1. THE RESILIENCE LANDSCAPE

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THIS STUDY, WHILE FOCUSING ON CLIMATE RESILIENCE, ADOPTS THE broader definition of resilience from the United Nations International Strategy for Disaster Reduction which defines resilience as: "the ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions through risk management" (UNISDR 2017). Resilience thinking helps link and integrate sectors such as infrastructure, social protection, health and reproductive health, and nutrition that have traditionally been somewhat disconnected. To ensure that appropriate connections are made, this report proposes that the government of Ethiopia and partners develop or use a resilience framework, according to which its many development programs can be structured and monitored for progress and outcomes.

A resilience framework considers a broad set of factors that influence resilience in a given context, including environmental conditions, the institutional environment, and the policy context. In the proposed resilience framework, also known as the Gender, Climate Change, and Nutrition Integration Initiative (GCAN) framework, resilience depends on several key elements, including the initial state of absorptive and adaptive capacity when a given climate shock or stress is experienced; the portfolio of available options; the actions taken in response to the climate signal; and the outcomes of those responses, which influence the context in which future climate shocks and stressors are experienced. Box 1 presents the elements of the climate resilience framework.

CLIMATE, RAINFALL SEASONALITY, AND AGRICULTURE IN ETHIOPIA

The GCAN framework emphasizes local climate conditions (signals) and the enabling environment, which includes national and local farming and food systems. Ethiopia has a complex topography and climate, with diverse rainfall patterns across the country. The availability or lack of water supplies influences agricultural production in both the crop-production zones in the highlands and the largely pastoralist areas in the lowlands (Singh et al. 2016).

The country has three distinct seasons in relation to rainfall. *Belg,* from February to May, is a short rainy season that supplies rainwater for crops and livestock in central Ethiopia (Degefu 1987; Gissila et al. 2004). The *kiremt* season, from June to mid-September, delivers water for agriculture in the western part of the country (Walker 2016) and is more reliable (Singh et al. 2016) (Figure 1). The *bega* season, from October to January, is typically dry. These regional differences result in different growing and harvesting cycles in the country.

Rainfall

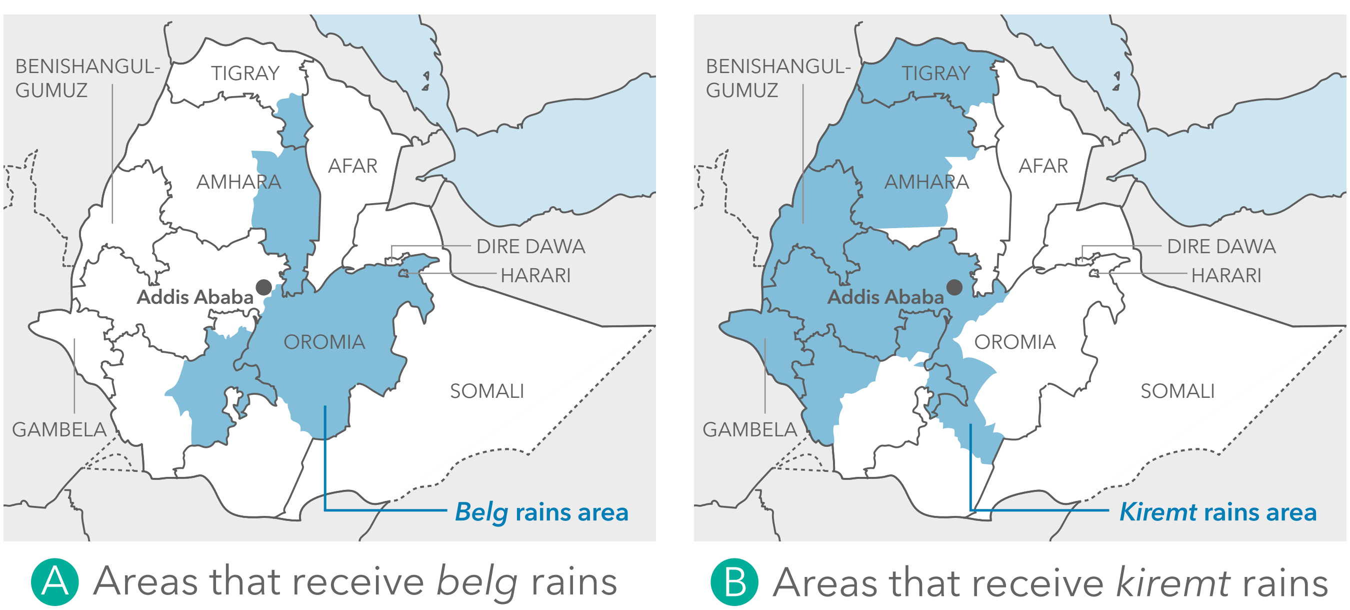
Ethiopia has experienced a large number of droughts over the last several decades, with five major droughts since 1980 (Araya 2011; Bachewe et al. 2015). Although Conway and Schipper (2011), who studied historical rainfall patterns in Ethiopia from 1982 to 2007, recorded no marked emergent changes in rainfall over time, Funk and colleagues (2012) showed that over the previous two decades the land area receiving a level of rainfall sufficient to support crop and livestock production had decreased by 16 percent. The regions particularly affected were Oromia and the Southern Nations, Nationalities, and Peoples' Region (SNNPR). Precipitation declines of 50–150 mm during the *belg* season occurred in the south-central and eastern parts of the country, while rainfall levels in the western and southern parts of Ethiopia declined during the *kiremt* season. Similarly, Ethiopia's National Meteorology Agency (NMA) found that while rainfall remained constant when averaged across the country, declines in some areas of the country have occurred since the 1990s (Ethiopia, NMA 2007).

