continued)

Table A.10 Societal change and development *(continued)*

Adaptation option (action)	Who/where	Scale of investment	Timing	Uncertainty	Development synergy	Comment
Education and training						
● Develop a range of education and training opportunities, and appropriate curricula covering climate risk and response, with different content and format to suit different stakeholders groups (e.g., policy makers, business owners, graduates, undergraduates, community leaders, women, elderly, schoolchildren) ● Key sectoral areas: agriculture, forests, ecosystems and biodiversity, water management, health, disaster risk management, energy, waste	Government, national NGOs, development partners	$10 million– $100 million	Immediate to <10 years	High	High	● Range of training materials that need to be developed is challenging; little exists at present ● Further analysis required to identify priority actions to develop feasible and affordable training and education materials and opportunities ● High level of investment required to allow provision of suitable extensive, nationwide training and education opportunities over the medium term

Note: NGO = nongovernmental organization.

References

Abel, Guy J., Michael Brottrager, Jesus Crespo Cuaresma, and Raya Muttarak. 2019. “Climate, Conflict and Forced Migration.” *Global Environmental Change* 54 (January): 239–49.

ACLED (Armed Conflict Location and Event Data Project). 2020. “Al Shabaab in Somalia and Kenya.” ACLED.

ADB (Asian Development Bank). 2012. *Climate Risk and Adaptation in the Electric Power Sector*. Manila: ADB.

AfDB (African Development Bank). 2016. “Transport Sector Needs Assessment and Investment Program.” AfDB, Abidjan.

AfDB (African Development Bank). 2020. “The Africa Infrastructure Index (AIDI) 2020.” AfDB, Abidjan.

Ahmad, Aisha. 2014. “The Security Bazaar: Business Interests and Islamist Power in Civil War Somalia.” *International Security* 39 (3): 89–117.

Ahmed, S.A., Flórez M. Guerrero, and P. Karanis. 2018. “The Impact of Water Crises and Climate Changes on the Transmission of Protozoan Parasites in Africa.” *Pathogens and Global Health* 112 (6): 281–93.

Aleena, J., V. Sejian, M. Bagath, G. Krishnan, V. Beena, and R. Bhatta. 2018. “Resilience of Three Indigenous Goat Breeds to Heat Stress Based on Phenotypic Traits and PBMC HSP70 Expression.” *International Journal of Biometeorology* 62: 1995–2005.

Ali, Nimo-Ilhan. 2016. *Going on Tahriib: The Causes and Consequences of Somali Youth Migration to Europe*. Nairobi and London: Rift Valley Institute.

Alongi, D.M. 2015. “The Impact of Climate Change on Mangrove Forests.” *Current Climate Change Reports* 1: 30–39.

Alonso, S., C.J. Chaccour, E. Elobolobo, et al. 2019. “The Economic Burden of Malaria on Households and the Health System in a High Transmission District of Mozambique.” *Malaria Journal* 18: 360.

Anderson, W., C. Taylor, S. McDermid, E. Ilboudo-Nébié, R. Seager, W. Schlenker, F. Cottier, A. de Sherbinin, D. Mendeloff, and K. Markey. 2021. “Violent Conflict Exacerbated Drought-Related Food Insecurity between 2009 and 2019 in sub-Saharan Africa.” *Nature Food* 2 (8): 603–15.

Arnell, N.W., and S.N. Gosling. 2016. “The Impacts of Climate Change on River Flood Risk at the Global Scale.” *Climatic Change* 134, 387–401.

Ash, K., and N. Obradovich. 2020. “Climatic Stress, Internal Migration, and Syrian Civil War Onset.” *Journal of Conflict Resolution* 64 (1): 3–31.

Aynte, A., E. Chen, and D. Mozersky. 2022. *Powering Ahead: The United Nations and Somalia’s Renewable Energy Opportunity*. Washington, DC.

Balthasar, Dominik. 2017. “State-Making at Gunpoint: The Role of Violent Conflict in Somaliland’s March to Statehood.” *Civil Wars* 19 (1): 65–86.

Barnes, Cedric, and Harun Hassan. 2007. “The Rise and Fall of Mogadishu’s Islamic Courts.” *Journal of Eastern African Studies* 1 (2): 151–60.

Barraclough, K., G. Blashki, S. Holt, and J. Agar. 2017. “Climate Change and Kidney Disease—Threats and Opportunities.” *Kidney International* 92: 526–30.

Barrow, Ibrahim Hassan. 2020. “Inter-Clan Conflicts in Somalia: When Peace Happen (Case Study Baidoa District, Bay Region).” *International Journal of Human Resource Studies* 10 (4).

Bhattacharjee, Shilavadra. 2022. “5 Major Ports of Somalia.” Marine Insight blog post, April 30.

Battini, M., A. Vieira, S. Barbieri, I. Ajuda, G. Stilwell, and S. Mattiello. 2014. “Invited Review: Animal-Based Indicators for On-Farm Welfare Assessment for Dairy Goats.” *Journal of Dairy Science* 97: 6625–48.

BBC News. 2021. “Somalia Declares Emergency Over Locust Swarms.” February 2.

Bernabucci, Umberto, Nicola Lacetera, Lance Baumgard, Robert Rhoads, Bruno Ronchi, and Alessandro Nardone. 2010. “Metabolic and Hormonal Acclimation to Heat Stress in Domesticated Ruminants.” *Animal: An International Journal of Animal Bioscience* 4: 1167–83.

Boitt, M.K., F.C. Langat, and J.K. Kapoi. 2018. “Geospatial Agro-Climatic Characterization for Assessment of Potential Agricultural Areas in Somalia, Africa.” *Journal of Agricultural Informatics* 9 (3).

Bolognesi, M., A. Vrieling, F. Rembold, and H. Gadain. 2015. "Rapid Mapping and Impact Estimation of Illegal Charcoal Production in Southern Somalia Based on WorldView-1 Imagery." *Energy for Sustainable Development 25:* 40–49.

Borg, F.H., J. Greibe Andersen, C. Karekezi, G. Yonga, P. Furu, P. Kallestrup, and C. Kraef. 2021. "Climate Change and Health in Urban Informal Settlements in Low- and Middle-Income Countries—A Scoping Review of Health Impacts and Adaptation Strategies." *Global Health Action* 14 (1):1908064.

Bradbury, Mark, and Sally Healy. 2010. "Whose Peace Is It Anyway? Connecting Somali and International Peacemaking." *Accord* 21.

Brecht H., S. Dasgupta, B. Laplante, S. Murray, and D. Wheeler. 2012. "Sea-Level Rise and Storm Surges: High Stakes for a Small Number of Developing Countries." *Journal of Environment & Development* 21 (1).

Broek, E., and C.M. Hodder. 2022. "Towards an Integrated Approach to Climate Security and Peacebuilding in Somalia." Stockholm International Peace Research Institute, Stockholm.

Brookings. 2020. "Foresight Africa: Top Priorities for the Continent 2020–2030." Brookings Institution, Washington, DC.

Buhaug, H., J. Nordkvelle, T. Bernauer, T. Böhmelt, M. Brzoska, J. W. Busby, A. Ciccone, et al. 2014. "One Effect to Rule Them All? A Comment on Climate and Conflict." *Climatic Change* 127 (3–4): 391–97.

Buhaug, H., and von Uexkull, N. 2021. "Vicious Circles: Violence, Vulnerability, and Climate Change." *Annual Review of Environment and Resources* 46 (1): 545–68.