Both seasonal and annual rainfall have exhibited high variability in many parts of the country. In addition, the frequency, magnitude, and intensity of droughts in Ethiopia have increased (Ethiopia, NMA 2007). For example, during the past 10 to 15 years, the frequency of spring droughts has increased throughout Ethiopia (Viste, Korecha, and Sorteberg 2013).

Temperature

Feyssa and Gemeda (2015) found that recent changes in temperatures are consistent with climate change projections, suggesting that the effects of climate change are already being felt in Ethiopia. The mean annual temperature in the country rose by

FIGURE 1 BELG- AND KIREMT-DEPENDENT AGRICULTURAL AREAS IN ETHIOPIA



Source: Adapted from Ethiopia Humanitarian Country Team (2015), cited in Singh et al. (2016).

BOX 1 ELEMENTS OF THE GENDER, CLIMATE CHANGE, AND NUTRITION INTEGRATION INITIATIVE CLIMATE RESILIENCE FRAMEWORK*

The Climate Signal

The climate signal represents the source of uncertainty, volatility, shocks, and longer-term changes. Long-term climate changes involve shifts in average temperature and rainfall conditions, as well as in the frequency of extreme weather events, such as droughts, floods, and storms. Shorter-term climatic changes and adverse weather events also influence resilience.

The Enabling Environment

The effects of climate change occur within a particular context or enabling environment, which influences the ability of individuals and groups—across a broad scale—to absorb and respond to the impact of the changes they experience. Policies, laws, and other institutions all influence individual, household, and group responses to climate shocks and stressors. At higher levels, such factors as international commitments, international aid flows, and the degree of political stability influence the resilience of nations and regions to climate shocks and stresses.

Absorptive Capacity

Absorptive capacity is defined as the sensitivity of individuals, groups, communities, countries, or regions to shocks and stressors—that is, factors that determine the extent to which different actors are directly affected by climate shocks and stressors, and the extent of the changes they need to make to preserve or improve their well-being. For example, a smallholder farmer with a diversified livelihood that includes farm and nonfarm income sources may not experience as great a loss of income upon delayed-onset rains as a neighboring farmer whose livelihood is dependent on a single rain-fed crop. The health and nutritional status of individuals at the time of a climatic shock also affect their absorptive capacity—for example, whether or not they can withstand an increased risk of infectious disease. Other factors, such as infrastructure and the strength of the social safety net, also influence absorptive capacity at the household level. Absorptive capacity at the country level would be influenced by such factors as the structure of the economy, the natural resource base, the level of poverty or inequality, and relations with other countries in the region.

Adaptive Capacity

Adaptive capacity is defined as the ability of different actors or groups of actors to respond to climate shocks, stressors, risks, or new opportunities. This ability depends on a variety of factors that interact in different ways based on social demographics, such as gender and age. At the individual or household level, these factors include the capacity of individuals to perceive and understand climate risks, access to financial capital and assets, human and social capital, access to information and technology, and time constraints. At the state or policy level, factors influencing adaptive capacity include policy makers' perceptions and risk preferences; levels of GDP; information systems; and the availability of technology, health systems, and access to markets.

Absorptive and adaptive capacity interact with the enabling environment to determine the range of response options available to decision makers from the individual to the state level. Important gender differences often limit the range of response options available to women. For example, women tend to have less access to information about climate, less knowledge about appropriate responses to climate challenges, and less access to agricultural technologies and resources. They are also less likely to be in positions of decision-making authority in community groups, institutions, and policy-making bodies. These and other difficulties limit the potential contribution of women to increasing resilience at the household, community, and national scales, and pose the risk that adaptation will occur in ways that do not reflect women's needs and priorities.

Response Options and the Decision-Making Context

Different actors—including individuals, households, groups, communities, and policy makers—respond differently to the climatic challenges they have experienced or anticipate. Responses can take several forms, from actions directed toward coping with the immediate impacts of a climate shock or stress, to adaptive or transformative approaches that protect or improve livelihoods and well-being outcomes over the longer run.

- Coping responses generally are strategies that utilize available resources, skills, and opportunities to address, manage, and overcome adverse climate stresses and shocks in the short to medium term.
- Risk management strategies involve plans, actions, or policies that aim to reduce the likelihood or impact (or both) of future negative events.
- Adaptation involves adjustments to actual or expected climate stimuli to avoid harm or exploit potential benefits to return to, maintain, or achieve a desired state.
- Transformative responses aim to change the fundamental attributes of a system or context to improve well-being outcomes, such as actions that address underlying social vulnerabilities.

The actions decision makers take in response to climate challenges often depend on complex negotiating processes in which different actors advocate for actions that meet their own needs, preferences, and priorities. Sometimes the interests of different actors overlap, but often they diverge.

Pathways from Climate Change Responses to Well-Being Outcomes

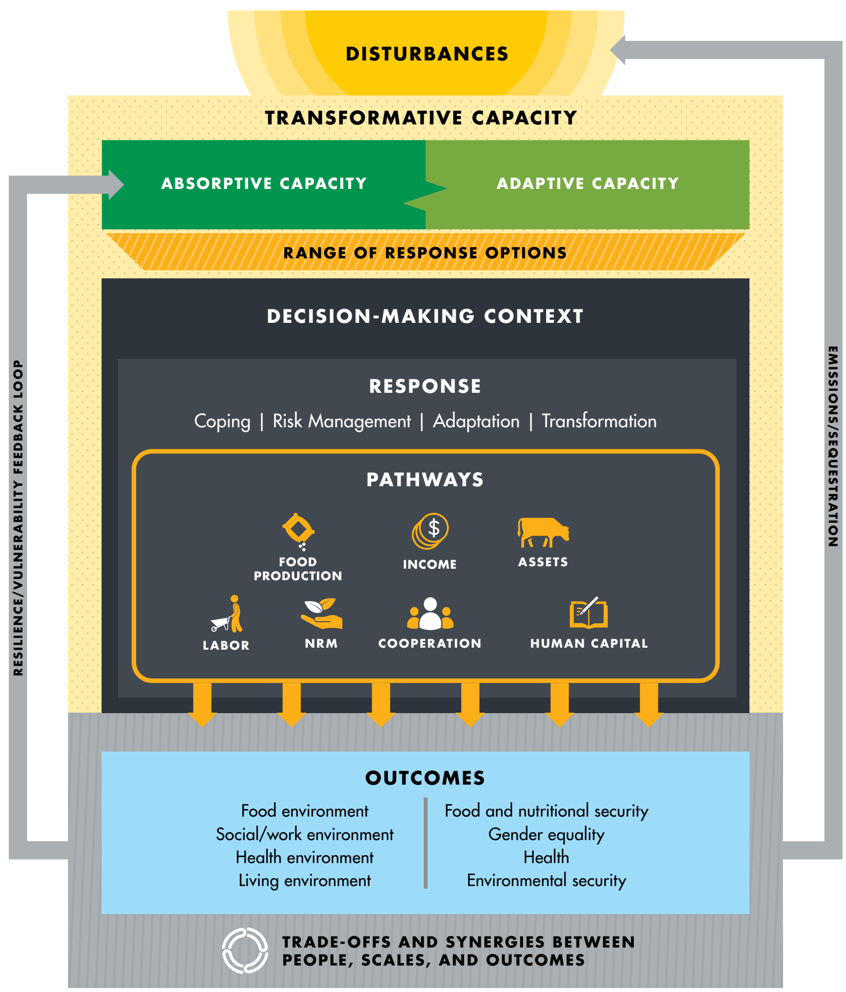
In addition to changes in the enabling environment and in adaptive and absorptive capacity, at least six possible pathways can be taken in response to climate shocks and stressors that can influence important well-being outcomes: (1) food production, (2) income, (3) asset dynamics, (4) labor, (5) natural resources, and (6) cooperation.

Well-Being Outcomes

Well-being outcomes include (1) food and nutritional security, (2) environmental security, (3) gender equality, (4) health, and (5) quality reproductive health as five final outcomes affected by the interaction of climate shocks and stresses with various responses to these challenges at different scales. Five interrelated "environments" mediate these outcomes: (1) the food environment, (2) the social/work environment, (3) the health environment, (4) quality reproductive health services, and (5) the living environment. The food environment encompasses the availability of food, the quality of diets, access to food (including both market access and affordability), and the stability of the food supply over time. The social/work environment involves shifts in the livelihood roles and responsibilities of men, women, and children. The health environment includes health stresses, control and prevention of epidemics and infectious disease outbreaks, and healthcare practices and infrastructure. Quality reproductive health services focus on ensuring effective emergency obstetric care, addressing unmet needs of family planning, and implementing the Minimum Initial Service Package for reproductive health in crises and beyond. The living environment includes changes in the availability and quality of natural resources as well as the physical infrastructure, such as health centers, schools, shelters from disasters, and sanitation systems.

Importantly, considerable linkages, trade-offs, and synergies occur among environments, development outcomes, time frames, and groups of people. For example, practices that improve food availability and access in the food environment through the increased use of chemical fertilizers or pesticides may have negative implications for environmental outcomes, such as water quality. In terms of trade-offs over time, some responses to climate shocks and stressors may yield short-term benefits that have negative implications for future resilience. For example, selling assets to meet consumptive demands following a climate shock may improve nutritional status in the short term but have negative implications for long-term availability of and access to food. Moreover, differences occur in terms of how the costs and benefits of the chosen response options are distributed among different groups of people.

CLIMATE RESILIENCE FRAMEWORK



Note: NRM = natural resource management.

*Under GCAN, the International Food Policy Research Institute, with input from USAID and its implementing partners, developed a conceptual framework (Bryan et al. 2017a) that integrates climate resilience, gender, and nutrition. The purpose of the framework is to identify and describe key elements of climate resilience while highlighting its linkages with gender and nutrition.