Campbell-Lendrum, D., L. Manga, M. Bagayoko, and J. Sommerfeld. 2015. "Climate Change and Vector-Borne Diseases: What Are the Implications for Public Health Research and Policy?" *Philosophical Transactions of the Royal Society B: Biological Sciences* 370 (1665): 20130552.

CARE International. 2022. "Somalia: Women and Girls Left Vulnerable in Worsening Drought." Press release. October 14.

Carleton. 2022. "Future of Food." Online course. Ottawa: Carleton University.

Carlton, E.J., A.P. Woster, P. DeWitt, R.S. Goldstein, and K. Levy. 2016. "A Systematic Review and Meta-Analysis of Ambient Temperature and Diarrhoeal Diseases." *International Journal of Epidemiology* 45 (1): 117–30.

Carrier, Neil, and Emma Lochery. 2013. "Missing States? Somali Trade Networks and the Eastleigh Transformation." *Journal of Eastern African Studies* 7 (2): 334–52.

Cecchi, G., R.C. Mattioli, J. Slingenbergh, and S.D. la Rocque. 2008. "Land Cover and Tsetse Fly Distributions in sub-Saharan." *Medical and Veterinary Entomology* 22: 364–73.

Chaseling, G.K., et al. 2021. "Extreme Heat and Cardiovascular Health: What a Cardiovascular Health Professional Should Know." *Canadian Journal of Cardiology* 37 (11).

Chatterjee, A., B.P. Kumar, S. Prakash, and P. Singh. 2019. "Annihilation of the Somali Upwelling System during Summer Monsoon." *Scientific Reports* 9 (1): 1–14.

Chaudhry, S., and J. Ouda. 2021. "Perspectives on the Rights of Climate Migrants in the Horn of Africa: A Case Study of Somalia." *Journal of Somali Studies* 8 (1).

Cheung S., J. Lee, and J. Oksa. 2016. "Thermal Stress, Human Performance, and Physical Employment Standards." *Applied Physiology, Nutrition, and Metabolism* 41 (6): 148–64.

CityCORE Africa. 2020. "City Coastal Resilience in Africa."

Clements, A., D.U. Pfeiffer, and V. Martin. 2006. "Application of Knowledge-Driven Spatial Modelling Approaches and Uncertainty Management to a Study of Rift Valley Fever in Africa." *International Journal of Health Geographics* 5 (1): 57.

Compagnon, Daniel. 1998. "Somali Armed Movements: The Interplay of Political Entrepreneurship and Clan-Based Factions." In *African Guerillas*, edited by Christopher Clapham, 73–90. Oxford: James Currey and Bloomington, IN: Indiana University Press.

Compagnon, Daniel. 2013. "State-Sponsored Violence and Conflict under Mahamed Siyad Barre: The Emergence of Path Dependent Patterns of Violence." Reinventing Peace, World Peace Foundation blog, October 22.

Cook, C., K. Wellik, and M. Fowke. 2011. "Geoenvironmental Diabetology." *Journal of Diabetes Science and Technology* 5: 834–42.

Coome, A., and M. Hussein. 2020. "Climate Crisis, Gendered Inequalities and Local Response in Somalia/Somaliland." *Forced Migration Review* 64 (1).

Cosselman, K., A. Navas-Acien, and J. Kaufman. 2015. "Environmental Factors in Cardiovascular Disease." *Nature Reviews Cardiology* 12: 627–42.

CUER (Center for Urban Environmental Reform). 2017. "The True Killer: Heat." Blog October 18.

Day R et al. 2017. "Fall Armyworm: Impacts and Implications for Africa." *Outlooks on Pest Management*. Nairobi: CABI.

Dehérez, D. 2009. "The Scarcity of Land in Somalia: Natural Recourses and Their Role in the Somali Conflict." Occasional Paper III. Bonn International Center for Conversion, Bonn.

Dek, A. 2021. "Climate Change and Violent Conflict: A Case Study of Puntland State of Somalia (2008-2020)." Research project. Department of Political Science, Diplomacy and Public Administration, University of Nairobi.

Del Pero, C., O.E. Bellini, M. Martire, and D. di Summa. 2021. "Sustainable Solutions for Mass-Housing Design in Africa: Energy and Cost Assessment for the Somali Context." *Sustainability* 13: 4787.

Devlin, C., S.M. Glaser, C. Villegas, and N. Poinsatte. 2020. *Rough Seas: The Causes and Consequences of Fisheries Conflict in Somali Waters*. Broomfield, CO: One Earth Future.

de Waal, Alex. 2015. *The Real Politics of the Horn of Africa: Money, War and the Business of Power*. Cambridge, UK: Polity.

de Waal, Alex. 2018. "The Prairie Fire that Burned Mogadishu: The Logic of Clan Formation in Somalia." Occasional paper. World Peace Foundation, Somerville, MA.

de Waal, Alex. 2020. "Somalia's Disassembled State: Clan Unit Formation and the Political Marketplace." *Conflict, Security & Development* 20 (5): 561–85.

Dhaysane, Mohamed. 2022. "Drought-Related Malnutrition Kills at Least 500 in Somalia." Voice of America online article, July 5.

Diallo, D., B. Diouf, A. Gaye, E.H. NDiaye, N.M. Sene, I. Dia, and M. Diallo. 2022. "Dengue Vectors in Africa: A Review." *Heliyon* 8 (5): e09459.

Doti, T. 2010. "Climate Variability, Pastoralists' Vulnerability and Options. The Case of the Borana of Northern Kenya." *Climate Change and Natural Resources Conflicts in Africa* 170: 189–204.

Dua, Jatin. 2017. "From Pirate Ports to Special Economic Zones: Violence, Regulation and Port-Making in the Somali Peninsula." DIIS-GovSea Working Paper 2017: 12.

Dwyer, C. 2009. "The Behaviour of Sheep and Goats." In *The Ethology of Domestic Animals: An Introductory T*ext, 2nd ed., edited by P. Jensen. London, UK: CABI.

El-Bushra, Judy, and Judith Gardner. 2016. "The Impact of War on Somali Men: Feminist Analysis of Masculinities and Gender Relations in a Fragile Context." *Gender & Development* 24 (3): 443–58.

The Economist. 2013. "The Centre Holds, But Only Just." May 11.

FAO (Food and Agriculture Organization of the United Nations). 2005. "Fishery Country Profile." FAO, Rome.

FAO (Food and Agriculture Organization of the United Nations). 2015. "Global Forest Resources Assessment 2015—Country Report for Somalia." FAO, Rome.

FAO (Food and Agriculture Organization of the United Nations). 2017. *The Impact of Disasters and Crises on Agriculture and Food Security*. Rome: FAO.

FAO (Food and Agriculture Organization of the United Nations). 2018. "Somalia Water Data at a Glance." Infographics.

FAO (Food and Agriculture Organization of the United Nations). 2020a. "Desert Locust Crisis Somalia Action Plan, January–December 2020, April Update." FAO Somalia, Mogadishu.

FAO (Food and Agriculture Organization of the United Nations). 2020b. "Greater Horn and Yemen Desert Locust Crisis Appeal." FAO, Rome.

FAO (Food and Agriculture Organization of the United Nations). 2021. "National Gender Profile of Agriculture and Rural Livelihoods." FAO, Mogadishu.

FGS (Federal Government of Somalia). 2018. "Somalia Drought Impact and Needs Assessment; Vol. 1, Synthesis Report."

FGS (Federal Government of Somalia) and World Bank. 2020. "Somalia 2019 Floods Impact and Needs Assessment."

FRS (Federal Republic of Somalia). 2013. "Federal Republic of Somalia National Adaptation Programme of Action (NAPA)."

FRS (Federal Republic of Somalia). 2018. "The Initial National Communication for Somalia to the United Nations Framework Convention on Climate Change (UNFCCC)."

Garris, Amanda. 2019. "Heat, Not Drought, Will Drive Lower Crop Yields, Researchers Say." *Cornell Chronicle* May 28.

Ghazani, M., G. FitzGerald, W. Hu, G.S. Toloo, and Z. Xu. 2018. "Temperature Variability and Gastrointestinal Infections: A Review of Impacts and Future Perspectives." *International Journal of Environmental Research and Public Health* 15 (4): 766.

Ginnetti, J., and T. Franck. 2014. "Assessing Drought Displacement Risk for Kenyan, Ethiopian and Somali Pastoralists." Data set. Norwegian Refugee Council Internal Displacement Monitoring Centre.

Godfrey, S., G. Hailemichael, and C. Seerle. 2019. "Deep Groundwater as an Alternative Source of Water in the Ogaden Jesoma Sandstone Aquifers of Somali Region, Ethiopia." *Water* 2019 11 (8): 1735.

Goergen, G., P.L. Kumar, S.B. Sankung, A. Togola, and M. Tamò. 2016. "First Report of Outbreaks of the Fall Armyworm *Spodoptera frugiperda* (J E Smith) (*Lepidoptera: Noctuidae*), a New Alien Invasive Pest in West and Central Africa." *PLoS One* 11 (10).

Gökçekuş, H., Y. Kassem, and A.M. Yusuf. 2022. "Impact of Climate Change on Water Resources in Somalia." *International Research Journal of Engineering and Technology* 09-02.

Government of Canada. 2020. "Reducing Urban Heat Islands to Protect Health in Canada: An Introduction for Public Health Professionals." Government of Canada, Ottawa.

Gronlund, C.J. 2014. "Racial and Socioeconomic Disparities in Heat-Related Health Effects and Their Mechanisms: A Review." *Current Epidemiology Reports* 1 (3): 165–73.

Guha-Sapir, D., and B. Schimmer. 2005. "Dengue Fever: New Paradigms for a Changing Epidemiology." *Emerging Themes in Epidemiology* 2.

Guo, C., Z. Zhou, Z. Wen, Y. Liu, C. Zeng, D. Xiao, M. Ou, Y. Han, S. Huang, D. Liu, X. Ye, X. Zou, J. Wu, H. Wang, E.Y. Zeng, C. Jing, and G. Yang. 2017. "Global Epidemiology of Dengue Outbreaks in 1990–2015: A Systematic Review and Meta-Analysis." *Frontiers in Cellular and Infection Microbiology* 7: 317.

Gure, A. 2021. "The Role of Climate Information and Early Warning Systems in Supporting Disaster Risk Reduction in Somalia." Technical Report No. WC-007. UNICEF WASH Cluster Somalia, Mogadishu.

Habte, Matiwos, Mitiku Eshetu, Melesse Maryo, and Dereje Andualem. 2021. "The Influence of Weather Conditions on Body Temperature, Milk Composition and Yields of the Free-Ranging Dromedary Camels in Southeastern Rangelands of Ethiopia." *Cogent Food & Agriculture.*

Hagmann, Tobias, Aditya Sarkar, Adan Aboker, Jamal Mohamed, Mahad Wasuge, Mohamed H. Ibrahim, Yassmin Mohamed, and Mark Bradbury. 2018. "Drivers, Governance and Political Economy of Urbanization in Somalia: Review and Research Gaps." Rift Valley Institute, Nairobi.

Hagmann, Tobias, and Finn Stepputat. 2016. "Corridors of Trade and Power: Economy and State Formation in Somali East Africa." DIIS Working Paper 8. Danish Institute for International Studies, Copenhagen.

Haile, Gebremedhin Gebremeskel, Qiuhong Tang, Siao Sun, Zhongwei Huang, Xuejun Zhang, and Xingcai Liu. 2019. "Droughts in East Africa: Causes, Impacts and Resilience." *Earth-Science Review* 193.

Hallegatte, S., C. Green, R. Nicholls, et al. 2013. "Future Flood Losses in Major Coastal Cities." *Nature Climate Change* 3: 802–06.

Hanmer, L., and E. Rubiano-Matulevich. 2022. "Want to Keep Internally Displaced People in Somalia Out of Poverty? Increase Women's Economic Opportunities." World Bank blogs, March 15.

Hanmer, Lucia C., Eliana Rubiano-Matulevich, and Julieth Santamaria. 2021. "Differences in Household Composition: The Hidden Dimensions of Poverty and Displacement in Somalia." Policy Research Working Paper 9818. World Bank, Washington, DC.

Harrod, Chris, Alejandro Ramírez, John Valbo-Jørgensen and Simon Funge-Smith. 2019. "Chapter 18: How Climate Change Impacts Inland Fisheries." In Impacts of Climate Change on Fisheries and Aquaculture: Synthesis of Current Knowledge, Adaptation and Mitigation Options, edited by Manuel Barange. Rome: Food and Agriculture Organization of the United Nations.

Heslin, A., and L. Thalheimer. 2020. "The Picture from Above: Using Satellite Imagery to Overcome Methodological Challenges in Studying Environmental Displacement." *Oxford Monitor of Forced Migration* 8 (2).

Hoehne, Markus. 2016. "The Rupture of Territoriality and the Diminishing Relevance of Cross-Cutting Ties in Somalia after 1990." *Development and Change* 47 (6): 1379–411.

Hsiang, Solomon M., Marshall Burke, and Edward Miguel. 2013. "Quantifying the Influence of Climate on Human Conflict." *Science* 341 (6151): 1212.

Hussein, M., C. Law, and I. Fraser. 2021. "An Analysis of Food Demand in a Fragile and Insecure Country: Somalia as a Case Study." *Food Policy* 101: 102092.

Iacono, G., A. Cunningham, B. Bett, and J. Wood. 2018. "Environmental Limits of Rift Valley Fever Revealed Using Ecoepidemiological Mechanistic Models." *PNAS*. Washington, DC: National Academy of Science.

ICRC. 2020. "Somalia: New Swarms of Desert Locusts Pose a Threat to Farmlands." Online article. December 14.

Ide, T., and J. Scheffran. 2014. "On Climate, Conflict and Cumulation: Suggestions for Integrative Cumulation of Knowledge in the Research on Climate Change and Violent Conflict." *Global Change, Peace & Security* 26 (3): 263–79.

IDMC (Internal Displacement Monitoring Centre). 2020. "The Impacts of Internal Displacement on Education in sub-Saharan Africa." IDMC, Geneva.

IDMC (Internal Displacement Monitoring Centre). 2021. "Impacts of Displacement: Displaced by Violence, Jos, Nigeria." IDMC, Geneva.

IDMC (Internal Displacement Monitoring Centre). 2022. "GRID 2022." IDMC, Geneva.

IFAD (International Fund for Agricultural Development). 2021. "Somalia Country Strategy Note (2022–2023)." IFAD, Rome.