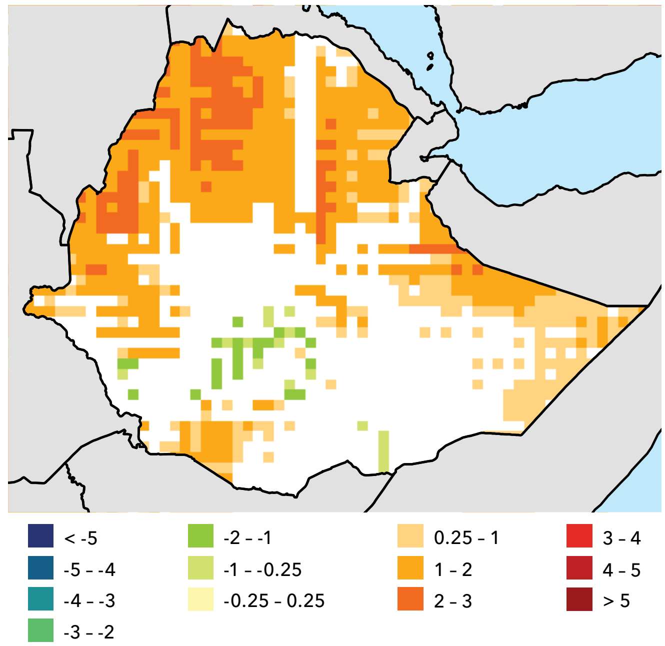
Source: Bryan et al. (2017b).

about 1.3°C between 1960 and 2006, and minimum temperatures increased more than maximum temperatures over the past decade. The rise in temperature is more pronounced in May and June. Conway and Schipper (2011) showed year-round warming in all regions of Ethiopia, with an annual warming of 1.2°C (range of 0.7°C–2.3°C) by the 2020s and of 2.2°C by the 2050s (range of 1.4°C–2.9°C), resulting in increased frequency of heat waves and higher rates of evaporation. The expectation is that rising temperatures will lead to more frequent extreme weather events. In fact, parts of Ethiopia have already experienced substantial warming of temperatures (Figure 2).

EL NIÑO–SOUTHERN OSCILLATION EVENTS SINCE THE 1980S

Several studies have illustrated the relationship between annual rainfall and El Niño–Southern Oscillation (ENSO) events in Ethiopia (Haile 1988; Attia and Abulhoda 1992; Nicholls 1994; Eltahir 1996). The anomalies of sea surface temperature in the South Atlantic and Indian Oceans, exacerbated by anthropogenic activities, impacted the rainfall supply in the country in the 1980s (Haile 1988; Wolde-Georgis 1997). Haile (1988) discussed the occurrence of drought in northern Ethiopia associated with deviations from rainfall every 3 to 5 years, whereas it was every 8 to 10 years for the whole country. Wolde-Georgis (1997) described ENSO years as having heavy *belg* rains and declines in *kiremt* rains. Furthermore, Attia and Abulhoda (1992) and Eltahir (1996) showed that ENSO reduced the flow of the Nile River, whose tributaries supply 85 percent of water in the highlands of Ethiopia, resulting in drought conditions in both 1986/87 and 1987/88. Nicholls (1994), Webb and von Braun (1994), and Ayalew (cited in Wolde-Georgis 1997) described famines associated with these drought periods. A 1984 drought hit an extensive area ranging from northern and central to eastern Ethiopia, thus impacting a large number of people (Singh et al. 2016). The 2015/16 drought covered similar areas (Figure 3) and showed an even larger precipitation decline than the 1984 drought.

FIGURE 2 CHANGE IN MEAN DAILY MAXIMUM TEMPERATURE (ºC) BETWEEN 1980 AND 2010 IN HOTTEST MONTH OF YEAR

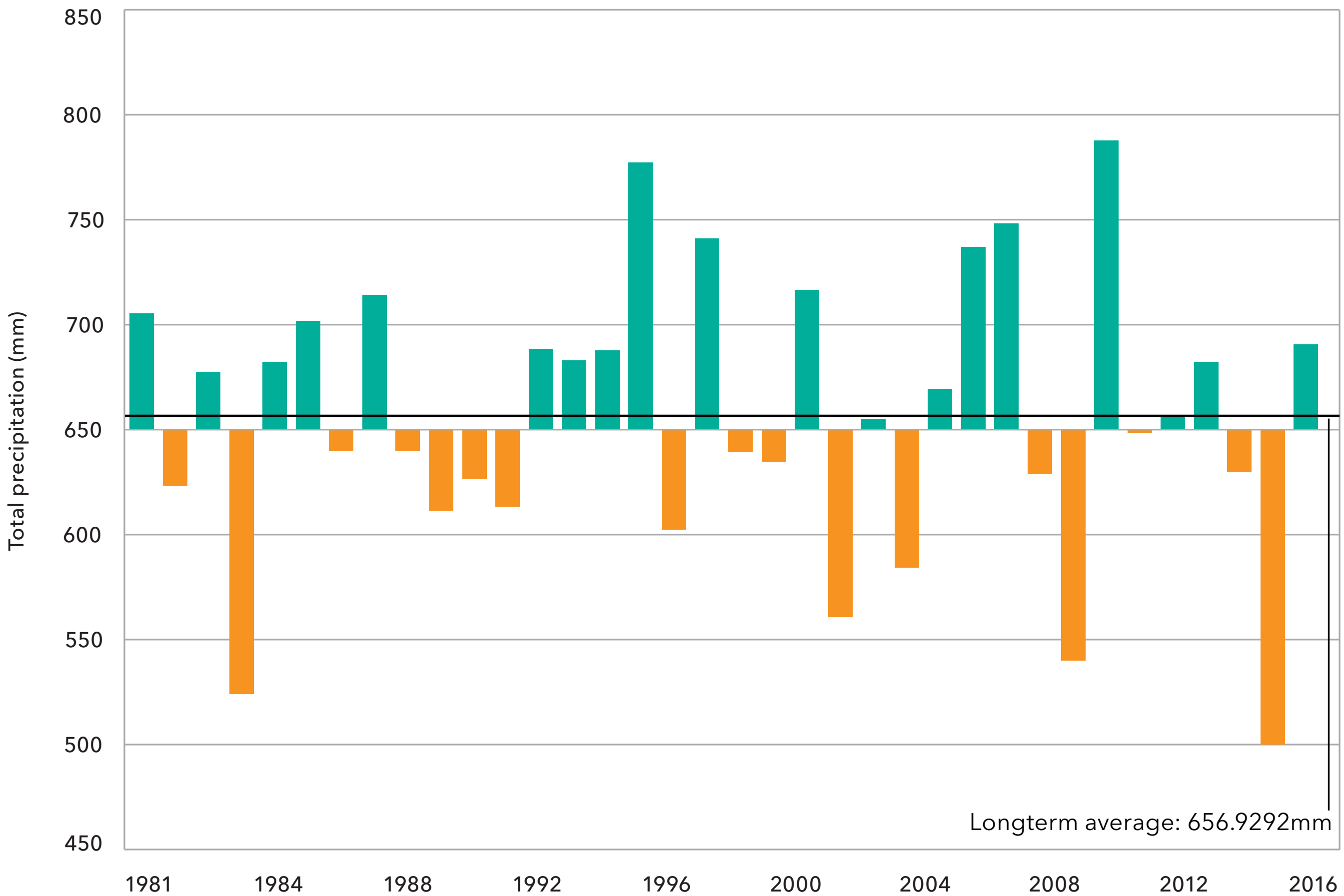


Source: Map generated from data provided by NASA (2019).

Note: Cells that show no significant trend at 10% significance level are masked out.

In 2015, the NMA of Ethiopia announced the failure of belg rains, followed by a severe delay and erratic pattern of kiremt rains (Singh et al. 2016), which resulted in the worst drought in 50 years (Davison 2015). Figure 4 maps this precipitation decline—only 50–75 percent of historical rainfall was received in the northern, central, and eastern parts of Ethiopia. Failed belg and delayed/erratic kiremt rains caused acute and widespread crop failure, asset depletion, and food insecurity, as well as acute malnutrition. More than 10 million people needed food relief in addition to the 7.9 million people already under the country's Productive Safety Net Programme (PSNP) (USAID 2016). It was also reported that approximately 6 million children were at risk from hunger, disease, and lack of water because of the El Niño-related drought (UNICEF 2016). Approximately 450,000 children were expected to be treated for

FIGURE 3 DEPARTURE FROM AVERAGE PRECIPITATION IN DROUGHT AREAS, 1981–2016



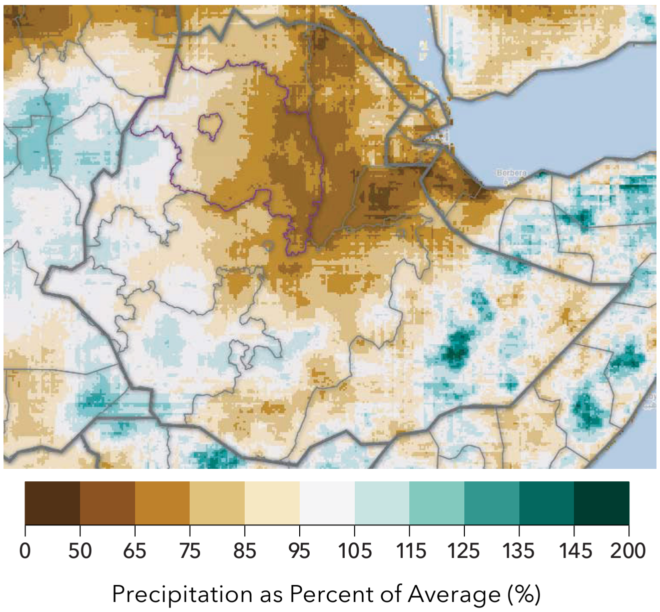
Source: Singh et al. (2016), using Climate Hazards Group InfraRed Precipitation with Station data (http://chg.geog.ucsb.edu/data/chirps/).

Note: Affected drought area: Continuous northern, eastern, and central Ethiopia with precipitation deficit of at least 15 percent during historical period, 1981-2016, February 1 to September 1.

severe acute malnutrition, and a further 2.2 million children and pregnant and lactating women for moderate acute malnutrition. The failure of the 2015 belg rains particularly affected smallholder farmers and pastoralists in the northeastern Afar and northern Somali Regions (OPM and HESPI 2018). In addition to the impacts of water shortages for agriculture and livestock activities, the El Niño drought affected domestic water supplies used for drinking, cooking, washing, and personal hygiene.

In response to the failure of rains, the government began to scale up food assistance and responded relatively quickly to the drought beginning as early as July 2015 in some areas (USAID 2016; OPM and HESPI 2018). Response funds were sourced from several development and resilience budgets. According to the country's Humanitarian Requirements Document (UNOCHA Ethiopia 2016), the National Disaster Risk Management Commission and the World Food Programme would mobilize funds to cover 7.6 million people, while the Catholic Relief Services–led Joint Emergency Operation would cover the needs of 2.6 million people. Several other groups increased or redirected investment.