International Crisis Group. 2011. "Somalia: The Transitional Government on Life Support." Africa Report No. 170. International Crisis Group, Brussels.

IOM (International Organization for Migration). 2022. "Situation Report: Somalia Drought Response, September 2022."

IPCC (Intergovernmental Panel on Climate Change). 2021. *Climate Change 2021: The Physical Science Basis. Summary for Policymakers*. Cambridge, UK, and New York: Cambridge University Press.

IPCC (Intergovernmental Panel on Climate Change). 2022a. *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Edited by H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, and B. Rama. Cambridge, UK, and New York: Cambridge University Press.

IPCC (Intergovernmental Panel on Climate Change). 2022b. *Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Edited by P.R. Shukla, J. Skea, R. Slade, A. Al Khourdajie, R. van Diemen, D. McCollum, M. Pathak, S. Some, P. Vyas, R. Fradera, M. Belkacemi, A. Hasija, G. Lisboa, S. Luz, and J. Malley. Cambridge, UK, and New York: Cambridge University Press.

IPPC (International Plant Protection Convention) Secretariat. 2021. Scientific review of the impact of climate change on plant pests—A global challenge to prevent and mitigate plant pest risks in agriculture, forestry and ecosystems. Rome. FAO on behalf of the IPPC Secretariat.

Islam, M.M., N. Islam, A. Habib, and M.M.H. Mozumder. 2020. "Climate Change Impacts on a Tropical Fishery Ecosystem: Implications and Societal Responses." *Sustainability* 12.

ISS (Institute for Security Studies). 2021. "Somalia Needs AMISOM, But the Jury Is Still Out." Online article. October 26.

Jalango, D., S. Jaquet, B. Schiek, V. Villa, C. Sarzana, A. Ghosh, K. Hickson, A. Achicanoy, A. Esquivel, C. Saavedra, F. Schapendonk, G. Pacillo, J. Ramirez-Villegas, and G. Grosjean. 2021. "WFP Critical Corporate Initiative: Climate Response Analysis Somalia." Alliance of Bioversity and the International Center for Tropical Agriculture; World Food Programme.

Jaspars, Susanne, Guhad M. Adan, and Nisar Majid. 2019. "Food and Power in Somalia: Business as Usual? A Scoping Study on the Political Economy of Food Following Shifts in Food Assistance and in Governance." Monograph. Conflict Research Programme, London School of Economics and Political Science, London.

Jaspars, Susanne, and Nisar Majid. 2021. "Somalia's Evolving Political Market Place: From Humanitarian Crisis to Permanent Precarity." Unpublished draft prepared for FCDO.

Jyothis, A., and D.J. Sailor. 2022. "Role of Pavement Radiative and Thermal Properties in Reducing Excess Heat in Cities." *Solar Energy* 242: 413–23.

Karamba, Wendy. 2021. "Improving Access to Jobs for the Poor and Vulnerable in Somalia." World Bank, Washington, DC.

Karamba, Wendy, and Isabelle Salcher. 2020. "Socioeconomic Impacts of COVID-19 on Households in Somalia." Report No. 1. World Bank, Washington, DC.

Kelley, C.P., S. Mohtadi, M.A. Cane, R. Seager, and Y. Kushnir. 2015. "Climate Change in the Fertile Crescent and Implications of the Recent Syrian Drought." *Proceedings of the National Academy of Sciences* 112 (11): 3241–46.

Keogh, Bryan. 2021. "Somalia is Facing Another Food Crisis: Here's Why—And What Can Be Done to Stop the Cycle." *The Conversation* April 29.

Khan, O., and S.S. Khan. 2022. "Customs Reforms Help Somalia Increase Tax Revenue Despite COVID-19 and Fragility." World Bank Governance for Development blog, July 28.

Killin, L., J. Starr, I. Shiue, and T. Russ. 2016. "Environmental Risk Factors for Dementia: A Systematic Review." *BMC Geriatrics* 16: 1–28.

Koubi, V. 2019. "Climate Change and Conflict." *Annual Review of Political Science* 22 (1): 343–60.

Kruse, S., O. Ezenwanne, et al. 2021. "Occupational Health Impacts of Climate Change across Different Climate Zones and Elevations in sub-Saharan East Africa." *African Journal of Environmental Science and Technology* 15 (6): 243–51.

Kulp, S.A., and B.H. Strauss. 2019. "New Elevation Data Triple Estimates of Global Vulnerability to Sea-Level Rise and Coastal Flooding." *Nature Communications* 10: 4844.

Kyobe Bosa, H., J.M. Montgomery, I. Kimuli, and J. Lutwama. 2014. "Dengue Fever Outbreak in Mogadishu, Somalia 2011: Co-circulation of Three Dengue Virus Serotypes." *International Journal of Infectious Diseases* 21 (Supp. 1,3).

Lallo, C.H.O., J. Cohen, D. Rankine, M. Taylor, J. Cambell, and T. Stephenson. 2018. "Characterizing Heat Stress on Livestock Using the Temperature Humidity Index (THI)—Prospects for a Warmer Caribbean." *Regional Environmental Change* 18 (12): 1-12.

Lamboll R., T. Stathers, and J. Morton. 2017. "Chapter 13: Climate Change and Agricultural Systems." In *Agricultural Systems*, 2nd ed., edited by S. Snapp and B. Pound, 441–90. Academic Press.

Lenton, T.M., C. Xu, J.F. Abrams, et al. 2023. "Quantifying the Human Cost of Global Warming." *Nature Sustainability* May.

Le Sage, A., and N. Majid. 2002. "The Livelihoods Gap: Responding to the Economic Dynamics of Vulnerability in Somalia." *Disasters* 26 (1): 10–27.

Lewis, Ioan M. 1989. "The Ogaden and the Fragility of Somali Segmentary Bationalism." *African Affairs* 88 (353): 573–79.

Li, X., L.C. Stringer, S. Chapman, and M. Dallimer. 2021. "How Urbanisation Alters the Intensity of the Urban Heat Island in a Tropical African City." *PLoS ONE* 16 (7): e0254371.

Lind, Jeremy, Rachel Sabates-Wheeler, and Sarah Kohnstamm. 2016. "Changes in the Drylands of Eastern Africa: Implications for Resilience-Strengthening Efforts." Institute for Development Studies, Sussex, UK.

Lindley, Anna. 2010. *The Early Morning Phone Call: Somali Refugees' Remittances*. New York: Berghahn Books.

Lwanga-Ntale, C., and B.O. Owino. 2020. "Understanding Vulnerability and Resilience in Somalia." *Jàmbá: Journal of Disaster Risk Studies* 12 (1).

Macusi, Edison D., et al. 2015. "The Potential Impacts of Climate Change on Freshwater Fish, Fish Culture and Fishing Communities." *Journal of Nature Studies* 14 (2).

Majid, Nisar, and Khalif Abdirahman. 2021. "The Jubbaland Project and the Transborder Ogadeen." Conflict Research Programme Research Memo. London School of Economics and Political Science, London.

Majid, Nisar, Khalif Abdirahman, and Shamsa Hassan. 2017. "Remittances and Vulnerability in Somalia: Assessing Sources, Uses and Delivery Mechanisms." Rift Valley Institute and the World Bank, Nairobi and Washington, DC.

Majid, Nisar, Aditya Sarkar, Claire Elder, Khalif Abdirahman, Sarah Detzner, Jared Miller, and Alex de Waal. 2021. "Somalia's Politics: The Usual Business? A Synthesis Paper of the Conflict Research Programme." London School of Economics and Political Science, London.