FIGURE 4 PRECIPITATION FROM FEBRUARY 1 TO SEPTEMBER 15, 2015 (BELG AND KIREMT SEASONS) AS A SHARE OF LONG-TERM AVERAGE PRECIPITATION



Source: Singh et al. (2016), using Climate Hazards Group InfraRed Precipitation with Station 4.8-km (1/20-degree) precipitation dataset (http://chg.geog.ucsb.edu/data/chirps/).

Note: Long-term average is 1981-2014.

In July 2015, US$143,761 of funds from the Office of Foreign Disaster Assistance of the United States Agency for International Development (USAID) were provided to GRAD (the former Graduation with Resilience to Achieve Sustainable Development program, now titled Feed the Future Livelihoods for Resilience Activity but still known by the GRAD acronym as GRAD-II) for seed and livestock activities in Guraghe Zone of SNNPR. CARE provided US$249,715 for livestock support to implementing partner Relief Society of Tigray (REST) in the Southern Zone of Tigray Region in December 2015. Furthermore, a livestock feed activity was initiated by Vétérinaires sans Frontières Germany in mid-August 2015 in three *woredas* (districts) in Afar Region using a crisis modifier (a funding mechanism designed to provide timely responses to suspected or apparent crises by development partners already operating on the ground) in a project funded by European Civil Protection and Humanitarian Aid Operations. Save the Children similarly introduced a crisis modifier into Peace for Development, a Somali Region project funded by the UK Department for International Development (DFID). In July 2015, DFID reallocated approximately $185 million toward emergency response, focusing on funding to the United Nations Humanitarian Response Fund, WASH (water supply, sanitation, and hygiene) projects under UNICEF, and the PSNP. The European Union (EU) provided approximately $68 million to the PSNP, with around $44 million released in December 2015 for use in 2016. The EU also provided $11.2 million toward therapeutic feeding programs through its nutrition program with UNICEF. By February 2016, USAID had reprogrammed $10 million of Feed the Future and water resources funds in response to the drought (USAID 2016). By March 2016, the government of Ethiopia had committed $700 million to the emergency response.

However, the full-scale humanitarian response started only several months after the failed *belg* and poor *kiremt* rainfall seasons. As a result, short-term coping mechanisms, such as large-scale sale of livestock by pastoralist communities and reductions in food intake, led to longer-term challenges, including increased malnutrition in children (OPM and HESPI 2018). The *meher* (main crop-growing season) assessment concluded that the expected harvest was far below expectations, with some regions experiencing crop losses of between 50 and 90 percent (UNOCHA Ethiopia 2016). Widespread decline in *meher* crop yields were reported from field assessments in Amhara, Tigray, and Oromia Regions. Pastoralists in Afar and Somali Regions were some of the first and hardest hit (Seaward 2016). The comprehensive response included, for the first time, child protection as a specific operational response area in the Humanitarian Requirements Document. Moreover, at *woreda* and *kebele* (district and ward) levels, specific institutional arrangements on the drought response were implemented, such as "daily follow-up," ensuring that means were put in place for distribution of food and other materials for managing the response (OPM and HESPI 2018). Interventions such as the Targeted Supplementary Feeding Programme aimed at providing nutritious food specifically to children under five and pregnant and nursing women.

THE ENABLING ENVIRONMENT

Climatic shocks do not occur in a vacuum. As described in Box 1, national policies, laws, and institutions—but also international flows of aid, foreign direct investment, trade relations, and overall stability—affect the response options to climatic shocks and stressors. One important element of the national institutional environment is land tenure. Land is important in all economies, including in largely agrarian communities where land is the largest productive asset, and particularly in those countries that undergo rapid economic and population growth. Tenure security increases incentives to invest in land, including in soil and water conservation technologies and in trees, which have longer pay-back periods than annual crops. In 1975, land in Ethiopia became public property supported by long-term use rights. In the late 1990s, the government of Ethiopia implemented its first land certification program, which was followed by a second-level land certification program in the early years of the following decade. Deininger, Ali, and Alemu (2011) found that the land rights reform increased tenure security, land-related investment, and rental market participation. Plots were registered in the names of both husband and wife, but there continued to be a gap in women's participation in land rights–related activities, suggesting that women's rights lagged behind those of men. Quisumbing and Kumar (2014) studied gender gaps in land rights in detail and found that gaps in knowledge about the land rights vested in the land certificates reduced the adoption of soil conservation practices as well as the planting of tree crops and legumes by women farmers. The authors suggested that closing the gendered knowledge gap about legal rights is an important step toward improving adoption of soil conservation technologies and other climate-smart agricultural practices.

Another element of the enabling environment worth mentioning is climatic forecasts that can help improve planning for droughts and long-term adverse climatic events, such as ENSO. Such forecasting capability has improved in recent years, allowing governments to prepare better by requesting or reserving resources for food aid, by increasing payouts and other resources as part of food safety net programs and operations, and by readying disaster relief operations. At the same time, many donors (and their taxpaying constituencies) continue to respond retroactively to climatic events, once local impacts have become known, reducing the full potential benefit of improved forecasting of adverse climatic events in low-income countries. One such forecasting group, FEWSNET (Famine Early Warning Systems Network), with more than 20 country offices, including an office in Ethiopia, issues monthly reports and 6- to 12-month forecasts of risks to food security, developed based on climate, agricultural production, food prices, trade, and nutrition information, to help decision makers and relief agencies plan and prepare for potential disasters. However, research on the adoption of climate services has shown that women are often excluded from such information. Providing information on climate change and climate-smart agriculture practices to the husband does not mean that this information will necessarily be passed on to the wife (Tall et al. 2014; Twyman et al. 2014). Thus, building resilience to climatic shock requires a gendered approach.

IMPACTS ON AGRICULTURE AND THE ECONOMY: ABSORPTIVE AND ADAPTIVE CAPACITIES

Agriculture is essential to the Ethiopian economy because it is a major contributor to economic activity and because the majority of the population is employed in this sector (Taffesse, Dorosh, and Gemessa 2012). According to data from the World Bank's World Development Indicators (World Bank 2017, based on the International Labour

Organization's ILOSTAT database as of March 2017), relative employment in agriculture increased from around 50 percent of the population in the 1990s to 60 percent in the following decade, and to 70 percent by 2015. Increasing the resilience of vulnerable people to climate stressors in agriculture is thus essential to support Ethiopia's development goals. Evidence indicates that both long-term climate change and shorter-term climate shocks such as ENSO events have negative impacts on crop and livestock production.

Crop production

Significant uncertainties persist regarding the effects of historical climate variability on agricultural productivity in Ethiopia. Although rainfall is a main determinant of crop yields, analysis of subnational rainfall and crop yield data shows a weak relationship between local rainfall and staple crop yields (Conway and Schipper 2011), suggesting that factors such as management are also important in determining crop yields. This finding is similar to that of Lobell and others (2008), who analyzed relationships between observed harvests and monthly temperature and precipitation for five regions in Africa. Relationships were significant in only 17 out of 41 cases. However, as shown later in this report, there is a clearer relationship between specific ENSO events and agricultural production, particularly during the 2015/16 El Niño (see Chapter 3).

Future changes in climatic conditions create further uncertainty. Jones and Thornton (2003) predicted that in the Ethiopian highlands surrounding Addis Ababa, maize yields might increase substantially with a changing climate, but overall yields for all main crops will essentially be unchanged. Thornton and others (2010) showed that yields of maize and beans in the tropical highland mixed systems of Africa are projected to increase, sometimes substantially, under some climate change scenarios. Kassie and colleagues (2015) showed that by 2050, maize yields in the Central Rift Valley of Ethiopia might decrease by 20 percent compared with the 1980–2009 period due to climate change. Araya and others (2015) showed that the median maize yield could increase by 1.7 percent, to 2.9 percent, during the period 2010–2039, but the range then widens from a 6.3 percent decrease to a 4.0 percent increase during 2040–2069, conditional on the model used. The Agricultural Model Intercomparison Project (AgMIP) of the US National Aeronautics and Space Administration (NASA) uses four different crop models to generate changes in yield projections under five different general circulation models (GCMs) for the period 2000–2050. Countrywide results indicate general agreement across GCMs on the types of effects expected from climate change for some crops (that is, negative for maize, wheat, sorghum, and groundnuts, and positive for rice) but some disagreement between models for other crops, such as barley, millet, and cassava (mostly negative), and for soybeans (NASA 2019).

Despite considerable climate variability, agricultural production trends in Ethiopia have been strongly positive. Overall, production of cereals has nearly doubled since 2006, and yields have grown by about 22 percent. However, national averages of staple crop yields are still at least 50 percent below on-station yields (Global Yield Gap and Water Productivity Atlas 2019), suggesting large yield gaps and potential for farmers to lift yields through changes in on-farm management, including additional use of agricultural inputs such as fertilizers and irrigation.

Nevertheless, climate variability and extremes, such as ENSO events, as well as long-term climate change, will likely put pressure on future crop yields. As a result, production capacity will be under increased stress given the projected effects of climate change, with added impacts from both biotic and abiotic stresses. The net effect is that crop yields are projected to increase but remain below a non-climate-change trajectory of yield improvements (see, for example, IFPRI 2017), with yield declines in times of climatic extremes. Moreover, climatic shocks will remain a major challenge for climate resilience and response options. Alemu, Korecha, and Mohamod (2017) analyzed the effects of historical ENSO phases from 1980 to 2014 on cereal productivity in the Upper Awash Basin (UAB), where *belg* rains account for about 183–310 mm of rain per year while *kiremt* rains contribute 465–906 mm. The authors found average cereal yield reductions of 16.0 percent and 5.3 percent due to El Niño and La Niña events, respectively, in the southern, south-eastern, and central regions of UAB, and 10.1 percent during El Niño and 9.1 percent during La Niña in the western highlands, with even higher reductions for some individual crops.

Livestock

Rain is an important source of water for herds and for growth of forage. Studies assessing linkages between livestock population and rainfall distribution (Desta and Coppock 2002; Angassa and Oba 2007; Tache and Sjaastad 2010) suggest a strong relationship—the drought years of 1984, 2000, 2002, 2009, and 2011 show comparatively high mortality rates of livestock because of feed deficiency and water scarcity. These same studies show low mortality rates of cattle, sheep, goats, and camels during the wet years of 1996, 2003, 2006, 2010, and 2014.