Majid, Nisar, Marika Theros, and Khalif Abdirahman. 2020. "Finding Peace in Somalia: the Galkaio 'local' Peace Agreement." Conflict Research Program Policy Brief. London School of Economics and Political Science, London.

MAPA. n.d. "Rift Valley Fever: 4. Clinical Signs and Pathology." Online instructional material. Spanish Ministry of Agriculture, Madrid.

Marchal, Roland. 2002. "A Survey of Mogadishu's Economy." European Commission Somalia Unit, Nairobi.

Marchal, Roland. 2011. "The Rise of a Jihadi Movement in a Country at War: Harakat Al-Shabaab Al Mujaheddin." SciencesPo Center for International Studies.

Maxwell, Daniel, and Nisar Majid. 2016. *Famine in Somalia: Competing Imperatives, Collective Failures, 2011–12*. New York: Oxford University Press.

Maystadt, Jean-François, and Olivier Ecker. 2014. "Extreme Weather and Civil War: Does Drought Fuel Conflict in Somalia through Livestock Price Shocks?" *American Journal of Agricultural Economics* 96 (4): 1157–82.

Menkhaus, Ken. 2007. "The Crisis in Somalia: Tragedy in Five Acts." *African Affairs* 106 (424): 357–90.

Menkhaus, K. 2014. "State Failure, State-Building, and Prospects for a 'Functional Failed State' in Somalia." *The Annals of the American Academy of Political and Social Science* 656 (1): 154–72.

Menkhaus, Ken. 2017. "Somalia Conflict and Situation Analysis." UNSOM. Unpublished draft.

MEP (MacAlister Elliott & Partners Ltd). 2021a. "Deliverable 1: Analysis of Remote Sensing and Model-Derived Data to Identify Characteristics of the Somali Current Regime and its Variation Over Time." Report for the World Bank. MEP, Lymington, UK.

MEP. 2021b. "Deliverable 3: Somali Fisheries Adaptations in Context of Potential Climate Change Impacts." Report for the World Bank. MEP, Lymington, UK.

MEWR (Ministry of Energy and Water Resources). 2021. "Shabelle Basin Diagnostic and Strategic Action Plan." MEWR, Mogadishu.

Ministry of Health. 2010. "Somalia National Strategic Plan for Malaria 2011–2015." Ministry of Health, Mogadishu.

Ministry of Health. n.d. "Somalia National Malaria Strategic Plan 2017–2020." Ministry of Health, Mogadishu.

MPWR&H (Ministry of Public Works, Reconstruction and Housing). 2019. "Road Infrastructure Program Somalia (RIP-Somalia): ToR for Design of Beledweyne-Galkayo Road." MPWR&H, Mogadishu.

Missirian, A., and W. Schlenker. 2017. "Asylum Applications Respond to Temperature Fluctuations." *Science* 358 (6370): 1610–14.

Mohamed, A.A., and A.I. Nageye. 2020. "Measuring the Effect of Land Degradation and Environmental Changes on Agricultural Production in Somalia with Two Structural Breaks." *Management of Environmental Quality* 32 (2): 160–74.

Mosley, Jason. 2015. "Somalia's Federal Future: Layered Agendas, Risks and Opportunities." Research paper. Chatham House, London.

Müller, A., S. Nilsson, A. Prakash, and E. Lazutkaite. 2021. "A Scoping Paper on the Ongoing Desert Locust Crisis 2019–2021+." TMG Working Paper.

Mumuli, S.O., and A.M. Oduori. 2010. "Monitoring of Mangroves in Somalia." FAO/SWALIM.

Muringai, R.T., P. Mafongoya, and R.T. Lottering. 2022. "Sub-Saharan Africa Freshwater Fisheries under Climate Change: A Review of Impacts, Adaptation, and Mitigation Measures." *Fishes* 7: 131.

Musse, Fouzia, and Judith Gardner. 2013. "A Gender Profile of Somalia." Updated draft prepared for the EU Somalia Mission.

Myers S.S., M. Smith, S. Guth, C. Golden, B. Vaitla, N. Mueller, A. Dangour, and P. Huybers. 2017. "Climate Change and Global Food Systems: Potential Impacts on Food Security and Undernutrition." *Annual Review of Public Health* 38 (1): 259–77.

Nardone, A., B. Ronchi, N. Lacetera, M.S. Ranieri, and U. Bernabucci. 2010. "Effects of Climate Changes on Animal Production and Sustainability of Livestock Systems." *Livestock Science* 130: 57–69.

NJDA (New Jersey Department of Agriculture). 2003. "Rift Valley Fever."

North, Douglass C. 1990. *Institutions, Institutional Change and Economic Performance*. Cambridge, UK: Cambridge University Press.

Nnko, H.J., P.S. Gwakisa, A. Ngonyoka, C. Sindato, and A.B. Estes. 2021. "Potential Impacts of Climate Change on Geographical Distribution of Three Primary Vectors of African Trypanosomiasis in Tanzania's Maasai Steppe: *G. m morsitans, G.pallidipes* and *G. swynnertoni*." *PLoS Negl Trop Dis* 15 (2).

Nunez, G.I., and U.J. Pape. 2022. "Poverty and Violence: The Immediate Impact of Terrorist Attacks against Civilians in Somalia." *Policy Research Working Paper Series* No. 10169. World Bank, Washington, DC.

NUPI and SIPRI (Norwegian Institute of International Affairs and Stockholm International Peace Research Institute). 2022. "Somalia: Climate, Peace and Security Fact Sheet."

Nuwer, Rachel. 2021. "As Locusts Swarmed East Africa, This Tech Helped Squash Them." *New York Times* April 8.

Oberg, C. et al. 2021. "Risk and Resilience of Somali Children in the Context of Climate Change, Famine and Conflict." *Journal of Applied Research on Children* 12 (1).

OCHA (United Nations Office for the Coordination of Humanitarian Affairs). 2020. *Humanitarian Response Plan: Somalia*. Mogadishu: OCHA Somalia.

OCHA. 2021. Humanitarian Response Plan, Somalia. Humanitarian Program Cycle 2022. Mogadishu: OCHA Somalia.

OCHA (United Nations Office for the Coordination of Humanitarian Affairs). 2022a. "August 2002 Drought Snapshot."

OCHA (United Nations Office for the Coordination of Humanitarian Affairs). 2022b. "Humanitarian Needs Overview Somalia."

Ogallo, L., P.O. Omondi, G. Ouma, and G. Wayumba. 2018. "Climate Change Projections and the Associated Potential Impacts for Somalia." *American Journal of Climate Change* 07 (02): 153–70.

Ogallo, L., G. Ouma, and P.O. Omondi. 2017. "Changes in Rainfall and Surface Temperature Over Lower Jubba, Somalia."

Omuto, C., Z. Balint, and M. Alim. 2014. "A Framework for National Assessment of Land Degradation in the Drylands: A Case Study of Somalia." *Land Degradation & Development* 25 (2): 105–19.

Orinde, A.B., T. Kimani, E. Schelling, J. Omolo, G.M. Kikuvi, and K.M. Njenga. 2012. "Estimation of the Rift Valley Fever Burden of Disease in the 2006/2007 Outbreak in Kenya." Paper presented at the 61st Conference of the American Society of Tropical Medicine and Hygiene, Atlanta, November 11–15, 2012. International Livestock Research Institute, Nairobi.

Otto, F.E.L., S. Philip, S. Kew, S. Li, A. King, and H. Cullen. 2018. "Attributing High-Impact Extreme Events across Timescales—A Case Study of Four Different Types of Events." *Climatic Change*, 149 (3): 399–412.

Owain, E.L., and M.A. Maslin. 2018. "Assessing the Relative Contribution of Economic, Political and Environmental Factors on Past Conflict and the Displacement of People in East Africa." *Palgrave Communications* 4 (1).

Oxfam. 2018. "Drought, Displacement and Livelihoods in Somalia/Somaliland." Oxfam GB, Cowley, Oxford.

Oxfam. n.d. "Disaster Risk Reduction in Drought Cycle Management: A Learning Companion." Disaster Risk Reduction & Climate Change Adaptation Resources. Oxfam, Oxford.

Pape, U., and P. Wollburg. 2019. "Impact of Drought on Poverty in Somalia." Policy Research Working Paper No. 8698. World Bank, Washington, DC.

Parkpoon, S., and G. Harrison. 2008. "Analyzing the Impact of Climate Change on Future Electricity Demand in Thailand." *IEEE Transactions on Power Systems* 23 (3): 1441–48.

Petrova, K. 2021. "Natural Hazards, Internal Migration and Protests in Bangladesh." *Journal of Peace Research* 58 (1): 33–49.

Peyre, M., V. Chevalier, S. Abdo-Salem, A. Velthuis, N. Antoine-Moussiaux, E. Thiry, and F. Roger. 2015. "A Systematic Scoping Study of the Socio-Economic Impact of Rift Valley Fever: Research Gaps and Needs." *Zoonoses and Public Health* 62 (5): 309–25.

PIK/Adelphi. 2022. "Climate Risk Profile Somalia." Potsdam: Potsdam Institute for Climate Impact Research and Berlin: Adelphi Research.

Plaza, S., and C. Cerruti. 2022. "How Drought Insurance and Value Chains Can Support Somalia's Livestock Economy." World Bank Africa Can End Poverty blog, October 3.

Porter, J.R., L. Xie, A.J. Challinor, K. Cochrane, S.M. Howden, M.M. Iqbal, D.B. Lobell, and M.I. Travasso. 2014. "Food Security and Food Production Systems." In: *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, edited by C.B. Field, V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White, 485–533. Cambridge and New York: Cambridge University Press.

Powell, D.P., B. Booth, S. Nicholson, and P. Good. 2015. "Reconciling Past and Future Rainfall Trends over East Africa." *Journal of Climate* 28: 24.

Pragna, P., P. Archana, J. Aleena, V. Sejian, G. Krishnan, M. Bagath, A. Manimaran, V. Beena, E. Kurien, and G. Varma. 2017. "Heat Stress and Dairy Cow: Impact on Both Milk Yield and Composition." *International Journal of Dairy Science* 12 (1): 1–11.

Qasim, Arsheen. 2020. "Six Things You Didn't Know About Desert Locusts." ReliefWeb press release February 14.

Rahimi, Jaber, Erwann Fillol, John Y. Mutua, Giuseppina Cinardi, Timothy P. Robinson, An M.O. Notenbaert, Polly J. Ericksen, Michael W. Graham, and Klaus Butterbach-Bahl. 2022. "A Shift from Cattle to Camel and Goat Farming Can Sustain Milk Production with Lower Inputs and Emissions in North sub-Saharan Africa's Drylands." *Nature Food* 3: 523–31.

Rahimi, Jaber, John Yumbya Mutua, An M.O. Notenbaert, Karen Marshall, and Klaus Butterbach-Bahl. 2021. "Heat Stress Will Detrimentally Impact Future Livestock Production in East Africa." *Nature Food* 2: 88–96.

RCREEE (Regional Center for Renewable Energy and Energy Efficiency). 2022. "Somalia." RCREEE, Cairo.

Rees, D.J., A.M. Omar, and O. Rodol. 1991. "Implications of the Rainfall Climate of Southern Somalia for Semi-Mechanized Rain-Fed Crop Production." *Agricultural and Forest Meteorology* 56 (1–2): 21–33.

Rembold, F., S.M. Oduori, H. Gadain, and P. Toselli. 2013. "Mapping Charcoal Driven Forest Degradation During the Main Period of Al Shabaab Control in Southern Somalia." *Energy for Sustainable Development* 17 (5): 510–14.

Reno, William. 2018. "The Politics of Security Assistance in the Horn of Africa." *Defence Studies* 18 (4): 499.

Rentschler, J., and M. Salhab. 2020. "People in Harm's Way: Flood Exposure and Poverty in 189 Countries." Policy Research Working Paper No. 9447. World Bank, Washington, DC.

Republic of Yemen. 2021. "Yemen Desert Locust Response Locust Project, Pest and Pesticides Management Plan (PPMP)." World Bank, Washington, DC.

Rhoads, M., R. Rhoads, M. Vanbaale, R.J. Collier, S. Sanders, W. Weber, B. Crooker, and L. Baumgard. 2009. "Effects of Heat Stress and Plane of Nutrition on Lactating Holstein Cows: Production, Metabolism, and Aspects of Circulating Somatotropin." *Journal of Dairy Science* 92 (5).

Richards, D.R., and P.J. Edwards. 2018. "Using Water Management Infrastructure to Address Both Flood Risk and the Urban Heat Island." *International Journal of Water Resources Development* 34 (4): 490–98.

Richardson, K., R. Calow, F. Pichon, S. New, and R. Osborne. 2022. "Climate Risk Report for the East Africa Region." Met Office, ODI, FCDO, Exeter.

Robine, Jean-Marie, Siu Lan K. Cheung, Sophie Le Roy, Herman Van Oyen, Clare Griffiths, Jean-Pierre Michel, and François Richard Herrmann. 2008. "Death Toll Exceeded 70,000 in Europe during the Summer of 2003." *Comptes Rendus Biologies* 331.

Robinson, Courtland, Linnea Zimmerman, and Francesco Checchi. 2014. "Internal and External Displacement among Populations of Southern and Central Somalia Affected by Severe Food Insecurity and Famine during 2010–2012." FEWS NET, Washington, DC.

Rojas-Downing, M.M., A. Pouyan Nejadhashemi, T. Harrigan, and S.A. Woznicki. 2017. "Climate Change and Livestock: Impacts, Adaptation, and Mitigation." *Climate Risk Management* 16: 145–63.

Romo-Barron, C.B., D. Diaz, J.J. Portillo-Loera, J.A. Romo-Rubio, F. Jimenez-Trejo, and A. Montero-Pardo. 2019. "Impact of Heat Stress on the Reproductive Performance and Physiology of Ewes: A Systematic Review and Meta-Analyses." *International Journal of Biometeorology* 63 (7): 949e62.

Roson, R., and M. Sartori. 2016. "Estimation of Climate Change Damage Functions for 140 Regions in the GTAP9 Database." Policy Research Working Paper No. 7728. World Bank, Washington, DC.

Rosenzweig, C., A. Iglesias, X.B. Yang, P.R. Epstein, and E. Chivian. 2001. "Climate Change and Extreme Weather Events: Implications for Food Production, Plant Diseases, and Pests." *Glob. Change Human Health* 2: 90–104.