ENSO events (El Niño and La Niña) have become regular occurrences for pastoral communities of Ethiopia, leading to rainfall uncertainty that affects pasture/rangeland, thereby influencing livestock populations (Hassen et al. 2017; Kandji, Verchot, and Mackensen 2006; Korecha and Sorteberg 2013). Hassen and colleagues (2017) studied the effect of reduced rainfall on livestock populations in eastern Ethiopia. Results illustrate the declining cattle and sheep population during El Niño (diminishing rainfall) in Shinile Zone, whereas goats and camels, which are more drought tolerant, are better adapted to low amounts of rain. Further, mortality rates of cattle rise with declines in the mean annual rainfall (compared with normal distribution) during ENSO (Hassen et al. 2017). The long travel distance to find better grazing areas and water resources could contribute to the high mortality rates of livestock during ENSO (Hassen et al. 2017). Megersa and others (2014) described comparable outcomes in Borana pasture areas, where scarcity of grazing lands and changes in climate conditions have triggered decreasing populations and productivity of livestock. Given uncertainty in the occurrence of rainfall, pastoralists tend to settle near water sources and to use seasonal mobility and destocking as adaptation options to alleviate the detrimental effects of ENSO.

Additionally, the change in the composition of rangeland plant species from grasses to woody plants because of climate change may have impacted cattle and sheep populations more than those of goats and camels (Abebe et al. 2012). Camels and goats can consume more bushy plant species than can sheep and cattle (Abate, Ebro, and Nigatu 2010; Megersa et al. 2014). Moreover, camels are preferred by herders due to their ability to produce relatively high amounts of milk despite environmental stress, thus providing income and nutrition to herders' families (Tilahun et al. 2016; Hassen et al. 2017).

The Agriculture Knowledge, Learning, Documentation and Policy (AKLDP) Project examined the early impacts of the 2015/16 drought in North and South Wollo and Wag Himra of Amhara National Regional State (ANRS). Farming of livestock, composed of cattle, oxen, sheep, and goats, is a major source of economic livelihood in these areas. In a climate-normal year (that is, without ENSO), appropriate meat quality is achieved in the *belg* period given sufficient forage and water, commanding better prices during trading (AKLDP Project 2016). However, the lack of rain in the 2015 *belg* period reduced meat quality and production, resulting in low meat prices in North and South Wollo and Wag Himra. Livestock prices in November 2015 were more than 50 percent below those in December 2014 in the study areas of ANRS. Inferior meat quality due to poor pasture, over-supply of livestock in the markets, and the "forced" nature of sales (inability of smallholders to negotiate for better prices because traders are aware of their urgent need for cash) were some of the reasons for the low prices, as were herders' needs to align livestock numbers to lower water and feed availability (AKLDP Project 2016).

Economic growth and poverty

The impacts of climate variability go beyond crop and livestock production to the broader economy. Block and others (2008) utilized a multimarket model with detailed analysis of climate variability to assess its impact on economic growth and poverty. The results showed that climate variability significantly reduces agricultural GDP growth, and because of the importance of agriculture in the economy, this also reduces nonagricultural and total GDP growth. Importantly, poverty also increases due to climate variability, adding urgency to policies, programs, and investment to improve resilience and response to weather shocks. Analysis presented later in this report provides new estimates of ENSO's impacts on food security and the Ethiopian national economy, including losses in GDP and worsening household poverty (see Chapter 3).

A focus on enhanced resilience is particularly important in Ethiopia's dryland areas, where according to Cervigni and Morris (2016), the agriculture-dependent population is expected to grow by about 60 percent between 2010 and 2030. A major shortcoming in the evidence base or literature on ENSO and other climate shocks in Ethiopia is a lack of differentiation between lowland (largely dryland areas) and highland (more productive areas) conditions and policy needs. This report evaluates policy options in light of their effects on highland versus lowland economies and populations.

NEED FOR ACTION: GROWING VULNERABILITY IN RURAL AREAS

Expenditures on humanitarian responses in Ethiopia average US$700 million per year and spiked during 2016 in response to the extreme ENSO event. Most of the funds were spent on food security interventions. Development programs have increased their flexibility to quickly expand the reach and intensity of support during disasters, for example by expanding the quantity and coverage of cash transfers or food-for-work programs under the government's PSNP. Knippenberg and Hoddinott (2017) showed that households with access to PSNP experience fewer months of food insecurity than do households without such access. Following a reported drought shock, households with PSNP access returned faster—after around two years—to their predrought food security level, whereas households not receiving any PSNP payments did not return to their (slightly higher) predrought food security levels until four years after the drought, on average.

Rural resilience can be achieved only if infrastructure development accelerates and if investments in agricultural research and development are increased. Even today only one-half of all Ethiopian farmers use chemical fertilizers, and growth in irrigated area, though commendable, remains too low to dramatically affect resilience outcomes in the next two decades. Crop insurance is also key to building resilience against climatic shocks. However, demand for insurance among poor farmers is low due to the associated high risks and costs, as well as low trust and insufficient understanding of insurance (Dercon et al. 2014).

Achieving climate resilience in rural areas will require the generation of much faster economic livelihood options outside agriculture, which in turn will necessitate a much faster opening to and support of foreign direct investment. Clearly, the share of people employed in the agriculture sector must decrease substantially for the country to achieve middle-income status.

The question remains of how emergency responses can be better linked to ongoing development programming. The next chapter discusses this question in detail, drawing on a literature synthesis and the experiences of key informants in Ethiopia.