RVI and HIPS (Rift Valley Institute and Heritage Institute for Policy Studies). 2017. "Land Matters in Mogadishu: Settlement, Ownership and Displacement in a Contested City." RVI, Nairobi.

Ryan, S.J., C.A. Lippi, and F. Zermoglio. 2020. "Shifting Transmission Risk for Malaria in Africa with Climate Change: A Framework for Planning and Intervention." *Malaria Journal* 19: 170.

Salah, A.A., I. Robertson, and A. Mohamed. 2015. "Estimating the Economic Impact of *Trypanosoma evansi* Infection on Production of Camel Herds in Somaliland." *Tropical Animal Health Production* 47: 707–14.

Salama, A.A.K., G. Caja, S. Hamzaoui, B. Badaoui, A. Castro-Costa, D.A.E. Facanha, M.M. Guilhermino, and R. Bozzi. 2014. "Different Levels of Response to Heat Stress in Dairy Goats." *Small Ruminant Research* 121: 73–79.

Samatar, Abdi. 1987. "Merchant Capital, International Livestock Trade and Pastoral Development in Somalia." *Canadian Journal of African Studies* 21 (3): 355–74.

Samatar, Abdi, Lance Salisbury, and Jonathan Bascom. 1988. "The Political Economy of Livestock Marketing in Northern Somalia." *African Economic History* 17: 81–97.

Samuel Hall. 2021. "Identifying Climate Adaptive Solutions to Displacement in Somalia: Assessment Report." IOM/UNEP.

SATG (Somalia Agriculture Technical Group). 2018. "Fisheries in Somalia." SATG, Mogadishu.

Scheelbeek, P., A. Khan, S. Mojumder, P. Elliott, and B.P. Vineis. 2016. "Drinking Water Sodium and Elevated Blood Pressure of Healthy Pregnant Women in Salinity-Affected Coastal Areas." *Hypertension* 68: 464–70.

Schewe, J., C. Otto, and K. Frieler. 2017. "The Role of Storage Dynamics in Annual Wheat Prices." *Environmental Research Letters* 12 (5): 054005.

SCS (Save the Children Somalia). 2022. "Drought Rapid Needs Assessment—Preliminary Findings." SCS, Mogadishu.

Sejian, V., R. Bhatta, J.B. Gaughan, F.R. Dunshea, and N. Lacetera. 2018. "Adaptation of Animals to Heat Stress." *Animal* 12: s431–s44.

Sieber, J. 2013. "Impacts of, and Adaptation Options to, Extreme Weather Events and Climate Change Concerning Thermal Power Plants." *Climatic Change* 121 (1).

Selby, J., O.S. Dahi, C. Fröhlich, and M. Hulme. 2017. "Climate Change and the Syrian Civil War Revisited." *Political Geography* 60: 232–44.

Shiferaw, B., K. Tesfaye, M.K. Berresaw, and T. Abate. 2014. "Managing Vulnerability to Drought and Enhancing Livelihood Resilience in Sub-Saharan Africa: Technological, Institutional and Policy Options." *Weather and Climate Extremes* 3 (C).

Simons, Anna, 1995. *Networks of Dissolution: Somalia Undone*. Boulder: Westview.

Sintayehu D.W., N. Tassie, and W.F. De Boer. 2020. "Present and Future Climatic Suitability for Dengue Fever in Africa." *Infection Ecology & Epidemiology* 10: 1782042.

SIPRI (Stockholm International Peace Research Institute). 2019. "Climate-related Security Risks and Peacebuilding in Somalia." SIPRI, Solna, Sweden.

SIPRI (Stockholm International Peace Research Institute). 2022. "Towards an Integrated Approach to Climate Security and Peacebuilding in Somalia." SIPRI, Solna, Sweden.

SIWI (Stockholm International Water Institute). 2019. "Somalia WASH Stakeholders Analyzed Some Climate Change and Emergency Criteria When Implementing WASH BAT." Blog, October 29.

SLU (Sveriges lantbruksuniversitet [Swedish University of Agricultural Sciences]). 2019. "Somaliland Gold under Threat of Extinction." Policy brief.

Somalia Institute for Development Research and Analysis. 2019. "Gender Dimensions of Climate Change Related Projects in Somalia." Somalia Institute for Development Research and Analysis, Garowe, Puntland.

SomInvest. 2022. "Somalia's Fisheries Sector." Somalia Investment Promotion Office, Mogadishu.

SSF (Somalia Stability Fund). 2017. "A Macro-Level Analysis of Conflict Drivers and Dynamics in Somalia." Unpublished.

SWALIM (Somalia Water and Land Information Management). 2012. "Hydrogeological Survey and Assessment of Selected Areas in Somaliland and Puntland." Nairobi.

Thalheimer, L., M.P. Schwarz, and F. Pretis. 2023. "Large Weather and Conflict Effects on Internal Displacement in Somalia with Little Evidence of Feedback onto Conflict." *Global Environmental Change* 79: 102641.

Thalheimer, L., Simperingham, E., and Jjemba, E. W. 2022. "The Role of Anticipatory Humanitarian Action to Reduce Disaster Displacement." *Environmental Research Letters* 17 (1): 014043.

Thalheimer, L., and C. Webersik. 2020. "Climate Change, Conflicts and Migration." In *Environmental Conflicts, Migration and Governance*, 59–82. Bristol University Press.

Thulstrup, A.W., D. Habimana, I. Joshi, and S. Mumuli Oduori. 2020. "Uncovering the Challenges of Domestic Energy Access in the Context of Weather and Climate Extremes in Somalia." *Weather and Climate Extremes* 27: 100185.

Ujunwa, A., C. Okoyeuzu, N. Nkwor, and A. Ujunwa. 2021. "Potential Impact of Climate Change and Armed Conflict on Inequality in Sub-Saharan Africa." *South African Journal of Economics* 89 (4): 480–98.

UNDP (United Nations Development Programme). 2019. "Promoting Resilience Through Integrated Approach to Water, Environment & Disaster Risk Management in Somalia." UNDP proposal.

UNDRR (United Nations Office for Disaster Risk Reduction). 2022. *Global Assessment Report on Disaster Risk Reduction 2022: Our World at Risk: Transforming Governance for a Resilient Future*. Geneva: UNDRR.

UNEP (United Nations Environment Programme). 2010. "Africa Water Atlas." UNEP, Nairobi.

UNEP (United Nations Environment Programme). 2019. "Regional Partnership Underway to Help Somalia Enforce the Ban on Illegal Charcoal Trade." Online article, May 30.

UNEP (United Nations Environment Programme). 2021. *Making Peace with Nature: A Scientific Blueprint to Tackle the Climate, Biodiversity and Pollution Emergencies*. Nairobi: UNEP.

UNFPA (United Nations Population Fund). 2014. "Population Estimate Survey 2014 for the 18 Pre-War Regions of Somalia." UNFPA, Somalia Country Office.

UNICEF (United Nations Children's Fund). 2022a. "Somalia Humanitarian Situation Report No. 4." UNICEF, Mogadishu.

UNICEF (United Nations Children's Fund). 2022b. "Somalia Humanitarian Situation Report No. 9." UNICEF, Mogadishu.

UNICEF (United Nations Children's Fund) and WASH Cluster. 2022. "Somalia Water Shortage Update, 23 April 2022." UNICEF and WASH Cluster Somalia, Mogadishu.

UNICEF and WHO UNICEF (United Nations Children's Fund and World Health Organization). 2021. *Progress on Household Drinking Water, Sanitation and Hygiene 2000–2020: Five Years into the SDGs*. Geneva: WHO and UNICEF.

UNIDO (United Nations Industrial Development Organization). 2021. "Sub-sector Mapping and Value Chain Analysis of the Fishery Sub-sector in Somalia." UNIDO, Vienna.

UN Monitoring Group for Somalia and Eritrea. 2012. "Report of the Monitoring Group on Somalia and Eritrea pursuant to Security Council resolution 2002 (2011)." S/2012/544.

UN Monitoring Group for Somalia and Eritrea. 2013. "Report of the Monitoring Group on Somalia and Eritrea pursuant to Security Council resolution 2060 (2012): Somalia." S/2013/413.

UN Women. 2022. "Gender, Climate and Conflict Analysis in Somalia and Assessment of Opportunities for Climate Agriculture and Livelihood Opportunities for Crisis-Affected and At-Risk Women in Somalia." UN Women, Mogadishu.

U.S. EPA (U.S. Environmental Protection Agency). 2008. "Reducing Urban Heat Islands: Compendium of Strategies." Draft. U.S. EPA, Washington, DC.

van Oldenborgh, G.J., S. Philip, H. Cullen, R. Singh, M. van Aalst, F.E.L. Otto, and J. Kimutai. 2017. "Rapid Analysis of Drought in Somalia, 2016." World Weather Attribution online article, March 30.

Vivekananda, J., M. Wall, F. Sylvestre, C. Nagarajan, and O. Brown. 2019. "Shoring up Stability: Addressing Climate and Fragility Risks in the Lake Chad Region." Adelphi Research, Berlin.

von Uexkull, Nina, and Halvard Buhaug. 2021. "Security Implications of Climate Change: A Decade of Scientific Progress." *Journal of Peace Research* 58 (1): 3–17.

Walker, D.P., J.H. Marsham, C.E. Birch, A.A. Scaife, and D.L. Finney. 2020. "Common Mechanism for Interannual and Decadal Variability in the East African Long Rains." *Geophysical Research Letters* 47.

Ward, P.J., H.C. Winsemius, S. Kuzma, M.F.P. Bierkens, A. Bouwman, H. de Moel, A. Díaz Loaiza, et al. 2020. "Aqueduct Floods Methodology." Technical Note. World Resources Institute, Washington, DC.

Ward, R.D., D.A. Freiss, R.H. Day, and R.A. MacKenzie. 2016. "Impacts of Climate Change on Mangrove Ecosystems: A Region-by-Region Overview." *Ecosystem Health and Sustainability* 2 (4).

Warsame, A.A., I.A. Sheik-Ali, O.M. Jama, A.A. Hassan, and M.B. Galad. 2022. "Assessing the Effects of Climate Change and Political Instability on Sorghum Production: Empirical Evidence from Somalia." *Journal of Cleaner Production* 360 (1): 131893.

WASH Cluster Somalia. 2022. "Somalia WASH Cluster Humanitarian Dashboard." Fact sheet.

Webersik, C., S.J. Hansen, and A. Egal. 2018. "Somalia: A Political Economy Analysis." Norwegian Institute of International Affairs, Oslo.

WHO (World Health Organization). 2003. *Climate Change and Human Health—Risks and Responses: Summary*. Geneva: WHO.

WHO (World Health Organization). 2018. "Rift Valley Fever." Online fact sheet. October 19.

WHO (World Health Organization). 2022. *World Malaria Report, 2021*. Geneva: WHO.

Wielogorska, E., M. Mooney, M. Eskola, N.E. Ezekiel, M. Stranska, R. Krska, and C. Elliott. 2019. "Occurrence and Human-Health Impacts of Mycotoxins in Somalia." *Journal of Agricultural and Food Chemistry* 67 (7): 2052–60.

World Bank. 2011. *Guide to Climate Change Adaptation in Cities*. Washington, DC: World Bank.

World Bank. 2017. "Measuring Rural Access, Update 2017/18." World Bank, Washington, DC.

World Bank. 2018. "Federal Republic of Somalia Systematic Country Diagnostic." World Bank, Washington, DC.

World Bank. 2019a. "Climate Change and Marine Fisheries in Africa: Assessing Vulnerability and Strengthening Adaptation Capacity." World Bank, Washington, DC.

World Bank. 2019b. "Somali Poverty and Vulnerability Assessment: Findings from Wave 2 of the Somali High Frequency Survey." Report No. AUS0000407. World Bank, Washington, DC.

World Bank. 2020a. "Impact of COVID-19: Policies to Manage the Crisis and Strengthen Economic Recovery." Somalia Economic Update Edition 5. World Bank, Washington, DC.

World Bank. 2020b. "Somalia Country Environmental Analysis: Diagnostic Study on Trends and Threats for Environmental and Natural Resources Challenges." World Bank, Washington, DC.

World Bank. 2020c. "Somalia Urbanization Review: Fostering Cities as Anchors of Development." World Bank, Washington, DC.

World Bank. 2021a. "Concept Note for Somali Sustainable Fisheries and Blue Economy Development Project (P178032)." World Bank, Washington, DC.

World Bank. 2021b. "Social Risks in Somalia: A Country Level Assessment and Proposed Management Approach." Unpublished. World Bank, Washington DC.

World Bank. 2021c. "Somalia Electricity Sector Recovery Project." World Bank, Washington, DC.

World Bank. 2022a. "National and Regional Roads Connectivity Policy Note." In *Policy Notes for the New Somali Government: Unlocking Somalia's Potential to Stabilize, Grow and Prosper*, 44–47. Washington, DC: World Bank.

World Bank. 2022b. "The Role of Institutions in Strengthening Resilience Outcomes in the Horn of Africa." Synthesis paper prepared for the Programmatic ASA on Strengthening Resilience in the Horn of Africa (P172358). Unpublished. World Bank, Washington, DC.

World Bank. 2022c. "Urbanization Policy Note." In *Policy Notes for the New Somali Government: Unlocking Somalia's Potential to Stabilize, Grow and Prosper*, 112–17. Washington, DC: World Bank.

World Bank. 2023. "Tanzania Economic Update—Clean Water, Bright Future: The Transformative Impact of Investing in WASH." *Tanzania Economic Update* Issue No. 18. Washington, DC: World Bank.

World Bank and FAO (Food and Agriculture Organization of the United Nations). 2018. "Overview: Rebuilding Resilient and Sustainable Agriculture in Somalia." Country Economic Memorandum.

Ying, J., M. Collins, W. Cai, et al. 2022. "Emergence of Climate Change in the Tropical Pacific." *Nature Climate Change* 12: 356–64.

Zanini, Gianni, Stephen Paul D'Alessandro, Verena Phipps-Ebeler, Catherine Mwende Ngumbau, Pascal Sanginga, Julia Seevinck, Yamina Cherrou, Andrew Read, and Stephen Akester. 2018. *Rebuilding Resilient and Sustainable Agriculture in Somalia: Volume 1 - Main Report*. Washington, DC: World Bank.

Zhang, D.D., Q. Pei, C. Fröhlich, and T. Ide. 2019. "Does Climate Change Drive Violence, Conflict and Human Migration?" In *Contemporary Climate Change Debates*, 51–64. Routledge.

WORLD BANK GROUP

1818 H Street NW
Washington, DC 20433
Telephone: 202-473-1000
Internet: www.worldbank.org